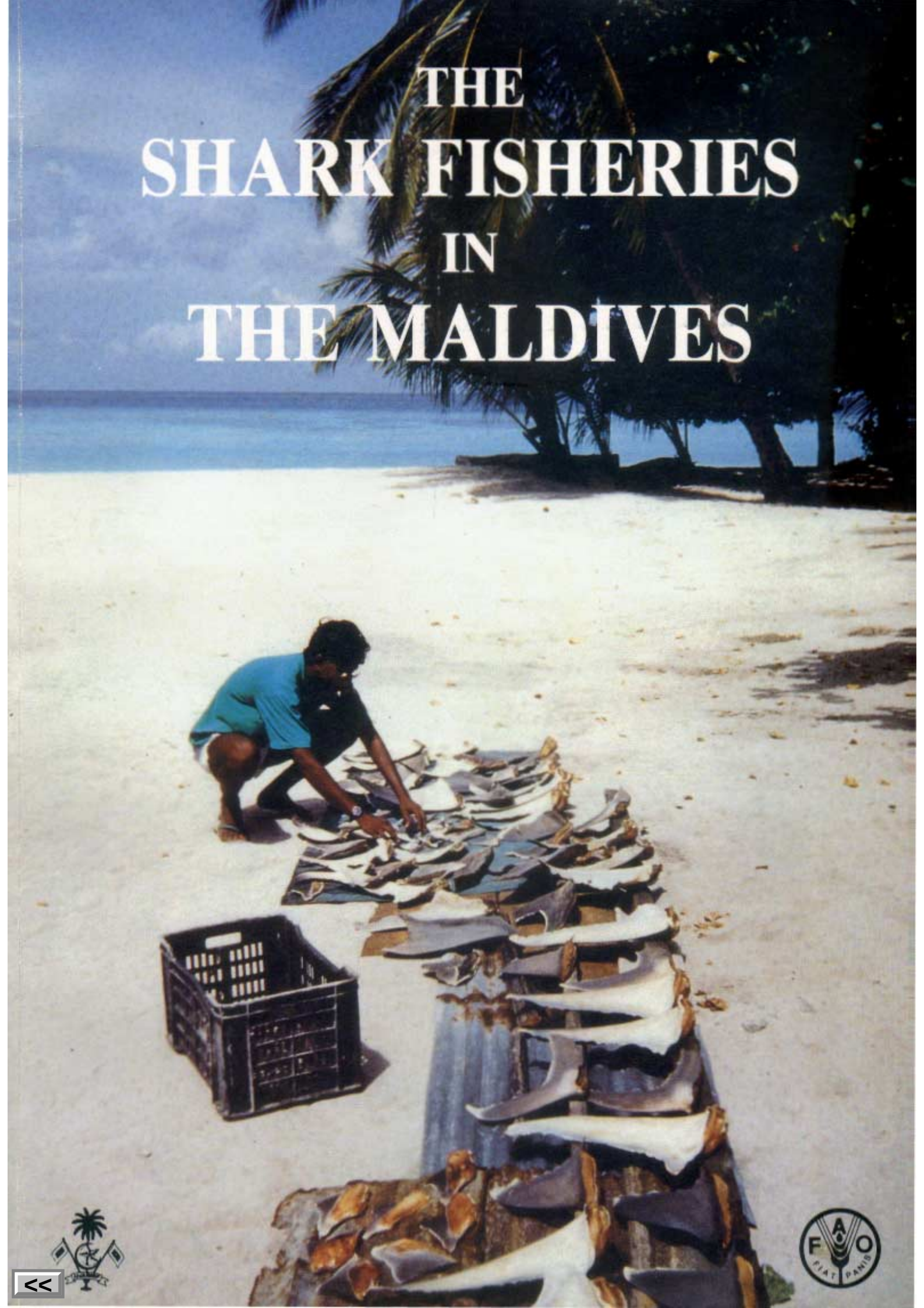
THE SHARK FISHERIES IN THE MALDIVES



The Shark Fisheries of the Maldives

A review

by

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and
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and
Food and Agriculture Organization of the United Nations.

1993

Tuna fishing is the most important fisheries activity in the Maldives. Shark fishing is one of the major secondary fishing activities. A large proportion of Maldivian fishermen fish for shark at least part-time, normally during seasons when the weather is calm and tuna scarce. Most shark products are exported, with export earnings in 1991 totalling MRf 12.1 million.

There are three main shark fisheries. A deepwater vertical longline fishery for Gulper Shark *(Kashi miyaru)* which yields high-value oil for export. An offshore longline and handline fishery for oceanic shark, which yields fins and meat for export. And an inshore gillnet, handline and longline fishery for reef and othe'r atoll-associated shark, which also yields fins and meat for export. The deepwater Gulper Shark stocks appear to be heavily fished, and would benefit from some control of fishing effort. The offshore oceanic shark fishery is small, compared to the size of the shark stocks, and could be expanded. The reef shark fisheries would probably run the risk of overfishing if expanded very much more.

Reef shark fisheries are a source of conflict with the important tourism industry. 'Shark-watching' is a major activity among tourist divers. It is roughly estimated that shark-watching generates US $ 2.3 million per year in direct diving revenue. It is also roughly estimated that a Grey Reef Shark may be worth at least one hundred times more alive at a dive site than dead on a fishing boat. Various recommendations are made for the resolution of conflicts between the tourism industry and shark fishermen. Recommendations on other issues are also made in this review, which was undertaken with the assistance of FAO through their Technical Cooperation Programme (project TCP/MDV/2252).

The FAO Representative for Shri Lanka and Maldives, Mr. p. Humans, greatly facilitated the implementation and execution of this project. The Hon. Abbas Ibrahim, Minister of Fisheries and Agriculture, Republic of Maldives, was instrumental in initiating and then encouraging this study throughout. The review was undertaken with the enthusiastic assistance of the Marine Research Section (MRS) under Messrs. Maizan Hassan Maniku and Ahmed Hafiz. Messrs. Ali Waheed, Ahmed Shareef, Hussein Zahir, Ibrahim Nadheeh and Mohamed Faiz assisted with field work. Mr. Ibrahim Nadheeh word-processed the manuscript of this report. Assistance was also received from Messrs. Adam Shakir, Shaheem Razee, Frank Siciliano and Ahmed Arif.

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RECOMMENDATIONS

The following is a summary of the recommendations made as a consequence of this review of the shark fisheries in the Maldives:

* MOFA should encourage private fishing businesses to develop offshore shark longlining using small vessels;
* Newly developed commercial shark longlining operations to be restricted to fishing beyond a certain distance offshore;
* Information on current status of Gulper Shark fishery to be broadcast, in order to minimize further investment in the fishery;
* Economic options to be considered to regulate the Gulper Shark fishery;
* Use of gilinetting within the tourism zone to be reviewed, and the banning of shark gilinetting in some atolls to be considered;
* Fish Head in An Atoll to be considered for protection from all types of fishing, but particularly shark fishing;
* Ministry of Tourism to draw up a list, of priority dive sites for protection;
* Landing of shark at night by fishing resort tourists to be banned;
* All fishing of Whale Shark to be banned;
* MRS staff to be trained in fishery stock assessment and management; and
* Extension material to be prepared for the fishermen, giving details of proper processing techniques, the potential of offshore longlining, and the problems of the shark fisheries.

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CONTENTS

AKEY

Abbreviations

Abbreviations used in this report include:

CIF	Cost, Insurance, Freight (import price)
FAO	Food and Agriculture Organization of the United Nations
FL	Fork length
FOB	Free on board (export price)
IUCN	The World Conservation Union
LOA	Length overall
MATI	Maldives Association of Tourism Industry
MOFA	Ministry of Fisheries and Agriculture (MOF, earlier)
MPE	Ministry of Planning and Environment
MRf	Maldivian Rufiyaa
MRS	Marine Research Section of MOFA
SAM	Scuba Association of Maldives
STO	State Trading Organization
TL	Total length
Uss	United States Dollar

Exchange Rates

Exchange rates for 1983 to 1991 were:

1983	US$ 1	=	MRf	7.00	1988	US$ 1	=	MRf 8.78
1984	US$ 1	=	MRf	7.05	1989	US$ 1	=	MRf 9.04
1985	US$ 1	=	MRf	7.10	1990	US$ 1	=	MRf 9.51
1986	US$ 1	=	MRf	7.15	1991	US$ 1	=	MRf 10.32
1987	US$ 1	=	MRf	9.22	1992	US$ 1	=	MRf 11.00 (appx.)

Source: MPE, 1992

Units of Measure

Units of measurement as used by Maldivian fishermen, in old records and elsewhere, include:

1	*kaivah*	=	9 inches		
1	*muh*	=	18 inches		
1	*riyan*	=	27 inches		
1	*bama*	=	one arms' span = 72"	=	1.83 m
1	*udubama*	=	height of man's reach = 90"	=	2.29 m
1	foot (1')	=	12 inches (12")	=	0.3048 m
1	nautical mile (nm)	=	1852 m		
1	*adubaa*	=	1.12 litres (1)		
1	gallon	=	8 pints	=	4.546 litres
1	hundredweight (cwt)	=	112 pounds (lb)	=	50.9 kg
1	metric tonne (t)	=	1000 kilograms (kg)		

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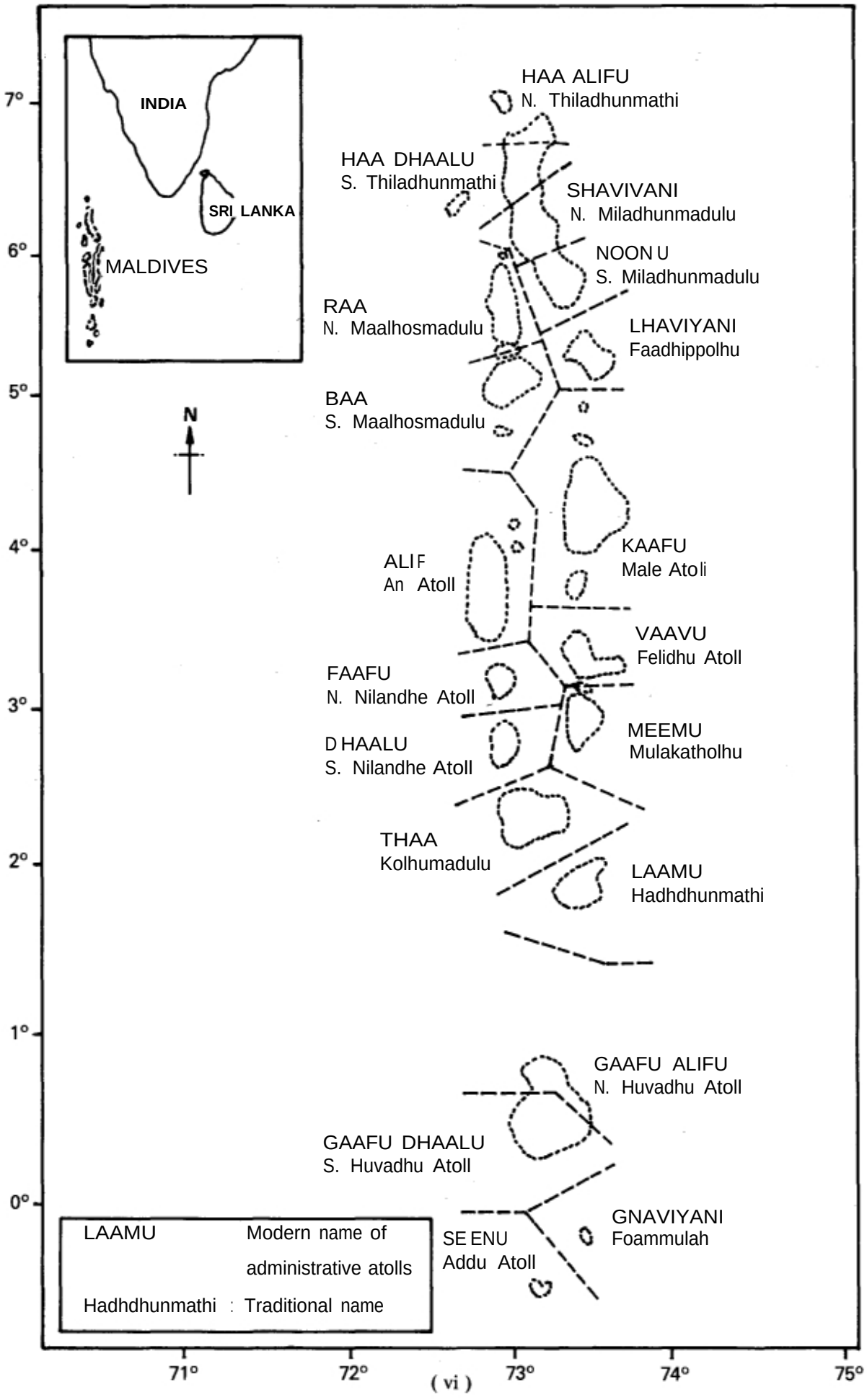
Fig 1: Map of the Maldives



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1
INTRODUCTION

1.1 *Background*

Over the last 15-20 years, the economy of the Republic of Maldives has undergone rapid expansion and diversification. The traditional tuna fishery, although still very important, is no longer the only major economic force in the country. New economic sectors, notably tourism, have developed. Within the fisheries sector itself, new fisheries have evolved. The most important of these are the shark fisheries. Most of the Maldivian shark catch is exported, and in 1991 export earnings from shark products were US$ 1.17 million (MRf 12.1 million).

In general, shark grow slowly, mature late, have small numbers of young and live for many years. 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 stocks are very easy to overfish. These same factors also mean that shark stocks, once overfished, may take years, even decades, to recover. Shark fisheries, therefore, require particularly careful monitoring and management, if economic returns are to be maximized in the long term (Holden, 1974, 1977; Bedford, 1987).

Recently, a number of serious problems affecting the Maldivian shark fisheries have come to light. These include suggestions of overfishing of the valuable deepwater Gulper Shark (or Spiny Dogfish) resource; conflict between fishermen catching shark and those targeting other resources; and complaints from the tourism industry about the reduction of shark numbers at particular 'shark diving' sites. Overfishing and/or unresolved conflicts between resource users could potentially result in considerable loss of income to poor fishermen. The removal of shark from popular diving sites could potentially result in enormous loss of income to the tourism sector (which is now the major contributor to GDP and to revenue for Government social development programmes).

The Ministry of Fisheries and Agriculture of the Maldives recognized the urgent need to assess and resolve these problems. It, therefore, requested assistance from FAO in carrying out a review of the current status of the Maldivian shark fisheries and in making recommendations for their management. This report presents the findings of that review, carried out from July 18 to November 17, 1992, and the recommendations.

1.2 *Development of the Maldivian shark fisheries*

Although justly renowned for its tuna fishery, Maldives has also had a minor shark fishery for centuries.

Maldivian boats *(dhonis)* are made of wood and, naturally, require regular maintenance to keep them in good condition. *Dhonis* are hauled up onto the beach every two weeks or so for their hulls to be cleaned and painted with shark liver oil. The interiors of the *dhonis* are soaked with oil every few weeks. With a national fleet of 4000-5000 vessels, there has long been a substantial demand for shark liver oil.

To fill that demand for oil there was a traditional shark fishery, known as *maa keyolhu kan* (literally, big line fishing). This targeted large Tiger Shark, which have enormous livers, and used gigantic locally made hooks. Similar hooks were also used to catch two other species with enormous livers, namely Whale Shark and Bluntnose Sixgill Shark. (A list of Maldivian shark, with scientific, English and Dhivehi names is given in Appendix II.)

This ancient pattern of shark fishing started to change in the early 1960s, with the introduction of longlining. The entry of Japanese tuna longliners into the central Indian Ocean, and the opening of a boatyard on Hulhule, which built small work boats, including some for longlining (Saleem, 1987), were the triggers for this development. Shark longlining started to spread through Maldives, replacing *maa keyo!hu kan* in the process.

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The next big change came in the mid-1970s with the widespread motorization of fishing craft, the introduction of gillnetting, and an increase in prices paid for shark fins. This led to a boom in shark catches which has been maintained since.

Along with development of new fishing techniques came developments in the utilization of shark products. Slowly the emphasis changed from a fishery for oil, in which fins might be valuable by-products, to a fishery driven by the high prices paid for fins, in which salt-dried meat is a valuable by-product and oil has only nominal value. In fact, less than half of all Maldivian fishermen now use shark oil for treating their boats: most use fish or coconut oil.

The final major development came in 1980. Japanese buyers visited the Maldives looking for a supply of high-value shark oil, rich in squalene, for use in cosmetics and pharmaceuticals. A small multihook handline (vertical longline) fishery soon developed for the deepwater Gulper Shark from which this oil is obtained.

Thus, by the beginning of the 1980s the current pattern of shark fishing had been established:

- Longlining and some handlining for oceanic shark;
- Gillnetting plus some handlining and longlining for reef shark; and
- Multihook handlining for deepwater shark.

2
Methods

Information presented in this review was obtained in two ways. First, all available information on shark fishing at the Ministry of Fisheries and Agriculture (MOFA) was reviewed. Major sources of information proved to be the reports of three fishing surveys:

- Exploratory offshore fishing survey (Anderson and Waheed, 1990), off the east coast of Maldives carried out aboard the chartered vessel *Matha Hari,* in the zone 30-100nm offshore from December 1987 to November 1988.
- Reef fish resources survey, phase 1 (Van der Knaap *et al.,* 1991) carried out aboard R.V. *Farumas* in N. Male Atoll from September 1987 to November 1988.
- Reef fish resources survey, phase 2 (Anderson *etal.,* 1992) carried out aboard R.V. *Farumas* in Shaviyani, Alifu, and Laamu Atolls from September 1989 to July 1991.

In addition, original data files maintained at the Marine Research Section (MRS) of MOFA and containing much information relating to shark biology, were used. Other information held at MOFA included records of export data compiled by the Department of Customs; information on a wide range of fishing gear, much of which had been published by MRS (1991); an unpublished summary report (Anon, 1985) of an exploratory offshore longline survey carried out aboard the R.V. *Miyavaali* from May 1983 to April 1984; and MOFA's annual fisheries journal *Rasain.* The latter contains several articles relating to shark fisheries, mainly in Dhivehi and notably by Ibrahim (1988, 1991), and a list of fishing activities carried out on a large number of islands (MOF, 1986-1988), which, although compiled in 1984-86 and now somewhat out of date, is still a useful source of information. MOFA has also published four volumes of a *Catalogue of Fishes of the Maldives.* Simple identification sheets, together with some additional information, are given for 16 species of shark in Vol.3 (MRS, 1988) and for 11 more shark in Vol.4 (MRS, 1992). The latter material was compiled during this survey.

The second major source of information was a series of interviews in July-November 1992 with people connected in some way with shark resources. Those interviewed included Government officials, businessmen, tourism industry representatives, 32 diving instructors (with an average of six years experience in the Maldives), and fishermen in over 50 islands (Appendix I).

Fishing islands in all administrative atolls except three (Gaafu Alifu, Gaafu Dhaalu and Foa Mulah) were visited. Fishermen were generally interviewed in groups of 2 - 4. Pictures in Compagno *et al.* (1989) were used as an aid to shark identification when talking to fishermen. Compagno (1984) and Bass *et al.* (1973-76) were used to identify shark specimens, In addition, a questionnaire on shark fishing activity was distributed on all fishing islands by MRS in May 1992. Replies were received from 170 islands by mid-November 1992 (Table 1).

Table 1 : Distribution of shark fishing activity in the Maldives
(Summary results from shark survey questionnaire sent to all fishing islands)

Atoll	No. inhabited islands	No. responses to questionnaire	No. islands with no shark fishing	Number of islands involved in shark fishing									
				Bottom-set gilinetting		Bottom-set longlining inside atoll		Drift longlining outside atoll		Gulper Shark fishing		Others	
				P/T	F/T	P/T	F/T	P/T	F/T	P/T	F/T	P/T	F/T
Haa Alifu Atoll (HA.)	16	14	6	4	—	2	—	3	—	5	—	3	—
Haa Dhaalu Atoll (HDh.)	17	9	3	3	—	2	—	4	—	3	1	3	—
Shaviyani Atoll (Sh.)	15	15	7	2	—	4	—	4	1	5	2	4	—
Noonu Atoll (N)	14	13	6	3	—	1	—	2	1	3	—	2	—
RaaAtoll(R)	16	15	10	3	—	3	—	3	—	2	1	2	1
Baa Atoll (B)	13	12	5	4	—	3	—	5	—	—	—	4	—
Lhaviyani Atoll (Lh.)	4	4	3	—	—	1	—	—	—	—	1	—	—
Kaafu Atoll (K)	9	8	6	—	—	1	—	1	—	—	—	2	—
Alifu Alifu Atoll (A.A.)	8	8	1	1		3	—	5	2	2	—	5	—
Alif Atoll (A)	10	10	3	4	—	3	—	3	2	1	—	3	—
Vaavu Atoll (V)	5	5	4	—	—	—	—	1	—	1	—	1	—
MeemuAtoll(M)	9	9	3	3	—	4	—	3	—	1	—	4	—
FaafuAtoll(F)	5	5	2	2	—	2	—	3	—	1	—	2	—
Dhaalu Atoll (Dh.)	8	8	2	3	1	3	—	3	2	3	—	5	—
Thaa Atoll (Th.)	13	12	5	4	1	3	1	3	1	3	2	4	—
Laarnu Atoll (L.)	12	4	3							1	—	—	—
Gaafu Alifu Atoll (GA)	10	8	5	1	—	1		1	1	1	—	2	1
Gaafu Dhaalu Atoll (G.Dh)	10	5	1	2	—	1	—	2	—	3	1	1	—
Gnaviyani Atoll (On)	1	1	—							1	—	—	—
Seenu Atoll (Addu/S)	5	5	3	1		—	1	1		1		1	1
TOTAL	200	170	78	40	3	37	3	47	10	37	9	48	3

(P/T = Part-time; F/T = Full-time)

3
The Shark Fisheries

3.1 *Fishing craft*

Shark fishing in the Maldives is carried out from the usual range of Maldivian fishing boats. There are no traditional, specialized boats for shark fishing.

A brief description of Maldivian fishing craft is given in MRS (1991), and a detailed account is given by Shafeeq (1991). The three main types of Maldivian fishing boats are the *masdhoni*, *vadhudhoni* and *bokkura*. All are open wooden craft. *Masdhonis* are about 10-1 Sm length overall (LOA), *vadhudhonis* are about 5-8m LOA and *bokkunas* are about 2-3m long. *Masdhonis* and *vadhudhonis* were, traditionally, sailing craft. Motorization of *masdhonis* started in 1974, and now almost all *masdhonis* active in fishing have had marine diesel engines of 22-33 hp installed. Motorization of *vadhudhonis* started much later, but is now becoming quite widespread, with

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12 hp marine diesel engines being particularly popular. *Bakkuras* are rowing boats, but some, particularly in Male, are now equipped with small outboard motors.

Shark fishing was very much a part-time activity in the past; only one or two trips to catch large shark for their liver oil were, perhaps, undertaken every year. This was usually done during periods when tuna fishing was poor and/or there was no wind to sail to the tuna fishing grounds. Shark fishing, therefore, often involved rowing to the chosen fishing site.

In recent years, with motorization and the development of export markets for shark products, there has been some specialization of vessels in shark fishing. The majority of shark fishing is still carried out part-time from *masdhonis* and *vadhudhonis* that are engaged in tuna, or other, fishing most of the time. However, there are two types of shark fishing that are carried out full-time by some fishermen using intermediate-sized, motorized fishing craft.

Full-time shark gillnet fishermen tend to use small masdhonis (9-10m LOA). These have non-permanent shelters erected midships, often some plastic tubing over one gunwhale as a runner for the net, and temporary brine tanks rigged in one of the hull compartments; they are otherwise unmodified. Full-time deepwater shark multihook handline fishermen tend to use large mechanized *vadhudhonis* (7-9m LOA) that have not been specially modified for shark fishing.

The number of fishing craft *(masdhonis* and *vadhudhonis* combined) reported to be engaged in shark fishing in 55 islands visited during this survey are listed in Appendix I. The number of islands engaged in shark fishing in each atoll, as recorded by the island offices in the Shark Fishery Survey questionnaires, is given in Table 1.

Combining the two sets of information allows the approximate number of vessels engaged in the three major shark fisheries to be estimated, as follows:

Shark longlining	(full-time)	13
(bottom-set and drift)	(part-time)	424
Shark gillnetting	(full-time)	47
(bottom-set)	(part-time)	372
Deepwater multihook handlining	(full-time)	31
	(part-time)	274

Many other boats engage in different types of shark-fishing (particularly handlining), at least part-time. In 1991, MOFA (1992) recorded that there were 2680 *vadhudhonis* and *1754* motorized *masdhonis,* of which *352* and 1252 respectively – 1604 in all – were actively engaged in fishing. Given these numbers, it is clear that some shark fishing is carried out by a large proportion of all active fishing vessels. In fact, over half of all islands report some form of shark fishing activity. Shark fishing, thus, is an important part-time activity, and a major source of income at times when other fishing activities are poor.

3.2 *Shark fishing methods and gear*

There are at least ten different methods of shark fishing employed in the Maldives, and these are outlined below. For further details, see MRS (1991). At present, the most important methods used are pelagic drift longlining, bottom-set gilinetting, deep multihook handlining, and simple handlining.

TIGER SHARK FISHING *(Maa keyolhu kan)*

Maa keyolhu kan is the traditional Maldivian fishery for big Tiger Shark. This fishery has been described by Didi (1983) and Ibrahim (1991). Presumably dating back hundreds of years, it was developed to meet the demand for crude shark liver oil for wooden boat maintenance. The main target was large Tiger Shark, since these shark have enormous livers.

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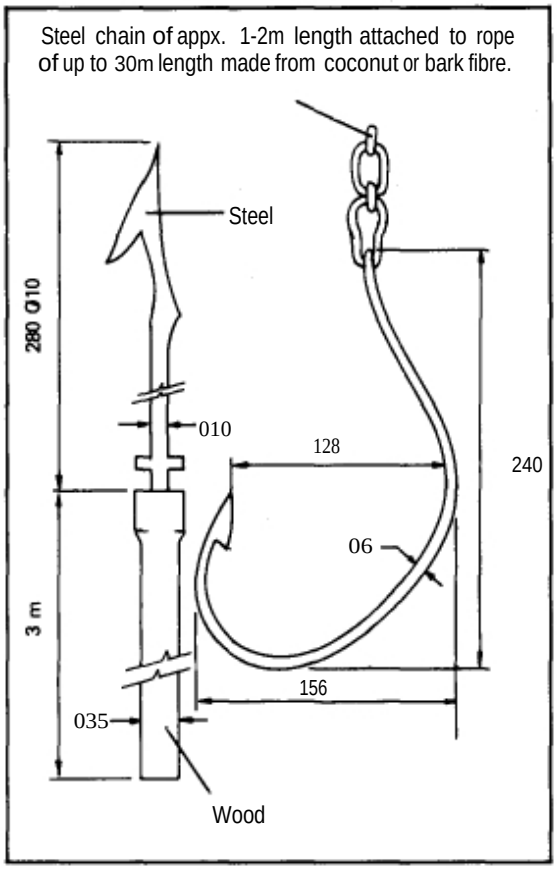
Dolphins were the preferred bait, although turtle, Manta Ray and octopus were also used. Two or three dolphins would be harpooned and then kept for a day or two to let them start rotting. The fishing boat (usually a sailing *masdhoni,* but sometimes a *vadhudhoni)* would then move to the chosen fishing site. Most atolls have one or more sites that are traditionally known to be good for Tiger Shark fishing. These are usually in areas of strong current, such as near a channel. Such sites are mostly inside the atolls, so the fishing boat would anchor, but in some cases *maa keyolhu kan* would be carried out while drifting outside the atolls. The bait would be suspended just above the water so that blood and decaying flesh dripped slowly into the sea. Once shark were attracted to the boat very heavy fishing gear (massive iron hooks with chain leaders and heavy harpoons, Figure 2) were used to catch and land them. Shark of 2-4m length were commonly caught by this method, but very large Tiger Shark, of up to 6m, were occasionally taken.

Since *maa keyolhu kan* was an ancient, and not entirely risk-free, occupation, there were many superstitious beliefs and rituals associated with it. *Maa keyolhu kan* has died out since the introduction of longlining in the early l960s.

Fig. 2. Hook and harpoon used in ***maa keyolhu kan*.*** the traditional Tiger Shark fishery (after MRS, 1991).
Note : All dimensions in mm unless otherwise stated.
* This fishery is now extinct in the Maldives.



SIXGILL SHARK FISHING *(Madu miyaru keyolhu kan)*

Madu miyaru keyolhu kan was a modification of *maa keyolhu kan.* Like *maa keyolhu kan,* it was a traditional fishery for large shark with large livers. However, in this case, the target was large deepwater shark, particularly the Bluntnose Sixgill Shark, *Hexanchus griseus (madu miyaru).*

The same single massive hook used for *maa keyolhu kan* was employed, but with a steel rod leader in three or four sections, not a chain one (photo page 13). The reason for this was that the gear was locally manufactured by hand, and it was difficult and time-consuming for a blacksmith to make a chain. A strong chain was necessary to catch Tiger Shark, but not for weaker Sixgill Shark.

The hook was baited with whole fish, usually reef fish, and set in 250m or more on the outer atoll slope. Fishermen judged the best place to fish by counting the number of oar strokes (typically 50-100) out from the edge of the outer atoll reef dropoff. The hook was sent to the bottom with a large coral boulder. The boulder was tied to the hook with a length of coconut or bark fibre rope *(roanu* or *vaká);* this was cut through by the shark once it took the bait. Bark fibre rope was traditionally used as the mainline in this fishery, but, in recent times, kuralon, polypropylene or even monofilament nylon lines have been used. This fishery has all but died out in the last few years and has been replaced by *kashi miyaru keyolhu kan* (deep multihook handlining for Gulper Shark).

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GULPER SHARK FISHING *(Kashi miyaru keyolhu kan)*

Kashi miyaru keyolhu kan is a multihook handliné (vertical longline) fishing technique for deepwater shark. It is a direct modificatioh of *madu miyaru keyolhu kan.* Instead of one massive hook, several small hooks are used. The target is Gulper Shark *(Centrophorus* spp.), known locally as Spiny Dogfish or *kashi miyaru.*

Several gear variations have been used, but the arrangement in most widespread use at present is illustrated in Figure 3 (see facing page). Typically, 6-8 small (no.6 or 7) circle hooks are used, attached by 20-40cm wire leaders to the mainline. The hooks are baited with cut fish. Small luminous beads may be threaded on the leaders. The mainline is usually 4mm polypropylene. This is available locally in 220m rolls; 2-5 rolls are used. The line is set in 250-800m depths on the outer slopes. Fishing is normally carried out by night, but depths below about 500m can be fished by day. The line is sent to the bottom with a coral boulder or sandbag, weighing about 30-40kg. This can be released prior to hauling by a sharp tug from the fishermen. Hauling is by hand.

One to four lines may be operated simultaneously, depending on conditions and boat size. The line operated from the bows will often be thicker than the others and have a heavier weight attached, as it is this line that holds the vessel during fishing. Lines are hauled when fish are felt, or after about two hours.

With some 300 vessels operating at least part-time in this fishery (see Section 3.1) there may be several hundred tonnes of coral rock being moved from shallow reefs to deep slopes every year.

In a few places, where the outer atoll reef drops away very steeply *(e.g.* to the east of Laamu Atoll), fishermen are able to anchor in 10-20m and fish in about 400m.

Fishing can be carried out from *masdhonis* or *vadhudhonis.* Typically they leave their islands around midday to collect coral boulders and bait, proceed to the fishing area outside the atoll before dark; and return to their islands between 0800 and 1000 the next day.

DRIFT LONGLINING

Drift longlining is a popular fishing technique for pelagic shark. Tuna and bilifish can be an important by-catch.

The gear is illustrated in Figure 4 (see facing page). Typically, one buoy is used for every five branchlines (one basket). If deeper-swimming species are targeted (notably the Bignose Shark — *Carcharhinus altimus)* one buoy may be used every ten branchlines. Square type tuna hooks (nos. 5, 6 or 7) are usually used, with cut fish bait.

