Work Plan Implementstion
(General Papers)

IPTP/88/GEN/14

REPORT OF THE EXPERT CONSULTATION ON THE STOCK ASSESSMENT OF TUNAS IN THE INDIAN OCEAN

Mauritius, 22-27 June 1988

Mailing Address	: P.O.Box 2004, Colombo, Sri Lanka
Street Address	: 1st Floor, NARA Building, Crow Island, Mattakkuliya Colombo 15
Telex	: 21989 IPTP CE / 22203 FAOR CE
Telephone	: 522369 / 522370 / 522371

INDO-PACIFIC TUNA DEVELOPMENT AND MANAGEMENT PROGRAMME (IPTP)
Colombo, Sri Lanka

TABLE OF CONTENTS

		Page
1.	OPENING OF THE MEETING	1
2.	ELECTION OF CHAIRMAN	1
3.	ADOPTION OF AGENDA AND ARRANGEMENTS FOR THE MEETING	1
4.	REVIEW OF NATIONAL FISHERIES AND RESEARCH PROGRAMMES	2
5.	REVIEW OF STATUS OF STOCKS	2
5.1	Small Tunas, Billfishes and Seerfishes	2
5.1.1	Small tunas	2
1	Description of fisheries	2
2	Stock structure and biological parameters	4
3	Stock status	4
5.1.2	Billfishes	4
1	Description of fisheries	4
2	Fisheries trends	4
5.1.3	Seerfishes	5
1	Description of fisheries	5
2	Biological parameters	6
5.1.4.1	Review of the last Expert Consultation's recommendations	6
1	General recommendation to improve statistics	6
5.1.4.2	Recommendations of 1988 Expert Consultation	7
5.2	Bigeye Tuna, Albacore Tuna and Southern Bluefin Tuna	10
5.2.1	Bigeye Tuna (BET)	10
1	Description of fisheries	10
2	Catch trends	10
3	Effort trends	11
4	Trends in catch per unit effort (CPUE)	11
5	Stock structure	12
6	Population parameters	12
7	Production model	12
8	Estimation of catch by age and virtual population analysis	12
9	State of stock	13
10	Recommendations	13
5.2.2	Albacore (ALB)	18
1	Catch trends	18
2	Effort trends	18
3	Trends in catch per unit effort (CPUE)	18
4	Stock structure	19
5	Population parameters	19
6	Production model	19
7	Other methods	19
8	State of stock	19
9	Recommendations	20

5.2.3 Southern bluefin tuna (SBF) 24
1 Description of fisheries 24
2 State of stock 24
3 Effects of current regulations 24
4 Recommendations 25

5.3 Yellowfin and Skipjack Tunas (YFT and SKJ) 27
5.3.1 Yellowfin tuna 28
1 Growth 28
2 Reproduction biology 29
3 Behaviour 29
4 Stock status 29

5.3.2 Skipjack tuna 30
1 Biological parameters 31
2 Status of stock 31
3 Behaviour 31
4 Recommendations 31

6. INTERACTION BETWEEN FISHERIES INCLUDING TUNA FISHERIES INTERACTION PROGRAMMES (TAGGING PROGRAM) 45

7. PROGRESS MADE IN THE COLLECTION OF STATISTICS 46

8. REVIEW OF KEY RESEARCH AREAS 53
1. Assessment 54
2. Stock structure 55
3. Movement/Migration 55
4. Biology 55
5. Summary 55

9. FOLLOW-UP TO THE EXPERT CONSULTATION 56
9.1 Future activities of IPTP 56
9.2 Other recommendations 56

10. ADOPTION OF THE REPORT 56

Appendix 1 - Inaugural address by Mr. M. Munbodh, Divisional Scientific Officer (Fisheries), Ministry of Agriculture, Fisheries & Natural Resources 57
Appendix 2 - List of participants 59
Appendix 3 - Agenda and time table 67
Appendix 4 - List of documents 68
Appendix 5 - Country reports 72
Appendix 6 - Executive summary report 85

REPORT OF THE
EXPERT CONSULTATION ON STOCK ASSESSMENT OF TUNA
IN THE INDIAN OCEAN
Mauritius, 22-27 June, 1988

1. OPENING OF THE MEETING

The Expert Consultation on the Stock Assessment of Tuna in the Indian Ocean was held at the Mahatma Gandhi Institute, Moka, Mauritius from 22 to 27 June 1988. On behalf of the The Indo-Pacific Tuna Development and Management Programme (IPTP), Mr. T. Sakurai, Programme Leader of IPTP, welcomed the participants and emphasized that this was a technical meeting and requested all participants to have frank discussions.

