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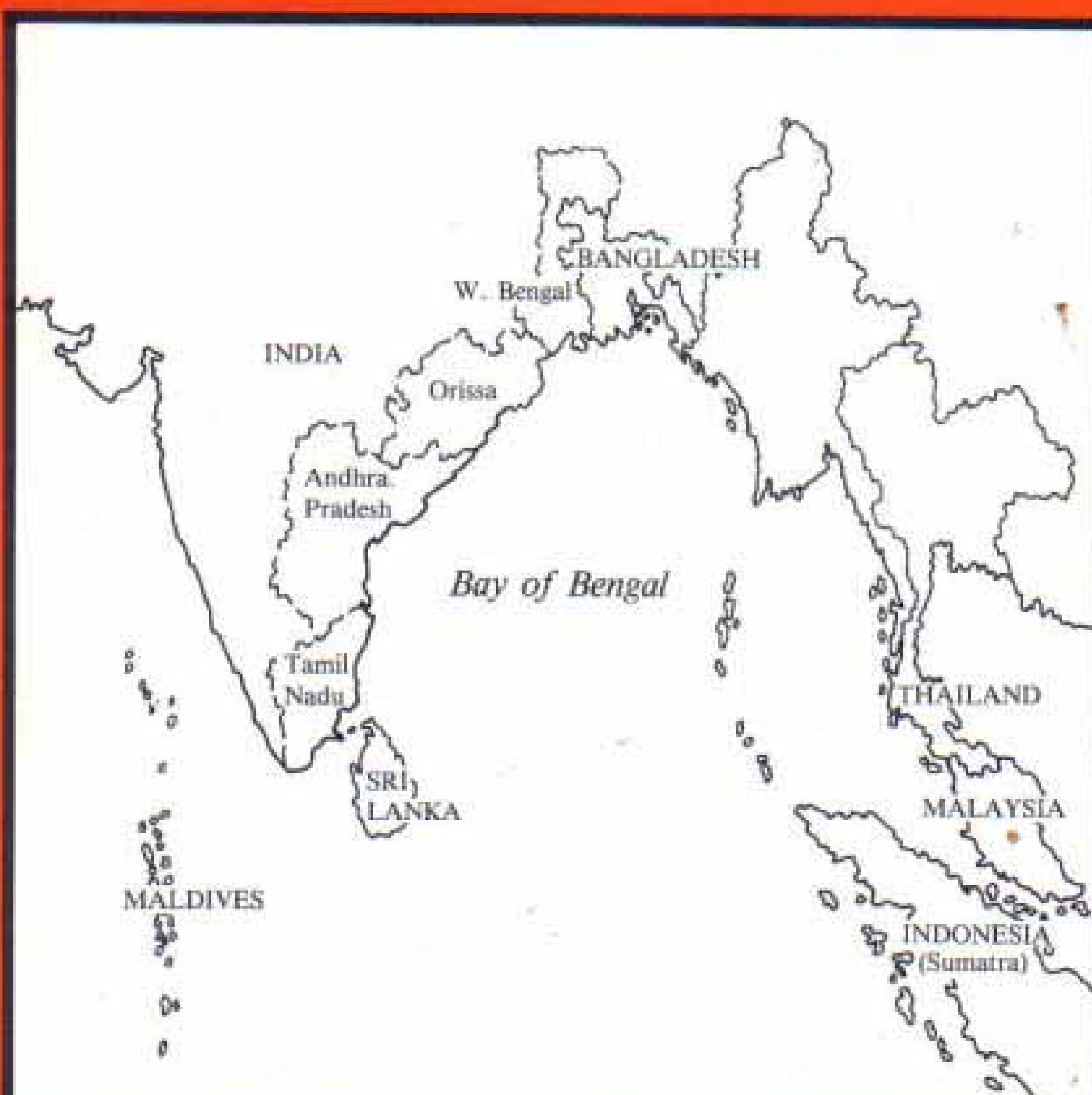
EXPLORATORY FISHING FOR LARGE PELAGIC SPECIES IN THE MALDIVES



For Fisheries Development
BAY OF BENGAL PROGRAMME

FAO/TCP/MDV/6651

EXPLORATORY FISHING FOR LARGE PELAGIC SPECIES IN THE MALDIVES

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This paper discusses the aims, methodology and findings of the project "Exploratory tuna fishing in the Maldives" TCP/MDV/6651(1). It was established in 1987 as part of a TCP (technical cooperation) agreement between the FAO and the Government of Maldives. The project was completed in December 1988.

The project was executed by the Marine Research Station of the Ministry of Agriculture and Fisheries with some support from the BOBP (Bay of Bengal Programme for Fisheries Development).

Under the project, exploratory surveys were carried out by the *vessel Matha Hari.* Despite limited fishing operations, useful information was obtained on the status of pelagic fish stocks, and on the feasibility of operating multi-day gillnet-cum-longline offshore fishing trips Data were also obtained on offshore tuna and sharks,

The BOBP is a regional fisheries programme that covers seven countries around the Bay of Bengal — Bangladesh,-India, Indonesia, Malaysia, Maldives, Sri Lanka and Thailand. It strives for the socio-economic betterment of small scale fisherfolk communities in the region by developing, demonstrating and promoting new ideas or techniques, new technologies, methodologies or systems to help small-scale fisherfolk.