Drift longlining is carried out outside the atolls, overnight. Two-night trips are sometimes made, but one-night trips are more usual. Thirty to 150 hooks (6 to 30 baskets) are deployed, depending on bait availability and vessel size.

Shark gilinetting *dhonis* will often anchor overnight on the outside of the atolls. If the currents and weather conditions are suitable they may stream 1-30 hooks on a surface longline astern (offshore) from the vessel.

BOTTOM-SET LONGLINING

Longlines of similar construction to the drift longline illustrated in Figure 4 are sometimes deployed as bottom-set longlines within the atolls. Typically, only 30-40 hooks are deployed. Anchors are attached at both ends of the mainline. Surface buoys may be used every five branchlines, the lengths of which are adjusted as required to keep the hooks just off the bottom. Cut fish is used as bait. Target species are reef- and atoll-associated sharks.

Fig. 3. Multihook handline for Gulper Shark ***(kashi miyaru keyolhu kan)*** (after MRS. 1991).

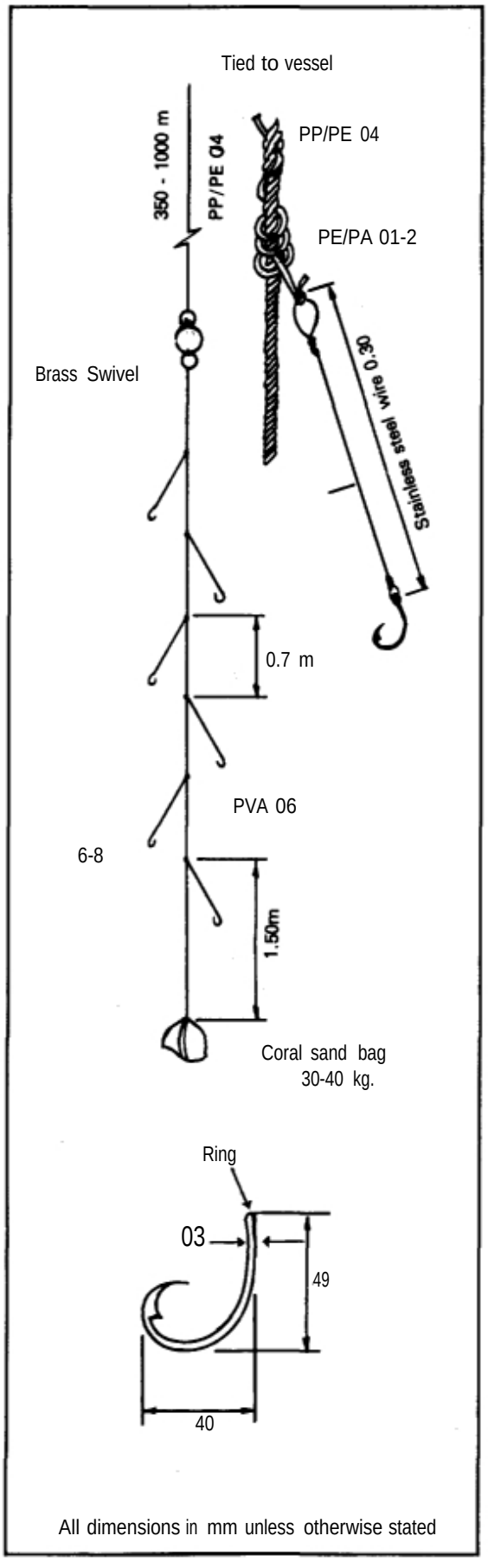
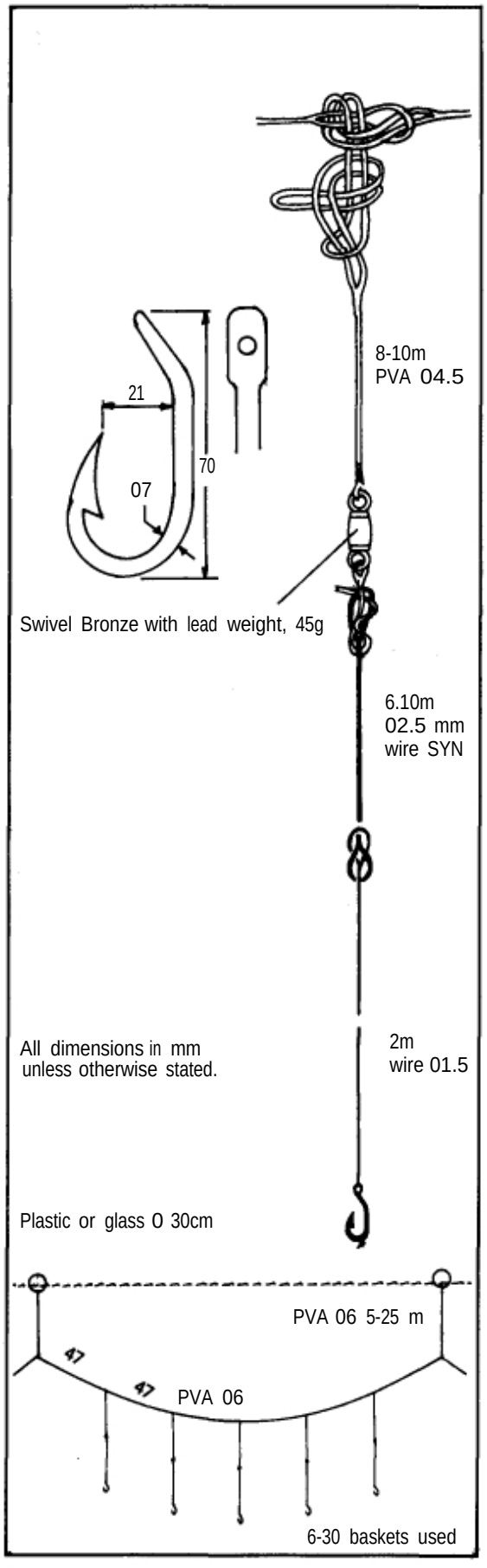


Fig. 4 Drift longline (after MRS, 1991).



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SINGLE HOOK VERTICAL LINING

Large shark just outside the atolls are targeted with a technique that is something of a hybrid between handlining and longlining. A single hook with wire leader is suspended by about 30m of nylon monofilament beneath a single 30cm diameter longline buoy. Up to ten such single buoy lines can be deployed and monitored at once. The buoyed lines are allowed to drift, but are checked regularly for catch. Cut fish is usually used as bait, but sometimes live bait (particularly small tuna) is used. In this case, only one line is normally operated at a time. This type of fishing is only carried out by day.

HANDLINING

Simple one-hook handlining is the main method used for reef fishing in the Maldives. Although targeting for reef fish, this method does catch some shark, particularly juveniles, at night. Nylon monofilament lines and standard hooks of various sizes are used. Fishermen switch to stronger lines with wire leaders if the reef fish they catch are being taken by shark before they can be landed. Occasionally, reef shark can be specifically targeted using this gear.

Night handlining is a popular recreational activity among tourists on resorts in the Maldives; some small shark are caught. Small oceanic shark seen from tuna pole-and-line *masdhonis* are also sometimes taken by handlining.

HAND CATCHING

Small oceanic shark, particularly juvenile Silky Shark *(Carcharhinus falciformis),* are sometimes taken by hand. Schools of these small shark are sometimes encountered near drifting flotsam. A dead tuna held in the water will bring them alongside, where they can be grabbed by the dorsal fin and quickly swung inboard.

BOTTOM-SET GILLNETTING

Gillnets are locally constructed from polyethylene twine of approximately 2mm diameter. Mesh size is 9-10" *(i.e.* about 23 - 25cm). Nets are made in panels, usually 12-14 meshes deep and 200-250 meshes long. The foot rope may be weighted with lead, but small coral pieces are more often used. The most commonly used net floats are pieces of old rubber slippers (flip-flops). The nets are set with coral boulders as sinkers and a buoy line at each end (see Figure 5 facing page). One or two panels may be set together if operated in a shallow lagoon, but full-time shark gillnetters typically set nets of 7-9 panels.

Shark gillnetting is a major occupation on at least eight islands: R. Maduveri, R. Meedhoo, N. Lhohi, A. Himendhoo, A. Dungati, F. Feeali, Dh. Bandidhoo and Th. Vilufushi. Fishermen from these islands (particularly Maduveri, Meedhoo and Dungati) typically undertake 14 - 18-day fishing trips to several atolls during the New Moon period, returning to their islands during the Full Moon period. Two 7-9 panel nets are set each evening, and hauled each morning. On the outer reef of the atolls, the nets are set perpendicular to the reef, down the slope. Within the atolls, they are set on the atoll floor, between or adjacent to reefs.

In general, gillnetters target shark, and by-catch is limited. Large reef fish are the most commonLy taken by-catch, but, occasionally, turtles are also taken. The by-catch is sometimes cut and hung in pieces on the net the next night to attract shark. It should be emphasized that the gillnets used are relatively small and of heavy construction; they are not comparable to the so-called 'wall-of-death' pelagic driftnets.

On Dh. Bandidhoo, a newly fabricated 6" (15cm) stretched mesh nylon multifilament net was observed. This net had proved very successful in increasing reef fish by-catch. As a result, there were plans to make more such nets.

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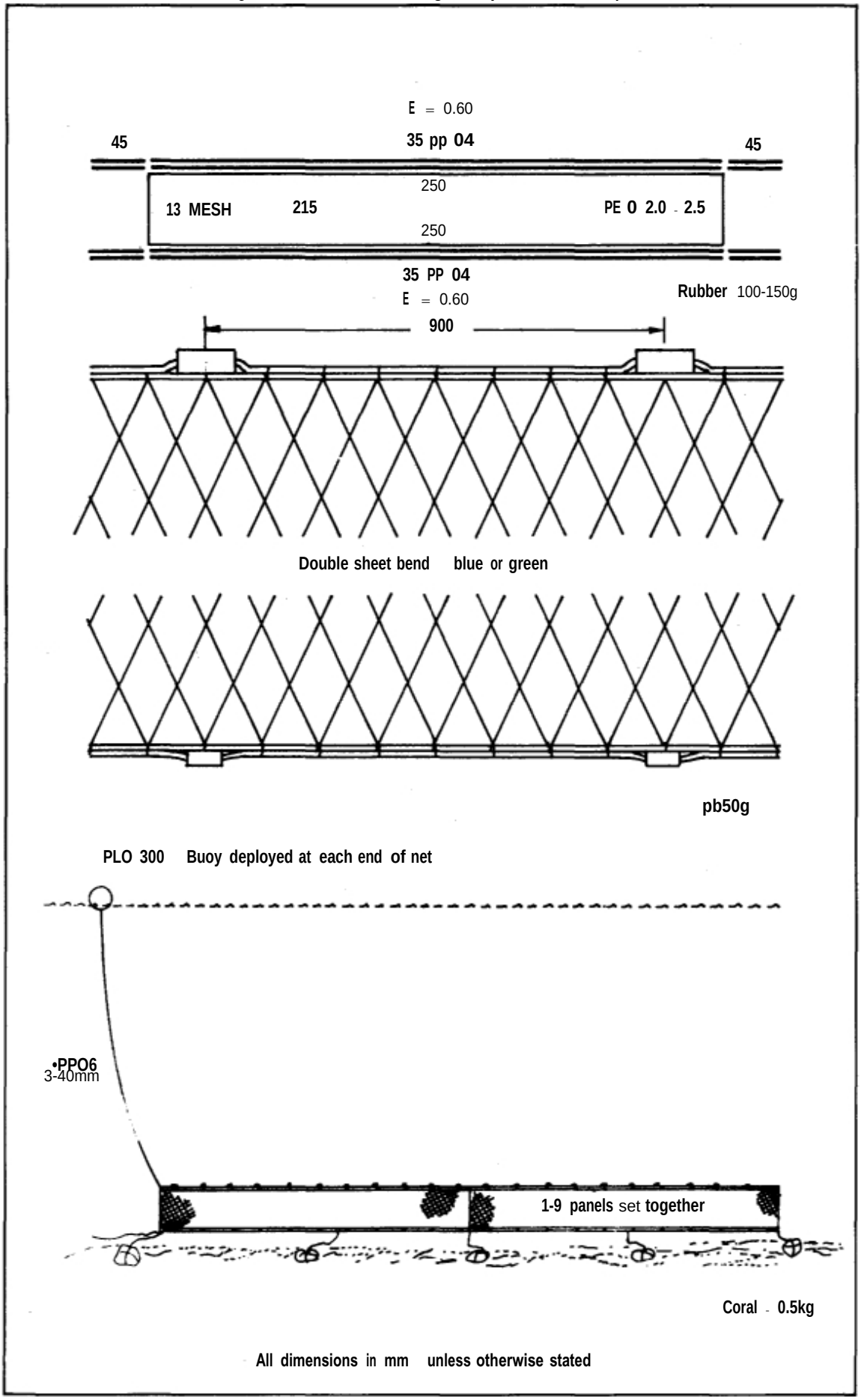
Fig. 5. Bottom-set shark gillnet (after MRS. 1991)



All dimensions in mm unless otherwise stated

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WHALE SHARK CATCHING

Whale Shark *(Rhincodon typus)* are occasionally caught using a large hook with chain leader and thick rope, similar to the gear used for *maa keyolhu kan.* The hook is thrust into the corner of the Whale Shark's mouth, sometimes with the aid of a pole. The Whale Shark is allowed to tow the fishing vessel for some time and becomes tired in the process. It is then killed with a large knife thrust into the brain or spinal cord.

This fishery is currently conducted seasonally from at least two islands: B. Dhonfanu and N. Manadhoo.

HARPOON

Large shark that approach the surface, including Whale Shark, are sometimes taken by harpoon. Some fishermen who practice *hey mas he/un* (a specialized lure and harpoon fishery for Wahoo and Sailfish) report that Hammerhead Shark (probably *Sphyrna lewini)* are sometimes taken by this method.

3.3 *Catches and catch rates*

A summary of the main types of shark caught by the main shark fishing gear is given in Table 2. Further details for the four most important shark fishing gear are provided below and in the subsequent pages.

Table 2 : Summary of major shark species taken by main fishing gear

SHARK SPECIES	*Single massive hook*	*Deep vertical long/me*	*Drift longline offshore*	*Drift long/me nears hore*	*Bottom-set longline*	*Bottom-set gil/net outside atoll*	*Bottom-set gilinet inside atoll*	*Bottom-set gil/net in shallow lagoon*	*Handline in atoll and on reefs*	*Handline offshore*
Hexanchus griseus		*				–	–	–	–	
Centrophorus spp	–	**				–	–			
Nebrius ferrugineus	–	–	–	–	*	*	*	*	*	
Rhincodon typus						–	–			
Odontaspisferox	–	–	–	–	–	*	–			
C. albimarginatus	–	–	*	*	**	**	*		*	
C. altimus	–	–	–	**	–	–	–	–	–	–
C. amb/yrhynchos					**	**	**		**	
C. fa/ciformis	–	–	**		–	–	–	–	–	**
C. longimanus	–	–	**	*		–	–			*
C. me/anopterus	–	–	–	–	–	*	*	**	*	
C. sorrah	–	–	–	–	*	*	**		*	
Galeocerdo cuvier		–	*	**	*	*	*		*	
Prionace glauca	–	–	*							
Triaenodon obesus					*	*	*		*	
Sphyrna lewini	–	–	–	*	*	*	*		s	

Notes Scientific, English and Dhivehi names of major shark species are listed in Appendix 11.

** Target species

* Also taken

OFFSHORE DRIFT LONGLINE

There appears to be a change in catch composition with distance offshore. The exploratory offshore fishing survey (Anderson and Waheed, 1990) operating within a zone 30-100nm off the east coast

of the Maldives mainly caught Silky Shark, besides Oceanic Whitetip Shark and Blue Shark. There was no change in catch composition or catch rates with distance offshore within that zone.

Maldivian fishermen operating nearer the atolls, and between the atolls, still catch these species (although very few Blue Shark), but they catch more Silvertip Shark and Tiger Shark, besides Hammerhead and Bignose Shark. It is likely that catch rates of shark closer than 3Onm offshore are higher than catch rates further out, but no data are available. Average catch rates by shark drift longline during the exploratory offshore fishing survey (Anderson and Waheed, 1990) were

	Nos/1000 hooks	*kg/1000 hooks*	*Average weight (kg)*
Shark	4&7	2231	458
Billfish	6.6	101	15.3
Yellowfin	0.9	32	35.5
Others	0.9	5	5.6
Total	57.1	2369	41.5

Thus, the shark hooking rate approached 5 per cent. It was suggested that this could be improved significantly by an experienced crew using heavier gear (in particular thicker wire leaders). About 5 per cent of shark were lost at the time of gaffing, and about 3 per cent of the hooks *(i.e.* potentially 60 per cent of shark catch) were lost, presumably to large shark.

It was noted that hooking rates were higher off north and central Maldives *(5.3* shark! 100 hooks) than off the southern Maldives (3.3 shark/100 hooks) (Anderson, 1990). It was also noted that more large shark were caught during the Southwest Monsoon season than during the Northeast Monsoon season (Anderson and Waheed, 1990). These findings are consistent with the results of an earlier offshore longline survey carried out by the Ministry of Fisheries (Anon., *1985).* During that survey, aboard the R.V. *Miyavaali,* shark catch rates by tuna drift longline off the north of the Maldives during the Southwest Monsoon were 1.7 shark/100 hooks. Catch rates off the south of the Maldives during the Northeast Monsoon were 0.7 shark/100 hooks.

Maldivian fishermen operating pelagic drift longlines nearer the atolls report that the highest catch rates in the central Maldives are achieved at the end of the Northeast Monsoon and at the beginning of the Southwest Monsoon. Fishermen in Ar Faafu and Meemu Atolls all report peak shark drift longline catches in the period *assidha* to *kethi-roanu (i.e.* April 8 - June 2). There may, in fact, be a progression of peak shark fishing from south to north. Fishermen in Thaa Atoll (Th. Hirilandhoo) report peak shark fishing earlier than in atolls further north, during *reyva-assidha (i.e.* March 26 - April 21). Fishermen in F. Feeali report that currents from the south at around this time result in the best shark catches.

Fishermen report no changes in pelagic shark drift longline catch rates over the last decade or so. A few fishermen thought catch rates had declined, while a few thought that they had increased, but most reported no obvious change. Typical catch rates are reported to be of the order of 4-6 shark! 1-00 hooks, which agrees well with the results of the exploratory offshore fishing survey. However, many fishermen report that catch rates average 10 - 12 shark/100 hooks in good areas at peak times.

BOTTOM-SET GILLNET

A large number of species are caught by bottom-set gillnet. The Blacktip Reef Shark appear to be the commonest species caught in shallow lagoons. The Grey Reef, Silvertip, Spottail, Whitetip Reef and Nurse Shark all make significant contributions to the catch in atoll basins. Bottom-set longlines deployed within the atolls are believed to have a similar catch composition.

The same species are taken outside the atoll, but because the net is often set much deeper than when inside, larger specimens are often taken as well as individuals of some moderately deep-dwelling species, notably the Smalltooth Sandtiger Shark.

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There appear to be major differences in species composition from north to south along the Maldivian atoll chain (Anderson, 1992; Anderson *et al.,* 1992). The small, and commercially low value, Sliteye Shark appear to be the commonest atoll basin shark in the north Maldives. In atolls south of Meemu and Faafu/Dhaalu, the Spottail Shark seem to be more important. The Blacktip Shark *((2.limbatus,* not the Blacktip Reef Shark, *C.melanopterus)* seem to occur only in the southern atolls. (See individual species accounts in Appendix III for further details).

There are only limited data available on gillnet catch rates. Fishermen report average catch rates of 6-8 shark per night, but observations during this survey suggest that *3-5* shark might be a better average. Nearly all gillnet fishermen agree that the highest catch rates are made in the southern atolls. Most gillnet fishermen also agree that gillnet catch rates have declined to some extent over the past decade.

HANDLINING FOR REEF SHARK

The same species are caught by handlining as are caught by bottom-set gillnetting. Most handline-caught shark are taken as by-catch during reef fish fishing. The average handline catch rates listed alongside were achieved during the second phase of the reef fish resources survey (Anderson *et al,* 1992)

		Night handline	*Day hand/me*
Shark:	no/hr	0.04	0.01
	kg/hr	0.13	0.04
Total fish :	no/hr	1.38	1.58
	kg/hr	2.48	2.46

These survey data probably underestimate commercial catch rates, but the proportions are probably valid. Certainly 3-4 times more shark are caught as by-catch at night than by day. However, fishermen sometimes target Grey Reef Shark *(thila miyaru)* ; much higher catch rates are made then, even during the day.

Anderson *et al.,* (1992) compared catches made with normal hooks and circle hooks in three atoll basins. The comparison was actually made using a light reef fish longline, but the results are probably directly applicable to handlining. Circle hooks caught, on average, 80 per cent more shark, weighing 32 per cent more than the standard hook catch.

DEEPWATER SHARK MULTIHOOK HANDLINE

The target species, and the main catch, of this fishery are Gulper Shark (Spiny Dogfish, *Centrophorus* spp.). Bluntnose Sixgill Shark are a significant by-catch. Also taken are several other as yet unidentified species of deepwater shark and Teleosts.

There are no hard data on catch rates available. There is, however, a large body of anecdotal evidence from many fishermen in many atolls. This evidence is highly consistent. All fishermen report greatly reduced catch rates, and the need to fish deeper and deeper in order to still find Gulper Shark. These changes appear to be greatest in the north, where this fishery has been carried on for longer than in the south. Quantifying these changes is difficult, but on the basis of anecdotal evidence catch rates typically drop to less than 50 per cent within two years of an island starting Gulper Shark fishing. Fishermen often start fishing at 200-300m depths but gradually extend their operations to 600-800m or even deeper.

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1. *Shark gillnet*
2. ***Hook used in*** madu miyaru keyolhu kan *(hook length appx. 33 cm)*
3. *Shark longliner from A. Ukulhas testing the line.*
4. *Shark-netting* dhoni *from R. Maduveri in H.A. Atoll.*

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3.4 Preparation of shark products

SHARK FINS

Fins are the first items removed from the shark carcass. Four fins are normally taken: first dorsal, both pectorals and the lower caudal lobe. The second dorsal, pelvics and anal may be taken from large shark, or those species with particular large finsets ***(e.g.*** the Lemon Shark, *Negaprion acutidens).*

The dorsal and pectoral fins are normally round-cut, often with considerable flesh attached. The lower caudal lobe and sometimes the other fins are straight-cut.

After removal, the fins are washed in sea water and laid out on mats on the ground or on drying tables. Sun drying lasts for 4-7 days, depending on fin size, fin cut and weather conditions. Care is taken to keep the fins out of any rain, as fresh water immersion encourages egg-laying by flies and subsequent growth of maggots.

Buyers in Male trim the meat from the dried fins. Fins are exported straight or 'L-cut'. Fin nomenclature and cut terminology are illustrated in Figure 6.

Drying sharkfins (mainly from Blacktip Reef Shark) at Sh. Kanditheem.

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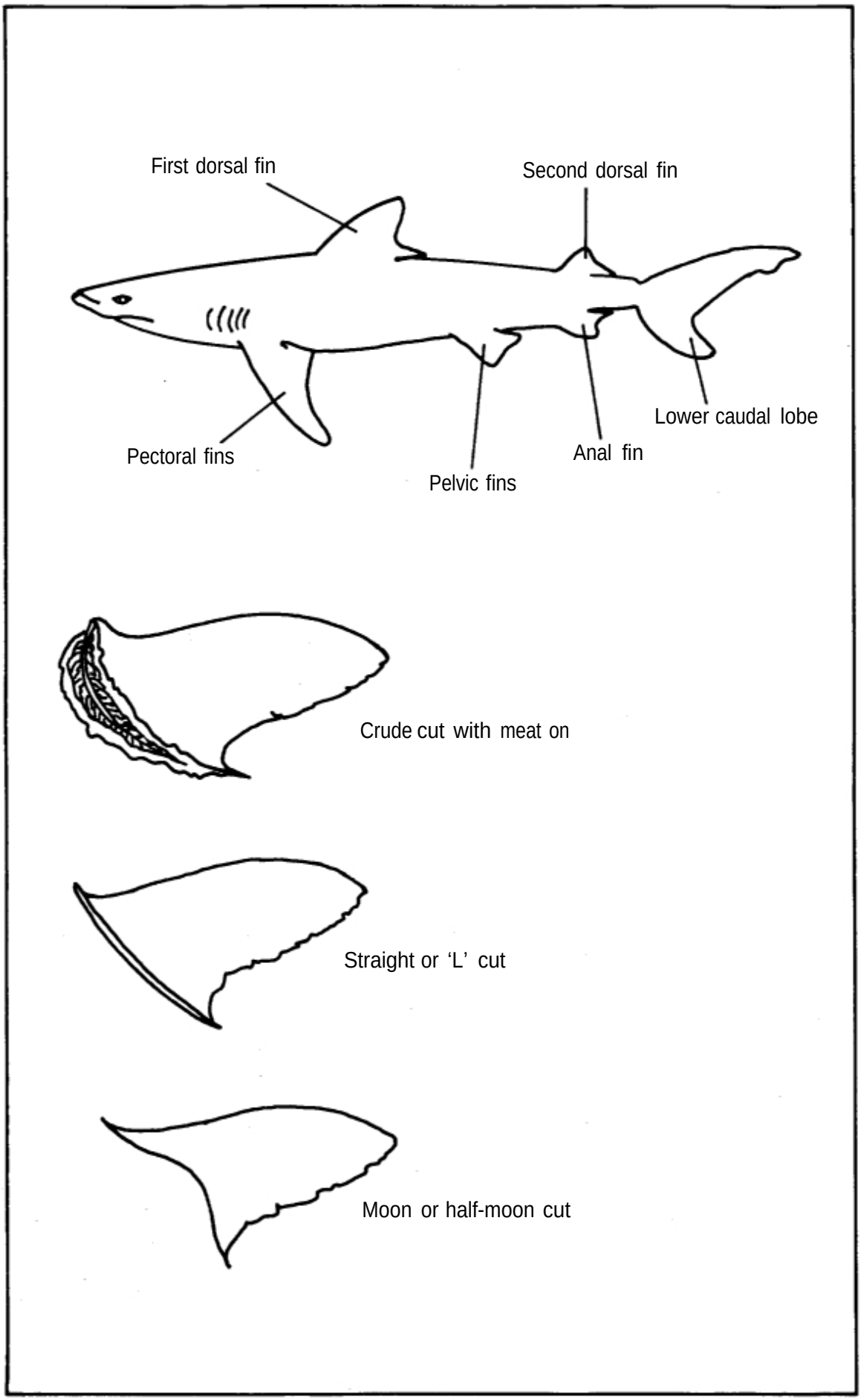
Fig. 6. Shark fin nomenclature



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SHARK MEAT

After the fins are removed, the head is also cut off. Small shark then tend to be cut open from the dorsal side; the guts and liver are removed; the meat is scored longitudinally; and either all the skin or just the dark (dorsal) skin removed. The shark meat is thus kept in one piece for salting.

Large shark, after removal of their fins and heads, are cut open from the ventral side. The guts and liver are removed; the body is cut in two, longitudinally, and the backbone removed; the inner side is scored ; and all the skin is removed from the outside. The shark meat is, thus, in two pieces for salting. Very large pieces may be further cut up to facilitate handling.

After preparing the shark fillets, they are cleaned in sea water and coarse salt is rubbed all over. The fillets are then placed directly into the brine tank. The brine tank is a more-or-less permanent concrete structure on an island. On shark-netting *dhonis* that stay out for two weeks or more at a time, the brine tank is temporarily rigged, using a waterproof sheet of 'plastic canvas' to line one of the hull compartments. Sufficient brine is added to just cover the salted fillets. The brine tank itself is covered with wooden boards or a plastic sheet. Fillets are left to soak for 3-5 days (or the duration of the trip, in the case of shark-netting *dhonis)* before rinsing in seawater and being put out to dry on drying tables. Sun drying lasts for 4-8 days or more. Quality of the end product is very variable.

Meat from deepwater shark is not suitable for salting, being too soft and/or oily. Meat of Gulper Shark can be sun-dried without salting. However, many fishermen who have eaten this meat report that it induces diarrhoea, with symptoms similar to those described for gempylic diarrhoea (Halstead, 1988). The eggs of Gulper Shark are widely eaten, without ill-effect.

SHARK SKIN

Shark skin is only rarely collected. Normally the skin is discarded after being removed in thin strips from the meat, prior to salting. However, there are two overseas markets for shark skin, and small quantities have been exported as trial shipments. Shark skin intended for tanning to make leather is removed in one piece, cleaned and salted. There is reported to be a second small market for shark skins for human consumption. Skin for this market requires little special preparation. Strips of skin are removed from the carcass in the normal manner, washed and hung up to sun-dry. Further processing occurs overseas.

Sometimes pieces of shark skin are used on the fishing islands as 'sand-paper' to clean wooden *dizonis,* prior to the application of oil. Tiger Shark skin is said to be particularly effective, and, presumably, was readily available for this purpose when *maa keyolhu kan* used to be practised.

Salt-dried shark hides at K. Thulusdhoo.

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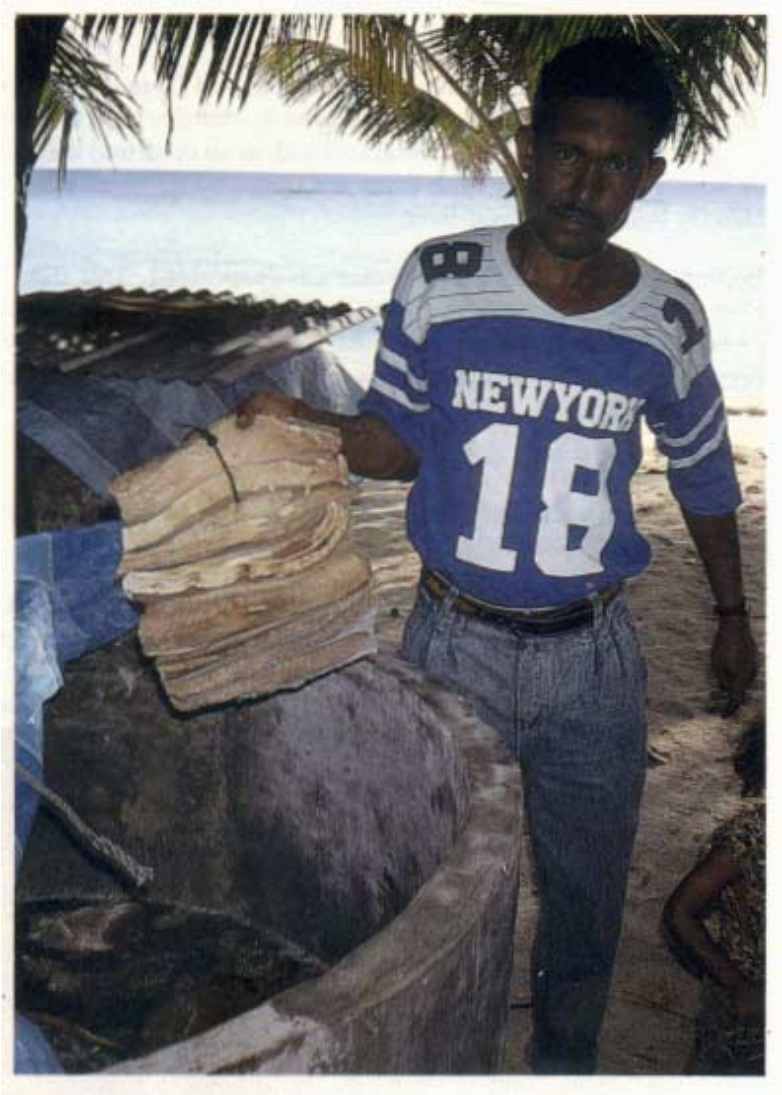

Fisherman from A. Ukuihas with shark meat and brine tank.

Salting shark meat on deck — note plastic-lined brine tank.

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SHARK LIVER OIL *(dhoni* oil)

Shark oil for treating wooden *dhonis* is prepared from the livers of a wide variety of shark. After removal from the shark, the liver is rinsed in seawater and then cut into strips or small cubes. These pieces are placed4n a metal container (such as an oil drum) and left to warm in the sun for a couple of hours, or even days. The livers are then boiled. Some fishermen omit the sun-warming, and directly boil the chopped liver.

