BIGEYE TUNA (*THUNNUS OBESUS*) IN THE MALDIVES

R. Charles Anderson

Marine Research Section, Ministry of Fisheries and Agriculture
Malé
Republic of Maldives

INTRODUCTION

The Maldives has a large traditional pole-and-line fishery, which targets surface-swimming tunas. The two main varieties caught are skipjack (*Katsuwonus pelamis*) and juvenile yellowfin tuna (*Thunnus albacares*). Bigeye tuna (*Thunnus obesus*) is caught in relatively small quantities. The Maldives has an effective tuna fishery statistics system, but separate records are not maintained for catches of bigeye tuna. Records of any bigeye tuna that are caught are lumped with yellowfin tuna.

The presence of bigeye tuna in Maldivian domestic catches was noted by Anderson (1986), Hafiz and Anderson (1988), and Yesaki and Waheed (1991). Information available up to and including 1990 on the occurrence of bigeye tuna in Maldivian catches was reviewed by Anderson and Hafiz (1991). They noted that bigeye tuna makes up a relatively small proportion of the Maldivian tuna catch, and that it appears to be more common in the south of Maldives than in the north. However, they were unable to quantify total bigeye catches with the data then available.

The domestic catch of bigeye tuna is mainly of juveniles taken by pole and line, although there are also catches by trolling, handline and longline. There are additionally catches of adult bigeye tuna taken by foreign longliners operating in the Maldivian EEZ.

The aims of this report are to review new information on the occurrence of bigeye tuna in the Maldives, and to present preliminary estimates of bigeye tuna catches by the Maldivian fleet.

METHODS

Thunnus catch sample data for the Maldivian pole-and-line fleet from before 1991 are taken directly from Anderson and Hafiz (1991). Note that the November 1990 sample from Laamu Atoll and the January-February 1990 sample from Lhaviyani Atoll have been corrected to include all *Thunnus* caught and recorded by reliable observers, not just those tagged. These alterations make minimal differences to the estimated percentage of bigeye tuna in the samples.

Since 1991, particular emphasis has been placed on sampling two regions:

1. The south of Maldives, which was under-sampled by Anderson and Hafiz (1991), but which was believed to have the highest abundance of bigeye tuna.
2. The northwest of Maldives during the southwest monsoon, when by far the highest seasonal catches of yellowfin tuna are made (Anderson, 1985 and 1988; Rochepeau and Hafiz, 1990).

Bigeye tunas are not always easy to identify from external characteristics, particularly when the fish are small and boat-worn. Therefore the preferred method of sampling was to examine the livers. However, this was only possible on a large scale at the tuna cannery on Felivaru island in Lhaviyani Atoll. The next best method was to examine the external characteristics of live or fresh-dead specimens. This was possible on a number of tuna-tagging trips, particularly in the south of the Maldives. The least satisfactory sampling method was to examine the external characteristics of landings. Whenever possible this was supplemented by liver sampling of contentious individuals. Such additional liver sampling was not possible at Malé fish market, so estimates of bigeye occurrence there must be considered as minimum values only.

Most *Thunnus* fork lengths were measured with a measuring board, to the full centimeter below. *Thunnus* from Malé market in 1993-95 and those from Baa and Raa Atolls in August 1992 were measured with tapes. Tape lengths were converted to board lengths following the procedures outlined in Anderson *et al.* (1995). Length-weight conversion factors used were those of Poreeyanond (1994) for bigeye tuna and Anderson *et al*. (1995) for yellowfin tuna.

Table 1. **Summary of results of bigeye tuna catch sampling activities in the north and centre of the Maldives.**

Date	Sampling location	Fishing location	No. *Thunnus* sampled	Size range (cm)	No. of bigeye	Purpose of sampling
12.86-4.87	Malé	Near Malé	1,337	24-135	1	Market sample
12.87-2.88	Malé	Near Malé	1,030	23-150	0	Market sample.
11.88	"Matha Hari"	E. of Lhaviyani	22	45-84	0	BET (liver)
2.89	Felivaru	Lhaviyani	909	30-84	5	BET (liver)
2.89	Haa Alifu	Haa Alifu	10	104-147	0	BET (liver)
2.89	Haa Alifu	Haa Alifu	200	53-147	0	BET (external)
1.90-2.90	Lhaviyani	Lhaviyani	322	24-78	0	Tagging
3.90	Lhaviyani	Lhaviyani	25	54-72	0	Tagging
7.90	Felivaru	Raa & Baa	675	NA	2	BET (liver)
10.90	Raa	Raa	82	37-56	0	Tagging
8.92	Baa	Baa	194	36-54	8	BET (external)
8.92	Raa	Raa	231	38-124	0	BET (external)
7.93-12.93	Malé	Near Malé	650	29-156	0	Market sample.
1.94-12.94	Malé	Near Malé	1,758	23-162	76	Market sample.
1.95-6.95	Malé	Near Malé	2,048	25-157	18	Market sample.
6.95	Raa	Raa	230	28-43	0	BET (external)
8.95	Baa	Baa	1,268		29	Tagging
Subtotal 1	Malé	Near Malé	6,823	23-162	95	Market sample.
Subtotal 2	Without Malé	North	4,168	24-147	44	-
TOTAL	-	-	10,991	23-162	139	-