This document is a technical report and has not been cleared either by the FAO or by the government concerned.

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Main Report

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1 INTRODUCTION

Pole and line fishing for tuna is the backbone of the fisheries sector in the Maldives. Exploitation is almost entirely by traditional craft (dhoni). The Government of Maldives is eager to expand the fishery beyond the present range of operation to utilize the resources in the country's EEZ. To achieve this, more information is required on the availability of resources for commercial exploitation in the offshore region. But traditional craft, with traditional systems of carrying live bait. find it difficult to extend their method into distant offshore ranges.

To explore the availability of resources and to try other fishing methods, a project "Exploratory tuna fishing in the Maldives", TCP/MDV/6651(1) was established in 1987. The objectives were

i. To obtain information on the availability of surface and deep swimming tunas and on the technical feasibility of their exploitation by small to medium size crafts in the 25-100 miles range of the EEZ of the Maldives.

ii. To introduce driftnet fishing for tuna.

FAO contributed US $ 96,000 to the project, and the duration was 22 months. However, due to delays in procuring a vessel, modifying and equipping it, fishing activities commenced only in November 1987 and were completed in December 1988. The Marine Research Station of the Ministry of Agriculture and Fisheries was the national agency responsible for the project. It was assisted in execution by the Bay of Bengal Programme (BOBP).

2. SURVEY METHODOLOGY/PROGRAMME

2.1 Survey Area

All operations were conducted off the eastern seaboard of the Maldives. All stations were in the range of 30-100 n miles offshore. Fishing operations were carried out in three latitudinal fishing zones:

Areas	Base atoll
Northern zone (north of 5°N)	Lhaviyani atoll
Central zone (3°N-5°N)	Male atoll
Southern zone (south of 3°N)	Laamu atoll

For logistic reasons (i.e. the proximity of the Felivaru cannery with its many facilities) most of the fishing was carried out in the north. Fig. 1 and 2 show the approximate positions of all stations.

2.2 Cruise schedule

Twenty four cruises, with a total of 49 stations, were carried out. Table 1 gives details of fishing effort by season and latitudinal zone.

2.3 Fishing methods/gear

A 52 ft wooden vessel Matha Hari, of 35 GT, was made available for the survey. This was by no means an ideal vessel for the work to be done but the only one readily available at that time. It was used after some modifications, and after installing deck equipment and a new steering system. The vessel was plagued with mechanical problems (notably frequent failure of the starter motor, fuel feeder pipes, fuel injectors, and exhaust outlet). Lengthy stays in Male were frequently necessary to rectify these recurrent faults. Another big problem, that of regular maintenance, also necessitated returning to Male.

Table 1: Distribution of fishing effort by area and season

(a) Northeast Monsoon Season (Dec. 87 - April 88)

Fishing zone		North	Central	South	Total
Nights fished	(no)	18	6	-	24
Gillnet sets	(no)	16	3.25	-	10.25
Tuna hooks	(no)	450	60	-	510
Shark hooks	(no)	1700	455		2155
Total hooks	(no)	2150	515		2665
Time trolled	(hr)	335	155	-	490

(b) Southwest Monsoon Season (June 88 - Nov. 88)

Fishing zone		North	Central	South	Total
Nights fished	(no)	14	1	10	25
Gillnet sets	no	13.5	0.5	8.5	22.5
Tuna hooks	(no)	160	100	485	74s
Shark hooks	(no)	1440	100	970	2510
Total hooks	(no)	1600	200	1455	3255
Time trolled	(hr)	255	15	137	407

(c) Both Seasons (Dec. 87 - Nov. 88)

Fishing zone		North	Central	South	Total
Nights fished	(no)	32	7	10	49
Gillnet sets	(no)	29.5	3.75	8.5	41.75
Tuna hooks	(no)	610	160	4x.5	1255
Shark hooks	(no)	3140	555	970	4665
Total hooks	(no)	3750	715	1455	5920
Time trolled	(hr)	590	170	137	897

Matha Hari operated both longline and gillnet gear. A full set of longlines should have consisted of 100 tuna hooks and 100 shark hooks. Often, however, only the shark hooks were deployed for a variety of reasons, the chief of which was the problem of obtaining suitable bait. Only a limited number of tuna longline operations was possible, for there was not enough quality bait. Low-quality deep frozen mackerel and fresh pieces of tuna were the bait types used. Although such baitfish are not very effective for tuna species, they were apparently responsible for a high catch-rate of sharks. It was felt that good quality bait fish such as fresh mackerel and squids would have led to a higher tuna catch rate. However, it was only possible to obtain.low-quality frozen mackerel seized from foreign vessels fishing illegally in the Maldives.

The multifilament gillnets were arranged in two identical parts. Each half comprised 6 panels (1,000 meshes) of 5" mesh, 5 panels of 6" mesh and 4 panels of 7" mesh.

A full set of gillnets (ie. a total of 30 panels, covering roughly 2.5 km) should have been set each night. On some occasions, however, particularly at the start of operations, only half the set was used.

In addition to the longlines and gillnets, trolling lines were used during passage between stations.

The gear mentioned above would constitute a suitable mix and quantity of a commercial gear complement for a small-to-medium scale fishing boat. For further details of vessel, gear and operations, see Field Document I.