Boiling continues until all the water has evaporated. This stage can be recognized in two ways. First, once all the water evaporates, the boiling liquid will no longer steam. Secondly, a thin wooden or cotton splint dipped in the liquid and then placed in the fire will ignite only if the water has been removed. The resulting oil is strained through a gunny sack into a suitable container.

SHARK LIVER OIL (squalene)

High-value, squalene-rich liver oil is prepared only from the livers of certain deepwater shark species, notably Gulper Shark (Spiny Dogfish, *Centrophorus* spp.)

The liver is removed carefully and placed in a container, such as a bucket or large cooking pot. After an optional period of sun-warming, the liver is broken up by hand. The resulting fluid is left to stand; any sediment settles to the bottom, and the oil is simply, decanted into a suitable container. Saualene content is checked by exnorters using a hand-held refractometer.

Painting a dhoni *with shark liver oil.*

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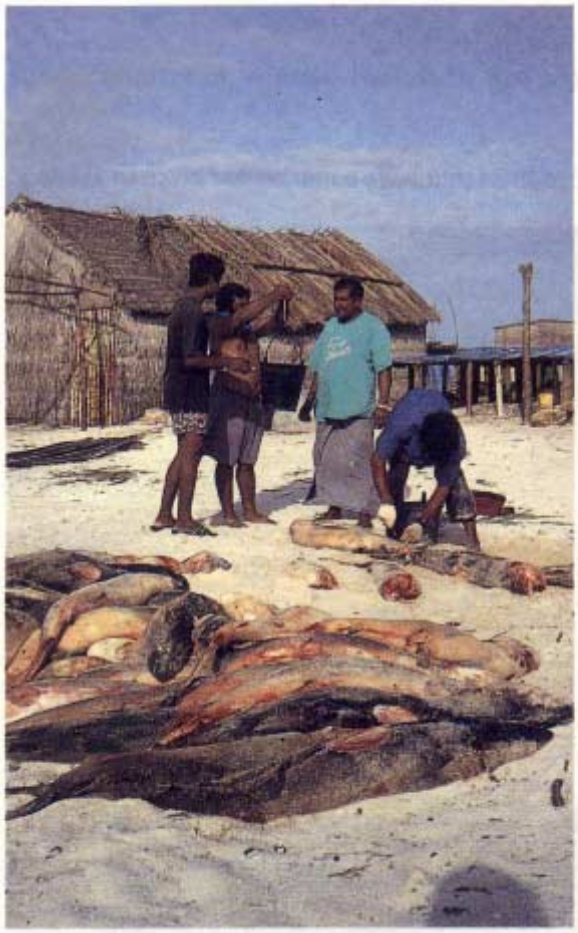
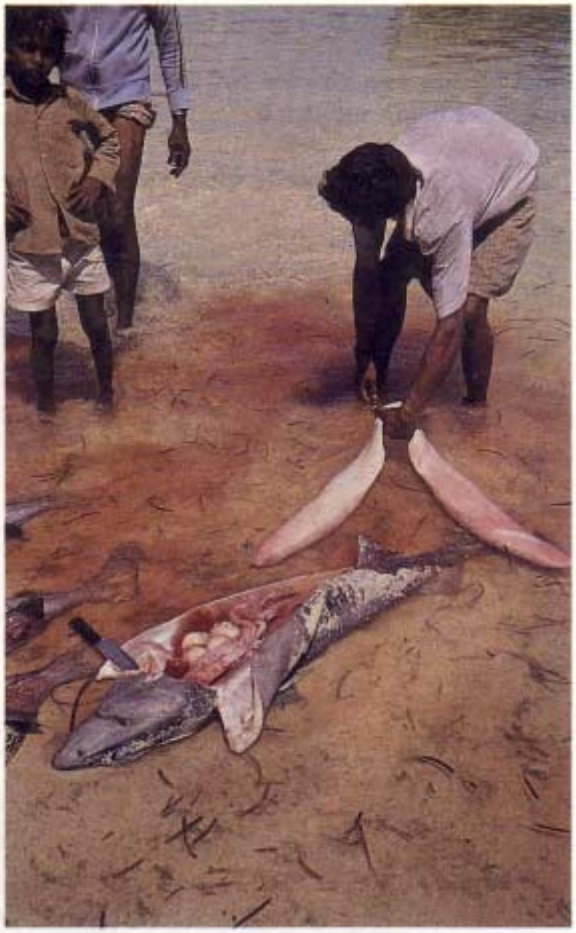
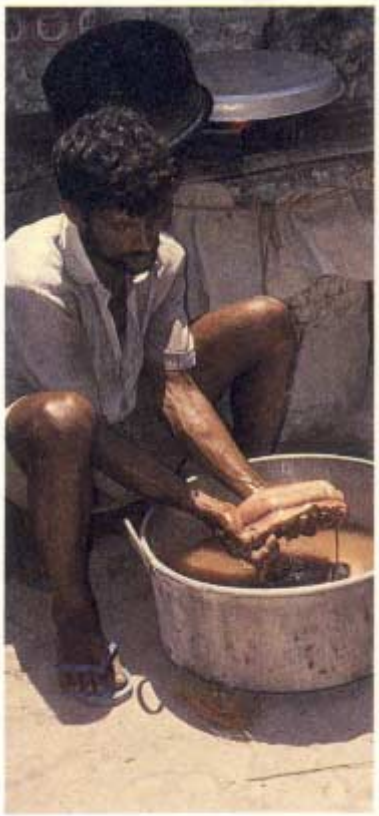


Cutting open Gulper Shark on the beach. Notice large bilobed liver, which, on average, weighs about 25 per cent of total bodyweight. (Above right)



MOFA staff weighing shark organs at R. Kandoludhoo. (Above left)



Breaking up Gulper Shark livers by hand to release the oil.

Preparing crude shark liver oil, A. Ukulhas. Note straining sack.

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JAWS

Jaws are cut out, cleaned and (sometimes) tied to a pair of crossed sticks – to maintain shape – before being sun-dried.

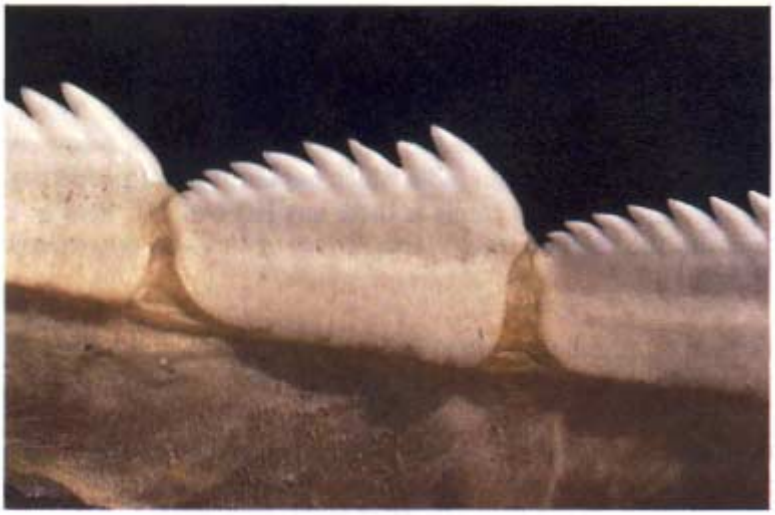
Details of the shark species which yield particular products that have a market are given in Table 3.

Upper teeth of Bignose Shark **(Carcharhinus altimus).**

Table 3: Reported utilization of Maldivian Shark

Name	Dhoni *oil*	*Export oil*	*Fins*	*Meat*	*Teeth*
Bluntnose Sixgill Shark	***		–	–	–
GulperShark	–		–	–	–
VariegatedShark	*			*	
TawnyNurseShark	*			**	
WhaleShark	***	–	–	–	–
Smailtooth Sandtiger	***	–	**	**	***
ThresherShark	*		*	**	*
ShortfinMako	**		*	**	***
Silvertip Shark	**		**	**	*
Bignose Shark	***		**	**	**
GreyReef Shark	**		**	**	*
Silky Shark	*		**	**	*
Oceanic Whitetip Shark	**	–	**	**	*
Blacktip Reef Shark	•		**	**	*
SpottailShark	**		**	**	*
Tiger Shark	***		***	**	***
SliteyeShark	–			*	
LemonShark	**		***	**	**
BlueShark	*		*	*	**
Whitetip Reef Shark	*	–	**	**	*
Hammerhead	**		**	**	*
Guitarfish			**	**	

Key: *** Excellent ** Average * Used but not very good – Not used



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1. *Distinctive lower tooth of the Bluntnose Sixgill Shark* (Hexanchus griseus)
2. *Jaws of Snaggletooth Shark* (Hemipristis elongatus)
3. *Distinctive upper teeth of Smailtooth Sandtiger* (Odontaspis ferox)
4. *Jaws of Kitefin Shark* (Dalatias licha)

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3.5 *Trade*

There is only limited trade in crude shark liver oil for treating *dhonis.* Livers from oceanic and reef shark are, as a matter of course, taken by the boat-owner as part of his catch share. The oil produced is used directly on the fishing boat. The oil applied to the outside of the hull, below the waterline, is mixed with *kadi,* a red powder imported from India which has anti-fouling properties. The more oil there is available the more used, so only rarely is there any left over. If there is, it may be traded within the island, or with the neighbouring island. Prices of this and other shark products are detailed in Section 3.6.

With the exception of crude shark liver oil, there is minimal consumption of shark products on the fishing islands. All other shark products are sold for export.

On some fishing atolls *(e.g.* **H.Dh. Kulhudhoofushi** and R. Kandholhudhoo) the fishermen may sell whole shark to local processors. In most cases, however, fishermen process the catch themselves. The main shark products produced for sale are dried fins, salt dried meat, high-quality deepwater shark liver oil and dried jaws.

There are, at present (November 1992), 39 Maldivian companies registered with the Ministry of Trade and Industry for the export of sea food products. Only about a dozen of these are actively involved in the export of shark products. Competition between the companies for supplies, and the need to meet minimum consignment quantities, means that there is some specialization. Three or four companies dominate the export of dried fins, two or three companies dominate the export of high-quality shark liver oil, and about six or seven companies export the majority of salt dried shark meat.

Dried shark fins are brought by fishermen to Male for sale to the Maldivian exporters. These buyers trim any meat from the fins, and carry out further drying if necessary. Fins are exported to Singapore. During February and March 1992, three-quarters of dried fin exports went by air, the rest by sea. A large proportion of the fins are reported to be re-exported, notably to Hong Kong. There is interest among Maldivian exporters in further processing shark fins in the Maldives and, for example, exporting extracted fin rays. This is unlikely to meet with approval from established fin traders in Singapore or Hong Kong.

Most salt-dried shark meat is taken by fishermen to K. Thulusdhoo, where STO and six private companies have dried fish warehouses. There it is sold to the company offering the highest price. Prior to export, it is subject to a quality control check by Ministry of Trade and Industry inspectors. All salt-dried shark meat is exported to Shri Lanka, nearly all of it by air from Hulhule to Colombo. Some is still exported by sea, but only in wooden, not steel, hulled ships because of problems with maintaining quality in the latter. It is widely reported that the profit margin from the export of salt-dried shark meat to Shri Lanka is extremely low, but that the business is a useful source of foreign currency.

High-quality deepwater shark liver oil is sometimes purchased directly from fishermen on their islands by exporters' agents. Otherwise fishermen bring the oil to Male for sale to one of the exporters. All high-quality deepwater shark liver oil is exported by sea to Japan.

Dried shark jaws are mostly sold in Male to buyers for tourist shops. Supply appears to exceed demand, so buyers are sometimes able to buy shark jaws at a very low price by waiting until fishermen are just about to leave Male and return to their islands. Fishermen occasionally sell jaws directly to tourist shops in resorts or in inhabited islands visited by tourists. Shops sell jaws directly to tourists as curios.

There has been some interest among tourist shop buyers in importing the more valuable types of jaws from Shri Lanka, but apparently price differences are insufficient to make this a worthwhile proposition. If demand for jaws increases with increasing tourist arrivals, this situation might change. The trade in teeth appears to be much smaller than that in whole jaws, although some large teeth are sold in tourist shops as pendants and other ornaments.

3.6 *Prices*

DRIED SHARK FINS

Prices paid to fishermen vary according to fin size, quality, species and international demand. Prices peaked in August-September 1992 at about the following levels

Below 6”	125 MRf/ kg	10” - 14”	650 MRf/ kg
6” - 10”	450 MRf/ kg	Above 14”	700 MRf/ kg

Prices have since dropped, and in October - November 1992 typical prices were

Below 6”	100 MRf/ kg	10” - 14”	450 - 500 MRf/ kg
6” - 10”	*350* - 400 MRf/ kg	Above 14”	550 MRf/ kg

The largest shark tend to be caught by longline. Fishermen report that longline-caught fins sell for about 400-550 MRf/kg on average. Other fins sell for 200-250 MRf/kg on average.

Average export (FOB) prices are listed in Table 4 and illustrated in Figure 7. These tend to follow international trends. The major price rise in 1987 was seen worldwide, and was caused by a combination of factors, including: a decline in supply from some overfished and/or regulated shark stocks; a major increase in demand in China; and a consequent scramble by buyers to secure dried fins (Cook, 1990). The dramatic fall in prices in 1990 probably reflects a temporary check in Chinese demand combined with some price manipulation by major international traders (Cook, 1990). However, prices recovered in 1991, and reached a new high in 1992 due to strong international demand.

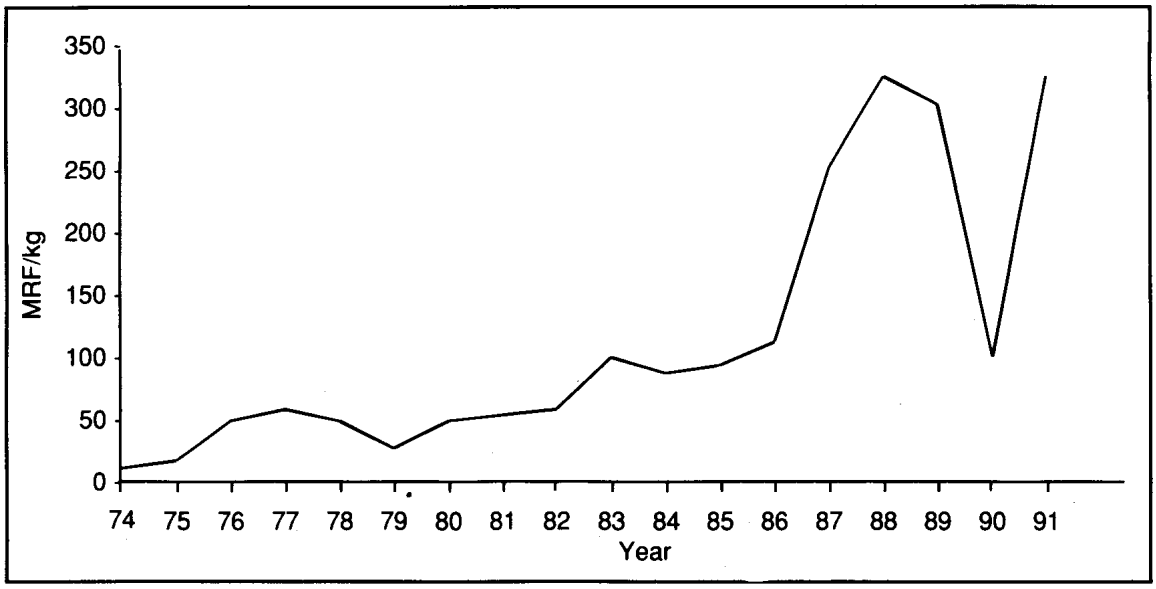
The historical data on shark fin exports available from the Maldives (Table 4) show that there was a major price rise in 1976, which is believed to have encouraged a major increase in production in the Maldives in 1977. This

Table 4 : Exports of shark fins (Quantity and value)

Years	*Shark fins (kg)*	*Sharkfins (MRf)*	*MRf/kg.*
1963	5842	35,000	5.99
1964	7,468	42,000	5.62
1965-7	N/A	N/A	N/A
1968	5,715	25,452	4.45
1969	N/A	N/A	N/A
1970	N/A	27,000	N/A
1971	N/A	18,000	N/A
1972-3	N/A	N/A	N/A
1974	8,000	120,000	15.00
1975	3,000	51,000	17.00
1976	8,000	417,000	52.13
1977	20,090	1,217,708	60.61
1978	24,560	1,348,759	54.92
1979	19,260	573,338	29.77
1980	27,701	1,363,414	49.22
1981	15,373	888,831	57.82
1982	19,988	1,373,104	68.70
1983	17,402	1,886,743	108.42
1984	10,600	1,015,394	95.79
1985	20,785	2,103,284	101.19
1986	18,434	2,345,861	127.26
1987	24,383	5,925,145	243.00
1988	15,576	5,104,805	327.74
1989	13,094	3,856,220	294.50
1990	17,826	1,798,870	100.91
1991	18,726	6,182,866	330.18

Sources: 1963-64 UNDP (1966); 1968 FJTFCA (1972); 1970-71 Tiwari (1972) 1974-76 MOF; 1977-78 CSCD (1983); 1979-91 MOFA

Fig. 7. Annual average shark export prices (FOB Male) 1974-1 991



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occurred at a time of major change in the Maldivian fisheries sector, with motorization, the introduction of fresh tuna purchasing for canning and frozen export, and also the introduction of gillnetting. The increase in shark catches in 1977 is probably a reflection of increased fishing effort as some fishermen took up shark fishing full time. Major international price fluctuations since 1977 *(i.e.* a drop in 1979, a major increase in 1987, a drop in 1990, and another increase in 1991) do not appear to have had such significant impacts on shark catches. The manpower shortage within the fisheries sector (see Section 7.3) undoubtedly limits the movement of fishermen between fisheries in response to short-term price changes. As a result, it seems that the shark fishing effort (on oceanic and reef shark, not deepwater ones) has not changed dramatically since 1977.

International dried shark fin prices have increased at a faster rate over the last decade than prices for salt-dried meat. This is probably a reflection of the economic growth of the major shark fin-consuming countries (notably Singapore, Hong Kong and Taiwan). During 1980-82 the average export price of dried shark fins *(58.58* MRf/kg) was 18 times greater than that of salt-dried shark meat (3.23 MRf/kg). In 1991, the dried shark fin price was 26 times greater than that of salt dried meat. As both the relative and absolute prices of shark fins increase, so too does the importance of income from shark fins to fishermen. At current prices, it is estimated that over 60 per cent of a shark's value is in its fins (see Section 6.2). For longline-caught sharks with large fins, this figure could approach 80 per cent.

SALT-DRIED SHARK MEAT

Prices to fishermen vary from 8 to 16 MRf/kg with 10-12 MRf/kg an average price. Price depends on quality, supply, and demand from Shri Lankan buyers. STO are not being offered shark meat by fishermen, because their purchase price is too low (Table 5). When they do buy salt-dried shark or other fish, it is invariably at the lower grade. Although now seldom used, the STO prices do at least provide a lower limit for prices paid by private businesses, thus perhaps helping to maintain fishermen's income.

Table 6: Estimated exports of dried salted **shark meat, 1980-1991.**

ear	*Export quantity (tonnes)*	*Export value ('000MRf)*	*Price (MRf/k&*
1980	477	1247	2.61
1981	265	844	3.18
1982	344	1341	3.90
1983	300	1459	4.86
1984	182	868	4.77
1985	358	2328	6.50
1986	317	2331	7.35
1987	420	3428	8.16
1988	268	2280	8.51
1989	225	2002	8.90
1990	307	2959	9.64
1991	322	4073	12.65

Table 5 : Prices paid to **fishermen by** STO/FPID for salt-dried shark meat **(July 1982** - Nov. 1992).

	Pnce paid for Shark meat (MRF/kg)	
Revision date	*Grade 1*	*Grade 2*
01 .07.82	4.50	4.50
01.08.82	5.75	5.75
01.11.83	6.60	4.85
10.12.84	6.85	5.25
16.02.85	8.60	7.25
16.07.85	6.80	5.75
15.10.85	10.01	7.70
14.03.86	12.35	9.50
01.04.86	6.85	5.75
01 .03.87	9.75	8.00
01.06.87	8.00	7.00
17.10.87	6.50	5.00
30.12.87	7.80	6.00
01.03.90	8.80	7.00
06.03.90	11.00	8.50
10.08.90	9.75	7.50

Source: STO/FPID; Compiled by MOFA.

Small quantities of salt-dried shark meat are sold at Male dried fish market for 15-20 MRf/kg. Prices for chunks of fresh shark meat at Male fresh fish market vary widely, according to total fish supply.'

Export (FOB) prices as estimated in section 4.2 are listed in Table 6. There seems to have been a slow but steady increase in prices paid for salt-dried meat over the last decade or so, with none of the dramatic variations shown by shark fin prices.

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HIGH-VALUE SHARK LIVER OIL (squalene)

High-value, squalene-rich Gulper Shark liver oil is bought from fishermen for 40-60 MRf/litre. Price depends on quality; squalene content, supply, and demand from Japanese buyers. In September 1992, prices in Male dropped from around 60-70 MRf/litre to around 40 MRf/litre. This was reported to be due to the Japanese market being saturated with supplies from other countries. Export (FOB) prices since the fishery started in 1980 are listed in Table 7. Prices paid by STO are listed in Table 8.

Table 7 : Exports of shark liver oil (quantity and value).

ear	*Quantity of oil (1)*	*Quantity of oil (kg)*	*Value of oil (MRJ)*	*Value/I (MRf)*	*Value/kg (MRf)*
1980	9,600	8,160	60,129	6.26	7.37
1981	27,200	23,120	349,275	12.84	15.12
1982	87,400	74,290	1,106,353	12.66	14.89
1983	63,400	53,890	1,796,010	28.33	33.33
1984	79,400	67,490	2,411,610	30.37	35.73
1985	53,400	45,390	1,890,751	35.41	41.66
1986	33,400	28,390	1,242,230	37.19	43.76
1987	40,000	34,000	1,040,168	26.00	30.59
1988	26,000	22,100	640,747	24.64	28.99
1989	19,002	16,152	724,297	38.12	44.84
1990	25,600	21,760	1,203,382	47.01	55.30
1991	39,765	33,800	1,814,530	45.63	53.68

Source: Customs data complied by MOFA.

Note: In the Fisheries Statistics the quantity of oil has been entered in litres from 1980-1989.
The quantity for 1990 and 1991 has been entered in metric tonnes.
The conversion factor used above is ¦ litre = 0.85kg.

Average export prices increased steadily from 1980 to 1986. There was a drop in 1987-88 following the imposition of restrictions on private exports. Since these restrictions were removed, export prices have increased again.

LOW-VALUE SHARK LIVER OIL *(dhoni* oil)

As shark liver oil is mostly used by the fishermen who catch the shark, to treat their wooden *dhonis,* there is only a little direct trade in this commodity. Prices quoted by fishermen varied from 7-28 MRf/litre, with 10-12 MRf/litre being the average price. For comparison, the following are the prices of two widely-used substitutes

Fish oil (from Felivaru cannery) : 3.50 MRf/litre
Coconut oil (from Shri Lanka) : 6-9 MRf/litre

Table 8 : Prices paid to fishermen by STO/FPID for Gulper Shark liver oil (Spiny Dogfish oil) (Jan. — Nov. 1982).

Revision date	*Price paid MRf/litre*
01.01.82	13.00
01.01.83	13.00
01.03.85	18.00
01.10.85	20.00
01.01.86	19.00
01.01.87	19.00
01.03.87	23.00
01.06.87	20.00
01.01.89	20.00

SHARK SKIN

The prices paid on Thulusdhoo by one buyer for dried salted hides were said to be 3-5 MRf/kg, depending on size. There is very little trade in shark skins, because fishermen feel the prices paid are too low to justify the extra work involved in removing the skin carefully.

DRIED SHARK JAWS

The prices paid to fishermen for shark jaws vary widely, dependinr on size and species. Fishermen may receive 2-10 MRf/set in Male for small to medium jaws of species with ordinary small teeth. Medium-sized jaws with eye-catching teeth may fetch around MRf 100. Large and spectacular jaws may fetch many hundreds of Rufiyaa. Supply appears to exceed demand, so prices paid to fishermen are not as high as they might be, and fishermen do not bother to collect all the jaws that they could.

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Prices paid by tourists in shops also vary considerably. Price depends on jaw size, tooth size, species and willingness to pay. A small, ordinary set may sell for MRf 10. A large set of Mako jaws may sell for over US$ 1000. High prices are also paid for large jaws from Tiger Shark and Smailtooth Sandtiger Shark (the name 'Smalitooth' being somewhat misleading in this case).

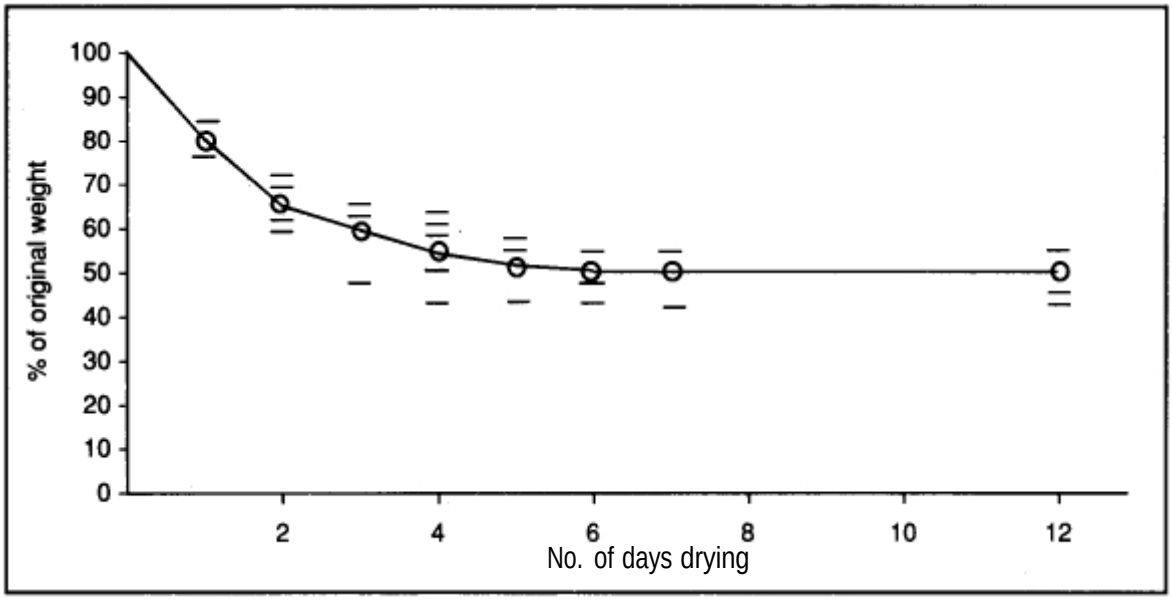
4
Shark Fishery Statistics

4.1 *Yields of shark products*

DRIED SHARK FINS

The yield of shark fins depends on several factors, including species and size of shark, type of cut and degree of drying. In order to determine weight loss due to drying, five sets of fresh shark fins were purchased from fishermen and dried to constant weight. Details are given in Figure 8. After drying, the fins weighed an average of 46 per cent of their original weight.

Fig. 8 Weight loss of fins during sun drying (n=5 sets)



There are three independent sets of data available from the Maldives relating to the yield of fins from shark. The first is from the exploratory offshore fishing survey (Anderson and Waheed, 1990). Unpublished data are available from four cruises at the end of which shark were sold to a buyer who paid for fins separately from the rest of the carcasses. The fins were removed by the buyer with an 'L-cut'. From 112 shark caught during the four trips, the average yield of wet fins was 3.18 per cent (range 3.01 - 3.56 per cent). The shark were mostly large (average weight 48kg). The main species involved was the Silky Shark (n = 96), but Oceanic Whitetip Shark (n = 15) and one Tiger Shark were also caught. The dried, fin yield is calculated as follows:

(1) Yield of dry fins = Yield of wet fins x Yield after drying
= 3.18 x 0.46 = 1.46%

The second data set is from the reef fish resources survey (Anderson *et al.,* 1992). Unpublished data on fin yield is available from one fishing trip to Laamu Atoll. Twenty small shark (average weight 5.3kg) of six species were caught. Their total weight was 111.2kg and they yielded 1.6kg of straight-cut dried fins. Thus

(2) Yield of dry fins = 1.44%

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Finset of Snaggletooth Shark (Hemipristis elongatus)

Cutting up a Grey Reef Shark on deck

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The third set of data was collected during this survey. Twentyone shark of eight species and a wide range of sizes (average weight 25kg) were cut up and their various components weighed (Table 9).

Table 9: Percentage weight composition of Maldivian shark

					Percentage contribution to total weight				
No.	*Species*	*L (cm)*	*Sex*	*Total weight (kg)*	*Head*	*Meat*	*Fins*	*Liver*	*Remainder*
	Nebriusferrugineus	93	F	4.3	16.5	51.8	5.8	4.7	21.2
2	"	107	F	5.6	17.9	51.9	4.3	7.2	18.7
3	"	162	M	18.8	18.1	49.1	6.1	5.3	21.4
4	C. albimarginatus	134	F	15.8	19.6	49.4	3.2	5.1	22.7
5	"	173	M	35.7	17.9	57.1	3.1	5.6	16.3
6	"	227	F	91.4	14.4	57.8	3.4	6.2	18.2
7	"	229	F	85.3	16.2	53.3	4.2	8.7	17.6
8	C. amblyrhynchos	127	M	12.2	18.0	51.7	3.3	9.0	18.0
9	"	140	F	18.0	18.9	52.2	4.4	6.7	17.8
10	"	144	F	21.0	13.8	51.4	4.3	9.5	21.0
II	*C. falciformis*	100	F	4.6	17.6	57.1	5.5	4.4	15.4
12	"	125	M	9.0	16.7	64.4	4.4	2.2	12.3
13	"	142	F	14.0	14.9	63.3	4.6	2.8	14.4
14	"	143	M	17.6	13.6	61.4	4.0	3.4	17.6
15	*C. longimanus*	167	M	25.3	15.0	60.1	8.3	5.1	11.5
16	*C. melanopterus*	114	F	8.2	14.8	61.5	2.8	8.6	12.3
17	"	118	F	10.4	15.5	59.9	3.4	4.8	16.4
18	*C. sorrah*	108	M	6.9	16.0	61.0	3.0	5.5	14.5
19	"	109	M	6.6	15.9	61.9	3.2	4.7	14.3
20	"	110	M	7.4	14.9	64.8	2.8	4.7	12.8
21	Negaprionacutidens	249	F	107.9	13.3	37.9	5.7	11.9	31.2
	Unweighted average	—	—	25.0	16.2	56.1	4.3	6.0	17.4
	Weighted average	—	—	25.0	15.4	52.4	4.5	7.5	20.2

Note: 1. All finsets comprise four fins except in the case of the 229cm *C. albimarginatus* (six fins), the *C. longimanus* (six fins) and the *N. acutidens* (eight fins).
2. Shark nos. 7, 10 and 21 contained embryos to weighing 0.9kg, 1.1 kg and 10.4 kg respectively.

Of these shark, three were Nurse Shark which do not yield exportable fins. The remaining 18 shark yielded an average of 4.5 per cent of wet fins. These fins were round cut with meat on, by fishermen interested in maximizing weight. Such fins have to be trimmed to an 'L-cut' by Male buyers before exporting. Weight loss during trimming is substantial. Commercial data shows that the average loss is about 33 per cent. However, for the five sets of fins (from this sample of 18) that were used to estimate weight loss during drying, the further weight loss during trimming was 31 per cent.

Thus:

(3) Yield of dry fins = Yield of wet fins x Yield after drying x Yield after trimming

= 4.5 x0.46 x 0.69 = 1.43%

The three estimates of dry fin yield from Maldivian shark are in remarkably good agreement. It is, therefore, suggested that the average yield of dried fins from Maldivian shark is about 1.44 per cent.

DRIED SHARK MEAT

The weighted average yield of fresh shark meat according to Table 9 is 52.4 per cent, the unweighted average 56.1 per cent. The difference is largely due to the presence of several small but high-yielding shark *(C. falciformis* and *C. sorrah)* and one very large but low-yielding shark *(N. acutidens)* in the sample. As a first approximation it is suggested that the average yield of fresh meat from Maldivian shark is 54 per cent.