Table 2. **Summary of results of bigeye tuna catch sampling activities in the south of the Maldives**

Date	Sampling location	Fishing location	No. *Thunnus* sampled	Size range (cm)	No. of bigeye	Purpose
5.90	Laamu	Laamu	53	58-81	0	Tagging
11.90	Laamu	L. & Satoraha	782	36-108	103	Tagging
12.92	Gnaviyani	Gnaviyani	152	40-131	33	BET (liver)
9.93	Laamu	Laamu	336	39-97	7	Tagging
11.93	Gnaviyani	Gnaviyani	64	45-139	0	Tagging
2.94	Gaafu Alifu	G.A.& Satoraha	836	29-55	89	Tagging
4.94	Laamu	L. & Satoraha	123	25-53	1	Tagging
8.94	Gaafu Alifu	G.A.& Satoraha	1,285	33-147	308	Tagging
4.95-5.95	Gnaviyani	Gnaviyani	50	42-116	0	Tagging
TOTAL	South	South	3,681	25-147	541	-

Catches of *Thunnus* have been recorded by the Ministry of Fisheries and Agriculture (MOFA) by atoll and by month since 1970. Total annual catches, and catches from the north and centre (referred to hereafter as the north) and south of Maldives are summarized in Table 3. For the purposes of this report the Kudahuvadhoo Channel at about 02° 40' N is considered to be the dividing line between the north and south of Maldives (see Discussion below, and Figure 1 for location map).

Available catch data for longliners operating in the Maldivian EEZ have been compiled by Klawe (1980) and by the Ministry of Fisheries and Agriculture (MOFA), and are summarized in Table 4.

RESULTS

A total of 26 samples of *Thunnus* were inspected for the presence of bigeye tuna (Tables 1 and 2). The great majority of these fish were caught by pole and line; a few were caught by trolling or handline. In every case the majority of the fish sampled were yellowfin tuna. Bigeye tuna made up 0-24% of the samples. Among the total of 14672 *Thunnus* sampled, 680 (4.6%) were bigeye tuna. A single longtail tuna (*Thunnus tonggol*) was present in the sample from Gaafu Alifu Atoll taken in February 1994.

There is a tendency for bigeye tuna to be more common in samples from the south of Maldives than in samples from the north of the country. The data from these two regions are therefore presented separately (Tables 1 and 2). In the north and centre of Maldives bigeye tuna made up 1.3% of the *Thunnus* catches by number (1.1% excluding Malé market samples, in which the proportion of bigeye is most likely to have been underestimated). In the south of the Maldives bigeye tuna made up an average of 14.7% of *Thunnus* catches sampled, by numbers.

Length-frequency distributions of bigeye tuna catches from the north of Maldives and from the south are presented separately in Figure2. For comparison, length-frequency distributions of yellowfin tunas caught at the same times and in the same locations are also presented. It

Table 2. **Estimation of bigeye tuna catches (t) in the Maldives by the domestic fleet.**