2.4 Operational bases and supplies

Since this was the first attempt at multi-day offshore fishing operations from the Maldives it had to make do with inadequate support facilities. The greatest concentration of facilities was at the cannery on Lh. Felivaru. Here, it was possible to buy ice and water, and sell small tunas. Fuel could sometimes be bought here but it was more often taken from vessels moored some distance away. Large tunas had to be sold to freezer vessels (for eventual export to Thailand), sharks could be disposcd of only at particular fishing islands. It took two whole days after a trip to get a buyer for the catches. In the northern fishing area, when based near Felivaru. it was normal to travel to R. Kandholudhoo to sell sharks. and on one occasion they could only be disposed of at Sh. Firubaidhoo. Also in the north a trip was made on two occasions to H. Dh. Hanimaadhoo (1.5 days away by sail from Fclivaru) to collect bait from a freezer vessel.

In the South, it was normal to sell sharks at Th. Olugiri. and tunas to a vessel near M. Mulaku. Bait could he obtained from the same vessel But ice had to be taken from another vessel near L. Hitadhoo. Water had to be got from a village well and rowed to the vessel in drums.

In Male ice was not available. and it was very difficult to sell the catch. For these reasons, only one-day operations were carried out in the central zone.

This brief description. and the fact that although only 49 fishing stations were completed. as many as 160 days were spent away from the project base in Male. demonstrates the very serious logistics problems the survey faced. A practical option for any future operation would be to use Felivaru as a full-time centre of operations. If regular catches of sharks were guaranteed it should be possible to identify a buyer nearer than R. Kandholudhoo. In this way much of the time-consuming trawl undertaken by Matha Hari could be avoided.

2.5 Crew

The crew of the exploratory fishing vessel were trained in the fabrication. operation and mending of drift gillnets and drift longlines. They also acquired expcricncc over the entire year of operation in night-time fishing and muttiday operation. A Sri Lankan masterfisherman, and the national fishing technologist assisted in training crew members.

The vessel crew were boatmen. not fishermen (although a few had some longlining experience). so they were not skilled in fishing. This problem was. however, gradually overcome as the project got under way and those who stayed with the project gained experience.

A more intractable problem was that the crew were not highly motivated to go out fishing. Even an incentive for fishing trips amounting to 50 % of the sales-had only a limited effect. White multiday offshore fishing trips were new to the Maldives, Mnldivians are not used to spending several days at a time on small vessels (a trip to Male from a distant island may take three days even in good weather, and lobster fishermen may spend several weeks at a time on a dhoni). For any operations in future. it would be important to identify active fishermen for crew. and to reward them appropriately. Because of the acute labour shortage in the Maldives this might not be easy. Matha Hari had problems in maintaining even a semi-skilled crew. and had to operate without a cook for some time.

2.6 Catch sampling procedures

As soon as fish were landed. catch compositions were estimated and biological sampling was done. A biologist and/or a fishing technologist was present on every cruise and his duty was to record details of capture of each fish (e.g. hook number if caught by longline. mesh size. and whether gilled or entangled if caught by gillnet), It did not always prove feasible to record in which section of the net (upper, middle or lower) the fish were caught, but some data were obtained from skipjack catches. (See Field Document II for details of biological sampling).

3. RESULTS OF FISHING

3. I Catches and catch rate

The total catch attained from 49 fishing nights (stations) during 23 cruises was 22.6 tonnes (t). It comprised of shark 68%, skipjack 2 1%, billfish 7%, yellowfin 3% and others 1% Sharks caught by longline constituted 50% of the total. Skipjack and shark caught by gillnet accounted for 20% each. The catch by other gear (trolling, handlinc and pole and line) was insignificant (2%). Details are given in Table 2.

The catch was distributed about equally over the two monsoon seasons-northeast (46%) and south-west (54%). The pattern of catch with regard to species and gear is almost identical for the two seasons.

Table 2: Matha Hari' catch summary for the whole project period

Cruise nos: 1-24	Longline: 1255 tuna hooks
No. stations: 49	4665 shark hooks
Dates: Dec. 87 Nov. 88	Gillnet: 41 .75 sets

a. Number Of pieces

	Gillnet	Longline	Others	Total
Skipjack	1018		71	1089
Yellowfin	101	8	8	117
Shark	170	244	15	429
Billfish	21	41	1	63
Others	140	4	20	164
Total	1450	297	115	1862

b. Weight (kg)

	Gillnet	*Longline*	*Others*	*Total*
Skipjack	4518.4		159.4	3677.8
Yellowfin	465.6	284.0	19.9	769.5
Shark	4133.9	11037. I	287.8	15458.8
.Billfish	896.4	541 .5	2.6	1440.5
Others	1X9.0	24.5	77.5	291 .o
Total	10203.3	11887.1	547.2	22637.6

The average catch rate was 462 kg of fish per night's fishing at an average effort of 85 per cent of the standard set of gillnet and 121 longline hooks. (See Table 3.)