In order to determine weight loss during processing, two pieces of shark meat (7.1kg and 4.5kg, fresh weight) were weighed daily during salting and drying. After two days salting and seven days drying the larger piece was reduced to 58 per cent of its original weight, while the smaller piece was reduced to 49 per cent. The larger piece of meat was rather thick, and the drying it received was thought to be slightly inadequate. As a first approximation it is therefore suggested that the average weight loss during salting and drying is 50 per cent. Therefore:

Yield of salt dried shark meat = 54 x *0.5*
= 27%

SPINY DOGFISH OIL

Due to poor weather during much of the survey period there was very little deepwater shark fishing. As a result, only seven Gulper Shark *(Centrophorus)* were caught. Details are as follows

Catch	*No.shark*	*Shark weight (kg)*	*Liver weight (kg)*	*Liver oil(l)*	*Oilyield (l/kg)*
a	1	4.0	0.94	0.95	0.238
b	5	82.1	23.2	22.5	0.274
	1	19.5	5.1	4.7	0.241
Total	7	105.6	29.24	28.15	0.267

Thus, the average yield is about 0.267 litres/kg, which is equivalent to about 0.23kg oil/kg shark (with a conversion factor of 1 litre oil = 0.85 kg). Liver weight averaged 27.8 per cent of body weight, slightly more than the 23.3 per cent noted for *Centrophorus* from Taiwan by Wu *et al.,* (1980).

4.2 *Shark product exports*

There are three major shark products that are exported from the Maldives: dried shark fins, salt dried shark meat, and squalene-rich shark oil. Separate export statistics are maintained by the Customs Department for shark fins (see Table 4) and shark oil-(see Table 7). Shark meat exports are lumped with reef fish exports under "salt dried reef fish". Note that only shark meat from "shallow water" reef and oceanic shark is exported; the meat from deep water shark is very soft and/or oily and is unsuitable for salt-drying. The quantity of shark meat exports can be estimated in one of two ways.

First, knowing the average yield of dried fins, the total catch can be estimated. The yield of dried shark meat can then be estimated using the appropriate conversion factor. However, it should be noted that fins are not taken from some shark *(e.g.* Nurse Shark, nor from very small individuals), and that small quantities of fins might be lost or spoilt during processing. The quantities involved are thought to be very small and on the basis of field observations are thought to amount to about 2 per cent of the total. Thus, for 1991

Total dried shark fin exports = 18.726 t
Dried fin yield = 1.44%
Shark catch yielding fins = (18.726 x 100)/1.44
= 1300t
Total shark catch = 1300 x 1.02
= 1326t
Dried shark meat yield = 1326 x 0.27
= 358t

Dried shark meat exports can be estimated in a second way, using the export invoices held by the Customs Department of private sea food trading companies. Not all exporting companies record dried shark meat separately from reef fish in their export invoices. However, a review of the 1991 records reveals the following information from ten exporting companies

	Quantify **(t)**	*Value ('000 US$)*
Salt-dried shark meat	200	287
Salt-dried reef fish	636	713
Total salt-dried fish	836	1000
Percentage shark	24%	29%

836t was 62 per cent of the total 'salt-dried reef fish' exports in 1991(1340t). Assuming that the value of 24 per cent shark is representative

Total dried shark exports in 1991 = 1340 x 0.24
= 322t

The difference between the two estimates is about 10 per cent. This is not very much considering the as.sumptions made and approximate nature of some of the conversion factors used. In fact, the first estimate (358t) is of total potential production, and so it should be greater than the second estimate (322t) which is of actual exports. The reasons for the difference include the following

- **There is a little local consumption of shark meat in the Maldives. A** few resorts offer 'shark steaks' in their restaurants; fresh shark meat is sold in Male fish market, almost entirely to expatriates; salt-dried shark meat is sold in Male dried fish market, mainly to Shri Lankans.

- **There** is some, **but very limited, 'finning' of shark,** i.e. taking the fins and discarding the carcass. Fishermen in Addu Atoll report doing this sometimes because of difficulties in marketing salt-dried meat. It may also happen elsewhere on rare occasions, when processing the meat is a problem.

- A limited quantity of meat is spoilt during processing and so is not exported.

It should be emphasized that these three factors are all relatively minor and, together, probably amount to no more than 10 per cent of the shark catch. Thus, the two estimates are, in fact, in very good agreement, which suggests that the conversion factors used and assumptions made are appropriate. Since detailed export invoices are not available for all years, and are, in any case, extremely laborious to compile, salt-dried shark meat exports for years prior to 1991 are estimated solely from dried shark fin export quantities (Table 10) using the following relationship

Salt-dried shark meat exports = 0.27 x 0.9 (shark fin exports x 100/1.44 x 0.98)

= 17.22 x shark fin exports

where 0.27 = yield of dried salt meat from fresh shark

0.9 = proportion of shark catch that yields exported meat

0.98 = proportion of shark catch that yields exported fins

1.44 = percentage yield of dried fins from fresh shark

It should be noted that this approach assumes that the conditions in 1991 applied in earlier years too. This might not be the case. For example, as fin prices have increased (Table 4), it is likely that fins are being taken from smaller and smaller shark, and that the incidence of 'finning' may have increased. In addition, local consumption of shark meat is likely to have increased; it certainly has done in Male. HOwever, these are probably relatively minor effects.

The export values of salt-dried meat can be estimated knowing the total export value of the 'salted dried reef fish' Customs category (Table 11); the ratio of shark to true reef fish in that category (Table 10); and the relative values of the two products. From the export invoice data summarized above, salt-dried shark meat is estimated to be worth 30 per cent more per kilo than salt-dried reef fish. This price differential is consistent with that between STO's shark meat and dried reef fish purchasing prices over the last decade (MOFA, 1989, 1992), and so is used as a first approximation in the calculation of export values of these two products (Table 11).

Estimates of shark meat exports (quantity, value and unit value) are summarizel in Table 6. Total values of shark product exports are summarized in Table 12. Note the erratic increase in export earnings from shark products over the last decade. Despite this increase, the contribution of shark products to the total export earnings of fisheries products (Table 13) has actually decreased over the same period: shark products brought in 15 per cent of all fisheries export earnings in 1982, but only 3 per cent in 1991. The enormous growth of export earnings from the existing tuna fishery, and the development of a new Sea Cucumber fishery are largely responsible for this relative decline in the importance of shark exports.

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Table 10: Estimation of total shallow-water shark catches and salt-dried shark meat exports. (All figures in metric tonnes(t))

(A) Year	(B) Exports of dried shark fins	(C) Estimated shark catch	(D) Estimated dried shark meat exports	(E) Total 'salted dried reef fish' exports	(F) Estimated Export of actual salt-dried reef fish
1979	19,260	1364	332	N/A	N/A
1980	27,702	1962	477	1590	1113
1981	15,374	1089	265	1032	767
1982	19,988	1416	344	1320	976
1983	17,403	1233	300	1151	851
1984	10,600	751	182	683	501
1985	20,785	1472	358	1895	1537
1986	18,434	1306	317	1671	1354
1987	24,383	1727	420	1440	1020
1988	15,576	1103	268	582	314
1989	13,094	927	225	627	402
1990	17,826	1263	307	751	444
1991	18,726	1326	322	1340	1018

Sowre: Columns B and E are from Customs export statistics Column C = B x 70.83 *(i.e.* 1.02B x 100/1.44)
ColumnD = Cx 0.243(i.e.0.9C x 0.27) ColumnF = E-D

Table 11: Estimated export values of dried salted shark meat and salted dried reef fish. ('000 MRf)

Year	Shark meat value	Reeffish value	Total
1980	1247	2237	3484
1981	844	1879	2723
1982	1341	2927	4268
	1459		
1985	2328	7687	10015
1986	2331	7658	9989
1987	3428	6404	9832
1988	2280	2054	4334
1989	2002	2752	4754
1990	2959	3291	6250
1991	4073	9904	13977

Note: 'Total' value refers to category 'salted dried reef fish' as collected by Customs and compiled by MOFA. This category in fact includes salt-dried shark meat as well as salt-dried reef fish. Values of these two categories are apportioned as described in the test.

Table 12: Export value **of shark products ('000** MRf)

Year	Dried fins	Liver oil	Salted dried meat	Total
1980	1363	60	1247	2670
1981	889	349	844	2082
1982	1373	1106	1341	3820
1983	1887	1796	1459	5142
1984	1015	2412	868	4295
1985	2103	1891	2328	6322
1986	2346	1242	2331	5919
1987	5925	1040	3428	10393
1988	5105	641	2280	8026
1989	3856	724	2002	6582
1990	1799	1203	2959	5961
1991	6183	1815	4073	12071

Table 13: Declared **FOB export** values **of major fisheries products ('000,000** MRf)

Year	Tuna	Shark	Reeffish	Sea cucumber	Aquarium fish	Others	Total
1980	21.8	2.7	2.2	—	0.2	1.9	2&8
1981	23.3	2J	1.9	—	0.2	0.3	27.8
1982	17.6	3.8	2.9	—	0.2	0.7	25.2
1983	38J	5.1	3.2	—	**0.4**	**2.8**	**49.6**
1984	66.9	4.3	**1.8**	—	**0.3**	**0.8**	**74.1**
1985	95.0	**6.3**	*1.7*	**0.0**	**0.6**	**0.6**	**110.2**
1986	98.1	5.9	**7.8**	**0.2**	**0.8**	**0.7**	**113.5**
1987	**151.5**	**10.4**	**6.5**	**3.1**	**0.9**	**0.1**	**172.5**
1988	**211.8**	**8.0**	**2.0**	39.5	**1.6**	**0.1**	263.0
1989	279.1	6.6	2.7	15.8	1.3	5.2	310.7
1990	318.1	6.0	3.2	31.6	1.3	1.2	361.4
1991	331.4	12J	99	20.5	3.5	1.6	379.0

Source: Customs data compiled by **MOFA**

Notes: 1. Customscategory'SaltedDriedReefFish' containsbothsharkmeatandreeffishandhasbeendividedasexplainedinthetext.
2. Numbers may not add up **due to rounding** off.

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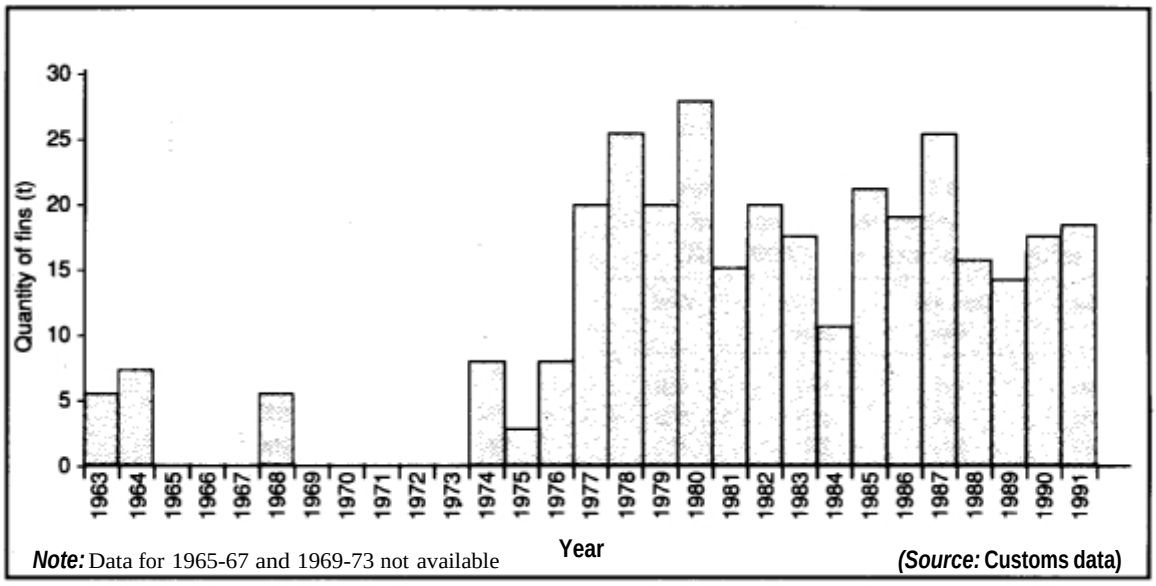
4.3 Shark catches

OCEANIC AND ATOLL-ASSOCIATED SHARK

As pointed out in the previous section, dried shark fin export figures can be used to estimate the total catches of shark from the reef shark and oceanic shark fisheries combined. Estimates of the total shark catches by these two fisheries for the years 1979 to 1991 are presented in Table 10. Since dried shark fin exports are assumed to be directly related to the size of the 'shallow water' shark fisheries, Figure 9 provides a useful picture of the relative size of these combined fisheries over the last three decades.

Fig. 9. Annual exports (tonnes) of dried shark fins from the Maldives



Note: Data for 1965-67 and 1969-73 not available ***(Source:*** **Customs data)**

Prior to 1977, shark catches were relatively low. For the years for which data are available, shark catches appear to have averaged about 460t/yr. **In** 1977 there was a sudden increase in shark fin exports. This is believed to be attributable to three factors

- Introduction **of** gillnetting. This followed Maldivian fishermen finding pieces of drifting gillnet from other countries. After some experimentation in local lagoons, these fishermen were able to adapt the nets for bottomset reef shark fishing, and soon learnt to make their own nets. Shark net fishermen interviewed in 1992 usually said that this fishery started **"about** 15 years **ago",** although **a few said it** started earlier, while others said it was later. The activities of a foreign fishing and fish exporting company (ICP Bangkok), which operated in Ari Atoll during 1976-1979, may also have assisted this development.
- Motorization **of the *masdhoni*** fleet. This started in 1974 and was well established by 1977 (Anderson, 1987). Motorization allowed more efficient longlining, and may well have been **a** necessary condition for the successful adoption of shark gillnetting.
- **Price Increase. The price paid for** shark fins increased substantially in 1976 (see Table 4), **presumably encouraging more fishermen to go shark fishing.**

The average annual **shark catch since 1977 has been about 1340t/yr. There** has **been considerable variation about** this **average value, but without** any **obvious trend (see Figure 9). There is a suggestion that shark catches might have declined since 1977-80, but the data are too variable for** any certainty **about this.**

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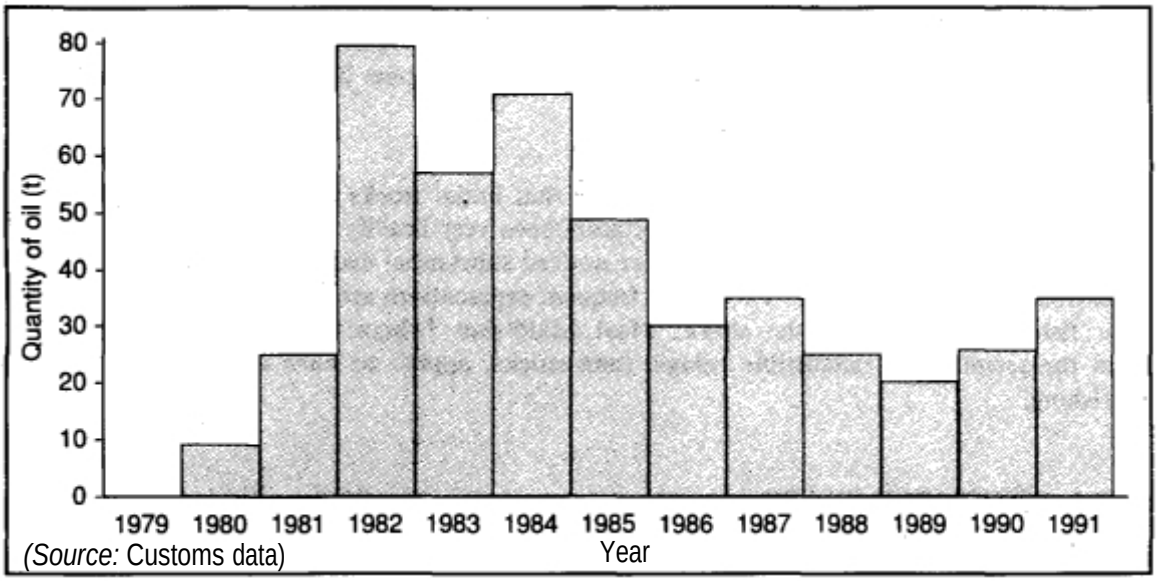
DEEPWATER BENTHIC SHARK

If it is assumed that the exports of high-value shark liver oil (see Table 7, Figure 10) are directly related to the size of the catch of Gulper Shark, then oil exports can be used to estimate shark catches. These peaked at about 330t/yr in 1981, declining to a low of about 70t/yr in 1989, since when there has been a slight increase again.

Fig. 10. Annual exports (tonnes) of high-value shark liver oil from the Maldives.



(Source: Customs data)

Only squalene-rich oil is exported. Therefore these catch estimates apply only to shark (notably Gulper Shark) which yield squalene-rich oil. Other deepwater shark (notably Bluntnose Sixgill Shark) are not included in these estimates. At present there is insufficient data to estimate the size of the non-squalene shark catch. AU that is known is that out of four sampled landings, totalling 12 shark, ten were *Centrophorus* and two were 'non-squalene' shark.

5
Status of Stocks

There are three major Maldivian shark fisheries, based on three major shark resources, namely

- the offshore pelagic shark,
- the atoll-associated shark, and
- the deepwater benthic shark.

All three are multispecies fisheries. No catch and effort data are available. It is, therefore, impossible to make a rigorous assessment of stock status. Nevertheless, some useful insights can be obtained from export data and anecdotal evidence.

DEEPWATER BENTHIC SHARK

Deepwater shark stocks appear to be fished very heavily, and have probably been overfished, at least in some areas. The fishery for Bluntnose Sixgill Shark *(madu miyaru keyolhu kan)* was probably carried on for centuries, but with a low level of fishing effort. The fishery for deepwater Gulper Shark *(kashi miyaru keyolhu kan)* started in 1980, but expanded rapidly, peaking in 1982-84, since when oil exports have declined (Table 7, Figure 10). Fishermen consistently report that catch rates are now very much lower than before, and that they have to fish much deeper than before. These trends appear to be most marked in the north Maldives, where this fishery started and fishing effort has been greatest. However, they are also reported from the south. The upturn in shark liver oil exports in 1990-91 (Figure 10) is attributed, in part, to a rise in prices – encouraging further fishing in already heavily fished areas – and partly to an expansion of fishing effort in the south.

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There are two further factors of relevance to this consideration of the status of deepwater benthic shark stocks

- Because they live in a cold and, possibly, food-limited environment, deepwater shark may have slower-than-average growth and reproduction rates, making them potentially even more prone to overfishing than shallow water shark.

- In the Maldives, the deepwater shark appear to be confined to the deep outer atoll slopes. This is little more than a thin ribbon of habitat encircling the country. The total area of this habitat is likely to be quite small, thus putting an upper limit on the initial size of the deepwater shark stocks.

What little evidence there is, therefore, suggests that initial stocks of deepwater Gulper Shark were not very large, and that these have certainly been very heavily fished, if not overfished. It is worth noting that although fishermen have noticed substantial declines in catch rates, they do not attribute this to overfishing. Their most frequent explanations are inadequate baiting, and too much fishing "disturbing" the shark. Most Maldivian fishermen, who have traditionally fished the seemingly inexhaustible pelagic tuna stocks, appear to have almost no concept of overfishing.

ATOLL-ASSOCIATED SHARK

Reef shark and other atoll-associated shark are fished by gilinet, handline and longline. Fishermen report somewhat lowered catch rates by gillnet over the last 15 years in the most heavily fished areas. There is a suggestion of a slight decline over the same period in dried shark fin exports (Figure 9), to which gillnet catches contribute. A minority of diving instructors report reductions in the numbers of reef shark at some dive sites over the last few years. This is little enough evidence to go on, but it does suggest that reef shark are being fished at a moderate level of fishing effort, which is probably sustainable, but that an increase in fishing effort would adversely effect stocks.

PELAGIC SHARK

The exports of dried shark fins come from both the pelagic (oceanic) and atoll-associated shark fisheries. While they provide some measure of the size of the two fisheries combined, export data do not provide any information about their relative sizes. It is, therefore, difficult to say much about pelagic shark catches. However, there has been little obvious trend in shark fin exports over the last 10-15 years, and if there has been a trend it is a decline that can be explained by reduced atoll shark catches. It seems likely that pelagic shark catches have not changed dramatically over this period.

The latest survey revealed that fishing effort on pelagic shark is relatively low, and also that it does not appear to have changed much over the last 10-15 years. These observations are consistent with the reports of fishermen who say that there have been no obvious changes in longline catch rates of pelagic shark. Taking into account the fact that oceanic shark stocks are likely to be relatively large, it is concluded that pelqgic shark stocks in Maldivian waters are underutilized, and that there is scope for increasing fishing effort on these resources.

It should be noted, however, that even pelagic shark stocks can be overfished (Bedford, 1987; Casey *et* al., 1992). This applies to the 'nearshore' pelagic shark such as the Bignose Shark and, perhaps, the Scalloped Hammerhead, the initial stock sizes of which may be limited by the relatively small size of their habitat. It also applies to the 'offshore' pelagic shark which, although they may have large initial stock sizes, are wide-ranging and, therefore, potentially subject to fishing effort by several fisheries. Pelagic shark are already heavily fished by Far Eastern longliners and Shri Lankan gillnet-cum-longliners in the Indian Ocean.

Fishermen from B.Dhonfanu and N. Manadhoo between them may take less than twenty Whale Shark a year nowadays. The catch for the whole of the Maldives is unknown, but may be less than thirty Whale Shark a year. Fishermen from B. Dhonfanu report that, ten years ago, Whale Shark were more common and they themselves would take about thirty a year.

The Whale Shark is undoubtedly rare in the Maldives, as it is elsewhere. Silas (1986) considered the Whale Shark to be vulnerable in Indian waters. Casey etal. , (1992) considered the Whale Shark to be at potential risk from pelagic fisheries. IUCN (1990) lists the Whale Shark as endangered, vulnerable or rare, but lacks sufficient information to say which of the three categories is most appropriate. Given the international concern about the status of the Whale Shark, it may be appropriate to consider the banning of all fishing for this species in Maldivian waters. The following factors could be borne in mind:

- The existing fishery is not very valuable in monetary terms. Meat and fins are not used. Fishermen report taking 100-200 litres of oil per shark. The oil is rarely sold, but has a nominal value of about 10 MRf/litre. Thus, each shark is worth about MRf 1500, and the entire fishery no more than MRf 45,000 *(i.e.* about US $ 4000). This is, in fact, a somewhat inflated estimate, as fishermen from B. Dhonfanu and N. Manadhoo could buy fish oil from the cannery at Lh. Felivaru at 3.50 MRf/litre if Whale Shark oil were not available. Using this figure, the total monetary value of the fishery may be less than US $1500 a year.

- Although the fishery is not very significant in monetary terms, the removal of thirty Whale Shark a year may have a significant impact on the local population.

- Many tuna fishermen state that Whale Shark often aggregate tuna schools, making it easy to catch the tuna. The association between Whale Shark and tuna is well known in other areas *(e.g.* Silas, 1986; Au, 1991).

- Whale Shark are a significant attraction for tourists.

6
Sharks and Tourism

6.1 *Background*

Tourism is the largest contributor to GDP in the Maldives and is a major contributor to Government revenue (MPE, 1992). Furthermore, the importance of tourism continues to increase, with 1992 bringing record numbers of tourist arrivals.

While the peaceful tropical island environment is a major attraction, so too is the marine environment. It is estimated that some 80 per cent of all tourists go snorkelling while in the Maldives, and that some 30-35 per cent of all tourists go diving *(source:* MATI and SAM). There are now some 70 island resorts, most of which have diving bases, and numerous 'safari' boats, many of which take divers out either part-time or full-time. For divers, the major attraction of the Maldives (over and above the warm, clear waters and rich coral reefs) is big fish, particularly Manta Ray and shark.

Shark in the Maldives do not have the exaggerated man-eating reputation that they have in some other countries. Although there are a few known cases of fishermen being bitten by shark during the course of their fishing activities, there are no recorded incidents of unprovoked attacks on tourist snorkellers or divers. As a result, shark-watching by divers has become a major activity in the

Maldives. It has been described as the "ultimate thrill" for many divers. There are three main shark species involved:

- Grey Reef Shark *(Carcharchinus amblyrhynchos).* This is a powerful, impressive looking animal which occurs in groups at specific sites, often near channel entrances. A close encounter with ten or more adult Grey Reef Shark is a thrilling experience for most people. These sharks are normally very shy, but some diving instructors, particularly in the past, have fed them so that they will readily approach divers. The best known sites for divers to see Grey Reef Shark are Fish Head (properly Mushimasmingili Thila) in Ari Atoll and Lion's Head in North Male Atoll. These two sites have shark resident year-round. Other sites in channels tend to have shark present at reasonable depths and in good numbers only when the current is onshore. Thus, Miyaru Kandu, Guraidhoo Channel and Emboodhoo Channel are good for Grey Reef Shark-watching only during the Northeast Monsoon season. On the other hand, Kuda Boli and Rasfari are best during the Southwest Monsoon season. (See Figure 19 for location map). It is most often mature females that come up to investigate divers; males and juveniles tend to stay deeper.

- Whitetip Reef Shark *(Triaenodon obesus).* One, two or, occasionally, more Whitetip Reef Shark can be seen at many Maldivian dive sites. This is a small species, not nearly as impressive as the Grey Reef Shark, but its widespread distribution means that it is probably seen more often and by more divers than any other shark species.

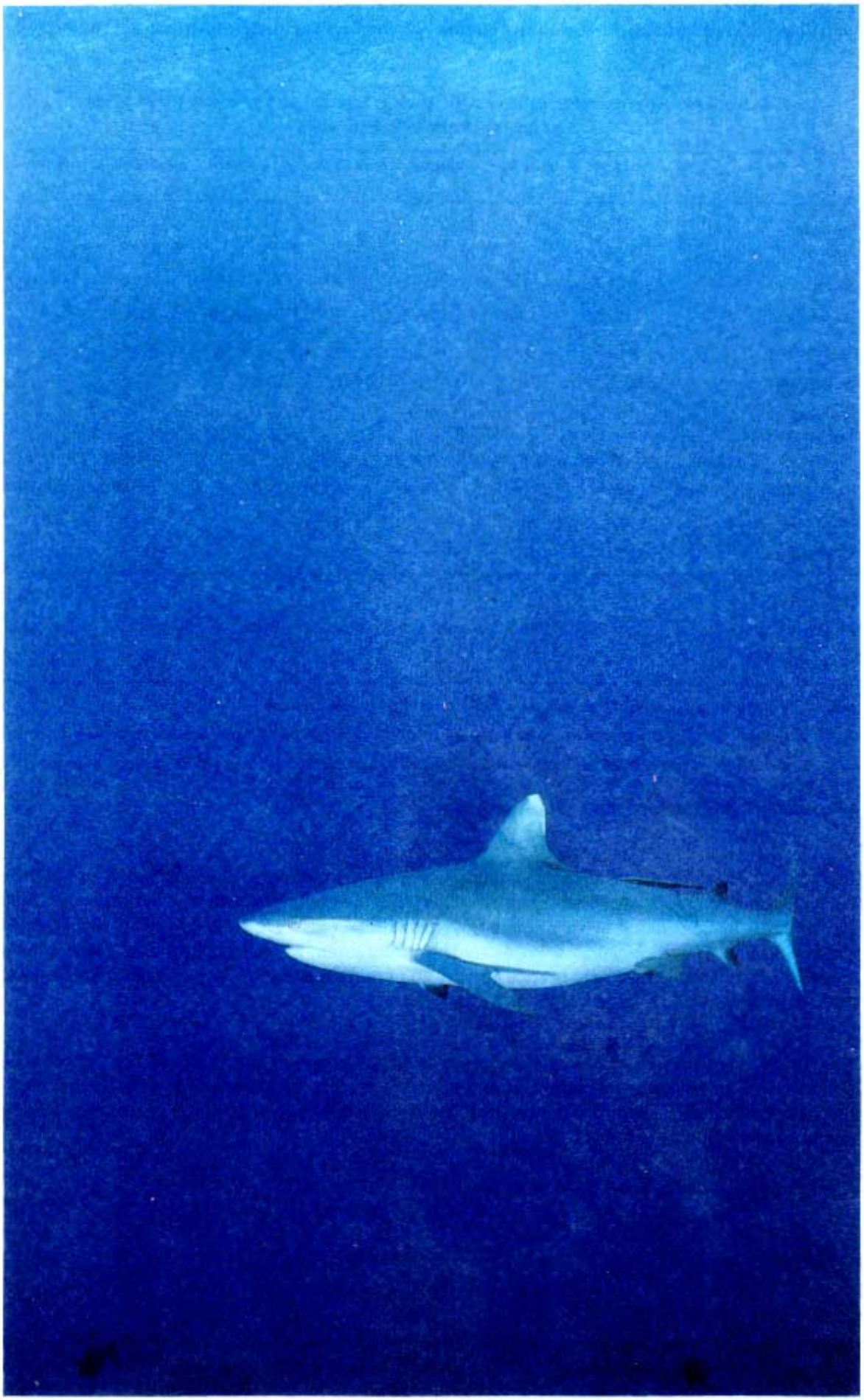
- **Scalloped Hammerhead Shark** *(Sphyrna lewini).* There are a few sites where Hammerhead are sometimes seen, but the major attraction for divers is the more-or-less permanent school of Scalloped Hammerhead at Rasdhoo Atoll. Dozens, or even hundreds, of these large shark can be seen very early in the morning off the reef outside Madivaru (Figure 19).

Other species that are seen occasionally include the Blacktip Reef Shark *(Carcharhinus melanopterus),* the Tawny Nurse Shark *(Nebrius ferugineus),* the Variegated Shark *(Stegostoma fasciatum),* the Silvertip Shark *(Carcharhinus albimarginatus)* and, very rarely, the Whale Shark *(Rhincodon typus).*

6.2 *Revenue from shark-watching*

The ability of diving tour operators to guarantee safe but exciting shark-watching in the Maldives is undoubtedly a major selling point. However, putting a monetary value on shark-watching is far from straightforward. Shark are only a part of the overall Maldives dive package. White sand beaches, sunshine, palm trees, clear water and colourful reef fish are also important. Assigning separate monetary values to all these components is clearly impossible. Nevertheless, as a first approximation the revenue generated from divers visiting specific shark-watching sites can be roughly estimated.

Interviews with 32 experienced diving instructors produced a list of 35 diving sites that are visited specifically to watch shark. Seven of these sites are used regularly by at least five of the instructors interviewed. Twentyseven sites are used regularly by only one or two of the instructors interviewed. One intermediate site (Banana Reef in North Male Atoll) was mentioned by four instructors, but this reef is frequented as much, or more, for its underwater scenery and reef fish



Grey Reef Shark as seen by divers in the Maldives

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as for its shark. The average number of dives made at each of the seven most 'popular' shark-watching sites was estimated from information supplied by the diving instructors (Table 14)

Table 14: ApproxImate estimates of diving **activity and revenue ('000 US$) at major shark-watching sites**

	Fish Head	*Maaya Thila*	*Madivaru*	*Lion's Head*	*Guraidhoo Channel*	*Kuda Faru*	*Rasfari*
High season (Dec-April, 151 days)							
No. boats/day	7(3-15)	3(1-5)	1.5(0-4)	3(1-8)	3(0-5)	2(1-4)	—
No. divers/boat	15(8-20)	12(8-20)	12(8-15)	12(7-20)	10(6-14)	10(8-16)	—
No. dives/day	105	36	18	36	30	20 x 0.5	—
No. dives/season	15855	5436	2718	5436	4530	1510	—
Low Season (May-Nov. 214 days)							
No. boats/day	3(0-5)	1(0-3)	1(0-2)	1(0-4)	—	2(0-3)	1(0-3)
No. divers/boat	10(4-16)	10(4-16)	8(2-12)	8(4-20)	—	8(6-12)	10(4-17)
No. dives/day	30	10	8	8	—	16 x 0.5	10
No. dives/season	6420	2140	1712	1712	—	1712	2140
Total							
No. dives/year*	22275	7576	4430	7148	4530	3222	2140
Revenue/year	670	230	130	210	130	100	60

Note: 1. The estimated mean numbers of boats and divers is given, followed by the ranges in parentheses.