Mr. M. Munbodh, Divisional Scientific Officer (Fisheries), Ministry of Agriculture, Fisheries and Natural Resources, Government of Mauritius, opened the meeting. His inaugural address is attached as Appendix 1.

A list of participants is attached as Appendix 2.

2. ELECTION OF CHAIRMAN

Mr. Richard Shomura, National Marine Fisheries Service, Honolulu Laboratory, USA, was unanimously elected as Chairman of the meeting.

3. ADOPTION OF AGENDA AND ARRANGEMENTS FOR THE MEETING

The provisional agenda and timetable prepared by the Secretariat were presented and adopted with a minor amendment. The adopted agenda and timetable are attached as Appendix 3.

A number of papers giving background information were presented by participants and by the Secretariat. The list of documents presented is attached as Appendix 4.

The following participants were appointed chairmen and rapporteurs of discussion groups as shown in the agenda:

Group	Chairman	Rapporteur
Small tuna, billfish and seerfish (Group 1)	Dr. N. Naamin	Dr. C. Anderson Mr. P. Chisara
Bigeye, albacore and southern bluefin tuna (Group 2)	Dr. Z. Suzuki	Dr. S.Y. Yeh Dr. J.P. Hallier
Yellowfin and skipjack tuna (Group 3)	Dr. A. Fonteneau	Dr. G. Sakagawa Mr. D. Poreeyanond

Interaction between fisheries (Group 4)	Mr. R.A. Al Barwani	Dr. F. Marsac Mr. J.A. Nageon De Lestang
Collection of statistics (Group 5)	Mr. M. Munbodh	Mr. D. Ardill Mr. J. L. Cort

4. REVIEW OF NATIONAL FISHERIES AND RESEARCH PROGRAMMES

Each participant presented a report on recent developments in the tuna fishery in his/her country and details of the research programmes being carried out.

Summaries of country statements presented by participants are given in Appendix 5.

5. REVIEW OF STATUS OF STOCKS

5.1 SMALL TUNAS, BILLFISHES AND SEERFISHES

IPTP organized a workshop on small tunas, billfishes and seerfishes in the Indian Ocean in Colombo in December 1987. A collective volume of the proceedings and documents presented at that meeting has been published. In view of this, it was not felt necessary to devote much time to the consideration of these species at this Expert Consultation. The importance of these species should, however, not be underestimated. The total recorded catch of this group amounted to 216,326 mt in 1986, a 100 percent increase over the last decade. Small tunas, seerfishes and billfishes typically constitute about 40 percent of the total catch recorded by IPTP. The actual catch may be even greater due to underreporting. Reported catches are summarized in Table 1. (see page 8).

Two atlases of tuna fisheries prepared by IPTP were presented at the Expert Consultation. These provide very useful summaries of information on the fisheries for and catches of small tunas and billfishes. Among other things they clearly demonstrate the importance of the artisanal fisheries. While most billfish are landed by the distant water longline fleets, most small tunas and seerfishes are landed by coastal countries. Within the IPTP region, which includes the Indian Ocean and S.E. Asia, 78 percent of all tuna landings are made by coastal countries.

5.1.1 SMALL TUNAS

1 Description of fisheries

Within the Indian Ocean substantial catches of small tunas (i.e. longtail, kawakawa and frigate/bullet tunas) are made exclusvely by the coastal countries. Countries with the largest reported catches are Indonesia and India. Other countries with important small tuna catches include Maldives, Sri Lanka, Thailand, Iran, Pakistan, Oman and U.A.E. The major gear throughout the region is gillnet, but other important gears are small purse seine (Indonesia, Thailand and India), trolling (Sri Lanka, India, Maldives) and pole and line (Maldives).