Table 3: Average catches per night by 'Matha Hari' for the whole project period

Cruise nos: 1 – 24	Longline: 121 hooks/night
No. stations: 49	Gillnet: 0.85 sets/night
Dates: Dec. 87 – Nov. 88	

a. Number of pieces per night

	Gillnet	*Longline*	*Others*	*Total*
Skipjack	20.8	–	1.4	22.2
Yellowfin	2.0	0.2	0.2	2.4
Shark	3.5	5.0	0.3	8.8
Billfish	0.4	0.8	0.0	1.2
Others	2.9	0.1	0.4	3.4
Total	29.6	6.1	2.3	38.0

b. Weight (kg) per night

	Gillnet	*Longline*	*Others*	*Total*
Skipjack	92.2	–	3.3	95.5
Yellowfin	9.5	5.8	0.4	15.7
Shark	84.4	225.2	5.9	31.5.5
Billfish	18.2	11.1	0. 1	29.4
Others	3.9	0.5	1.5	5.9
Total	208.2	232.6	11.2	462.0

There is a remarkable similarity in catch rates between the two seasons. The only difference that might be of significance. is that fewer but larger sharks were caught during the southwest monsoon period.

The average catch rate of the shark longline was 237 kg per 100 hooks (Table 4). while the tuna longline yielded only 68 kg per 100 hooks (Table 5).

Table 4: Shark longline – average catch rates per 1000 hooks

NE season: 2155 hooks — Dates: Dec. 87 – Nov. 88
SW season: 2510 hooks
Total : 4665 hooks

a. Number of pieces per 1000 shark hooks

	NE season	*SW season*	*Total*
Skipjack			–
Yellowfin	1.4*	0.4	0.9
Shark	51.5	46.2	48.7
Billfish	5.1	8.0	6.6
Others	0.9	0.8	0.9
Total	58.9	55.4	57.1

b. Weight (kg) per 1000 shark hooks

	NE season	*SW season*	*Total*
Skipjack	–	–	–
Yellowfin	45.9*	19.9	31.9
Shark	2206.5	2252.1	2231.0
Billfish	101.0	100.4	100.7
Others	4.4	6.0	5.3
Total	2357.8	2378.4	2368.9

* Includes one bigeye tuna of 29 kg.

Table 5: Tuna longline – average catch rates per 1000 hooks

NE season: 510 hooks — Dates: Dec. 87 – Nov. 88
SW season: 745 hooks
Total: 1255 hooks

a. Number of pieces per 1000 tuna hooks

	NE season	*SW season*	*Total*
Skipjack	–		–
Yellowfin	5.9	1.3	3.2
Shark	9.8	16.1	13.5
Billfish	9.8	6.7	8.0
Others	–	–	–
Total	25.5	24.1	24.7

b. Weight (kg) per 1000 tuna hooks

	NE season	*SW season*	*Total*
Skipjack	–	–	–
Yellowfin	158.9	72.5	107.6
Shark	288.2	646.9	501.2
Billfish	95.5	48.3	67.5
Others	–	–	–
Total	542.6	767.7	676.3

Assuming that the full complement of gear had been used. the theoretical catch rate would have been 561 kg per night's fishing composed as follows:

1 set gillnet	*245* kg	(Table 3 adjusted to full set)
100 shark hooks	*237* kg	(Table 4)
100 tuna hooks	68 kg	(Table 5)
Other gear	11 kg	(Table 3)

3.2 Sharks

The bulk of the catch (68%) comprised of sharks (Table 2). Of these, about 70% (by weight) were caught by longline, the average weight of fish being 45 kg. The hooking rate for the shark longline was about five per 100 hooks (Table 4). against only one for the tuna longline. The species composition in the longline catch was (in number of fishes):

Silky shark	*Carcharhinus falciformis*	*59%*
Oceanic white-tip	*Carcharhinus longimanus*	*29%*
Blue shark	*Prionace glauca*	*8 %*
Others: (Silver-tip shark	*Carcharhinus albimarginatus*	*4%*
Tiger shark	*Galeocerdo cuvier*	
Shortfin mako)	*Isurus oxyrinchus)*	

Sharks caught by gillnets (27%) were only half as big (24 kg per fish) as those caught by longline. The dominating species was the silky shark (90%). The Oceanic white-tip accounted for the balance (10%).

A major problem encountered in the longline operation was to bring the sharks onboard. As much as 10% was lost at the time of gaffing. This corresponds to 5% of the total catch. The losses could perhaps be reduced as the crew gain experience.

While sharks formed the most valuable component of the catch, they were destructive, damaging the other fish caught and the fishing gear. It is estimated that:

- 3-4% of the skipjacks caught in gillnets,
- 20% of the billfish caught in gillnets and
- 15% of fish other than shark caught by longline

were damaged by shark bites. (No sharks were bitten.) These constituted about 2% of the total catch.

Some of the fish bitten were not badly damaged and could be used for bait or food. Most were, however, extensively damaged and of no further value. One consolation is that while attacking fish trapped in the gillnet, sharks sometimes got entangled'themselves. On the basis of unquantified observations it seems likely that the weight of sharks caught in this way might well compensate for the fish lost.

The number of hooks lost from longlines was recorded after most fishing nights. It is assumed that most of this damage was done by sharks, although large billfish may also have been responsible. The rate of hook loss is estimated at about 3%. This compares well with the hooking rate of sharks of about 5%. More hooks were seen to be lost whenever more sharks were caught. Shark catches could have been increased had stronger gear been used (notably chain rather than wire leaders). Sharks inflicted damage on gillnets too, but this could not be quantified.

3.3 Skipjack Tuna

Skipjack tuna *(Katsuwonus pelamis)*accounted for 21% of the catch by weight. Most skipjack were caught by gillnet (94%). Other gears were pole and line (4%) and trolling lines (2%).