2. Guraidhoo Channel is good for shark-watching in the high season only; Rasfari has a good shark population only in the low season.

3. Kuda Faru is not just a shark-watching site; the number of shark-watching dives is considered to be equal to half of all dives made there.

* No. shark-watching dives at 7 sites = 51,300 per year.

It is stressed that there is considerable variation in site usage from day to day, depending on weather, current, client numbers, shark numbers etc. Therefore, averages are hard to determine and these figures must be considered as very rough approximations only. They do, however, clearly show the importance of Fish Head as a major shark-watching site, as well as of Maaya Thila, Lion's Head and Madivaru. Kuda Faru is undoubtedly an important site too, but it is visited for its coral and reef fish as well as its shark.

The annual average number of shark-watching dives at the remaining sites is also difficult to estimate accurately. As a first approximation, it is assumed that each site has shark present for only half the year; each site is visited by one boat with ten divers a day; only half of the dives made at each site are specifically to see shark. Thus

No. shark-watching dives at 28 sites = 28 x 0.5 x 10 x 365 x *0.5*
= *25,550* per year

No. shark-watching dives at *35* sites = *25,550* + 51,300
= 76,850 per year

MAT! and SAM (pers. comm.) estimate that about 500,000 dives are made annually in the Maldives. If about 77,000 of these are shark-watching dives, this implies that the average diver making two dives per day will make at least two shark-watching dives per week. This appears to be a reasonable figure.

The average cost of a dive varies between operators and also depends on what kind of package the diver is on. However, US $ 30 is the rough average cost for a dive including boat trip. Thus

Estimated direct revenue from shark-watching dives = 30 x *76,850*
= US $ 2.3 million/yr

6.3 *Shark-watching and shark-fishing*

Whatever the inadequacies of the above analysis, it is clear that diving operators have a considerable financial interest in the maintenance of healthy reef shark stocks. It is not surprising, therefore, that diving operators have made vigorous protests on occasions when they have seen fishermen operating at popular dive sites. Particular cases have involved alleged incidents of net fishing at both Fish Head anà Lion's Head, and handlining at several sites.

From early February to late June 1992 there were no shark at Fish Head, which caused considerable concern among diving operators. Many suspected at the time that the shark had been caught by fishermen. However, the same shark did return after *4-5* months. The shark at Fish Head do seem to disappear for a few weeks every year some time between February and May, perhaps for breeding. In retrospect, it seems that the disappearance in early 1992 was just a longer version of this annual phenomenon. Nevertheless, considerable concern remains about the potential damage that could result from uncontrolled reef shark fishing at the most popular shark-watching dive sites.

Various parties have called for a ban on all shark-fishing in the Maldives, a ban on shark-netting and, more realistically, a ban on fishing at these sites.

There is a little doubt that a Grey Reef Shark is worth very much more alive at a popular dive site than dead on a fishing ***dhoni.*** If we assume that there are twenty mature shark that are regularly seen by divers at Fish Head *(i.e.* excluding the smaller shark that are normally out of sight), then the value of each shark can be roughly estimated as

One living Grey Reef Shark = Shark-watching revenue/20
= 670,000/20
= US $ 33,500 per year at Fish Head

Making similar assumptions for the country as a whole we have

One living Grey Reef Shark = (Total revenue/20)/35 sites
= US $ 3300 per year

The value of dead Grey Reef Shark can also be estimated. Assuming a very large mature shark weighing 30 kg, the proportions noted in Table 9, the product yields noted in Section 4.1, and the prices noted in Section 3.6, then

Yield of salt dried meat = 30 x 0.52 x *0.5*
= 7.8kg
Value of salt dried meat = 7.8 x 12
= MRf94
Weight of dried fins = 30 x 0.044 x 0.46
= 0.6kg
Value of dried fins = 0.6 x 400
= MRf240
Nominal value of jaws = MRf 10
Nominal value of liver oil = MRf 10
Total value of dead shark = MRf 354
= US $ 32 appx.

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In round figures, one Grey Reef Shark may be worth 100 times more alive at a dive site than dead on a fishing boat. At the most popular shark-watching site (Fish Head), it may be worth 1000 times more alive than dead. These are annual values. Since Grey Reef Shark may live to at least 18 years (Radtke and Cailliet, 1983) and these shark in the Maldives may stay for several years at the same site, their cumulative value may, in fact, be several times greater.

The total estimated direct revenue from shark-watching (US $ 2.3 million) is twice as great as the total export earnings from all three major shark fisheries (US $ 1.17 million, ref. Tables 12 and 13). If it is assumed that the oceanic shark fishery and the reef shark fishery each contribute 50 per cent to the export of fins and salt-dried shark meat, then each of these fisheries was worth about MRf 5.1 million (US $ 0.5 million) in 1991. The catch of reef shark for the entire country is, thus, roughly estimated to be worth less than one quater of the revenue generated by shark-watching in the tourism zone. Once again, it must be stressed that these figures may not be particularly accurate. **They** are **simply intended to show the order of magnitude of the difference** between the values **of one** resource **exploited in two different** ways. Nevertheless, these results are comparable to findings from elsewhere. For example, DiSilvestro (1991) shows that a living elephant in Kenya may be worth US $ 900,000 over its lifetime in terms of income from tourists. The ivory from an average elephant was worth about US $ 1000 to poachers before the international ban on the ivory trade in January 1990.

It is important, however, to consider not only how much money is being generated, but also whom it benefits. Fishermen are among the least well off members of Maldivian society, and rely directly on their catches for their income. They would not benefit directly from any restrictions on reef shark fishing.

This is not to say that they do not benefit both directly and indirectly from diving activity in the Maldives. For example, an average of about US $ 8 from every US $ 30 spent on a dive goes on the cost of the boat. The boat may be owned or chartered by the resort. In either case, it provides employment for crew who might otherwise be working as fishermen. As a case in point, between July 1991 and August 1992, seven of 19 *dhonis* from A. Dungati left shark fishing to take employment at newly-opened resorts nearby.

The diving school also provides employment for Maldivians, as does the resort in other departments. The diving school pays import duty on all diving equipment. The resort pays bed tax, import duties and, in some cases, lease fees to the Government. Diving, thus, directly and indirectly, contributes significantly to Government revenue, a major proportion of which is directed to health, education and other social development programmes. Fishermen and their families do, therefore, benefit indirectly from diving.

Although an estimated US $2.3 million is generated annually in direct shark-watching dive income, some of this income would presumably have bten spent on diving even if there were no shark in the Maldives. Therefore, a final factor to be considered is whether or not a significant drop in reef shark numbers would adversely affect diving tourist arrivals. There is, of course, no way of knowing for sure, but most diving instructors agree that it would cause a drop in diver arrivals. They note the number of divers who return to the Maldives specifically for shark-watching; the disappointment of divers who do not see the expected numbers of shark on particular dives or during their holiday as a whole; and the many other diving destinations internationally that do not have nearly so many shark as the Maldives but are cheaper and more accessible. This last is an important point.

The Maldives currently has a competitive advantage over many other diving destinations because of the abundance of its fish and shark life. This is in large part due to the lack of spearfishing and reef fishing. If major reef fish and reef shark fisheries are not developed, then this advantage will be retained, or even extended, if other countries overfish their reefs.

6.4 Night fishing

Many resorts offer night fishing excursions for their guests. With new East Asian tourist markets being tapped, night fishing, with simple single hook handlines, has become especially popular in the last year or so. Small shark are sometimes caught. They are sometimes released, but they are also often killed and brought back to the resort where, normally, no use is made of them. This waste could be avoided if guests were encouraged or instructed to return all shark to the sea alive. Returning the shark alive would allow the possibility of them being

- caught again by tourists;
- caught by commercial fishermen;
- seen underwater by divers; and/or
- growing to maturity and reproducing.

7
Interactions between Fisheries

7.1 *Pelagic shark and tuna-fishing*

Tuna-fishing is the most important fisheries activity in the Maldives. Oceanic shark, particularly Silky Shark, regularly associate with tuna schools. This behaviour is well documented in other tuna-fishing areas *(e.g.* **Au,** 1991). Juvenile Silky Shark *(oivaali miyaru)* associate with tuna under floating objects; adults *(ainumathi miyaru)* associate with free swimming schools.

It is almost universally accepted among Maldivian fishermen (most of whom have at least some experience of both tuna and shark fishing) that taking shark from tuna schools disturbs the tuna, causing them to stop feeding and to go deep or disperse. Many fishermen further believe that tuna are actively led by large shark, and that removing the shark can have a long-term adverse effect on tuna-fishing. Since pelagic shark eat tuna, this seems unlikely. A minority of Maldivian fishermen believe that tuna follow shark, not because they need a leader but because they want to keep an eye on potential predators!

In view of the importance of tuna-fishing in the Maldives, the Ministry of Fisheries issued a notice on November 10, 1981 (I'laan no. 48/81/34/MF) banning livebait lining, longlining and shark-fishing in general during the day in tuna-fishing areas. On February 10, 1986, the Ministry of Defence and National Security issued a notice warning that action would be taken against fishermen found to be breaking these rules. Some restrictions on the exporting of shark products were also introduced in 1986 (shark meat and oil exporting was restricted to STO), but these were relaxed after a couple of years. Subsequently, on May 19, 1992, the Ministry of Fisheries and Agriculture issued a further notice (I'laan no. 16/92/29/FA.A1) revoking the earlier rule, but still banning livebait line fishing on tuna schools when pole-and-line fishing is being carried out.

These rules, and their own observations, mean that many tuna fishermen object to any form of pelagic shark fishing. However, pelagic shark stocks are the ones showing greatest potential for increased exploitation. Any development of an offshore shark longline fishery will have to take the attitudes of the tuna fishermen into account.

7.2 *Shark gillnetting* vs *tuna livebait fishing, diving, and reef-fishing*

Bottom-set gillnets are one of the major gear used for shark fishing in the Maldives. As such, shark-netting is a major source of income for fishermen and the country. Of particular significance is the fact that many gillnetters operate full-time. Despite, or perhaps because of, the importance of gillnetting there are several objections to it.

The great majority of tuna fishermen object to shark-netting as they believe that it "disturbs" the tuna livebait, resulting in reduced livebait catches. This general opposition is compounded by the fact that shark-netters move between atolls. Tuna fishermen have strong objections to fishermen coming from other areas and fishing on "their" reefs. As a result, gillnet buoys are often stolen and nets tampered with. Open confrontation, although far from common, is not unknown.

Divers also object to shark-netting. They see it as potentially the most damaging form of fishing to reef shark stocks. They also stress the dangers that nets pose for divers, but, given the clarity of Maldivian waters and the heavy construction of Maldivian shark nets, this danger is perhaps overstated.

At present, gillnet fishermen target shark but they do take other species (notably reef fish) as by-catch. There are plans on Dh. Bandidhoo to introduce 6" mesh nylon multifilament nets, specifically to take more reef fish (see page 8). If this trend spreads to other islands, the nature of the gillnet fishery could change, from one targeting shark to one targeting reef fish. Admittedly this is unlikely to happen overnight as long as shark fin prices are high and salt-dried reef fish prices are low. Also, reef fish stocks are at present underexploited, and there is room for expansion of the reef-fishing effort (Anderson *et. al.,* 1992). However, the experience of many other countries is that uncontrolled gillnetting can be extremely detrimental to coral reef fish stocks.

7.3 *Manpower requirements for shark* vs *tuna fishing*

With a population of only 230,000 **and a booming economy, the** Maldives is unusual among South Asian countries in having an acute labour shortage. Much foreign labour is imported. Within the Maldivian work force itself, there has been a shift from the less attractive fisheries sector to other more attractive sectors. As a result, the fisheries workforce is aging and declining in relative importance, despite a high population growth rate of about 3.4 per cent per annum (MPE, 1982).

Within the fisheries sector the fact that the fisheries are not saturated allows fishermen to shift between fisheries in order to maximize earnings. However, the Government of Maldives has made substantial investments in infrastructure for tuna exports. There is, therefore, much interest in keeping fishermen in tuna fishing.

Because of manpower shortages, at least one fishing island (H.A. Maarandhoo) has recently stopped shark-fishing. On several other islands, manpower shortages result in less shark-fishing than there would otherwise be. This in itself is not a problem; indeed, it means that shark resources are less likely to be overfished. For the country as a whole, however, the manpower shortage is undoubtedly causing reduced fisheries production and export earnings.

8
Conclusions and Recommendations

8.1 *Pelagic shark fisheries*

The oceanic shark resource is relatively largà and underexploited. There is scope for expansion of the offshore shark fishery. Fishing survey results (Anderson and Waheed, 1990) show that substantial shark catches can be made using shark longline. Fishing is best carried out from a relatively small vessel, perhaps 11-14m LOA. A modified *dhoni* is ideal; a larger vessel would require much higher investment costs and a larger crew.

The *dhoni* could be modified in two ways. First, by installing a self-winding hydraulic longline drum. This would allow a crew of about four to handle with relative ease a longline of about 400 hooks. Such a longline should produce catches in excess of one tonne a night. As the vessel may be out for three or four nights, or more, at a time, the second modification required is some form of crew accommodation. A wheelhouse with bunk space, a small galley and toilet should be sufficient.

If the shark meat is salted on board there may be no need to carry ice, although if ice were available it could be used for bait storage. As the vessel would be operating some distance offshore, due consideration should be given to crew safety. An outline sketch showing one possible configuration for such a vessel is given in Figure 11 (see facing page).

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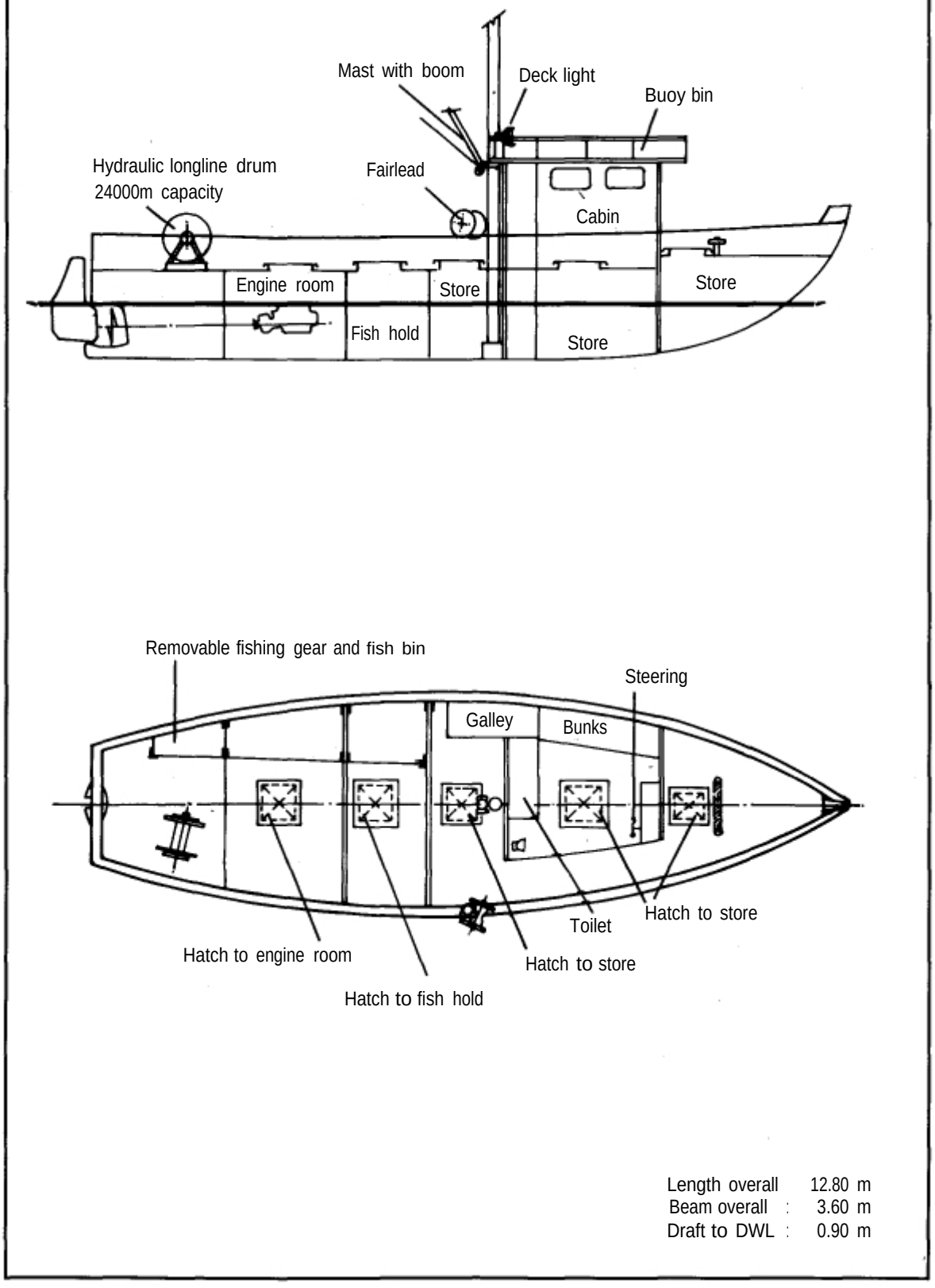
Fig. 11 Suggested configuration for an offshore shark longlining vessel, based on a second generation *dhoni* hull.



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It is recommended that MOFA encourages private fishing businesses to develop offshore shark longlining, using small -vessels of the type described above. MOFA could do this by broadcasting information about the potential of this fishery, and providing detailed technical information and assistance to interested parties.

There is potential for conflict with existing tuna fisheries. However, if regulations were introduced, the difficulties in monitoring and enforcing them would be enormous.

It is recommended that MOFA simply advises that any newly developed commercial shark longlining operations be restricted to fishing beyond a certain distance (for example 12 miles) offshore in order to minimize disturbance to the tuna fishery.

8.2 *Reef shark fisheries and tourism*

In the central part of the Maldives (particularly in An and Male Atolls), reef shark resources are being exploited by two competing users : shark fishermen and tourist divers. Diving brings very much more money into the country than shark fishing.

It is recommended that, as a first step, MOFA should recommend to the National Environment Commission that the country's most outstanding shark-watching site (Fish Head, or Mushimasmingili Thila, in Ari Atoll) be considered for protection. This protection should be in the form of a ban on all types of fishing within a radius of at least 1 km from the main reef.

Since shark can and do move considerable distances from their 'home' reefs, such protection may not by itself be entirely effective.

It is recommended that the use of gilinets within the tourism zone be reviewed (see pp. 41, 42, 45).

It is recommended, in view of the high frequency of diving at Fish Head, and the likelihood that this will increase if the site is protected, that MOFA suggests to the Ministry of Tourism that it request the Maldives Association of Tourism Industry (MATI) and the SCUBA Association of Maldives (SAM) to draw up a code of conduct for divers and dive boats visiting Fish Head, in particular, and dive sites, in general.

It is recommended that MOFA, through the Fisheries Advisory Board, asks the National Environment Commission to request the Ministry of Tourism to draw up a list of other priority dive sites to be considered for protection.

It is recommended that MOFA, through the Fisheries Advisory Board, and after discussion with the Ministry of Tourism, the Ministry of Planning and Environment, and MAT!, should consider banning the landing of shark by night-fishing resort parties.

8.3 *Deepwater Gulper Shark fisheries*

The deepwater Gulper Shark *(kashi miyaru)* stocks are very heavily fished, and probably overfished in many areas. This fishery would almost certainly benefit from a reduction in fishing effort. However, the difficulties of monitoring and enforcing fisheries regulations mean that there are really only two practical methods of controlling such a fishery: banning it or controlling exports. Banning the fishing of Gulper Shark is at present considered to be unnecessary and inappropriate.

It is recommended, as a first step, that MOFA disseminates information on the current status of the Gulper Shark fishery through radio broadcasts. The aim of these broadcasts should be to prevent any further investment by fishermen and boat-owners in the Gulper Shark fishery.

It is recommended, that the Economics Unit of MOFA, in consultation with MRS, study the various economic options *(e.g.* imposition of export duties or quotas for high-quality shark liver oil) as a means of regulating the fishery. Such a study would require some estimate of sustainable yields.

8.4 Monitoring and assessment of shark resources

The Maldivian shark resources are valuable and merit regdlar monitoring in order to provide information necessary for management advice. Detailed data on catch, fishing effort, species composition, size frequency, reproduction etc. need to be collected. A first priority must be the collection of biological data from the deepwater Gulper Shark fishery. The inclusion of a 'shark' category in the fisheries statistics collection forms is a step in the right direction, but this data must be compiled by gear if it is to be of any value.

In the long term, there is a fundamental need for further training of Marine Research Section staff, in order that data collected may be analyzed and interpreted, and management recommendations made.

It is recommended that priority be given to the training of MRS staff in fields related to fishery stock assessment and management.

It is recommended that as trained manpower becomes available, MRS should assign a fisheries biologist full-time to shark resource monitoring and management. The long-term managçment of oceanic shark resources will undoubtedly require international cooperation; MRS should endeavour to participate in any future international pelagic shark management activities.

8.5 *Extension*

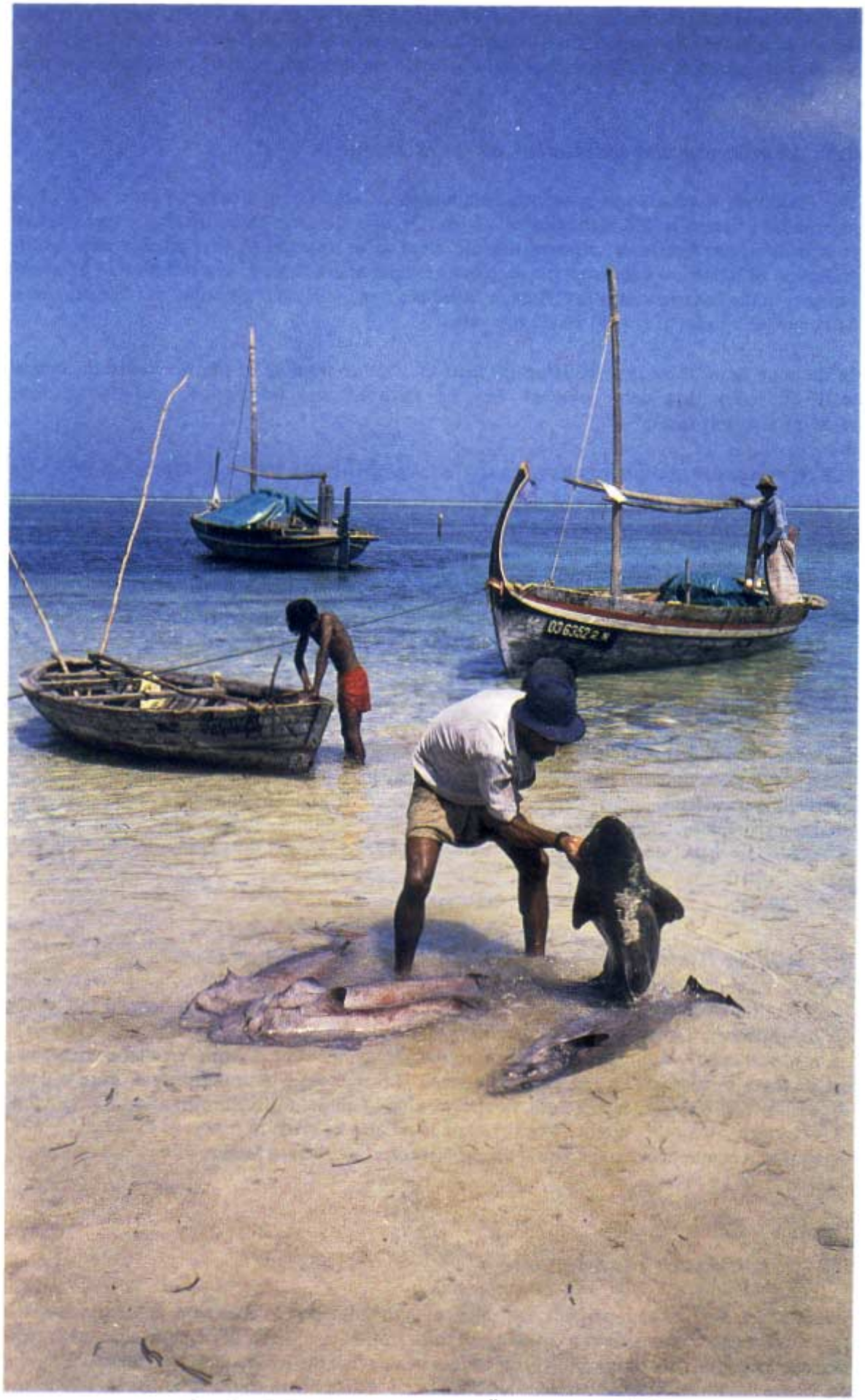
It is recommended that the Extension Section of MOFA, after consultation with MRS, should prepare extension material (for printing and broadcasting) to inform fishermen of the dangers of overfishing in general, and of the problems of the shark fisheries in particular. The potential of offshore shark longlining and correct shark processing techniques should also be disseminated. A booklet on shark, describing all these issues, could be prepared for distribution to fishermen and schools.

8.6 *Gillnet fishing*

In view of the strong opposition to shark gillnetting expressed by both tuna fishermen and tourist diving operators, it is recommended that MOFA give careful consideration to the future of shark-netting, particularly within the main tourism zone. It should be noted, however, that there are two major shark-netting islands (A. Dungati and A. Himendhoo) within the central tourism zone. A possible first step could, therefore, be the banning of gillnet fishing in Alifu and Kaafu Atolls by fishermen from other atolls. Consideration could also be given to means of encouraging atoll development committees to report fisheries problems and conflicts to MOFA with recommendations for action to be taken.

8.7 *Whale Shark conservation*

Whale Shark are rare and, perhaps, endangered, in the Maldives as elsewhere. It is recommended that MOFA give consideiation to banning all fishing of Whale Shark, taking into account the low monetary value of the existing fishery, the serious impact that the fishery may nevertheless be having on Whale Shark stocks, and the possible benefits of Whale Shark to the tuna fishery and to the tourist industry.



Landing Gulper Shark from a small dhoni *at Th. Vilufushi*

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APPENDIX I

Number of dhonis reported to be engaged In shark fishing in the islands visited during the shark fisheries survey (August-October 1992)

	Gillnetting		*Longlining*		*Spiny Dogfish*		*Others*
Island	*F/T*	*P/T*	*F/T*	*P/T*	*F/T*	*PIT*	*PIT*
HA. Huvarafushi	—	1	—	—	—	—	
H.A.Kelaa	—	—	—	—	—	—	—
H.A. Maarandhoo	—	—	—	—	—	—	—
H.A. Thakandhoo	—	—	—	—	—	1	—
H.A.Baarah	—	—	—	5	—	—	—
H.Dh. Kuthudhufushi	—	—	—	10	—	1	—
H.Dh. Makunudhoo	—	—	—	2	—	I	—
Sh. Kanditheem	—	2	—	5	—	35	*Madu miyaru*
Sh.Lhaimagu	—	—	—	3	—	—	—
Sh. Funadhoo	—	—	—	3	—	5	*Madu miyaru*
N.Kudafari	—	—	—	4	—	—	—
N. Manadhoo	—	—	—	15	—	20	*Whale Shark*
R.Alifushi	—	—	—	—	—	5	*Madumiyaru*
R.Vaadhoo	—	—	—	—	—	—	—
R. Kandholhudhoo	—	—	—	—	—	10	*Oivaali miyaru*
R. Maduvvari	12	17	—	12	—	—	—
R. Meedhoo	16	14	—	16	—	—	—
B. Dhonafanu	—	—	—	5	—	—	*Whale Shark*
B. Thulhadhoo	—	—	—	2	—	—	*Oivaali miyaru*
B.Goidhoo	—	—	—	6	—	—	—
Lh. Kurendhoo	—	—	—	—	4	6	—
Lh. Naifaru	—	—	—	—	—	—	*Oivaali miyaru*
K.Thulusdhoo	—	—	—	—	—	—	—
K.Malé	—	—	—	—	—	—	—
A. Dungati	12	—	—	—	—	—	—
A.Mahibadhoo	—	—	—	3	—	—	—
A.Maandhoo	—	2	—	2	—	—	—
A. Himendhoo	—	10	—	10	—	—	—
A.Ukulhas	—	—	—	7	—	—	—
A.Rasdhoo	—	—	I	—	—	—	—
A.Thoddoo	—	—	—	10	—	—	—
V. Keyodhoo	—	—	—	—	—	—	*Madu miyaru*
V.Rakeedhoo	—	—	—	3	—	—	—
M.Dhiggaru	—	—	—	—	—	2	—
M. Maduvvan	—	1	—	2	—	—	*Madu miyaru*
M. Mulaku	—	—	—	—	—	1	*Madu miyaru, Oivaali miyaru*
F.Magoodhoo	—	4	—	4	—	—	—
F.Feeali	—	16	—	8	—	—	—
Dh. Kudahuvadhoo	—	—	—	—	—	—	*Oivaali miyaru*
Dh. Maaeboodhoo	—	—	—	12	—	—	—
Dh. Hulhudheli	—	—	—	—	—	3	*Madu miyaru*
Dh. Bandidhoo	—	18	—	18	—	—	—
Dh. Meedhoo	—	—	—	24	—	I	*Madu miyaru*
Th.Vilifushj	—	8	—	12	—	10	—
Th. Hirilandhoo	—	2	—	5	—	1	*Madu miyaru*
Th. Kandoodhoo	—	—	—	4	—	3	*Madu miyaru*
L.lsdhoo	—	—	—	—	—	6	—
L. Dhabidhoo	—	—	—	—	—	2	—
L.Maabaidhoo	—	-	-	-	-	-	-
L.Mundoo	—	—	—	—	2	15	—
L. Maamendhoo	—	—	—	—	—	—	—
L. Maavah	—	—	—	2	—	2	*Oivaali miyaru*
S. Hithadhoo	—	—	—	3	—	3	*Oivaali miyaru*
S. Maradhoo	—	—	—	—	—	—	—
S.Feydhoo	—	—	—	—	—	—	—
TOTAL	40	95	1	217	6	133	—

Note: Excludes reef shark handlining

Abbr.: *(FIT* = Full-time PIT = part-time) H.A. = Haa Alifu H.Dh = Haa Dhaalu Sh. = Shaviyani N. = Noonu R. = Raa B. = Baa Lh. = Lhaviyani K. = Kaafu A. = Alif V. = Vaavu M. = Meemu F. = Faafu Dh. = Dhaalu Th. = Thu L. = Laamu S. Seenu

APPENDIX II

Maldivian shark names

In the Maldivian language (Dhivehi), shark are known as *miyaru.* A few individual species that are large, distinctive and have probably been subject to widespread fishing since early times have simple and distinctive names. For example

Femunu	Tiger Shark
Fehurihi	Whale Shark
Madu miyaru	Sixgill Shark

These names are used and recognized by fishermen throughout the length of the Maldives. However, for most shark species the situation is not so simple. Some common species are given different names in almost every island; some groups of shark are lumped together under 'catch-all' names; some shark appear to have no separate common name at all; some names may be used for completely different shark in different areas; and some fishermen may sometimes give or change shark names almost at whim.

The proliferation of names between islands and atolls is well illustrated by three common shark: the Silky Shark *(Carcharhinusfalciformis),* the Oceanic Whitetip Shark *(C. longimanus),* and the Blacktip Reef Shark *(C. melanopterus).* Listed on the following pages are 13, 19 and 19 names respectively for these species. In fact, in these cases, the situation is not as confusing as it might at first seem. For *C. falciformis,* most names are variations on a theme referring to the association of this species with tuna schools *(ainu)* or to its rather dark coloration *(kaihu).* Juvenile *C. falciformis* associate with floating objects *(oivaali)* and are universally known as *oivaali miyaru.* Most names of *C. longimanus* refer to the long pectoral fins *(kanfaiy)* and/or to its supposedly weak or slow nature ***(fee).*** Most names of *C. melanopterus* refer to its shallow lagoon habitat *(faihu)* and its pale brown coloration *(dhon).*

Some names are used for a number of different species. Thus, *aadhaige m!yaru* (Common Shark) refers to *C. falciformis* but also to *C. amblyrhynchos, C. melanopterus,* and *T. obesus. Loathandi miyaru* (brass bangle shark) can refer to any grey shark with a brassy sheen. *Dhon miyaru* (pale or white shark) can refer to any light-coloured species, and may even be used for some Gulper Shark that are slightly less dark than others.