LONGTAIL TUNA (LOT)

Total recorded longtail tuna catches in the Indian Ocean have increased from about 3,000 t in 1976 to over 20,000 t in 1986. This increase is probably due to better reporting as well as increased catches.

Longtail is the most neritic of the tunas. Catches are not made in the high seas or around oceanic islands. The highest catches are taken in the northern Arabian Sea by Oman, Iran, Pakistan and India (Table 2). Substantial catches are made in the north east Indian Ocean by Thailand and Malaysia.

KAWAKAWA (KAW)

Total catches of kawakawa in the Indian Ocean were estimated at 25,978 t in 1985 and 28,369 t in 1986. Kawakawa is found in continental shelf areas, but is less truly neritic than longtail tuna, also being caught around oceanic islands.

Within the Indian Ocean, the highest kawakawa catches are made by India. The estimated catch was 18,169 t in 1986 and 14,959 t in 1987. This is an average of about 58% of the total tuna catch of India. Most are caught close to the mainland, although minor landings are made in the Lakshadweep.

No other country in the Indian Ocean has comparable kawakawa catches, but those with catches in excess of 1000 t per annum include Comoros, Iran, Maldives, Oman, Pakistan, Sri Lanka, United Arab Emirates and People's Democratic Republic of Yemen. Sizeable catches are also landed by Thailand and Indonesia but separate statistics for this species are not recorded.

Within the Indian Ocean the major gears used in the capture of kawakawa are gillnet, small purse seine and trolling line.

FRIGATE TUNA (FRI)

The total recorded catch of frigate and bullet tunas in the Indian Ocean in 1986 was 12,635 t. The majority of this is frigate tuna, but separate records for these two species are not usually kept.

Substantial catches of *Auxis* are made by both Indonesia and Thailand. In both cases seines are the principle gear. Neither country reports separate catch estimates for *Auxis* to IPTP.

In India the catches of *Auxis* in 1986 and 1987 were estimated at 8,485 t and 4,888 t, respectively. This is an average of over 20% of all the Indian tuna catch (excluding Lakshadweep). The principle gear is gillnet.

In Sri Lanka total *Auxis* catch was estimated at 1,367 t in 1986. This was taken mainly by gillnet.

In Maldives the catches of frigate tuna in 1986 and 1987 were 1,778 t and 1,921 t. The principal gear is livebait pole and line.

1986 catch estimates for *Auxis* in UAE were 540 mt and Iran 326 mt.

2. Stock structure and biological parameters

No new information was presented at the meeting.

3. Stock status

Given the lack of effort statistics and even details of catch by species from some countries, meaningful stock assessment is almost impossible. One approach suggested to avoid the need for effort statistics was a yield per unit area method to derive a crude index of abundance for neritic tunas on continental shelf areas. There are several problems with this approach, but in the absence of other information it might be used to give some crude indications of stock status. It does, for example, suggest that yields of longtail tuna from the Gulf of Oman are higher than anticipated and, therefore, that a real effort to obtain the information necessary to carry out a more rigorous assessment of stock status be made.

5.1.2 BILLFISHES

1 General description of fisheries

The annual production of the billfishes (Marlins, Sailfish, Swordfish) in the Indian Ocean increased from 4,800 t in 1976 to 17,000 t in 1986. It is assumed that actual catches would be higher if all the countries concerned could have responded in giving out their data. Billfishes are widely distributed in the tropical Indian Ocean and most of the catch is made by the industrial Japanese, Korean and Taiwanese longline fisheries (Table 2). However, relatively good catches of billfishes have been recorded from local fisheries such as those of India and Sri Lanka. In many other countries some catches are made but no catch statistics are available, for example in Indonesia, Iran, Arab Republic of Yemen and Mauritius. In India catches of billfishes were 1,486 t in 1986. Most of this catch is made on the western coast by gill net fishery. In Sri Lanka a total of 1,666 t of billfishes were recorded in 1986 although the annual production is estimated from sampling programmes to fluctuate between 2,500 and 3,000 t.

2 Fisheries Trends

BLUE MARLIN (BUM)

Total catches from industrial longliners in the Indian Ocean have shown a more or less constant production for the past four years (1983-1986) with an average catch of 2,500 t. Fishing grounds occur mostly in areas between latitude 10N and 10S. This species is most abundant in the northern part of the Western Indian Ocean although high hooking rates are reported in areas around Madagascar and Northern Australian coast during the 1st and 4th quarters.