Year	*Total Thunnus catch*			*Estimated bigeye catch*		
	North	*South*	*Total*	*North*	*South*	*Total*
1970	1,530	459	1,989	8	73	81
1971	940	287	1,227	5	45	51
1972	1770	306	2,076	10	48	58
1973	4,822	653	5,475	27	103	130
1974	3,462	666	4,128	19	105	124
1975	3,257	517	3,774	18	82	100
1976	4,135	756	4,891	23	119	142
1977	3,584	889	4,473	20	140	160
1978	2,935	649	3,584	16	103	119
1979	3,579	710	4,289	20	112	132
1980	3,696	533	4,229	20	84	105
1981	3,965	1,319	5,284	22	208	230
1982	3,505	500	4,005	19	79	98
1983	5,383	858	6,241	30	136	165
1984	4,965	2,159	7,124	27	341	368
1985	4,208	1,858	6,066	23	294	317
1986	4,113	1,208	5,321	23	191	213
1987	4,824	1,844	6,668	27	291	318
1988	4,691	1,844	6,535	26	291	317
1989	4,296	1,786	6,082	24	282	306
1990	3,544	1,735	5,279	19	274	294
1991	4,817	2,894	7,711	26	457	484
1992	6,469	2,228	8,697	36	352	388
1993	7,163	2,947	10,110	39	466	505
1994	10,281	2,845	13,126	57	450	506

is possible that some bigeye may have been present in Malé market samples during months when none were recorded. To minimize this potential source of bias, only those yellowfin sampled in months during which bigeye tuna were recorded at Malé market are included.

Bigeye tuna sampled in the north of Maldives were much smaller than those sampled in the south (Figure 2). In the north the modal length was about 36 cm, and the mean weight 1.1 kg. In contrast, in the south the modal length of bigeye tuna was about 58 cm, and the mean weight 3.6 kg. Although there was a difference between the average sizes of yellowfin tuna taken in the north and in the south at the same time as the bigeye, it was much less marked. In the northern yellowfin sample the modal length was about 44 cm, and the average weight 2.6 kg. In the southern yellowfin sample the modal length was about 46 cm, and the average weight 3.3 kg.

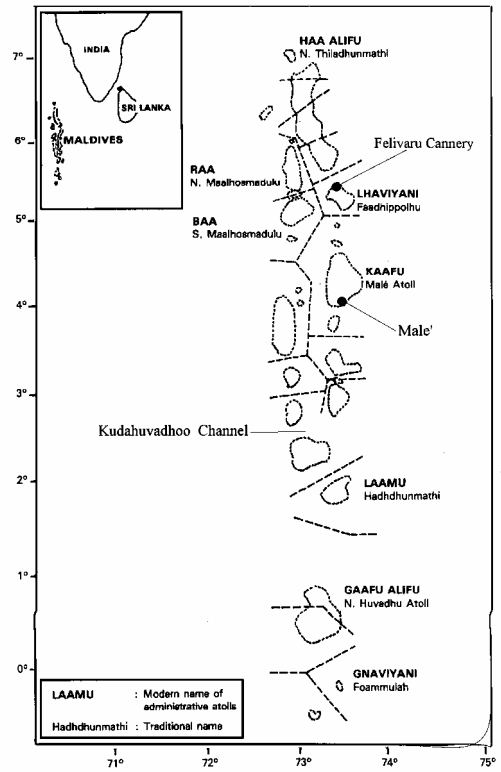
DISCUSSION

Anderson and Hafiz (1991) and Anderson (1992 and 1993) suggested that bigeye tuna may be more abundant in the south of Maldives than in the north. The results presented here support this idea. Bigeye tuna makes up an estimated 1.3% of the *Thunnus* catch by numbers in the north of the Maldives, and an estimated 14.7% in the south. Excluding Malé market samples, the estimated contribution of bigeye

Table 3. **Summary of reported yellowfin and bigeye tuna catches by longliners operating in the Maldivian EEZ.**

Year	*Yellowfin catch (t)*	*Bigeye catch (t)*	*% bigeye*	*Source*
1972	401	374	48	Klawe (1980)
1973	119	146	55	Klawe (1980)
1974	53	54	50	Klawe (1980)
1975	718	1,436	67	Klawe (1980)
1976	447	366	45	Klawe (1980)
1977	636	498	44	Klawe (1980)
1986	157.5	83	35	MOFA, Malé
1989	103.0	136	57	MOFA, Malé
1990	126.5	168	57	MOFA, Malé
1995	136.0	538.6	79	MOFA, Malé
1993-5	77.1	118.2	61	MIFCO, Malé
TOTAL	2,974.1	3,917.8	57	-

Figure 1. Location map.



tuna to the *Thunnus* catch in the north of the Maldives is 1.1%.

Because of the differences in average size of bigeye tuna sampled in the north and south of the Maldives, the contribution of bigeye tuna by weight to total *Thunnus* catch is very much greater in the south than it is in the north. Assuming that the samples taken are representative, and given the average weights and percentages noted above, the contribution of bigeye tuna by weight to the

Thunnus catch is estimated to be 0.55% in the north (including Malé) and 15.8% in the south.