Confusion that can arise over the use of the same name for different shark in different areas is illustrated by the Nurse Shark *(Nebriusferrugineus),* the Variegated Shark *(Stegostomafasciatum),* and the Whitetip Reef Shank *(Triaenodon obesus). N. ferrugineus* is widely known as *nidhan miyaru* (sleeping shark), *S. fasciatum* as *hitha miyaru* and *T. obesus* as *faana miyaru* (grouper shark). However, in M. Maduvvari, the names for *N. ferrugineus* and *S. fasciatum* have been swopped. Also, *T. obesus* is known as *hitha miyaru* in R. Meedhoo and *S. fasciatum* as *faana miyaru* in several central atolls.

Fishermen consider the Guitarfish *(Rajiformis, Rhinobatoidei)* to be shark; and call them *madi miyaru* (Ray Shark). Non-fishermen sometimes confuse *madi miyaru* and *madu miyaru* (Sixgill Shark). *Madu miyaru* are known as *madi miyaru* in Addu Atoll, but the fishermen there are well aware of the distinction.

It is clearly not always easy to communicate with Maldivian fishermen and to be sure that all parties are talking about the same species. The list on the following pages is therefore offered as a rough guide to some of the common names in use. The first and sometimes also second Dhivehi names listed for each species are recommended for general use as being distinctive and already widespread. It should be borne in mind that many names used by fishermen could not be assigned to species, and that several identifications are only tentative. Also, this list is far from comprehensive, particularly as no names from Gaafu Alifu and Gaafu Dhaalu Atolls are included.

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Names of Maldivian shark species

Scientific name	*English name*	*Dhivehi name*	*Area of use*	*Atoll*
Hexanchus griseus	Bluntnose Sixgill Shark	*Madu miyaru*	Widespread	
		Madi miyaru	Addu Atoll	Seenu
Centrophorus spp.	Gulper Shark	*Kashi miyaru*	Widespread	
	Spiny Dogfish	*Maa kashi miyaru*	H. Dh Makunudhoo	Haa Dhaalu
			Th. Vilufushi	Thaa
		Koalhi miyaru	Sh. Kanditheem	Shaviyani
		Kaathu miyaru	M. Dhiggaru	Meemu
Stegostoma fasciatum	Variegated Shark	*Hitha miyaru*	An Atoll	Alif
			F. Feeall	Faafu
		Faana miyaru	K., F., and	Kaafu, Faafu and
			Dh. Atolls	Dhaalu
		Oashikuri miyaru	Sh. Kaditheem	Shaviyani
			H.Dh. Makunudhoo	Han Dhaalu
		Ras miyaru	N. Kudafari	Noonu
		? *Olhufathi miyaru*	R. Meedhoo	Ran
		Nidhan miyaru	M. Maduvvari	Meemu
		? *Nidhanmaru*	R. Maduvvari	Ran
		Kunboa miyaru	R. Kandholhudoo	Ran
		Samara miyaru	V. Keyodhoo	Vaavu
Nebriusferrugineus	Tawny Nurse Shark	*Nidhan miyaru*	Widespread	
		Nidhanmaru	Northern Atolls	
		Nidhaa miyaru	N. Kudafari	Noonu
		Nidhanbara	Addu Atoll	Seenu
		Goimaru	Nothern Atolls	
		Goimiyaru	Dh. Makunudhoo	Dhaalu
		? *Gohmiyaru*	M. Maduvvari	Meemu
		? *Hila miyara*	R. Meedhoo	Ran
		Hitha miyaru	M. Maduvvari	Meemu
Rhincodon typus	Whale Shark	*Fehurihi*	Widespread	
Odontaspisferox	Smailtooth Sandtiger	*Theyo miyaru*	Ari Atoll	Alif
		Hikandhi thun miyaru	R. Vaadhoo,	Ran
			Addu	Seenu
		Meedha miyaru	Sh. Kanditheem	Shaviyani
			Dh. Bandidhoo	Dhaalu
Alopias superciliosus	Bigeye Thresher	*Kandi miyaru*	Widespread	
		Loabodu kandi miyaru	HA. Baarah	Han Alifu
		Nagoo miyaru	Addu Atoll	Seenu
Alopias vulpinus	Thresher Shark	*Kandi miyaru*	Widespread	
		Thandi miyaru	F. Magoodhoo	Faafu
		Nagoo miyaru	Addu Atoll	Seenu
Isurus oxyrinchus	Shortfin Mako	*Woshimas miyaru*	Widespread	
		Weshimas miyaru	Addu Atoll	Seenu
		Meshimas miyaru	Addu Atoll	Seenu
C. albimarginatus	Silvertip Shark	Kattafulhi miyaru	Widespread	
		Thila miyaru	Widespread	
		Thila kolu miyaru	Dh. Meedhoo	Dhaalu
		Vaadhili miyaru	An Atoll	Alif
		Voadhili miyaru	Ari Atoll	Alif
		Hiruelhi miyaru	F. Feeali	Faafu
		Urahakolhu hudhu miyaru	Dh. Maneboodhoo	Dhanlu
		Ushaakolhu hudhu miyaru	Th. Vilufushi	Than
C. altimus	Bignose Shark	Mendhan miyaru	Widespread	
		Mendhaa miyaru	Widespread	
		Mendhey miyaru	Widespread	
		Theyo miyaru	Widespread	
C. amblyrhynchos	Grey Reef Shark	Thila miyoru	Widespread	
		Thila koihu miyaru	V.and Dh. Atool	Vanvu and Dhaalu
		Thila kuri miyaru	M. Maduvvari	Meemu
		Thila kolhu dhon miyaru	F. Magoodhoo	Fanfu
		Vahboa miyaru	K. Mate	Kanfu
		Faanimaru	Northern Maldives	
		? Aadhaige miyaru	Sh. Lhaimagu	Shaviyani
		? Feeoasha miyaru	Th. Hirilandhoo	Than

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Scientific name	*English name*	*Dhivehi name*	*Area of use*	*Atoll*
C. falciformis	Silky Shark	*Oivaali miyaru*	Widespread (juv.)	
		Ainumathi miyaru	Widespread	
		Ainu miyaru	Widespread	
		Mas ainu miyaru	Widespread	
		Mas miyaru	Widespread	
		Aadhaige miyaru	Widespread	
		Loadhuni miyaru	HA. Baarah	Han Alifu
		Loadhandi miyaru	H.Dh. Kulhudhufushi	Haa Dhaalu
		? Kandu miyaru	R. Meedhoo	Ran
		? Medhu miyaru	R. Maduvvari	Ran
C. limbatus	Blacktip Shark	*? Loathandi miyaru*	Widespread	
		? Dhon miyaru	Th. Hirilandhoo	Than
		? Thun hima miyaru	Dh. Bandidhoo	Dhanlu
C. longimanus	Oceanic Whitetip	*Feekanfaiy miyaru*	Widespread	
		Bodukanfaiy miyaru	Ari Atoll	Alif
			F. Magoodhoo	Fanfu
		Kanfaiy bodu miyaru	Th. Vilufushi	Than
			F. Feeali	Fanfu
		Dhigukanfaiy miyaru	Dh. Maneboodhoo	Dhanlu
		Maakanfwy miyaru	Sh. Kanditheem	Shaviyani
		Feeboa miyaru	Widespread	
		Fee miyaru	Widespread	
		Feeuraha miyaru	L. Dhambidhoo	Lhaviyani
		Feeoasha miyaru	Dh., Th., and L. Atolls	Dhaalu, Than and Lhaviyani
		Bodufee miyaru	Th. Hirilandhoo	Than
		Koaka miyaru	Sh. and N. Atolls	Shaviyani and Noonu
		Madu miyaru	B. Thuthaadhoo	Baa
		Lhos miyaru	HA. Hoarafushi	Han Dhaalu
		Vaali miyaru	HA. Baarah	Han Alifu
		Goh kanfathi miyaru	V. and M. Atolls	Vaavu and Meemu
		Faalha miyaru	Dh. Meedhoo	Dhaalu
		Ishikulhu miyaru	S. Hithadhoo	Seenu
		Ushaakolhu hudhu miyaru	S. Maradhoo	Seenu
		7 &iafa(hi miyaru	S. Hithadhoo	Seenu
C. melanopterus	Blacktip Reef Shark	*Faihu mathi dhon miyaru*	Sh. Kanditheem	Shaviyani
			F. Feeali	Fanfu
		Falhu miyaru	K. and Lh. Atoll	Kanfu and Lhaviyani
		Falhu mathi miyaru	R. Maduvvari	Ran
		Falhu dhon miyaru	H. Dh. Makunudhoo	Han Dhaalu
		Falhu mathi mai miyaru	A. Rasdhoo	Alif
		Falha miyaru	S. Hithadhoo	Seënu
		Dhon miyaru	R., Sh., F. and Dh. Atoll	Ran, Shaviyani, Fanfu and Dhaalu
		Dhon fan miyaru	H. Dh. Makunudhoo	Han Dhaalu
		Dhon faiy miyaru	H. A. Kelan	Han Alifu
		Gondu miyaru	*Mi* Atoll	Alif
		Gondu dhashu miyaru	A. Himendhoo	Alif
			? Th. Vilufushi	Than
		Olhafathi miyaru	N. Manadhoo	Noonu
		Olhu miyaru	Dh. Kudahuvadhoo	Dhaalu
		Mendhan miyaru	H.A. Hoarafushi	Han Alifu
		Aadhaige miyaru	HA. Kelaa	Han Alifu
			S. Maradhoo	Seenu
		Ishakolhu miyaru	S. Feydhoo	Seenu
		Kalhu miyaru	? V. Keyodhoo	Vanvu
		Kalhafathi miyaru	F. Magoodhoo	Fanfu
		Kalhavathi miyaru	M. Maduvvari	Meemu
C. sorrah	Spottail Shark	*Thilaa kolhu dhon miyaru*	Ari Atoll	Ailf
		Dhon miyaru	Th. Atoll	Than
		Ura miyaru	A. Himendhoo	Alif
Galeocerdo cuvier	Tiger Shark	*Femunu*	Widespread	
		Femunu miyaru	Widespread	
		Alhigaa miyaru	Widespread	
		7Huras miyaru	Widespread	

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Scientific name	*English name*	*Dhivehi name*	*Area of use*	*Atoll*
Loxodon macrorhinus	Sliteye Shark	*Oashi miyaru*	Raa Atoll	
		Hikandhi thun miyaru	Kanfu	
		Olhufathi miyaru	Sh. Kanditheem	Shaviyani
		Loathandi miyaru	**M.** Maduvvari	Meemu
			Dh. Kudahuvadhoo	Dhaalu
Negaprion acutidens	Sicklefin Lemon Shark	*Olhufathi miyaru*	Widespread	
		Vani dhon miyaru	R. and Sh. Atolls	Ran and Shaviyani
		? Dhon miyaru	L. Manvah	Laamu
		Faana miyaru	Th. Hirilandhoo	Than
		Falhu femunu	Dh. Atoll	Dhaalu
Prionace glauca	Blue Shark	*Andhun miyaru*	Widespread	
		Garahitha miyaru	A. Mahibadhoo	Alif
Triaenodon obesus	Whitetip Reef Shark	*Faana miyaru*	Widespread	
		Uraha kolhu hudhu miyaru	R. Alifushi	Ran
			Dh. Bandidhoo	Dhanlu
		? Uraha kolhu dhon miyaru	F. Magoodhoo	Fanfu
		Ushakolhu miyaru	Addu Atoll	Seenu
		Uraha dhashu miyaru	Lh. Naifaru	Lhaviyani
		Hitha miyaru	R. Meedhoo	Ran
		Olhufathi miyaru	R. Maduvvari	Ran
		7 Aadhaige miyaru	N. Manadhoo	Noonu
		Thilakolhu miyaru	Dh. Meedhoo	Dhaalu
		Nidhanseyku	Th. Hirilandhoo	Than
Sphyrna lewini	Scalloped Hammerhead	*Kaaligandu miyaru*	Widespread	
		Kanoihi miyaru	B., A., F and Dh. Atolls	Baa, Alif, Fanfu and Dhanlu
		Ashigandu miyaru	F., Dh. and Th. Atolls	Fanfu, Dhaalu and Than
		Thelaagandu miyaru	Addu Atoll	Seenu
Rhina ancylostoma	Bowmouth Guitarfish	*Madi miyaru*	Widespread	
		? Kalhu madimiyaru	Lh. Naifaru	Lhaviyani
Rhynchobatus djiddensis	Giant Guitarfish	*Madimiyaru*	Widespread	
		Hikandithun madimiyaru	Widespread	
		Madi nidhan maru	R. Atoll	Raa
		Dhon madi miyaru	Lh. Naifaru	Lhaviyani
		Madimaa miyaru	M. Maquvvari	Meemu

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APPENDIX III

Accounts of shark species found in the Maldives

Biological information about shark in Maldivian waters is available for four sources:

- The exploratory offshore fishing survey carried out by MRS with assistance from FAO/BOBP (Anderson and Waheed, 1990). Original data are maintained at MRS.
- The reef fish resources survey carried out by MRS with assistance from FAO/BOBP (Van der Knaap et al., 1991; Anderson et al., 1992). Original data are maintained at MRS.
- This survey.
- Other published information.

To date, 26 species of shark have been positively identified from the Maldives. Four species (three *Centrophorus* and one proscylliid) have been collected but it has not been possible to name them at present. Four more species are believed, on circumstantial and anecdotal evidence, to exist in Maldivian waters. Thus, a total of 34 shark species are currently thought to be found in the Maldives. Many more species will no doubt be found as further studies are made. This applies particularly to deepwater shark: the seven species listed here are from a total of only 14 specimens.

At least two species of Guitanfish (Rajiformes, Rhinobatoidel) occur in the Maldives: Rhina ancylostoma and Rhyncobatus djiddensis. Although these are, strictly speaking, rays, Maldivian fishermen consider them to be shark, calling them madi miyaru. These two species are not dealt with here, but have been mentioned in Table 3 and Appendix II.

Summaries of biological information relating to shark collected in Maldivian waters are presented in the pages that follow. The order of presentation and the majority of the names used follow Compagno (1984). Where possible, a colour photograph of each species is included. Colour sketches are given for those species which have been positively recorded in the Maldives but for which no photograph is available. These sketches are based on Compagno (1984) with the kind permission of FAO.

Length-weight relationships for some species are presented in Table 15. Van den Knaap etal. (1991) recorded fork lengths of shark, and presented fork length-weight relationships for three species. Fork length-total length relationships for these species are presented in Table *15.*

Table 15. Summary of length-weight and length-length relationships for Maldivian shark (weight in kg, length in cm)

Relationship/species	*a*	*b*	*N*	*r*	*Length range*	*Source*
Fork length-Total length						
C. albimarginatus	1.210	3.417	38	0.99	58 – 102 cm FL	A
C. amblyrhynchos	1.183	5.584	21	0.99	58 – 92cm FL	A
Loxodon macrorhinus	1.103	9.885	57	O.%	63 – 73 cm FL	A
Fork length-Weight						
C. albimarginatus	0.6457	3.138	59	0.98	58 – 102cm FL	A
C. amblyrhynchos	0.3311	3.293	36	0.94	53 —92cm FL	A
Loxodon macrorhinus	1.708	2.736	289	0.78	47 – 76 cm FL	B
Total length-Weight						
C. albimarginatus	0.2239	3.216	47	.0.99	74 – 229 cm TL	A
C. amblyrhynchos	0.01264	3.337	23	0.98	73 – 144 cm TL	A
C. falciformis	0.8174	2.914	203	0.99	56— 257 cm TL	C
C. longimanus	1.822	2.780	65	0.99	74— 263 cm TL	C
C. sorrah	0.1267	3.327	16	0.99	69— 112cm TL	A

Note: 1. Relationships are of the form TL = a FL + band W = $ax\ 10^{-5} L^{b}$

2. N = numbers in sample; r = correlation coefficient.

Sources: A. Unpublished data at MRS.
B. Van der Knaap *et al.* (1991).
C. Anderson and Waheed (1990).

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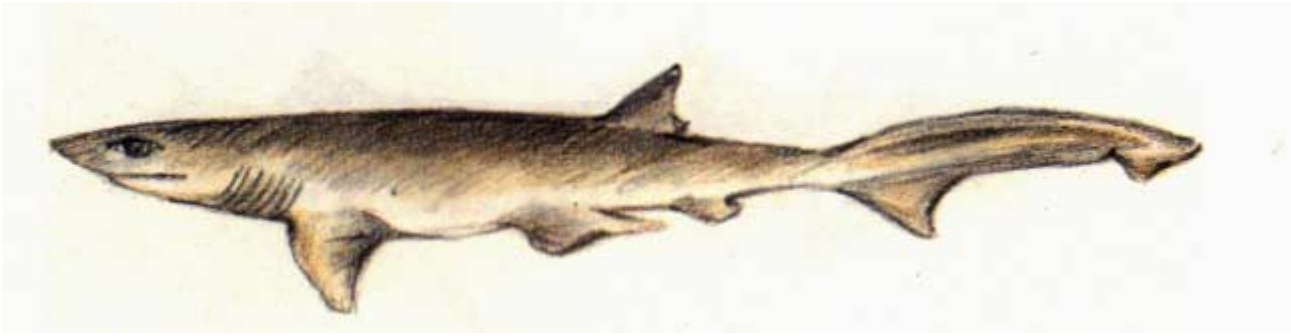
FRILLED SHARK *Chiamydoselachus anguineus* (Garman, 1884).

Not positively recorded from the Maldivies. However, many fishermen who fish for deepwater Gulper Shark report occasional catches of a species known as *yen miyaru* (eel shark). Since deepwater eel are also taken as by-catch in this fishery, many fishermen say that *yen miyaru* is not a shark. A minority of fishermen, however, say that *yen miyaru* is, indeed, a shark and tentatively identified it from drawings as *C. anguineus.*

SHARPNOSE SEVENGILL SHARK *Heptranchias perlo* (Bonnaterre, 1788).

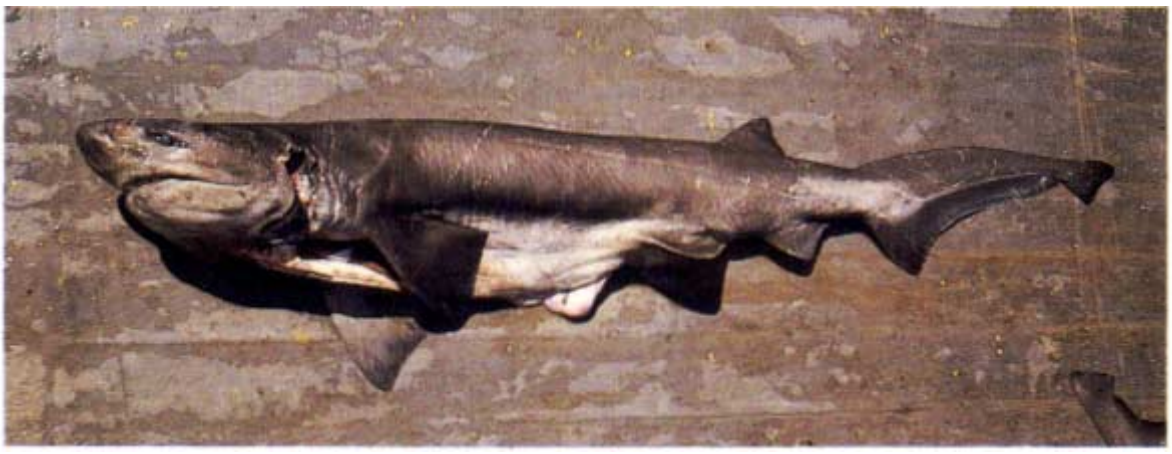
A single specimen of 8.4 kg was recorded by Stromme (1983). It was caught by bottom trawl in 248m about 4 km east of A. Thoddoo on August 22, 1983 by the Norwegian research vessel *Dr. FridtjofNansen* during an UNDP/FAO fish resources survey. Probably taken by Maldivian fishermen in the deepwater shark fishery as *madu miyaru,* but not seen by us.



Sharpnose Sevengil Shark

BLUNTNOSE SIXGILL SHARK *Hexanchus griseus* (Bonnaterre, 1788).

A single female of 195cm TL was observed by R C Anderson on R. Ailfushi on October 4, 1990. The jaws were preserved. It was reported to have been caught in about 400m. From fishermen's descriptions, this appears to be the main species known as *madu miyaru. Madu* means slow or soft, a reference to their behaviour and to the texture of their meat. Reported to be relatively common in 200 m+ on outer atoll slopes throughout the Maldives.



Bluntnose Sixgill Shark

BRAMBLE SHARK Echinorhinus brucus (Bonnaterre, 1788).

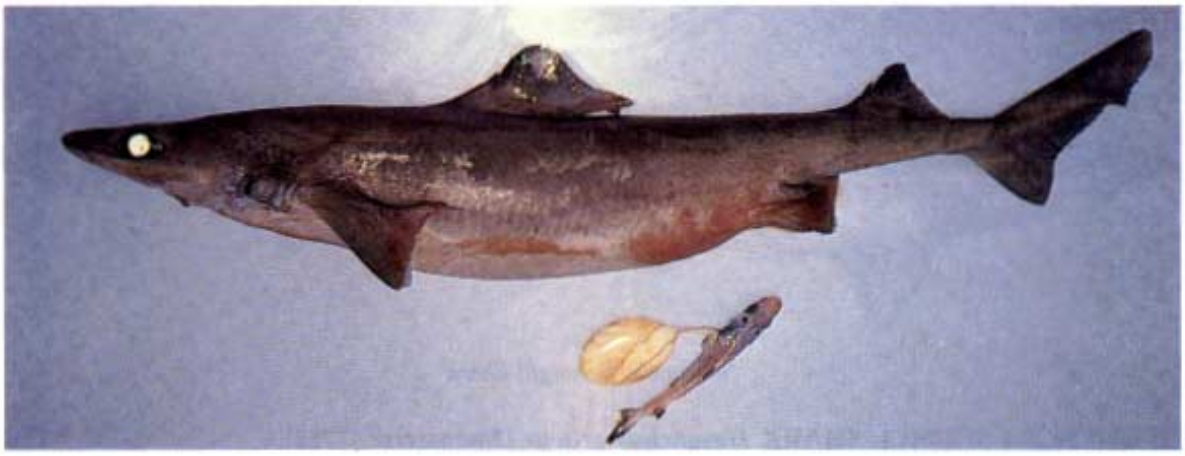
Not positively recorded from the Maldives. However, many fishermen who fish for deepwater Gulper Shark report occasional catches of a large spine-covered shark known as *berebedhi miyaru. Berebedhi* is a thorny tree (Indian coral tree, *Erythrina variegata).* Fishermen consistently identified this species from drawings as *Echinorhinus brucus.*

GULPER SHARK *Centrophorus* spp.

Gulper Shark are common in Maldivian waters where they are known in Dhivehi as *kashi miyaru* (Spine Shark) and in English as Spiny Dogfish. They form the basis of the deepwater shark liver

oil fishery ***(kashi miyaru keyolhu kan).*** This fishery peaks during the calm of the Northeast Monsoon, so there was little activity during the period of this survey. As a result only seven specimens were seen (one on L. Mundoo on October 1, 1992, and six on Th. Vilufushi on October 29, 1992). In addition, Anderson saw and collected material from three specimens on R. Alifushi on October 4, 1990. These ten specimens are believed to represent three species. However, the taxonomy of *Centrophorus* is not well worked out and it is not currently possible to assign names to these putative species with any degree of confidence.

All three have sessile, block-like denticles, thus belonging to a group which Compagno (1984) characterized as being "particularly troublesome". Compagno (pers. comm., January 30, 1992) was unable to positively name two Alifushi specimens sent to him for identification. Much further work will be needed to sort out this problem. Material collected from the specimens seen during this survey has been sent to Dr. Compagno.



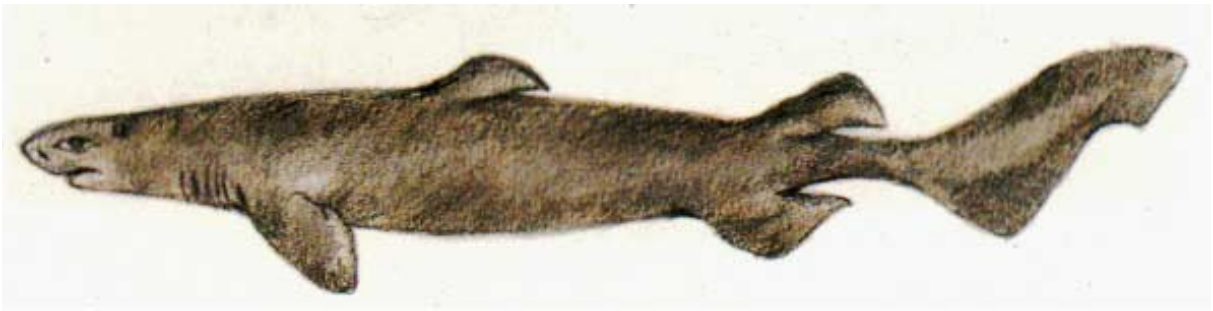
Gulper Shark

KITEFIN SHARK *Dalatias licha* (Bonnaterre, 1788)

A single set of dried jaws was purchased from a fisherman on L. Isdhoo on September 30, 1992. The shark from which they came was caught "some time before" on a deep vertical longline set for Gulper Shark. The fishermen called this shark *kashineh miyaru* (no spine shark).

It is apparently rare; the jaws were collected only because this species had not been seen before. The jaws are preserved at MRS (catalogue no. MRS - 0397 - 92) and have the following dental formula: 8 - 1 - 8 / 9 - 1 - 9. (See photo, p. 21).

This specimen constitutes a new record for the Maldives and, apparently, for the central Indian Ocean.



Kitefin Shark

COOKIE-CUTTER SHARK Isistius brasiliensis (Quoy and Gaimard, 1824)

Not positively recorded from the Maldives. However, during the exploratory offshore fishing survey (Anderson and Waheed, 1990), two fish (a large Skipjack Tuna and a Swordfish) were caught which each had a smooth almost hemispherical crater about 3cm in diameter in its belly (Anderson, pers. obs.). This might have been caused by ***I.*** *brasiiensis.* The two fish were caught on consecutive nights (August, 8-9 and 9-10, 1988) approximately 75 km east of Thaa Atoll.

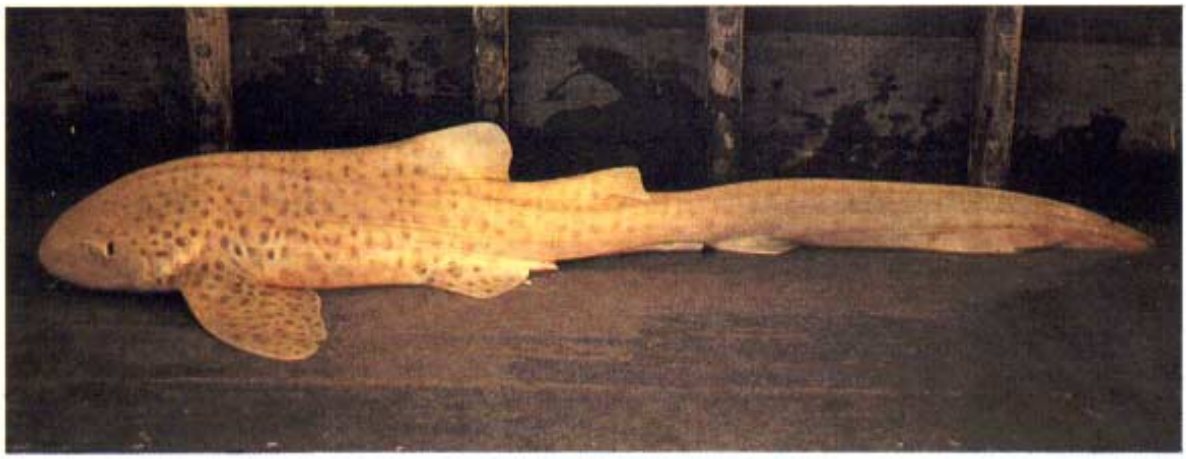
VARIEGATED SHARK *Stegostoma fasciatum* (Hermann, 1783)

Previously recorded from the Maldives by Compagno in Fischer and Bianchi (1984) and MRS (1988). This species does not appear to be especially common in the Maldives. It is most often known as *hitha miyaru.* It occurs mainly in the atoll basins. *S. fasciatum* is occasionally taken by bottom-set gillnet or bottom-set longline. It is occasionally seen resting on the bottom by divers.

During the reef fish resources survey (Van der Knaap *et al.,* 1991; Anderson *et al.,* 1992) ten specimens were caught, all by bottom-set longline within the atolls. These ranged in length from 112cm to 180cm TL (average weight 19.6kg). The Variegated Shark may be more common in the north Maldives than the south, if catch rates during the reef fish survey are a reliable indication:

Shaviyam Atoll	0.06 shark / 100 longline hooks	Ari Atoll	0.02 shark / 100 longline hooks
N. Male Atoll	0.01 shark /100 longline hooks	Laamu Atoll	0.00 shark /100 longline hooks

Given the very small numbers involved, these catch rates may not be representative. Nevertheless, there is some anecdotal evidence to support the suggestion of latitudinal variation in abundance. Fishermen from the northern Maldives readily recognized drawings of *Stegostoma fasciatum;* fishermen from the southern Maldives had some difficulty identifying drawings of this species; and fishermen from Addu Atoll do not know of this species at all.



Variegated Shark

TAWNY NURSE SHARK *Nebrius ferrugineus* (Lesson, 1830)

Previously recorded from the Maldives by Compagno in Fischer and Bianchi (1984) and MRS (1988). Widely known in the Maldives as *nidhan miyaru* (Sleeping Shark). This is a bottom-dwelling, reef-associated species that usually rests in caves during the day. The same caves maybe used for extended periods of time, and some become well-known to divers. Caught at night using bottom-set gillnet, bottom-set longline and handilne. Table 9 gives details of three small individuals caught by bottom-set giinet near Sh. Kanditheem on August 26, 1992. Four *N. ferrugineus* were caught by bottom-set longline and night handline during the reef fish resources survey (Van der Knaap *et al.,* 1991; Anderson *et al.,* 1992). These ranged in length from 134 to 226 cm TL (the largest illustrated in Anderson *et al.,* 1992, p.25, plate *5).*

•*N. ferrugineus* is used mainly for salt-dried meat production, but there was a small market for large, live individuals for stocking resort 'shark pools'. Five or ten years ago shark pools were something of a fashion, and about ten resorts each had one, but now only one or two remain. Old pools have been removed or filled in, and new ones are not being built. Because *N. ferrugineus* is some what more reef-associated than *Stegostoma fasciatum,* it is seen more often by divers. It appears to be more vulnerable to night handlining, but was less vulnerable to the longlines used in the atoll basins during the reef fish resources survey.

WHALE SHARK Rhincodon typus Smith, 1829

Previously recorded from the Maldives by Compagno (1984) and MRS (1988). This massive, open water shark is well known to Maldivian fishermen who call it *fehurihi.* The Whale Shark feeds on plankton and small schooling fish, and, in the Maldives, appears to migrate seasonally to the

areas where such food supplies are most abundant. During the Northeast Monsoon season (December to April) the current flows from east to west. During the Southwest Monsoon season (May to November) the current flows from west to east. As the currents pass across the Maldives, there is considerable upwelling, mixing and stirring up of sediment. As a result there is a plankton bloom on the 'downstream' side of the Maldives. This appears to be particularly pronounced in the north and central Maldives where the double atoll chain may promote greater mixing, and where the monsoonal reversal is strongest (Anderson, 1992; Woodroffe, in press).