BLACK MARLIN (BLM)

Black marlin appears to be the most coastal species of all the marlins. Total catches in the Indian Ocean in 1986 was 1,600 t and almost half of it was contributed by industrial longliners. This species is commonest in the coastal waters of the Indonesian archipelago, East Africa, North Australian coast and Bay of Bengal. Other countries that catch this species but lack statistics include Kenya and Mozambique.

STRIPED MARLIN (MLS)

Fishing grounds with high catches are mostly located between 10N to 10S with an extension to 20N during the 1st and 2nd quarters. Total catch for 1986 in the Indian Ocean was 2,945 t. The longliners alone recorded 2,721 t and the other 224 t was contributed from the minor fisheries, mainly from Mozambique and Sri Lanka.

SAILFISH (SAI)

The longliner catches in the Indian Ocean have shown a considerable decline of catches from 800 t in 1970 to a mere 143 t in 1986. However, the minor fisheries have shown higher catches for the two years 1985 and 1986. The catches were around 1,000 t. It is assumed that such higher catches from the artisanal fisheries could reflect the better statistical coverage especially from Sri Lanka rather than a real increase. Higher longline hooking rates have been observed off the Indian subcontinent, Madagascar and Northern Australian coast.

SWORDFISH (SWO)

There are two major fishing grounds: one in the north between latitudes 10N and 10S and the other in the south between 30S and 45S. With a total catch of 2,700 t in 1986 (Table 1) the production of swordfish in the Indian Ocean appears to be very low compared to other oceans where specific fisheries aiming at this species have been developed. Indian Ocean potential is still unknown. Areas which show high catches and high hooking rates include Somalia, South Africa, Western Bay of Bengal and Southern Australia.

A paper on sport fishing for billfishes in Mauritius was presented during the meeting.

5.1.3 SEERFISHES

1 Description of fisheries

The seerfish fisheries are of considerable importance to the food supply in many coastal countries in the Indian Ocean region. The fisheries are mostly artisanal and the fishing gears used are mainly gillnets; in some countries troll line and handline are also used. The species exploited are narrow-barred king mackerel (*Scomberomorus commerson*), Indo-Pacific king mackerel (*S. guttatus*) and Wahoo (*Acantocybium solandri*). Unidentified seerfish (*Scomberomorus* spp.) forms a large part of the recorded catch.

Catches of seerfishes in the Indian Ocean have shown a remarkable increase over the past decade from about 41,000 t in the early seventies to 87,337 t in 1986. India and Oman are two major fishing countries for seerfish (53,906 t in 1985 and 49,592 t in 1986). Most of the remaining catch in 1986 comes from Pakistan (8,016 t), Indonesia (4,770 t), U.A.E. (6,180 t), and Iran (1,162 t).

Fishing takes place all year round in Indonesia, Yemen, Oman, Iran and Sri Lanka. In the U.A.E. coast fishing for seerfish is most active during the winter season. In most of these areas seerfish stocks seem to be fished by more than one country.

2 Biological parameters

No estimates of biological parameters have been submitted to the IPTP, except from Omani and Indian waters. Length frequency distribution and otoliths of narrowed-barred king mackerel (Scomberomorus commerson) taken from waters of Oman were examined for size composition and growth. Length-at-age 1 and 2 for this species was estimated to be 48 and 84 cm, respectively. Preliminary yield per recruit analyses suggest yield could be increased by increasing the size at first capture.

There are indications that some biological information on seerfish are available in India; seerfish have been studied and some stock estimate computed.

5.1.4.1 REVIEW OF LAST EXPERT CONSULTATION'S RECOMMENDATIONS

1 General recommendation to improve statistics

Action taken. There is a real need for accurate catch records by species and gear. There has been some improvement, but there is still much to be done, particularly by coastal countries.

2 Recommendation to encourage and/or assist countries bordering the Gulf of Oman to initiate biological sampling programmes to monitor the recent development in the longtail tuna fisheries.