Anderson (1992) demonstrated that many fish species, including tunas, show variations in abundance from north to south along the Maldivian atoll chain. In particular, for many fishes the Kudahuvadhoo Channel seems to mark a significant boundary. This channel, at about 02º 40'N, divides the north-central double chain atolls from the southern single chain atolls. As a first approximation, in order to quantify catches, it is assumed that this channel also marks something of a boundary for bigeye tuna. The recorded catches of *Thunnus* in the two regions north and south of the channel over the 25-year period 1970-94 are presented in Table 3. Note that discrepancies between the IPTP and the MOFA databases may have led to minor errors in the years 1984-87. Using the estimated percentage contribution of bigeye tuna by weight to the *Thunnus* catch in the two regions given above, the total Maldivian catch of bigeye tuna by year was estimated (Table 3 and Figure 3).

The total bigeye tuna catch of the Maldivian fleet (mainly by pole and line) is estimated to have increased from about 100 t/yr in the 1970s about 500 t/yr at present. This increase is a reflection of the increase in Maldivian tuna catches in general, and of yellowfin catches in particular. The estimated contribution of bigeye to the total Maldivian catch of *Thunnus* increased from about 3% during the 1970s to about 5% over the last few years. This reflects the increasing proportion of *Thunnus* caught in the south of Maldives over the last couple of decades (about 16% during the 1970s, and about 28% during 1990-94). The estimated contribution of bigeye to the total Maldivian catch of all tunas was about 0.4% in the 1970s and 0.6% during 1990-94.

The presence of juvenile bigeye tunas in Maldivian catches has been previously documented, but this paper presents the first catch estimates. The estimated domestic Maldivian catch is relatively small in terms of weight: 500 t, compared with a total Indian Ocean catch of 68,000 t in 1993 (IPTP, 1995). Nevertheless, because the bigeye caught in Maldives are small juveniles this catch may not be insignificant in terms of numbers of fish taken. The status of the Indian Ocean stock of bigeye tuna is not well known, but the stock is thought to be heavily exploited (IPTP, 1994). Attempts should be made to refine the current estimates of Maldivian bigeye catches, so that they can be incorporated in future stock assessments.

It is emphasized that the present estimates of bigeye tuna catches in the Maldives are first approximations only. For example, these estimates are based on rather limited sampling during 1986-95, which may not be applicable to the years 1970-85. Even within the period 1986-95 there may have been intra-annual and interannual variations in bigeye tuna abundance that have not been adequately accounted for (particularly taking into account the great variation in frequency of occurrence of bigeye between *Thunnus* samples). Other potential sources of error include:

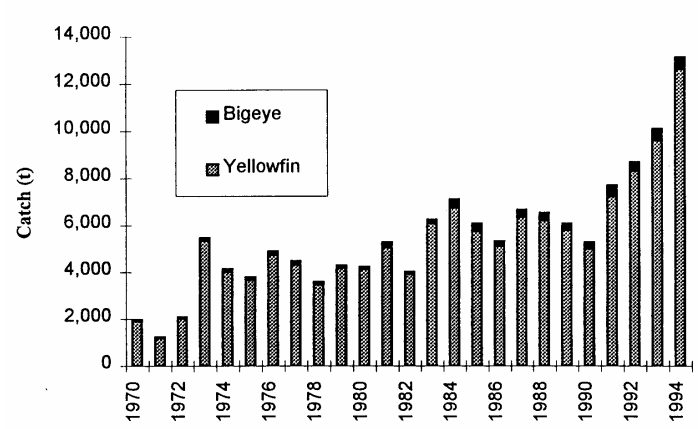
1. Variations in abundance associated with El Niño events, which are known to affect other tuna species in Maldivian waters (Anderson, 1993).
2. Mechanization of the Maldivian pole-and-line fleet, which took place during the second half of the 1970s, and may have changed bigeye catchability, for example by increasing ability to fish offshore.
3. Increased fishing pressure on the Indian Ocean bigeye stock, which may have adversely affected recruitment to the Maldivian fishery.
4. The great increase in the use of FADs in Maldivian waters in the last few years, which might have some influence on the catchability of juvenile bigeye (18 out of the 29 bigeye tunas recorded from Baa Atoll in August 1995 were caught on a FAD, even though most fishing was on schools not associated with FADs).