Figure 12 (see facing page) shows the seasonal distribution of Whale Shark in the Maldives as reported by fishermen in interviews and questionnaires. In the north and central Maldives, Whale Shark are seen most commonly on the eastern side of the Maldives (and the eastern side of western atolls) during the Southwest Monsoon. During the Northeast Monsoon, the opposite is true:

Season	*% observations on 'west'*	*% observations on 'east'*	*No. obs.*
SWMonsoon	10	90	30
NEMonsoon	78	22	36

In the south, there is no such obvious seasonal pattern. Fishermen invariably say that they see Whale Shark when bait *(i.e.* livebait for tuna pole-and-line fishing) is abundant. The most important single livebait species is the Silver Sprat or *rehi (Sprateioides gracilis);* this occurs most frequently on the western side of the Maldives during the Northeast Monsoon and on the eastern side during the Southwest Monsoon (Anderson and Hafiz, 1988).

SMALLTOOTH SANDTIGER *Odontaspisferox* (Risso, 1810)

This shark has not been seen by us, but its jaws, with their spectacular teeth, are highly prized and often seen for sale in tourist shops. One set of jaws purchased from a Male shop (catalogue no. MRS-402-92) was reputed to be from B. Kendhoo (see photo, p. 21). Its dental formula is:

$$\frac{19\text{-}4\text{-}2\text{-}1\text{—}1\text{-}2\text{-}4\text{-}20}{20\text{-}2\text{—}1\text{-}22}$$

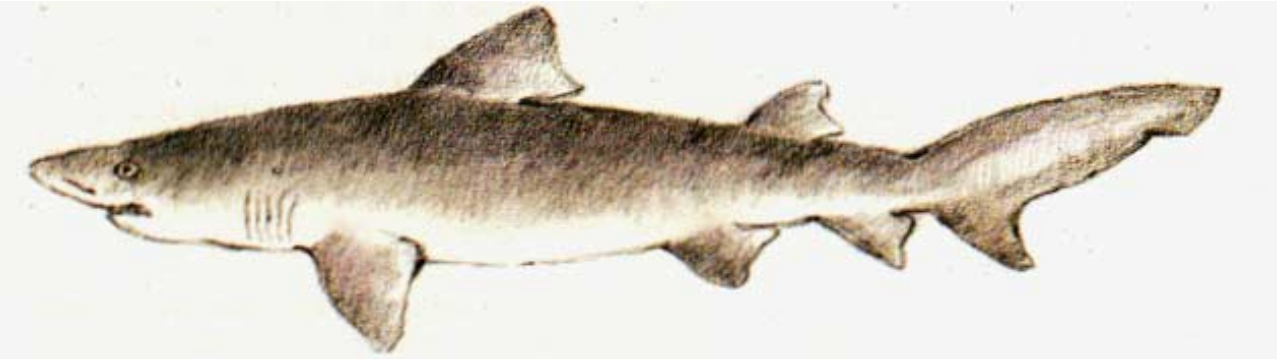
Five other jaws from the same source had dental counts within the following ranges:

$$\frac{17/19\text{-}4\text{-}2\text{-}1/2\text{—}1\text{-}2\text{-}4\text{-}18/19}{17/19\text{-}1\text{—}1\text{-}16/19}$$

Only one jaw had two upper symphysial teeth on one side; in all other cases there was only one upper symphysial tooth on each side. One set of jaws seen at A. Dungati had three, not four, rows of small intermediate teeth between the upper anterior and lateral tooth rows. Teeth appeared to have two, not three pairs of cusplets. Djfferentiation between lower anterior and lateral teeth was often unclear, so separate tooth counts were not made.

This shark is known locally as *theyo miyaru* (oil shark, on account of it large liver) and as *meedha miyaru* (rat shark, on account of its appearance). Fishermen report that this is a fat shark growing to at least 3m. It is plain coloured, without spots. Fishermen cannot recognize it from drawings in Compagno (1984) or Compagno *et al.* (1989).

0. ferox is reputedly caught on outer reef slopes from intermediate depths (about lOOm) by bottomset gillnet. It may also be taken at somewhat greater depths as by-catch in the vertical longline fisheries for Sixgill Shark and Gulper Shark. This report is the first record of *0. ferox* for the Maldives and, apparently, in the.central Indian Ocean.



Smailtooth Sandtiger

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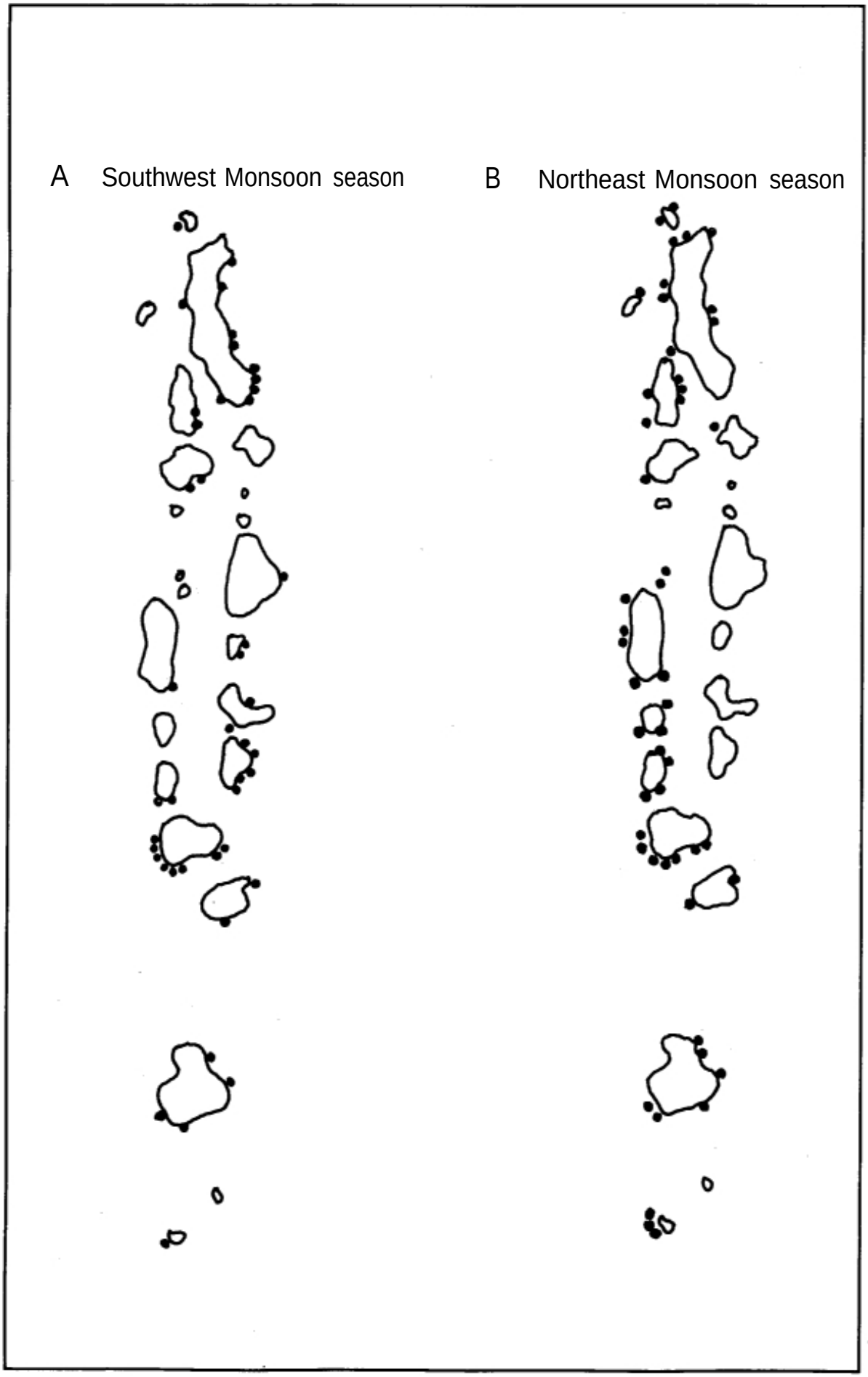
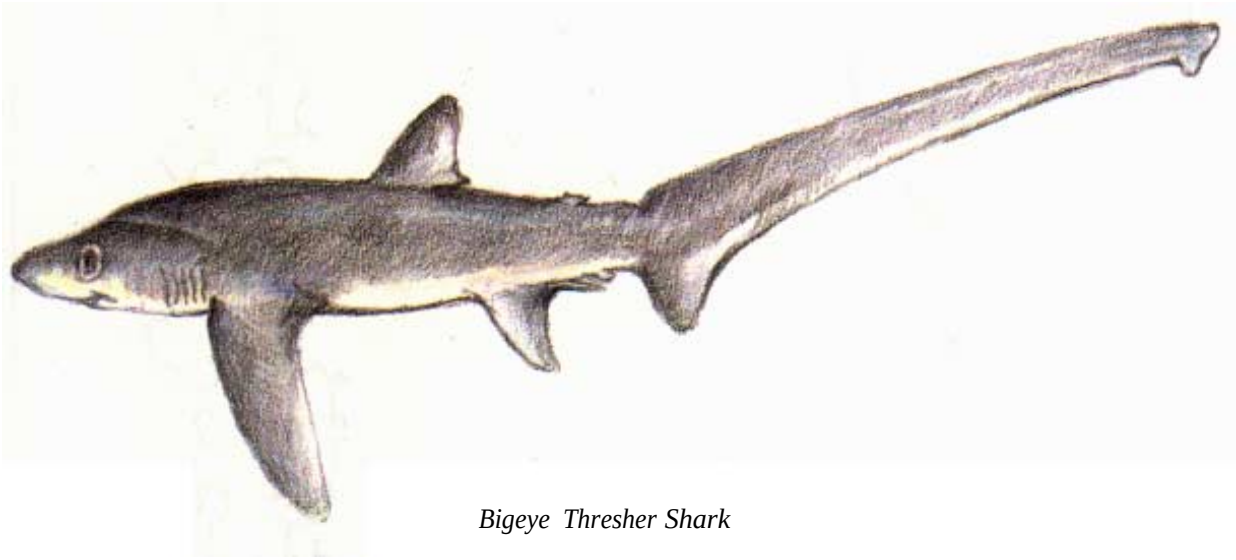
Fig. 12 Seasonal distribution of Whale Shark *(Rhincodon typus)* in the Maldives as reported by fishermen.



BIGEYE THRESHER SHARK *Alopias superciiosus* (Lowe, 1839)

Previously recorded from Maldivian waters by Gubanov (1978), as was *A. vulpinus.* Not seen by us, although we have seen dried Thresher tails. These two species are relatively common in Shri Lankan waters (R. Maldeniya, NARA, Colombo, and J. Moron, IPTP, Colombo, pers. comm.). They were also consistently identified by Maldivian fishermen from the colour drawings in Compagno *etal.* (1989). The third Thresher species, *A. pelagicus*, was not mentioned by Gubanov (1978). It is apparently not common in Shri Lankan waters and was never identified by Maldivian fishermen.

Thresher Shark are known in Dhivehi as *kandi miyaru* (Sword Shark). They are not especially common: none was taken during the exploratory offshore fishing survey (Anderson and Waheed, 1990). They do, nevertheless, appear to form a regular if infrequent component of pelagic shark longline catches. Fishermen from F. Feeali, however, report high catch rates of Thresher Shark in one area of the Alihuras Kandu (the 'inland sea' between the two rows of atolls in the central Maldives) during periods when the current is from the south.



Bigeye Thresher Shark

THRESHER SHARK *Alopias vulpinus* (Bonnaterre, 1788)

Previously recorded from the Maldives by Gubanov (1978) and Compagno (1984). See comments for *A. superciliosus* above.

Thresher Shark

SHORTFIN MAKO *Isurus oxyrinchus* Rafinesque, 1809

Previously recorded from the Maldives by Compagno (1984) and MRS (1988). A single female of 150 cm TL, weighing 22 kg, was caught by longlimng during the exploratory offshore fishing survey (Anderson and Waheed, 1990). Maldivian fishermen know this species as *woshimas miyaru. Woshimas* is the Dogtooth Tuna, *Gymnosarda unicolor.* The strong, symmetrical tail of the Shortfin Mako is apparently reminiscent of that of the Dogtooth Tuna.

I. oxyrinchus is taken regularly but infrequently by pelagic longline. Its jaws are highly prized; large examples may sell for more than US $ 1000 in Male, although US $ 200-400 is a more usual price. This species is considered to be potentially dangerous by Maldivian fishermen.

Shortfin Mako

FAMILY PROSCYLLIIDAE

Anderson collected a male 565 mm TL proscylliid shark from R. Alifushi on October 4, 1990. It was taken in about 400m by vertical longline together with one *Hexanchus griseus* and three *Centrophorus* spp. It represents an undescribed genus and species, intermediate between *Gollum* and *Pseudotriakis* (L.J.V. Compagno, pers. comm., January 30, 1992, May 27, 1992). Iwo other western Indian Ocean specimens are known at present, in German and Russian collections (Compagno, pers. comm.).

Proscylliid Shark

STARSPOTTED SMOOIH-HOUND *Mustelus manazo* (Bleeker, 1854).

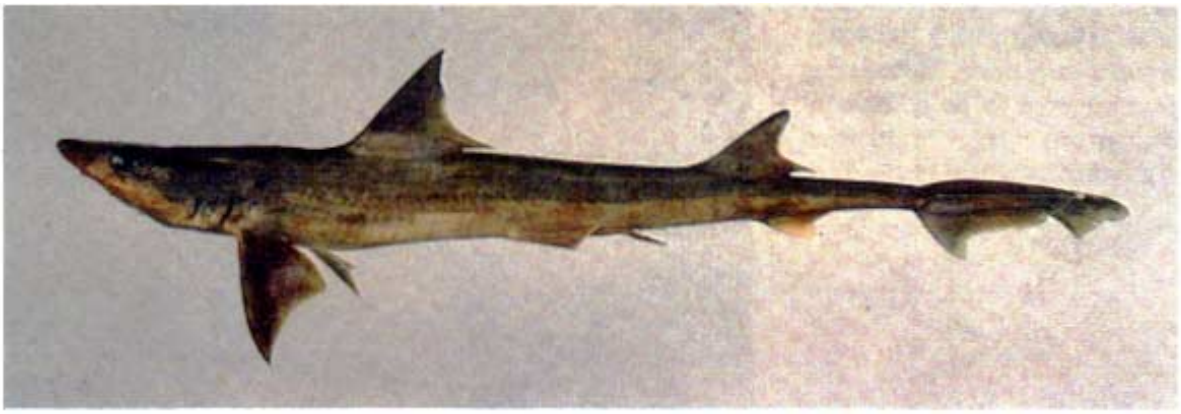
Ihis species was recorded by MRS (1988) as *Mustelus mosis*, but a 71cm specimen from the Maldives has been identified by P.C. Heemstra (pers. comm. to J.E.Randall) as *M. manazo*. Heemstra noted that this specimen has an unusually large internarial space. Also, Maldivian specimens are not obviously white-spotted. During the reef fish resources survey, six specimens were caught, all by bottom longline set in 150-200m outside the atolls. Details are as follows:

Date	*TL(cm)*	*Wt(kg)*	*Sex*	*Stomach*	*Depth*	*Location*
23.11.87		2.5		?	150-200	K. Makunudhoo
23.11.87	96	2.9	F	Crab	150-200	K. Makunudhoo
23.11.87	117	5.7	F	Crab	150-200	K. Makunudhoo
14.3.91	71	1.1	F		180m	K. Giraavaru
15.7.91	101	4.0	F	Lobster	150m	L. Gaadhoo
16.7.91	85	1.9	F	Shrimp	190m	L. Gaadhoo

Ihe 85cm TL specimen was noted to have the tips of its dorsal fins edged with black, those of the 'other fins' with white.

Only 'fork Iengths' were recorded for the three specimens caught in November 1987. These have been converted to total-lengths based on the proportions of the three 1991 specimens.

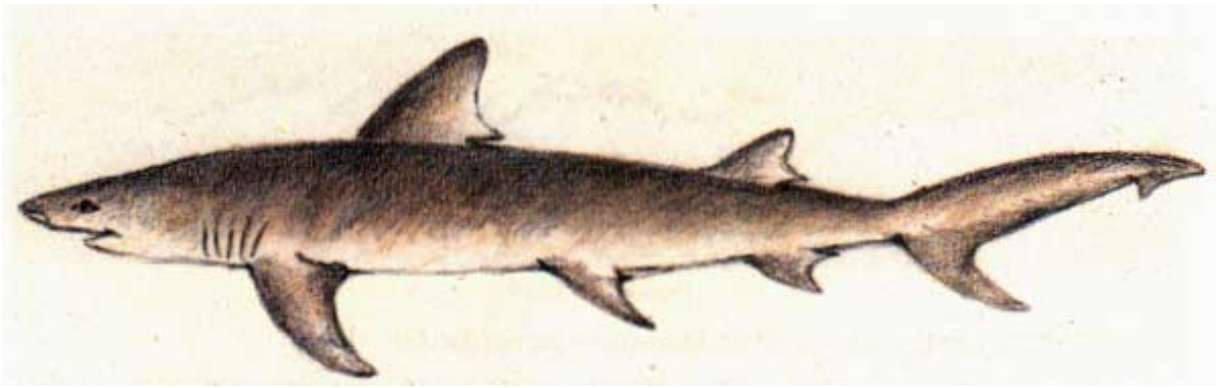
Note that all five specimens for which sex was recorded were females and all four specimens for which stomach contents were determined had eaten crustaceans.



Starspotted Smooth-Hound

SNAUGLETOOTH SHARK *Hemipristis elongatus* (Klunzinger, 1871)

A single set of jaws and the accompanying fin set wtre seen aboard a shark-netting *dhoni* from .R. Maduuvariri, in Haa Dhaalu Atoll. The shark from which they came was caught by bottomset gilinet outside H.A. Baarah on August 23, 1992. It was reported to be about five feet *(i.e.* 1.5m) long (see photos on pages 21 and 27). The dental formula was: 14 - 14/17 - 17. This is within the range noted for *H. elongatus* by Bass *et al. (*1975). There was a toothless space at the midline of each jaw. The central upper teeth were very fine, hooked and not serrated. The lower teeth were serrated on the outer edge only, and had one or two cusps on each side. *H. elongatus* appears to be rare in the Maldives, this being the first record. The fishermen collected these jaws only because they had never seen this species before. Randall (1986) notes that this species is "not known from any oceanic islands".

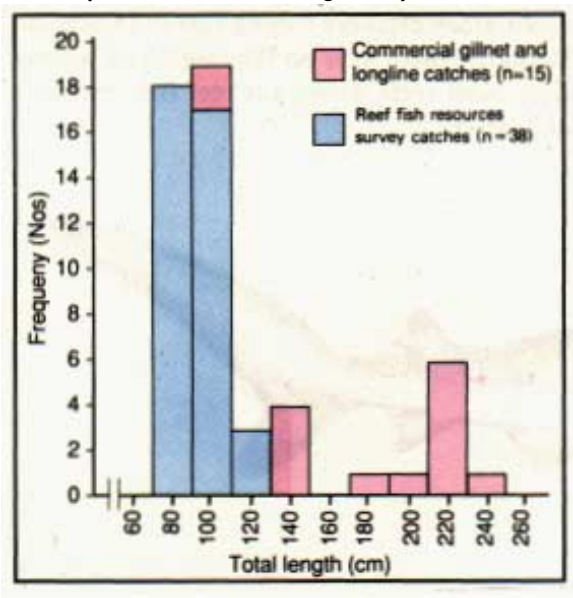


Snaggletooth Shark

SILVERTIP SHARK *Carcharhinus albimargjnatus* (Ruppell, 1837),

This species appears to be widely distributed and relatively common throughout the Maldives. It has previously been recorded by MRS (1988). It is known locally as *kattafuihi miyaru,* a reference to the distinctive white edging of its fins *(kattafuihi* is the barred flagtail, *kuh!ia mugil).* It is taken by a variety of commercialgear including longline inside and outside the atolls, bottomset gilinet and handline. Only large individuals were caught offshore during the exploratory offshore fishing survey (Anderson and Waheed, 1990); six individuals were all between 205cm and 233cm TL. This is probably a true reflection of the absence of juveniles from offshore waters (Compagno, 1984). In contrast, only juveniles (74 to 125 cm TL) were caught during the reef fish resources survey (unpublished data, MRS). This demonstrates the abundance of juveniles in the atolls, but is probably not a true reflection of adult abundance. The light gear aimed at reef fish that was used during that survey was not suitable for catching large shark.

Fig. 13. Length Frequency Distribution for Silvertip Shark *(Carcharhinus albimarginatus)*



Large Silvertip Shark are caught adjacent to the atolls by Maldivian fishermen (including the Silvertip Shark listed in Table 9). Available length frequency data are summarized in Figure 13. There was no obvious seasonality in the occurrence of the smallest shark caught during the reef fish resources survey; juveniles of 74-80 cm TL were taken in February, March, May, June and November. The sex ratio of 57 juvenile Silvertips (74 to 125cm TL) was 0.51 ±0.13 males: 0.49 ±0.13 females: (Note that all sex ratios are presented as estimated frequencies ± approximate 95 per cent confidence limits). Of 57 stomachs examined, 40 were empty, twelve contained remains of fish, three contained cephalopod remains, and four contained unidentified material reminiscent of tea leaves.

Silvertip Shark

BIGNOSE SHARK *Carcharhinus altimus* (Springer, 1950)

This species was identified from two sets of jaws from A. Ukulhas. These jaws (MRS-0380-92 and one set sent to the South African Museum, Capetown) constitute the first record of this species from the Maldives. Their respective dental formulae are:

$$\frac{14\text{-}1\text{-}16}{14\text{-}2\text{-}14} \quad \text{and} \quad \frac{15\text{-}1\text{-}15}{15\text{-}1\text{-}15}$$

A photograph of teeth from the MRS specimen is included on page 20. Maldivian fishermen report that *C. altimus* is taken almost exclusively by pelagic longline. This is surprising, as accounts of the biology of this species tend to categorize it as a bottom-dwelling shark found on the deeper parts of continental shelves and insular slopes, usually in 90m-430m *(e.g.* Bass *et al., 1*973; Compagno, 1984; Randall, 1986).

Maldivian fishermen report that this species is only taken outside the atolls, and the areas where it is reported to be caught appear to be those where the bottom depth is of the order of 200m - 500m. For example, the two specimens from A. Ukulhas were taken north of A. Thoddoo where the bottom depth is about 300m. *C. altimus* is reported to be common in the Alihuras Kandu, *i.e.* the 'inland sea' between the two rows of atolls in the northern and central Maldives where the bottom depth is about 250m - 450m. It seems, therefore, that *C. altimus* may, in the Maldives at least, be a vertical migrator, moving from the bottom at 200m - 500m in the day, to nearer the surface at night. The most widely used Maldivian name for this species, *mendhan miyaru* or midnight shark, may be a reference to the time at which it is most likely to be caught. (Another widely used name, *theyo miyaru* or oil shark, is a reference to its large liver).

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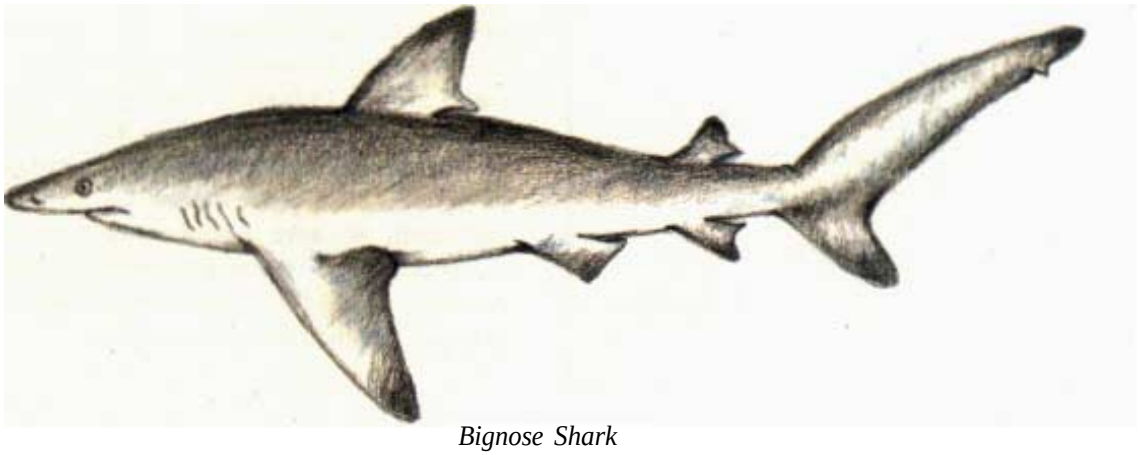
Both sets of jaws had (benthic?) stingray barbs embedded in their lower mandibles, although that from the MRS specimen is now lost. It may also be of significance to note that of the 429 shark caught between 30 nm and 100 nm offshore by the exploratory offshore fishing survey (Anderson and Waheed, 1990), not one was a Bignose Shark. Similarly, there were no Bignose Shark among 650 shark taken inside the atolls and on the immediate outer reefs during the reef fish resources survey (Van der Knaap *et al.,* 1991; *Anderson et al.,* 1992).

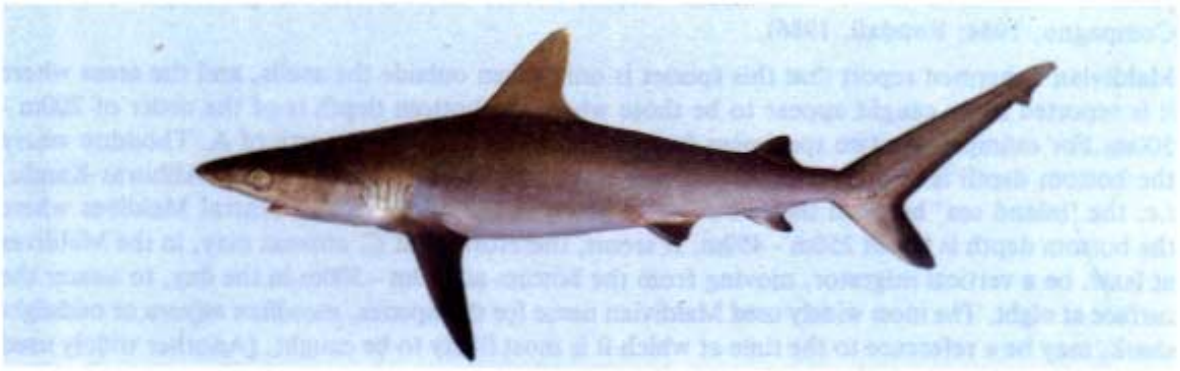


Bignose Shark

GREY REEF SHARK *Carcharhinus amblyrhynchos* (Bleeker, 1856)

Previously recorded from the Maldives by Klausewitz (1958), Eibl-Eibesfeldt and Hass (1959), MRS (1988), Nahke and Wirtz (1991), and Randall (1992). We follow Randall (1986, 1992) in considering *C. wheeleri* to be a synonym of *C. amblyrhnchos*. The Grey Reef Shark is a very common reef-associated species in the Maldives. Its association with submerged reefs *(thila),* particularly in channels, gives this species one of its Dhivehi names *(thila miyaru).* The Grey Reef Shark forms a major part of catches by bottomset gillnet, bottomset longline and handline. During the reef fish resources survey (Van der Knaap *etal.,* 1991; Anderson *etal,* 1992) only juveniles were caught because of the light gear used. The sex ratio of 36 juveniles (71cm to 115cm TL) was 0.56 ±0.16 males : 0.44 ±0.16 females. Divers note that mature females are the shark seen most often at shark-watching dive sites (see p. 36). Divers also note that Grey Reef Shark show two types of seasonal movements.

The first type of movement is related to the seasonal changes in monsoon currents. Groups of shark congregate near the mouths of channels running into the atolls that are exposed to the prevailing currents. They therefore appear to be found in greatest numbers on the western sides of atolls during the Southwest Monsoon (May to November) and on the eastern sides during the Northeast Monsoon (December to April). The second type of movement is that of mature females which disappear from some sites for a few weeks every year between March and May. This is believed to be related to breeding. The only breeding data available is that of a 144cm TL female caught on August 24, 1992 in HA. Atoll which contained two embryos, of 48cm and 49cm TL. The smallest free-swimming individual recorded during the reef fish resources survey was one of 53.5cm TL, *i.e.* about 69cm TL (unpublished data, MRS).



Grey Reef Shark

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SILKY SHARK *Carcharhinus falciformis* (Bibron, 1839)

The Silky Shark is an abundant offshore species. It has previously been recorded from the Maldives by MRS (1988). It was by far the most abundant species of shark taken during the exploratory offshore fishing survey, nearly 70 per cent of all shark taken being of this species (Anderson and Waheed, 1990). From that survey, carried out off the eastern side of the Maldives, the following information was obtained:

- Small Silky Shark (56cm - 130cm TL)were most abundant during the Northeast Monsoon. This is consistent with the experience of Maldivian fishermen who know that juvenile Silky Shark *(oivaali miyaru)* congregate under floating objects *(oivaali)* and drift with the prevailing currents.
- Large Silky Shark (170cm - 260cm TL) were most abundant during the Southwest Monsoon. This is also consistent with the experience of Maldivian fishermen who believe that adult Silky Shark *(ainumathi miyaru)* associate with free-swimming tuna schools *(ainu)* which swim into the current.
- Intermediate-sized Silky Shark (130cm - 170cm TL)were under-represented in survey catches, perhaps as a result of differential migration.
- The smallest Silky Shark taken (four individuals of 56cm-63cm TL)were all much smaller than the sizes at birth quoted by most authorities, *i.e.* 70cm to 87cm (Compagno, 1984; Randall, 1986) . However, Branstetter (1987) noted that some Silky Shark in the Gulf of Mexico might be born as small as 55cm TL. Maldeniya and Suraweera (1991) too have recorded the presence of Silky Shark of about 60cm TL in Shri Lankan gillnet catches. The four small Maldivian shark were all caught in December 1987 and November 1988. Yet another small Silky Shark (60cm TL) was observed by Anderson in Male Market in December 1990. This suggests that there may be seasonal gestation, with a parturition peak in November to December. Further study, particularly from the west coast of the Maldives, will be required to test this suggestion.
- Sex ratio varied with size:

56-169cm TL (n = 101)	0.49 ±0.10 males:	0.51 ±0.10 females
170-239cm TL (n = 122)	0.68 ±0.08 males:	0.32 ±0.08 females
240-260cm TL (n = 11)	0.18 ±0.23 males:	0.82 ±0.23 females
56-260cm TL (n = 234)	0.58 ±0.06 males:	0.42 ±0.06 females

Sivasubramanium (1969) also noted an excess of males in longline catches of *C. falciformis* in the north-central Indian Ocean.

- Catch rates for all gear were over three times higher off the north and central Maldives than off the southern Maldives. For shark longline the following catch rates were obtained:

North/Centre in NE Monsoon: 2.9/100 hks

North/Centre in SW Monsoon: 4.1/100 hks

South in SW Monsoon : 1.0/100 hks

Average : 2.9/100 hks

A MRS staff member measures juvenile Silky Shark at R. Kandoludhoo

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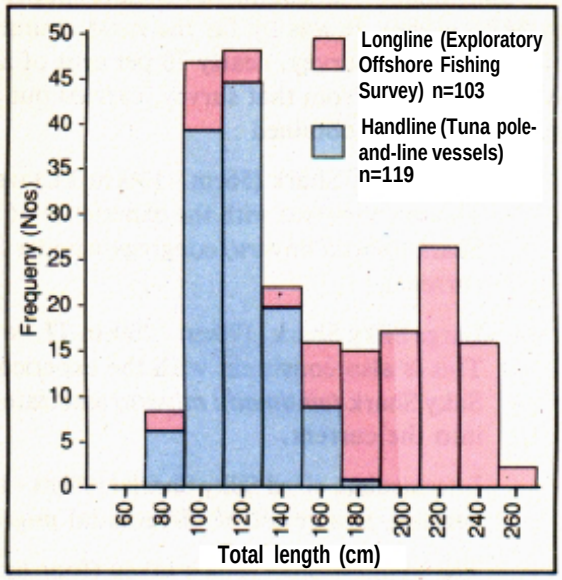
There are two main commercial fisheries in Maldives for Silky Shark. These are pelagic longlining for large specimens, and seasonal fisheries for small individuals. As mentioned earlier, schools of juvenile Silky Shark are associated with floating objects *(oivaali)*. These are carried to the Maldives by the monsoon currents, so tend to be found off the west coast in the SW Monsoon season, and off the east coast in the NE Monsoon season. Fishermen search out these drifting objects because tuna, especially Yellowfin Tuna (Anderson, 1985)., and other fish aggregate underneath. It is reliably reported that juvenile Silky Shark are caught by hand after being attracted alongside the fishing boat with a dead tuna dangled overboard. They are also taken by handline. Length frequency histograms of samples from the two fisheries are presented in Figure 14.