Action taken. IPTP has encouraged the countries bordering the Gulf of Oman to initiate biological sampling of their longtail tuna fisheries. A workshop on the tuna resources of this area is planned for December 1988.

3 Recommendation to monitor fisheries in Bangladesh, and to a lesser degree in Burma, as this country already has a gillnet fishery for Hilsa which could possibly be diverted to harvest small tuna resources.

Action taken. Little progress has been made on the monitoring of small tuna catches in Bangladesh and Burma.

4 Recommendation to prepare a synopsis of biology of longtail, kawakawa and frigate/bullet tunas.

Action taken. IPTP has prepared a synopsis of the biology of longtail tuna. Synopses on kawakawa and frigate/bullet tuna in the Indian Ocean have not yet been prepared.

5 Recommendation to initiate biological studies to determine growth and other biological parameters.

Action taken. Limited progress has been made on the determination of growth and other biological parameters of small tunas.

6 Recommendation to complete the mapping of the resources of small tunas and present these results at the workshop scheduled for 1987.

Action taken. The mapping of small tuna resources has been completed. The Expert Consultation congratulated IPTP on this outstanding work.

7 Recommendation. A review of biological information be prepared for the workshop on small tuna and seerfish to be organized in 1987.

Action taken. A review of biological information on seerfishes was not prepared for the workshop on small tunas and seerfishes held in December 1987.

8 Recommendation. Maps of major fishing grounds based on longline records be prepared by IPTP.

Action taken. The mapping of fishing grounds of billfishes based on longline records was completed by IPTP.

5.1.4.2 RECOMMENDATIONS OF 1988 EXPERT CONSULTATION

There is still a need to improve the collection of statistics from the region. In particular the need for all countries to report small tuna and seerfish catches by gear was emphasized.

Table 1. Catches of small tuna, seerfish and billfish, from 1972 - 1986

SPECIES	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
LOT	666	869	2126	2421	3046	3305	1936	4589	3215	5710	15337	15957	16329	28962	21570
KAW	14204	12264	15832	16756	16529	15019	9660	14480	8282	23113	25507	21322	29080	25978	28369
FRZ	3186	6626	6006	4057	2708	3086	1661	1701	1595	2908	4967	5675	9337	6501	12635
TUN	20770	47005	36476	28616	38578	39738	38431	41965	55558	34369	46048	42810	33232	61638	49337
TOTAL	38826	66764	60440	51850	60861	61148	51688	62735	68650	66100	91859	85764	87978	123079	111911
COM	13300	11200	12850	11557	14364	17003	17914	20481	16018	34978	43333	47428	43359	57719	58217
GUT	600	600	759	498	315	100	157	245	182	13661	15570	15685	14479	19340	13831
STS	0	0	0	0	0	0	0	0	0	279	165	230	225	76	2575
WAH	0	0	0	0	0	0	0	0	0	0	1	61	713	59	6
KGX	23217	19323	25570	23801	28531	23081	21050	30798	34200	4511	7971	5422	3963	16140	12708
TOTAL	37117	31123	39179	35856	43210	40184	39121	51524	50400	53429	67040	68826	62739	93334	87337
BUM	1792	939	1374	2286	1550	1429	2605	2534	2440	2692	2416	3146	3410	3397	3638
BLM	124	71	53	30	13	92	68	87	180	147	123	297	334	438	1607
MLS	1430	966	1932	1161	833	1755	2803	2468	3025	3121	1559	1891	2148	4150	2945
SAI	500	200	245	438	384	148	219	248	312	172	163	149	126	1220	1229
SWO	836	769	726	983	774	923	1631	1424	1197	1395	1597	1952	1807	2943	2689
BIL	896	800	2406	852	1240	1453	2214	3356	2663	3165	4978	2648	3257	5043	4907
TOTAL	5578	3745	6736	5750	4794	5800	9540	10117	9817	10692	10836	10083	11082	17191	17015

Table 2. Catches of small tuna, seerfish and billfish, by country in 1986 (Indian Ocean) (metric tons)