In the western Indian Ocean purse-seine fishery, bigeye tuna make up 17% of *Thunnus* catches from log sets, but less than 3% from sets on free schools (Hallier, 1994). Maldivian fishermen search for floating objects, particularly during the juvenile yellowfin tuna fishing seasons (Anderson, 1985). It is not known to what extent regional and seasonal variations in the occurrence of floating objects within Maldivian waters will effect bigeye tuna catches.

Maldeniya *et al.* (1991) sampled gillnet and troll landings for bigeye tuna on the southwest coast of Sri Lanka. They found an incidence of 0.7% bigeye tuna among 2018 small *Thunnus*, the remainder being yellowfin tuna. The bigeye tunas in that sample were on average smaller than the yellowfin, and were within the range 36-56 cm FL. These results are similar to those obtained from the north Maldives. Overall, there is a suggestion of a cline in bigeye tuna abundance, increasing from north to south:

Beruwala, Sri Lanka	(6°27' N)	0.7%
North Maldives (excluding Malé)	(7°00' N - 4°50' N, but mostly S of 6°N)	1.1%
Malé, Maldives	(4°10' N)	1.4%
South Maldives	(1°55' N - 0°25'S)	14.7%

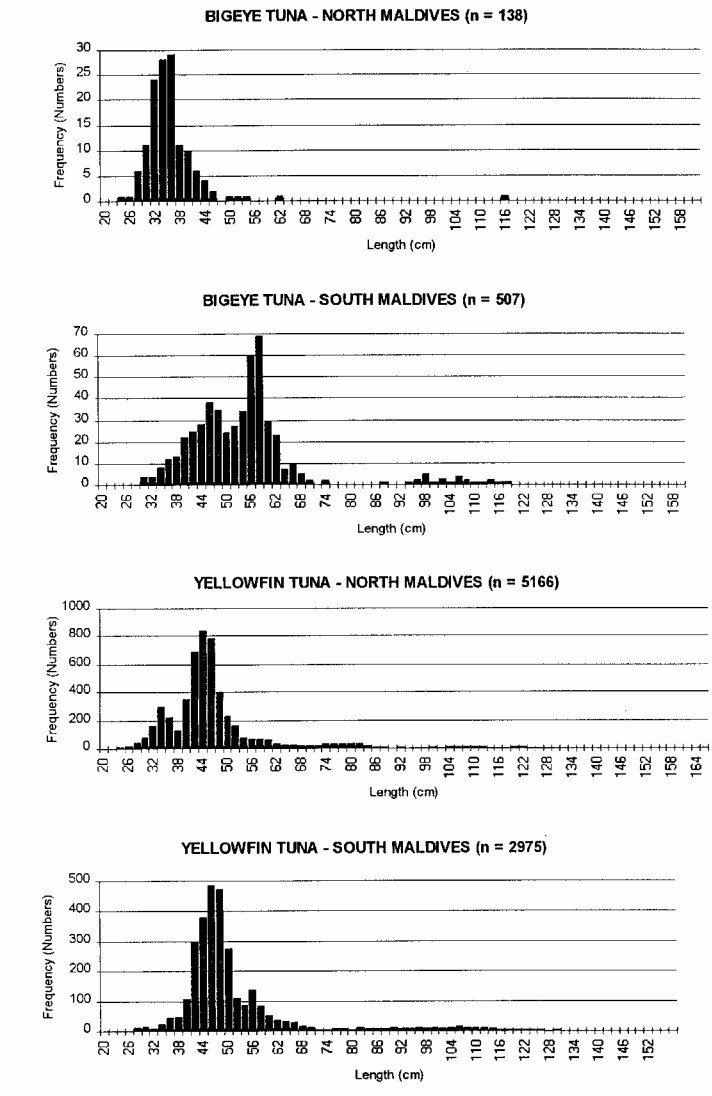
***Figure 3**. Estimated annual catches of yellowfin and bigeye tunas by the Maldivian fleet, 1970-94.*



There appears to be an abrupt increase in the frequency of bigeye occurrence between Malé and the south of Maldives. It is not known to what extent this is a true reflection of the actual situation, or a result of inadequate sampling in the intermediate area. It is therefore recommended that further sampling in the region between Malé and Laamu Atoll should be carried out.