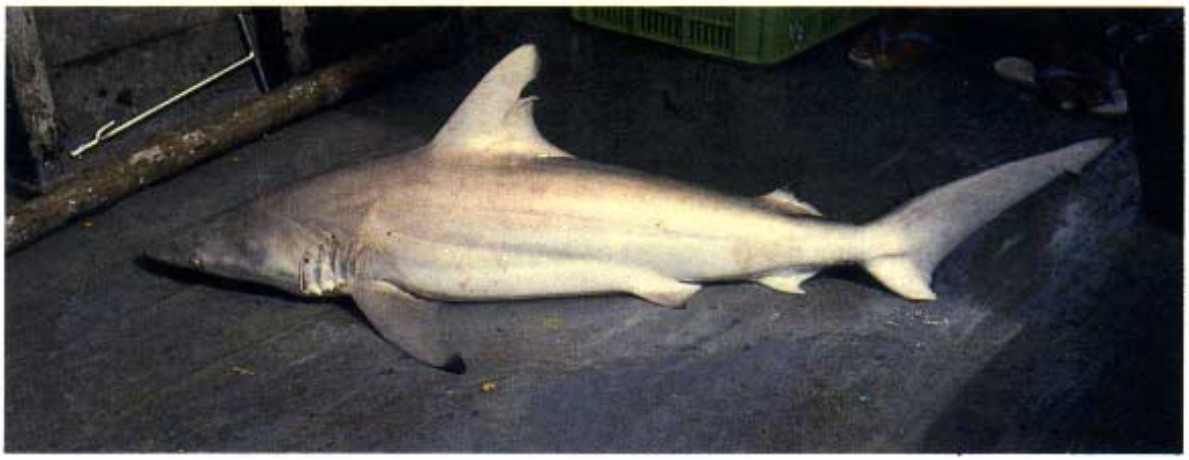
Fig 14. Length Frequency Distribution for Silky Shark *(Carcherhinus falciformis)*



BLACKTIP SHARK *Carcharhinus limbatus* (Valenciennes, 1839)

The only record of *C. llmbátus* from the Maldives is that of four specimens (77-111cm TL) all taken inside Laamu Atoll during the reef fish resources survey (Anderson *et al.*, 1992). All of them were noted to be remarkably active when landed on the boat. The depths of capture of all were about 40-50 m. These shark had black tips to their dorsal, pectoral and pelvic fins, but not on their anal fin or lower caudal lobe. The leading edge of the caudal fin was touched with black. There was an interdorsal ridge. The dental formula of a 82cm TL specimen was: 15 - 3 - 15 / 15 - 1 - 15.

It was noted that the 111 cm TL specimen had 14 rows of lateral teeth on each side of the upper jaw.



Blacktip Shark

OCEANIC WHITETIP SHARK *Carcharhinus longimanus* (Poey, 1861).

Previously recorded from the Maldives by Compagno (1984) and MRS (1988). During the exploratory offshore fishing survey, 23 per cent of all shark caught were of this species (Anderson and Waheed, 1990). That survey produced the following results:

- There was some evidence of vertical size segregation, with large individuals being caught deeper than small ones.
- There was some evidence of sexual segregation. The overall sex ratio was 0.42 ±0.11 males : 0.58 ± 0.11 females (n = 74, size range 74-263cm TL). The excess of females was most noticeable within the length range 110-179cm TL, where the sex ratio was 0.29 ±0.14 males : 0.71 ±0.14 females, a significant departure from 1: 1.

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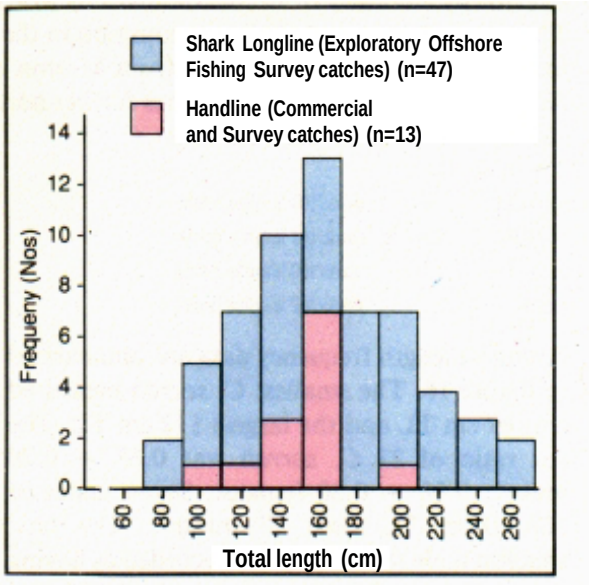
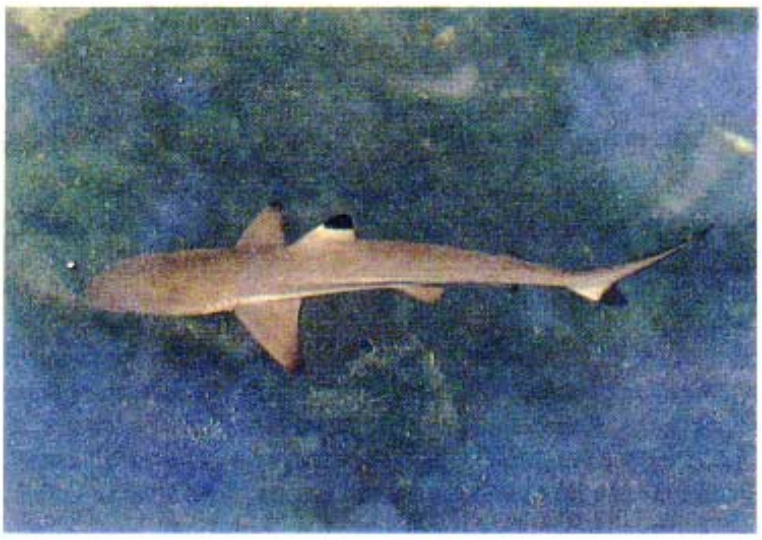
– There was some evidence of geographic segregation, with Oceanic Whitetip Shark catch rates- being twice as high south of 3 degrees N as they were north of that line. This is the opposite of the situation with Silky Shark.

Oceanic Whitetip Shark are taken commercially by pelagic shark longliners and incidentally by tuna fishermen, using handlines, who happen to see them. Available length frequency data are summarized in Figure 15. The Oceanic Whitetip Shark has a large number of Maldivian names (see Appendix II), but most of them refer to the long and distinctive pectoral fins.

Fig. 15. Length Frequency Distribution for Oceanic Whitetip Shark *(Carcharhinus longimanus)*



Oceanic Whitetip Shark



Blacktip Reef Shark

BLACKTIP REEF SHARK *Carcharhinus melanopterus* (Quoy and Gaimard, 1824)

Previously recorded from the Maldives by Klausewitz (1958), Compagno (1984) and MRS (1988). This is not a deep-dwelling species, being found in shallow lagoons *(faihu,* hence one Maldivian name for this *species, falhu miyaru)* as well as on reefs from 0m to 30m or, sometimes, more. Its shallow water habitat means that it may be seen by snorkellers and by beachwalkers more commonly than any other shark. It is also taken more frequently by gillnets set in lagoons than other shark species *(e.g.* those specimens listed in Table 9). It is not common on deeper reefs or in the atoll basins. Only two of 650 sharks taken during the reef fish resources survey (Van der Knaap *et al.,* 1991; Anderson *et al.,* 1992) were *C. melanopterus.* As with the Nurse Shark (see page 55) there was a very small market for live Blacktip Reef Shark to stock resort shark pools.

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SPOTTAIL SHARK *Carcharhinus sorrah* (Valenciennes, 1839)

Previously recorded from the Maldives by MRS (1988) and Anderson *et al.* (1992, figure on p.23). This species appears to be more common in the south Maldives than in the north. It has been seen in commercial handline catches from Meemu Atoll and commercial longline catches from Thaa Atoll, but not in commercial catches further north. Catch rates by atoll during the reef fish resources survey were (MRS, unpubl. data):

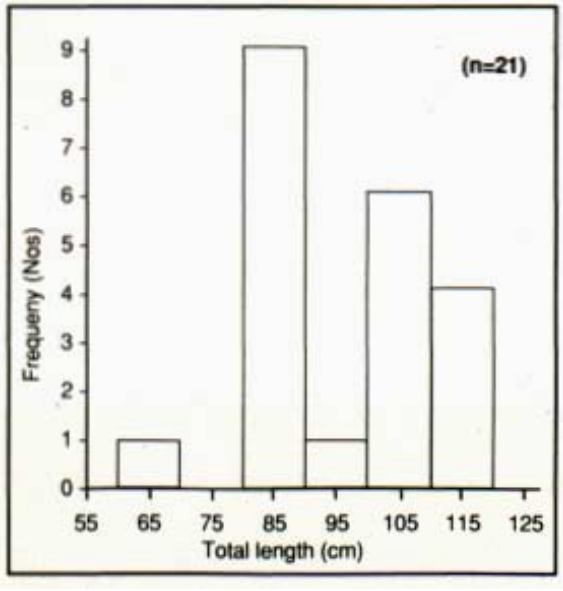
Shaviyani	0	shark/100 longline hooks
N. Male	0.01	shark/100 longline hooks
An	0.02	shark/100 longline hooks
Laainu	0.14	shark/100 longline hooks

Available length frequency data **are** summarized **in Figure 16. The smallest *C. sorrah* measured was 69 cm TL** and **the largest 112 cm TL. The sex ratio of 21 *C. sorrah* was 0.67 ±0.20 males : 0.33 ±0.20 females. Seven males of 108-110cm TL were all mature. The next smallest male (86cm TL)** was **recorded as having "claspers starting to grow". A female of 112 cm TL was recorded as having "developing embryos". The tooth counts of** three **specimens were:**

$$\frac{12 - 1 - 12}{11/12 - 1 - 11/12}$$

Six **of 16 stomachs examined contained food. Four contained fish, two crustaceans.**

Fig. **16. Length Frequency Distribution for Spottail Shark *(Carcharhinus sorrah)***



Spottall Shark

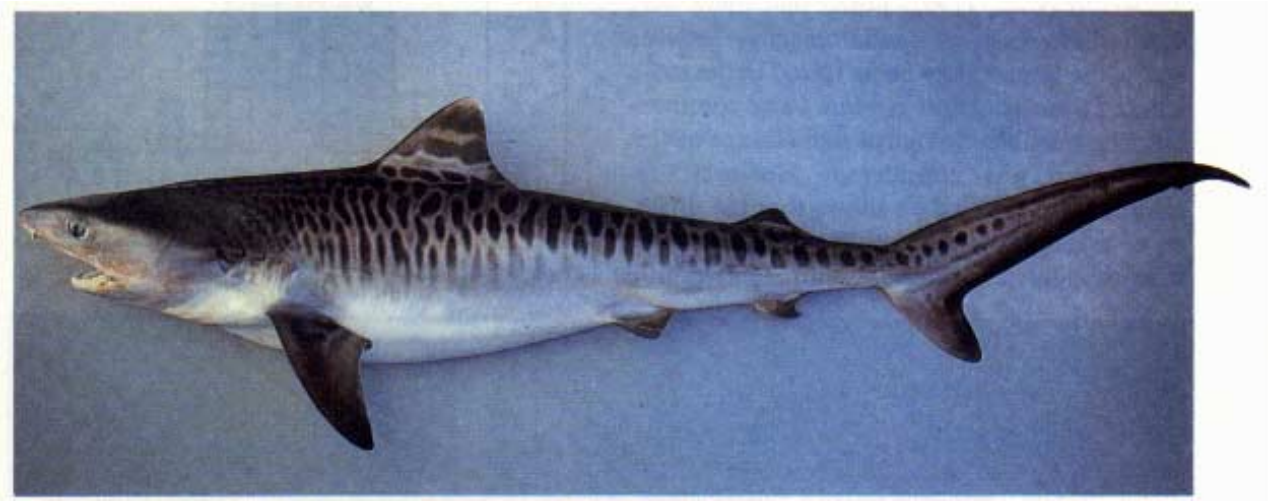
TIGER SHARK Galeocerdo cuvier (Peron and Lesueur, 1822).

Previously recorded from the Maldives by Compagno in Fischer and **Bianchi (1984) and MRS (1988). The Tiger Shark is widespread throughout the Maldives, and well known to Maldivian fishermen, who call *itfemunu.* Particularly large specimens which have lost their distinctive stripes** and **are uniform pale grey in colour** are **sometimes** called ***al higaa miyaru.***

Large Tiger Shark have enormous livers, which yield substantial quantities **of oil suitable for** treating **wooden *dhonis.* These shark have therefore been subject to a** specialized **fishery *(maa keyolhu kan,* see page 4) in the Maldives from ancient times. Reliable fishermen report that Tiger Shark about 6m long were sometimes taken by this fishery, although shark of 2-4m were more frequent. Randall (1992b) notes that the largest Tiger Shark actually measured appears to be one of 5.5m from Cuba, but that lengths of up to 6m** are **likely. During the exploratory offshore fishing survey, Tiger Shark of 2.1** - 3.0m **were caught by pelagic longline over 30 nm offshore (Anderson** and Waheed, 1990).

During the reef fish resources survey, nine Tiger Shark of 76 to 132cm TL were caught by light bottomset longlines within the atolls. Maldivian fishermen report that the best longline catches of Tiger Shark are made in the intermediate zone, outside the atolls but not too far offshore. Fishermen report that Tiger Shark and Bignose Shark (see page 61) are often caught together.

Four of six juveniles (83-132cm TL) caught had food in their stomachs. This included a Porcupinefish *(Diodontidae),* a Parrotfish *(Scaridae),* other unidentified fish, a Mantis Shrimp *(Stomatopoda)* and a chicken's foot and feathers. Cetaceans are known by Maldivian fishermen to be a favourite food of Tiger Shark. Dolphin were the preferred bait for *maa keyolhu kan.* In September 1992, fishermen from B. Kendhoo were reported to have caught 12 Tiger Shark that had been feeding on the rotten carcass of a whale drifting in the ocean outside Baa Atoll.



Tiger Shark

SLITEYE SHARK *Loxodon macrOrhinus* (Muller and Henle, 1839).

Previously recorded from the Maldives by MRS (1988). This small shark was caught in large numbers in the atoll basins by bottomset longline during the reef fish resources survey (Van der Knaap *et al.,* 1991; Anderson *et aL,* 1992). In fact, about 70 per Cent of all. sharkcaught during that survey were of this species. Major findings were:

- *Loxodon macrorhinus* was caught exclusively in the atoll basins. It appears to be much more common in the north than in the south, if longline catch rates are an accurate indication:

Shaviyani	1.26 shark/100 longline hooks
N. Male	1.80 shark/100 longline hooks
Mi	0.52 shark/100 longline hooks
Laamu	0.09 shark/100 longline hooks

- *L. macrorhinus* shows remarkable sexual segregation. In Shaviyani, Ari and Laamu Atolls, only males were caught. There may be a seasonal component to this sexual segregation; most females were caught November- February, when much longlimng was carried out in N. Male Atoll, but little in other atolls.

- *L. macrorhinus* shows remarkable size segregation. Only two specimens of less than 80cm TL were recorded. Length-frequency data are summarized in Figure 17 (overleaf). The largest specimens measured in each of four atolls were:

Shaviyani	91 cm TL (n = 123)
N. Male	94 cm TL (n = 144)
Ari	89cmTL(n = 49)
Laamu	84 cm TL (n = 5)

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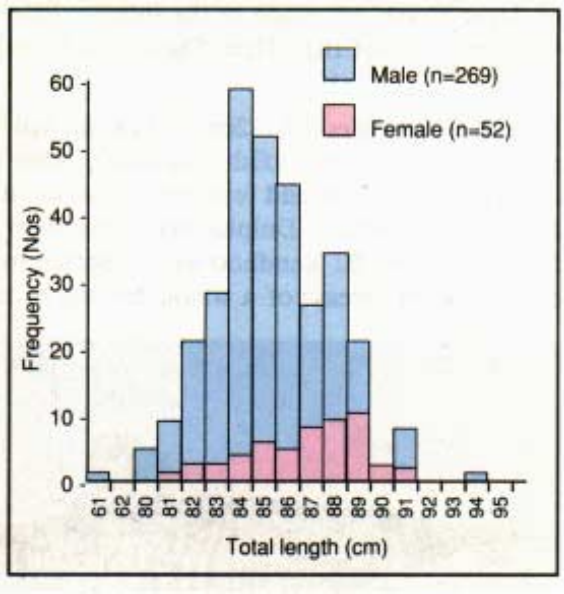
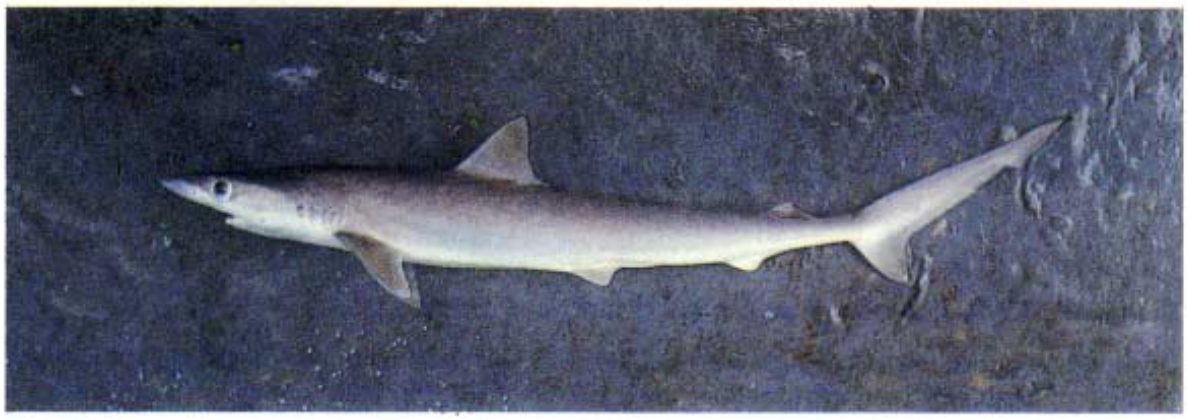
The previously recorded maximum length for this species appears to be 91cm TL (Wheeler, *1959;* Springer, 1964; Compagno, 1984). Females tend to be larger than males (Figure 17), but the 94 cm specimen was a male. A *95* cm male was recorded from N. Male Atoll by MRS (1988); it was caught during initial trials for the reef fish resources survey (Van der Knaap *et al.,* 1991) and so was not included among the 144 specimens noted above.

In addition to the maximum size differences, Anderson *et al.,* (1992) noted that there were small differences in modal lengths between atolls, the largest sizes being found in the atolls where *L. macrorhinus* appears to be commonest. The possible biological significance of this correlation was considered. However, re examination of the data shows that the differences in lengths between atolls are much smaller than thought, and probably not significant.

Fig. 17. Length Frequency Distribution for Sliteye Shark *(Loxodon macrorhinus)*





Sliteye Shark

SICKLEFIN LEMON SHARK *Negaprion acutidens* (Ruppell, 1837)

Previously recorded from the Maldives by Compagno in Fischer and Bianchi (1984). This species appears to be widespread, but uncommon in the Maldives. One of its Maldivian names *(faihu femunu,* shallow lagoon Tiger Shark) reflects both its sometimes shallow habitat and its potentially dangerous nature. One set of jaws (catalogue no. *MRS-375-92)* has the following dentition: 14-2-13/14-1-13.

It is possible that some posterior lateral teeth were removed during the cleaning of these jaws. The 249cm TL female listed in Table 9 was caught by dropline just outside north An Atoll on September *15,* 1992. It contained ten embryos of 58 to 63cm TL.

Sicklefin Lemon Shark

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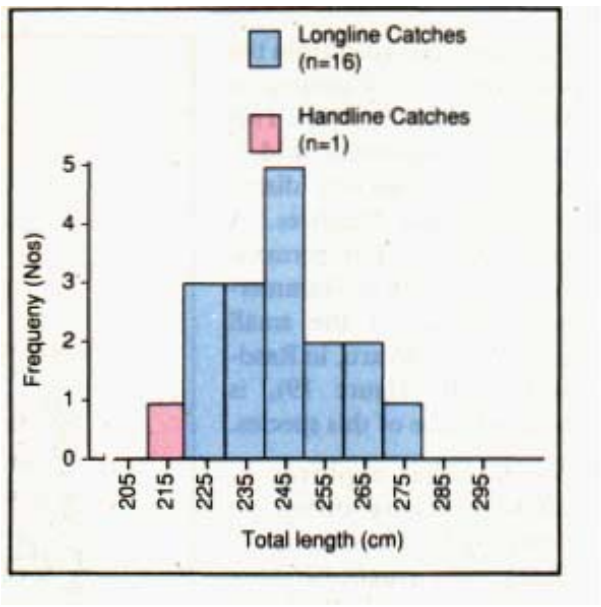
BLUE SHARK *Prionace glauca* (Linnaeus, 1758)

Previously recorded from the Maldives by Gubanov and Grigoryev (1975), Compagno (1984), MRS (1989), and Anderson and Waheed (1990). This is a large, offshore species, and is sometimes taken by pelagic longline. It does not appear to come very close to, or even inside, the atolls as *C. falciformis* and *C. longimanus* occasionally do. Most Blue Shark in Maldivian waters appear to be medium-sized males, according to two separate surveys

	Gubanov and Grigoryev (1975)	*Anderson and Waheed (1990)*
Mean length (cm)	232	244
Length range (cm)	190-273	219-273
Mean weight (kg)	50.7	56
Percentage male	96	94
Number	71	17

Fig. 18. Length Frequency Distribution for Blue Shark *(Prionace glauca)*



For both samples combined, the sex ratio is 0.95 .+ 0.04 males : 0.05 .±0.04 females. Figure 18 summarizes length frequency data from the exploratory offshore fishing survey (Anderson and Waheed, 1990).

Blue Shark

WHITETIP REEF SHARK *Triaenodon obesus* (Ruppell, 1837)

Previously. recorded from the Maldives by Randall (1977, 1992), Compagno (1984), MRS (1988) and Nahke and Wirtz (1991). This is a common, reef-associated species. It is often seen underwater by divers and, to a lesser extent, by snorkellers. *T. obesus* is caught commercially by bottomset gilinets and night handlining. Only nine individuals, of 56-1 14 cm TL, were caught, mainly by night handlining, during the reef fish resources survey (Van der Knaap *et al.*, 1991; Anderson *et al.*, 1992). One female of 102 cm TL contained two embryos of 40.9 and 42.6 cm TL. One male of 97 cm TL was recorded as being mature. Both specimens were smaller than the sizes cited by most authorities as being those at which maturity is attained (Randall, 1977; Compagno, 1984).

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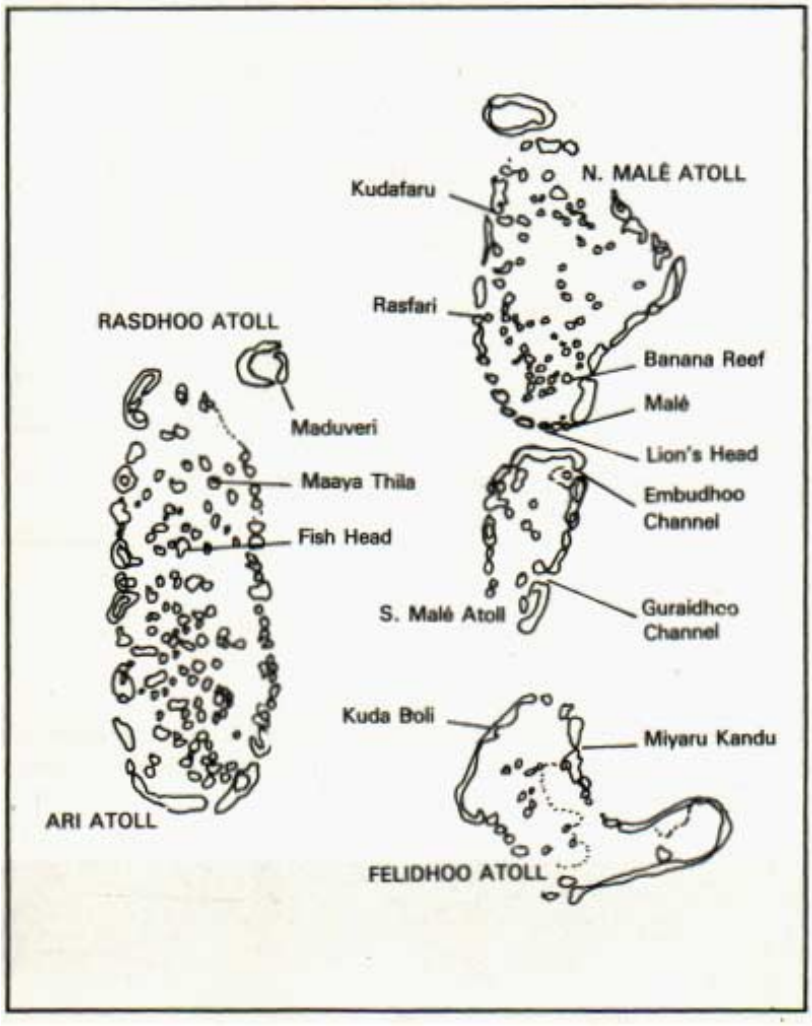
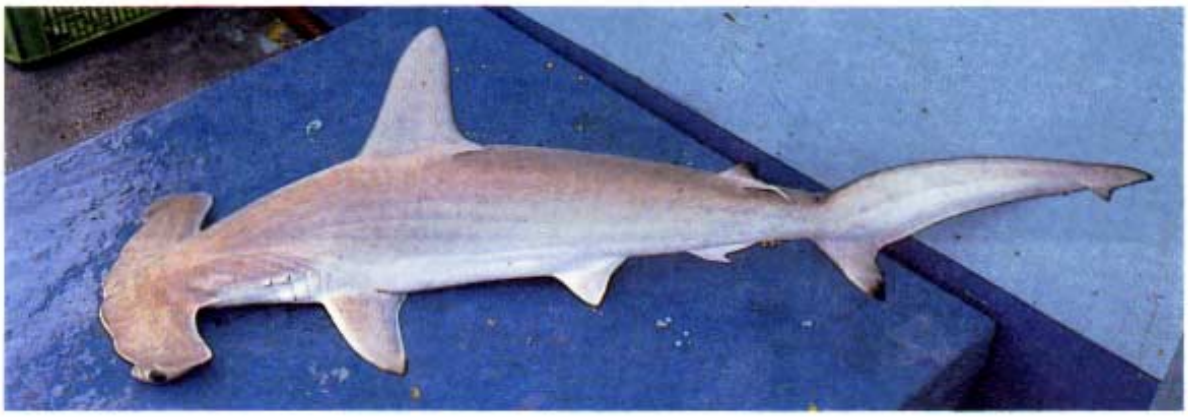
Fig. 19 **Locations of some major shark-watching dive sites**



Previously recorded from the Maldives by Compagno (1984) and MRS (1988). This species is apparently widespread, but patchily distributed, in the Maldives. A large, more-or-less permanent aggregation of Hammerhead Shark off the small island of Madivaru, in Rasdhoo Atoll (Figure 19), is believed to be of this species.

During the exploratory offshore fishing survey no Scalloped Hammerhead Shark were caught offshore (Anderson and Waheed, 1990), but one 50.3cm TL male was caught inside Laamu Atoll by night handlining (MRS, 1988). During the reef fish resources survey (Van der Knaap et al., 1991; Anderson et al., 1992) only three Scalloped Hammerhead Shark, 111-168 cm TL, were caught. Two of these were taken in Laamu Atoll, the other in N. Maté Atoll. Two large females (232cm and 235cm TL) were landed at Maté on September 21, 1992, having been caught by pelagic longline outside S. Maté Atoll. The larger female contained twenty embryos of 30-35 cm TL (mean 34cm TL).



Scalloped Hammerhead Shark

GREAT HAMMERHEAD SHARK Sphyrna mokarran (Ruppell, 1837),

Not positively recorded from the Maldives. However, fishermen report occasional captures of very large Hanunerhead. Fishermen on Sh. Kanditheem report catching in 1988 an enormous Hammerhead in a gillnet set inside a deep lagoon. The shark was so big that it was measured. It was reported to be 9 *riyan* 1 muh.long ***(i.e.*** 665 cms.). Allowing 10 per cent for measuring over the curvature of the body rather than straight this translates to almost 6 m. This is close to the maximum reported length of S. ***mokarran;*** no other Hammerhead approaches this size (Compagno, 1984).

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The BOBP brings out the following types of publications:

Reports (BOBP/REP/...) which describe and analyze completed activities such as seminars, annual meetings of BOBP's Advisory Committee, and subprojects in member-countries for which BOBP inputs have ended.

Working Papers (BOBP/WP/...) which are progress reports that discuss the findings of ongoing work.

Manuals and Guides (BOBP/MAG/...) which are instructional documents for specific audiences.

Information Documents (BOBP/INF/...) which are bibliographies and descriptive documents on the fisheries of member-countries in **the region.**

Newsletters *(Bay of Bengal News)* which are issued quarterly and which contain illustrated articles and features in nontechnical style on BOBP work and related subjects.

Other **publications which include books** and other miscellaneous reports.

Those marked with an asterisk (*) are out of stock but photocopies can be supplied.

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36. *Hilsa Investigations in Bangladesh.* (Colombo, 1987.)
37. *High-Opening Bottom Trawling in Tamil Nadu, Gujarat and Orissa, India : A Summary of Effort and Impact.* (Madras, 1987.)
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39. *Investigations on the Mackerel and Scad Resources of the Malacca Straits.* (Colombo, **1987.)**
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52. *Feeds for Artisanol Shrimp Culture in India* — Their Development and Evaluation. J F Wood et a!. (Madras, 1992.)
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57. *Introduction of New Outrigger Canoes in Indonesia.* **G Pajot,** *O* Gulbrandsen. (Madras, 1993).
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92. *Nursery Cage Rearing of Post-Larvae of Penaeus Monodon in West Bengal, India.* H. Nielsen, **R.** Hall. (Madras, 1993.)
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12. *The Fisherfolk of Puttalam, Chilaw, Galle and Matara — A study of the economic status of the fisherfolk of four fisheries districts in Sri Lanka.* (Madras, 1991.)
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2. ***The** Shark Fisheries of the Maldives.* R.C. Andersen, H. Ahmed. Ministry of Fisheries and Agriculture, Maldives. (Madras, 1993).

NOTE : Apart from these publications, the BOBP has brought out several folders, leaflets, posters etc., as part of its extension activities. These include Post-Harvest Fisheries folders in English and in some South Indian languages on anchovy drying, insulated fish boxes, fish containers, ice boxes, the use of ice etc. Several unpublished reports connected with BOBP's activities over the years are also available in its Library.

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Recently, a number of serious problems affecting the Maldivian shark fisheries have come to light. These include suggestions of overfishing of the valuable deepwater Gulper Shark (or Spiny Dogfish) resource; conflict between fishermen catching shark and those targeting other resources; and complaints from the tourism industry about the reduction of shark numbers at particular 'shark diving' sites. Overfishing and/or unresolved conflicts between resource users could potentially result in considerable loss of income to poor fishermen. The removal of shark from popular diving sites could potentially result in enormous loss of income to the tourism sector (which is now the major contributor to GDP and to revenue for Government social development programmes).

The Ministry of Fisheries and Agriculture of the Maldives recognized the urgent need to assess and resolve these problems. It, therefore, requested assistance from FAO in carrying out a review of the current status of the Maldivian shark fisheries and in making recommendations for their management. This report presents the findings of that review, carried out from July 18 to November 17, 1992, and the recommendations.

Ministry of Fisheries and Agriculture, Male, Republic of Maldives.

Food and Agriculture Organization on the United Nations.

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