COUNTRIES	LOT	KAW	FRZ	TUN	COM	GUT	KGX	STS	WAH	BUM	BLM	MLS	SAI	SWO	BIL	TOTAL
							SPECIES									
Australia	135	0	0	20	0	0	300	0	0	0	0	0	0	0	0	455
Bahrain	0	0	0	0	290	0	0	0	0	0	0	0	0	0	0	290
Bangladesh	0	0	0	67	0	0	0	0	0	0	0	0	0	0	0	67
China (Taiwan)	0	0	0	0	0	0	0	0	0	1177	252	1625	11	1152	0	4217
Comoros	0	1300	0	140	0	0	420	0	0	0	0	0	0	0	0	1860
Djibouti	0	0	0	30	0	0	70	0	0	0	0	0	0	0	0	100
Egypt	0	0	0	300	0	0	0	0	0	0	0	0	0	0	0	300
India	185	18116	8485	2780	20285	12816	0	2175	0	0	0	0	0	0	1486	66328
Indonesia	0	0	0	21600	4220	550	0	0	0	0	0	0	0	0	0	26370
Israel	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	100
Japan	0	0	0	0	0	0	0	0	0	1328	437	1104	143	1150	0	4162
Kenya	0	0	0	0	51	0	0	0	0	0	0	0	0	0	0	51
Korea Rep.	0	0	0	822	0	0	0	0	0	16	0	109	0	6	2678	3631
Kuwait	0	0	0	0	94	0	0	0	0	0	0	0	0	0	0	94
Maldives	0	1071	1779	45	0	0	0	0	0	0	0	0	0	0	0	2895
Mauritius	0	0	0	400	0	0	0	0	0	0	0	0	0	0	0	400
Mozambique	0	0	0	280	0	0	380	0	0	0	0	0	0	0	0	660
Qatar	0	0	0	3	98	0	0	0	0	0	0	0	0	0	0	101
Reunion	0	0	0	190	0	0	0	0	0	0	0	0	0	0	0	190
Saudi Arabia	0	0	0	264	0	0	8864	0	0	0	0	0	0	0	0	9128
Seychelles	0	323	0	0	0	0	0	0	6	0	0	0	3	0	0	332
South Africa	0	0	0	0	13	0	8	0	0	0	0	0	0	0	0	21
Sri Lanka	0	1360	1367	4	0	0	383	0	0	1113	918	107	748	371	0	6371
Tanzania	0	0	0	70	400	0	0	400	0	0	0	0	0	0	477	1347
Thailand	1895	0	0	1497	0	0	2283	0	0	0	0	0	0	0	0	5675
U.S.S.R	0	0	0	5562	0	0	0	0	0	4	0	0	0	0	0	5566
Yemen Arab Rep.	307	438	0	0	2673	0	0	0	0	0	0	0	0	0	0	3418
Yemen P.D.R.	90	1270	20	0	890	0	0	0	0	0	0	0	0	10	0	2280
Iran	11710	1870	326	0	697	465	0	0	0	0	0	0	3	0	0	15071
Pakistan	3275	1225	18	3535	8010	0	0	0	0	0	0	0	321	0	266	16650
Oman	0	0	0	11728	14316	0	0	0	0	0	0	0	0	0	0	26044
U.A.E	3973	1396	540	0	6180	0	0	0	0	0	0	0	0	0	0	12089
TOTAL	21570	28369	12635	49337	58217	13831	12708	2575	6	3638	1607	2945	1229	2689	4907	216263

5.2 BIGEYE TUNA, ALBACORE AND SOUTHERN BLUEFIN TUNA

5.2.1 BIGEYE TUNA (BET)

1 Description of fisheries

Bigeye tuna (Thunnus obesus) occur throughout the Indian Ocean, between about 20 N and 50 S latitudes. The major fishing grounds are between 15 N and 15 S latitudes and between 25 S and 40 S latitudes off the African and the Australian coasts of the Indian Ocean.

Japanese, Korean and Taiwanese longline fleets have been traditionally the major bigeye producers. Recently some secondary bigeye catches were made by the French and Spanish purse seiners.

2 Catch trends

Catches of bigeye tuna by gear and country are listed in Table 3. Since the beginning of the longline fishery in the Indian Ocean in 1952, bigeye catches have increased and reached 37,000 t, in 1968; subsequently the catch declined steadily until 1973. Since 1974, catches have remained above 25,000 t; a noticeable peak occured in 1978 at 54,000 t. The average catch for the 1982-86 period is 41,000 t, the highest average value for a five year period since the beginning of the fishery.