Large quantities of bigeye tuna are caught by longliners in the central Indian Ocean (*e.g.* IPTP, 1988; Yang and Park, 1988), including the area of the Maldivian EEZ. Prior to the declaration of the Maldivian EEZ in 1976, Far Eastern longliners fished in this area. Some records of their catches are given by Klawe (1980). For some of the time since then licensed joint-venture

Figure 2. Length Frequencies of Bigeye Tuna and Yellowfin Tuna from the North and South of Maldives.



longlining in the outer zone (*i.e.*, 75-200 miles offshore) has been permitted. In addition, a commercial longliner has been operated in the same area by the Maldives Industrial Fisheries Company (MIFCO) since 1993. Available catch data have been compiled by the Ministry of Fisheries and Agriculture (MOFA), and are summarized in Table 4. The quantity of bigeye caught by longliners in the Maldivian EEZ is usually more than that of yellowfin tuna, with an average of 57% of the total recorded longline catch of these two species being bigeye tuna. The particularly high incidence of bigeye in the 1994 licenced longliner catch can be attributed to the fact that most of these vessels were Korean, and were presumably targeting bigeye tuna with deep longlines (*e.g.* Yang and Park, 1988).

REFERENCES

ANDERSON R.C. (1985) Yellowfin tuna in the Maldives. IPTP Coll. Vol. Work. Docs. 1: 34-50.

ANDERSON R.C. (1986) Republic of Maldives tuna catch and effort data 1970-1983. IPTP/86/WP/14. 59pp.

ANDERSON R.C. (1988) Growth and migration of juvenile yellowfin tuna (*Thunnus albacares*) in the central Indian Ocean. IPTP Coll. Vol. Work. Docs. 3: 28-39.

ANDERSON R.C. (1992) North-south variations in the distribution of fishes in the Maldives. Rasain 12: 210-226.

ANDERSON R.C. (1993) Oceanographic variations and Maldivian tuna catches. Rasain 13: 215-224.

ANDERSON R.C. AND A. HAFIZ (1991) How much bigeye in Maldivian yellowfin tuna catches? IPTP Coll. Vol. Work. Docs. 6: 50-52.

ANDERSON R.C., M.S.ADAM, H.SHAFEEU AND I.NADHEEH (1995) Preliminary report of length and weight frequency sampling activities, 1994-95. Unpublished report, Marine Research Section, Ministry of Fisheries and Agriculture, Malé. 19pp.

HALLIER J.-P. (1994) Purse seine fishery on floating objects: What kind of fishing effort? What kind of abundance indices? Pp.192-198. In: J.D. Ardill (ed.) Proceedings of the Fifth Expert Consultation on Indian Ocean Tunas, Mahé, Seychelles, 4-8 October 1993. 275pp.

HAFIZ A. AND R.C.ANDERSON (1988) The Maldivian tuna fishery - an update. IPTP Coll. Vol. Work. Docs. 3: 334-344.

IPTP (1988) Atlas of industrial tuna longline and purse-seine fisheries in the Indian Ocean. IPTP, Colombo. 59pp.

IPTP (1994) Report of the expert consultation on Indian Ocean tunas. Fifth session, Mahé, Seychelles, 4-8 October 1993. IPTP/94/GEN/22: 32pp.

IPTP (1995) Indian Ocean Tuna fisheries data summary, 1983-1993. IPTP Data Summary No.15: 137pp.

KLAWE W.L. (1980) Longline catches of tunas within the 200-mile economic zones of the Indian and western Pacific Oceans. FAO Indian Ocean Prog. Dev. Rep. 48: 83pp.

MALDENIYA R., P.DAYARATNE AND B.BONIFACE (1991) Incidence of juvenile bigeye tuna (*Thunnus obesus*) among the tuna catches in south-west coast of Sri Lanka. IPTP Coll. Vol. Work. Docs. 4: 108-110.

POREEYANOND D. (1994) Catch and size groups distribution of tunas caught by purse seining in the Arabian Sea, Western Indian Ocean, 1993. Pp.53-55. In: J.D. Ardill (ed.) Proceedings of the Fifth Expert Consultation on Indian Ocean Tunas, Mahé, Seychelles, 4-8 October 1993. 275pp.

ROCHEPEAU S. AND A.HAFIZ (1990) Analysis of Maldivian tuna fisheries data 1970-1988. IPTP/90/WP/22: 56pp.

YANG W.S. AND Y.C.PARK (1988) Distribution of yellowfin and bigeye tunas by the Korean longline fishery in the Indian Ocean. IPTP Coll. Vol. Work. Docs. 3: 89-93.

YESAKI M. AND A. WAHEED (1991) Preliminary results for yellowfin tuna (*Thunnus albacares*) from the Maldivian tuna programme. IPTP Coll. Vol. Work. Docs. 6: 1-6.