The average catch rate by gillnet was 24. 4 fishes per set (Table 2) at an average weight of 4.4 kg per fish. Differences in catch rates between seasons and fishing zones were small.

Catches of skipjack could vary dramatically from day to day. For example, on the last cruise undertaken, in November 1988, only one skipjack was caught by during the first three nights, but 65 were caught the following two nights. Catch on full moon nights was poor presumably because the fish could see the net and avoid it, or were swimming deeper. Other factors which the crew felt influenced catch rates were cloud cover and wind speed/sea state. These observations were quantified by scoring each factor on a scale of 1 to 3 (with much moonlight. little cloud cover and calm conditions all scoring lowest). Scores were summed up to give an overall catchability index' for each night's fishing. The correlation of these indices with skipjack catches for the 35 nights for which a complete data set was available showed a highly significant positive relationship. The highest skipjack catches were made on rough, cloudy. moonless nights. This also suggests that mean catches of skipjack by gillnet could be improved in a commercial fishery by concentrating the fishing effort to suitable periods and at nights.

The experiment with different mesh sizes in the gillnet indicates that the 5 and 6 inch meshes are about equally good while the the 7 inch mesh is about 80% as efficient as the others. Details are as follows :

Mesh size (inches)	5	6	7
1. No. of fishes caught (%)	43	33	24
2. Average weight (kg)	3.6	4.8	5.4
3. Catch efficiency (1 x 2)	155	158	130

3.4 Billfish

The contribution from billfish to the total catch was 7%. Relatively large fishes (33 kg) were caught in gillnets and smaller ones (13 kg) by the longline.

The dominant species was the swordfish, *Xiphias gladius* (83%). The others were sailfish (8%) and black marlin (6%).

3.5 Yellowfin Tuna

The yellowfin, *Thunnus albacares* accounted only for 3% of the total catch. Small fishes (4.6 kg) were caught in the gillnets and a few (8) larger ones (36 kg) by longline.

4. COMMERCIAL FEASIBILITY

The results from exploratory fishing cannot by themselves establish or negate commercial feasibility. There are many reasons :

- The vessel was not suitable. being too large. and therefore too expensive to operate and maintain.
- The logistics for obtaining supplies (including bait for tuna long lining) and selling fish were poor.
- The crew lacked experience in operating the gear and staying out on multi-day trips.

There is therefore no point in comparing the costs and earnings of the exploratory fishing. In fact the earnings were only MRF 50,000 against operational costs of MRF 350.000.

However, the catch rates attained provided valuable information for assessing the prospects of commercial exploitation of the offshore resources. A very similar fishery, recent but well established, exists in Sri Lanka; input costs from that fishery may provide pointers to the potential in the Maldives. But let us first examine the fish prices in the Maldives.

4.1 Fish Prices

The Maldivians prefer high-quality tuna for consumption, and they do not eat shark. Any commercial gillnet and/or longline operation would therefore probably be export-oriented. The Government's State Trading Organization (STO) controls the export of most tuna and shark products. It buys fresh tuna for canning or freezing. but does not buy fresh shark. The prices it paid in 1988 are:

Tuna less than 2 kg per fish	1-10 MRF/kg
Tuna more than 2 kg per fish	1.95 MRF/kg
Salt dried shark meat -1st grade	7.80 MRF/kg
-2nd grade	6.00 MRF/kg

Note: 9.7 Maldivian Rufiya (MRF) = 1 U.S. $

During the survey, sharks were salted by the crew on one occasion when no buyer could be found. After most fishing trips a buyer was found on one of the fishing islands, but sometimes only after an extensive search. Typical prices paid were:

Whole sharks	2.50 MRF/kg
Sharks minus fins	2.00-2.20 MRF/kg
Shark fins (large size only)	50 MRF/kg
Billfish	0.60-0.75 MRF/kg

It was very difficult to sell the catch at Male and prices were much lower in the central fishing zone.

The actual prices realized for the fish caught during exploratory fishing were:

Skipjack	1.90 MRF/kg
Yellowfin	1.95 MRF/kg
Shark	2.77 MRF/kg
Billfish & others	0.82 MRF/kg

4.2 **Costs**

In order to get an idea of the cost structure for a new fishery similar to that undertaken on an exploratory basis, a "typical" offshore vessel from Sri Lanka is used for comparison. This boat (introduced under an Abu Dhabi loan) is 10.4 m long, has a fish hold of 7.5 m^3 and a 60 hp engine. It commercially operates 60 panels (500 meshes each) of driftnets and 200 longline hooks (40 baskets) i.e. the same amount of gear that was used during the exploratory fishing in the Maldives. The cost picture (1988) of such a boat is as follows (in MRF converted from SRL Rs. at a ratio of 1:4).

Investment		535,000
Boat including SSB radio and gear hauling equipment	465,000	
Fishing gear	*70,000*	
Annualfixed cost of Depreciation and insurance		70,000
Annual variable costs		260,000
Fuel*	60,000	
Ice*	45,000	
Food	15,000	
Repairs	15,000	
Crew Share	110,000	
Miscellaneous	15,000	
Total Annual Cost		330,000

* The Sri Lankan figures for fuel and ice have been adjusted (a) upwards for higher prices in the Maldives-35% and 120% respectively and (b) downwards for fewer days at sea in the Maldives-180 against 216.

One can therefore assume that it would cost about MRF 330,000 per year to operate a suitable boat engaged during 180 days of the year in driftnetting and shark longlining.

4.3 Earnings

Maldivian fishing boats are supposed to operate a minimum of 180 days per year to maintain their fishing license. If we assume that our hypothetical vessel would do that, the number of fishing days would probably be about 150, the balance being spent on travel to fishing areas and between bases. But such an operation would be uneconomical with the catch rates attained during the survey. The earnings would be only MRF 150,000 against the costs of MRF 330,000. The question is therefore whether the catch rates could be more than doubled in fully commercial fishing operations.

4.3.1 Tuna Longlining

The tuna longline was the least successful of the three gear used. Better bait would have generated a higher catch, but regular supply of bait would be a problem for a commercial venture. Locally caught scads may be used as bait. but freezing facilities would be required to ensure regular supplies. Obviously this fishery can be successful. as the presence of Far Eastern longliners in the Indian Ocean over the last 35 years demonstrates. However. these vessels rely for profit on very high prices in their home markets for an excellent quality product. Two recent tuna longlining ventures in the Maldives were not much of a success. STO carried out longlining operations using a confiscated Far Eastern longliner in mid-1986. Fishing was carried out for a short while only as the vessel was felt to be of more value as a freezer. A private joint venture operation involving two Taiwanese longliners was carried out in 1987. This did not last long. because licensing arrangements for fishing in the EEZ were too restrictive (they have since been relaxed). Tuna longlining is therefore ruled out as a viable option for our purpose.

4.3.2 Driftnetting and Shark Longlining

The fishing gear in use under this option would consist of 30 panels of driftnets and 200 longline hooks. According to the survey results (see 3.1) this would produce 245 + 2 x 237 + 11 = 730 kg of fish per day.

- By using only 5" and 6" mesh nets, the driftnet catch of skipjack will increase (section 3.3)
- BY not fishing during the full moon period but using this time for vessel maintenance and crew holidays average catch rates will be **higher**
- By using stronger longline gear and the shark-fishing experience gained by the crew, the shark catch rates will go up.

The combined effect of these factors would, at a conservative estimate, push up catch rate by 20% to 875 kg per fishing day.

Considering the prices obtained during the exploratory fishing and the new catch composition, one may assume an average price of 2.45 MRF/kg with 150 fishing days. This would produce a yearly gross revenue of MRF 320,000. Such an operation would thus nearly cover the costs, but would not of course be an attractive investment proposition.

4.3.3 Shark Longlining

A second option would,be to use only longlines because of the relatively high catch rates. Our hypothetical vessel could easily operate 400 longline hooks driftnets. The catch rates during the exploratory fishing indicate that the daily catch rate would be 4 x 237 + 11 = 960 kg.

The catch rate could easily be pushed up by 20% i.e. to 1150 kg in a specialized fishery with appropriate gear and an experienced crew.

With 150 days of fishing and a shark price of 2.77 MRF/kg the gross revenue would be MRF 475,000. The operation would thus produce a yearly surplus of MRF 145,000 which is equivalent to nearly 30% of the invested capital-in other words, a proposition worth further consideration.

It is important to assess whether an assumption of 150 days of fishing and 180 days of total operation is realistic.

The breakeven point for revenue would be attained at 103 fishing days. The cost items would also need to be checked. A positive finding in this regard during the exploratory fishing was that the shark catch rate doesn't vary with distance offshore. This suggests that there is no need for boats to go far out-a fact that keeps the fuel bill down and makes it less streneous for the crew.

4.4 Comparison with the Commercial Pole and Line Fishery,

During the course of the exploratory fishing, *Matha Hari* caught an average of 108 kg of skipjack and 11 kg of yellowfin per complete gillnet set. Pole and line vessels operating inshore of *Matha Hari* in the same areas at the same times recorded an average catch of 539 kg of skipjack and 51 kg of yellowfin per day trip. At no time was the pole and line catch lower than the gillnet catch. (The pole and line data are based on monthly catch rates by atoll-the smallest unit of comparison available). A word of caution. though. The catch rate by mechanized masdhonis (i.c. pole and line boats) in the atolls nearest to the areas of operation of Matha *Hnri* were twice the average pole and line catch rate for the Maldives as a whole in recent years. The catch rate of ***Matha*** *Hnri* would certainly have been higher under commercial conditions by (i) using a full set of nets (ii) by using only S-6" mesh nets and (iii) by avoiding fishing during the full moon. But it seems unlikely that the rates would even reach the national average of about 260 kg of skipjack per day.

Another factor to consider is that of quality of skipjack and yellowfin. A multi-day gillnetter can compete on quality, but this requires relatively short soaking time and careful icing.

It is concluded that drifting gillnets for tuna do not constitute a suitable alternative to the existing pole and line fishery.

5. CONCLUSIONS

Despite the rather limited fishing operations by *Matha Hari,* the Prime aims of the survey-to find out more about the status of pelagic fish stocks and the feastbility of operating multi-day gillnet-cum-longline offshore fishingtrips in the Maldivian EEZ-were to a large extent fulfilled. Much information on offshore tuna and sharks was collected. The new shark data are particularly valuable. As for the feasibility assessment, the survey clearly encountered many of the constraints to be faced by such an operation. The use of gillnet as an alternative to pole and line for catching tuna was shown to be unviable. Shark catches were high, and a preliminary assessment of the shark longline fishery shows good potential.

However, a realistic approach towards a regular and continuous supply of consumable items-such as fuel, block or crushed ice and fresh water necessary for medium range fishing operations-is essential. At present, the market for fresh fish in the Maldives is centralized at the Felivaru Canning Factory and the Male local fish market. As a result, it's difficult to operate in other regions where disposal of the catch is practically impossible at present. Therefore, careful consideration to the issue of catch disposal will be essential for the development of medium-scale fishing in the Maldives. The human crew factor is also very important. Are Maldivian fishermen prepared to work regularly on multi-day fishing boats-and at what price'? As noted by Engvall (1987) the development of the offshore fishery in Sri Lanka took 20 years to materialize from the time the potential was realized. From the admittedly limited data obtained during this survey it may appear that the time is not yet ripe for a similar development in the Maldives.

Tuna fishing has been the mainstay of the Maldivian economy for centuries. In recent years the Government has invested heavily in developing and improving collection, freezing and canning facilities, in order to increase export earnings (Saleem, 1987). Because of this enormous investment, and its traditional importance, the fishing industry of the Maldives is likely to remain focussed on tuna fishing in the foreseeable future.

Therefore, while the identification of 'new' fishery resources (such as pelagic sharks, reef fishes or beche-de-mer) is of course of great value to the country, the greatest developments are likely to be seen within the existing tuna fishery. The mechanization of masdhonis, starting in 1974, was a particularly important step since it more than doubled tuna catch rates (Anderson, 1987). Largely because of this, a steady decline in the number of active fishermen-attracted by higher wages and easier working conditions in other sectors such as tourism, transport and construction-has not led to a drop in total tuna production. Nevertheless, there is concern that if the number of active fishermen continues to fall; so too will fish catch. Any fishing method that can improve the tuna catch rate would then be very attractive. The results of this survey are therefore of value in allowing a comparison of gillnet and pole and line. The survey results indicate that even an improved gillnetting operation would not catch more tuna than the pole and line vessels: a negative finding, but important nevertheless.

One way in which tuna catch rates by the existing pole and line fleet might be improved is by the deployment of FADs. The Ministry of Fisheries has been conducting FAD trials for some time (Naeem, 1988). A more drastic departure would be to allow purse seining in the outer waters of the Maldivian EEz. This, however, would have other serious implications.

6. REFERENCES

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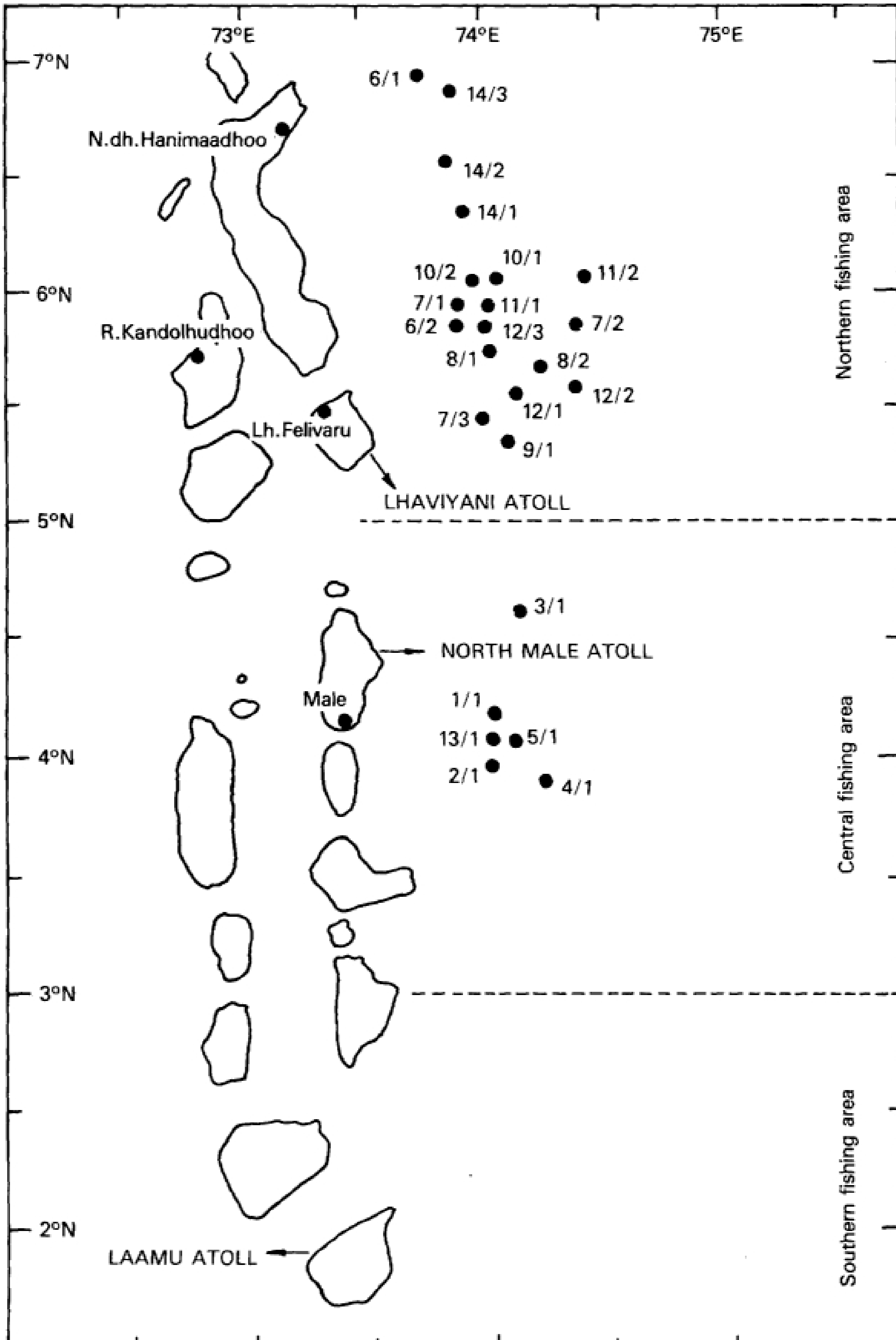

Note: ● *Location of fishing station*

Fig. 1 Approximate positions of fishing stations during the northeast moonsoon season (Dec. '87—April '88)

(Numerator: Cruise number. Denominator = number)

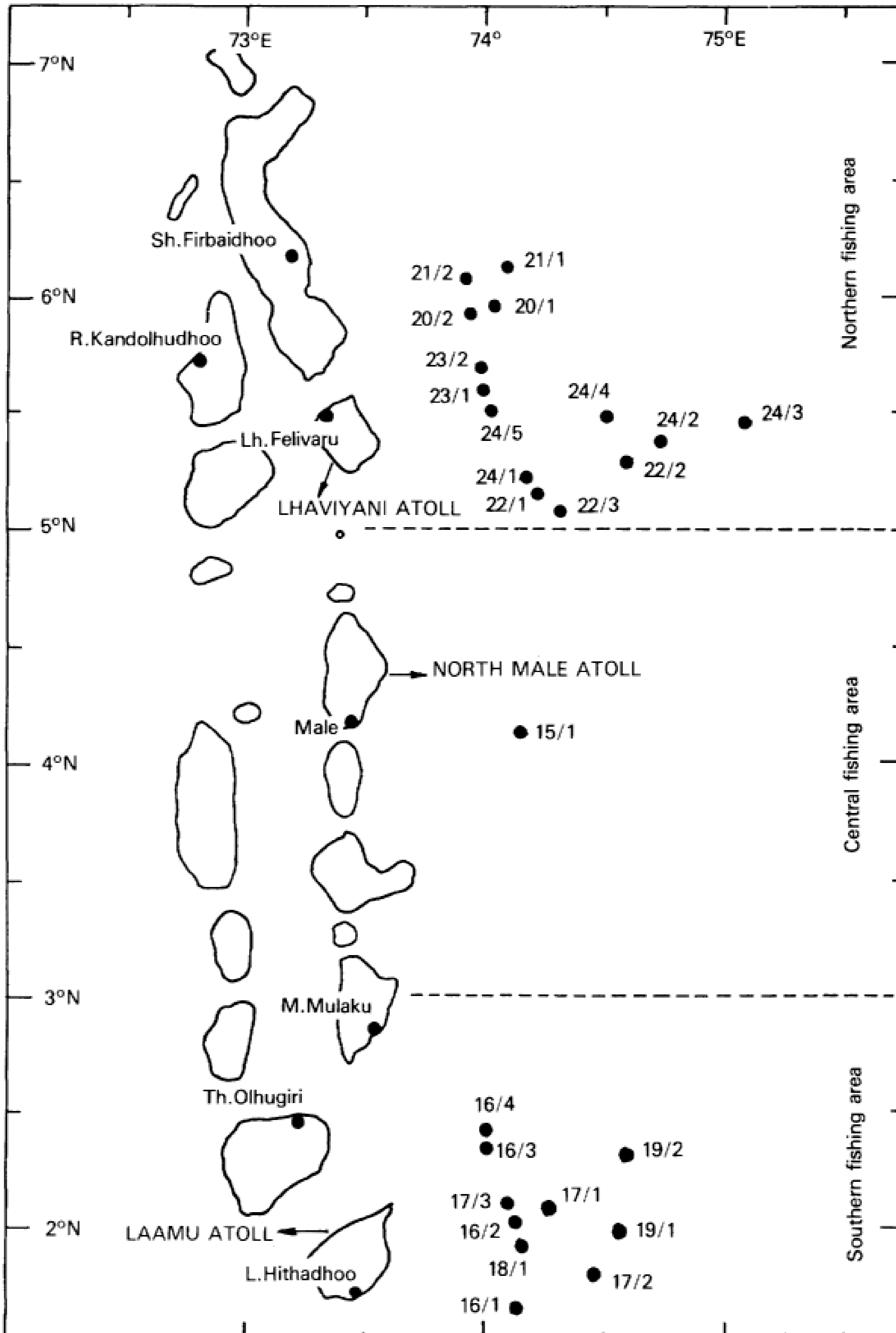

Fig. 2 **Approximate positions of fishing stations during the southwest monsoon season (July—Nov.'88)**

(Numerator: Cruise number. Denominator = Station number)