Japan was the dominant fishing nation in the Indian Ocean from 1952 to 1974. Japan's bigeye catch reached a maximum of 25,000 t in 1968 and declined sharply thereafter. By 1974 the catch had declined to a level where Korea became the dominant fishing nation for bigeye tuna. Korean catches remained dominant until 1982 after which Japan resumed the dominant position. The catch of Taiwanese longliners has been relatively constant in recent years at about 9,000 t annually, the highest catch 9,500 t being recorded in 1986.

Purse seiners conducted experimental fishing in the Indian Ocean beginning in 1973 - 1974. In 1979 a large purse seiner, resumed operations from Mauritius and had encouraging results. This stimulated other vessels to explore the Indian Ocean. By late 1984, forty-nine purse seiners were fishing in the Western Indian Ocean primarily for yellowfin and skipjack tuna. Catches of bigeye tuna were also taken; catches for 1984, 1985 and 1986 were 2,400 t, 3,800 t and 5,400 t, respectively.

Purse seine bigeye catches collected so far show:

- Underestimation due to mis-identification of bigeye in the French purse seine catch of 1983 - 1984.

- Underestimation due to mis-identification of bigeye in the Spanish and USSR purse seine catches in 1985 - 1987.

Therefore, improvement should be made in order to get a better estimate of the bigeye purse seine catch and adjustments made for other species.

These bigeye represent a by-catch of the skipjack and yellowfin oriented purse seine fishery. Based on French purse seine data bigeye were more commonly taken with log-associated schools (4.8%) than with free-swimming schools (2.3%). These figures may be underestimated.

The sizes of longline-caught bigeye ranged from 40 to 165 cm; most purse seine-caught bigeye were from 45 to 65 cm in length.

3 Effort trends

The longline effective effort on bigeye has fluctuated over time (Fig. 1). As reported by IPTP in 1985, the effects on effort reached a peak in 1967. The fluctuating changes in effective effort has largely been influenced by changes in fishing strategy of the fleets; particularly those vessels which adopted the deep longlining technique. The change to deep longline gear was a shift to bigeye tuna as the target species. The Korean fleet, for example, operated principally in the tropical Indian Ocean and targetted on bigeye and yellowfin tuna. The Japanese and Taiwanese fleets in contrast, directed a large part of their effort to the southern Indian Ocean, targetting on southern bluefin tuna and albacore, respectively.

Purse seine fishing effort in the Western Indian Ocean increased markedly from 1983 to 1985. Since 1985, purse seine effort decreased slightly from 10,000 to 8,500 fishing days. Interestingly the purse seine catch of bigeye tuna increased during this period; the increase was more a reflection of the overall increased catch (from 106,000 t in 1984 to 163,000 t in 1987) than a change in fishing strategy by the fishery.

4 Trends in catch per unit effort (CPUE)

Longline fishing effort of the Japanese and Korean fleets is directed toward catching bigeye tuna. A long and complete series of detailed catch and effort data is available for the Japanese fleet (Fig. 2). Data from this fleet were used to estimate effective fishing effort and effective catch rate (CPUE); procedures used were those adopted at the 1985 IPTP meeting. The present results (Fig. 3) are practically the same as reported in 1985; differences are minor due to adjustments of some catch rates based on improvements in the data series.

The standardized CPUE of the Japanese longline fishery showed a sharp decline immediately after the start of the fishery in 1952 (Fig. 2); subsequently the decrease continued, but at a slower rate up to 1966. Except for the sudden increase during 1977-78, the steady decline of the CPUE continued into the eighties. However, from 1983 the Taiwanese longline CPUE increased and more recently Japanese longliners have experienced higher CPUE during 1987 and early 1988 than the previous year.

It is unknown for the moment whether this increased CPUE is the result of increased adult biomass or changes in catchability.

5 Stock structure

At present there is no conclusive information on stock structure of the Indian Ocean population of bigeye tuna. Genetically isolated sub-stocks, separated by geographic distance, may exist; however, based on cumulated catch data from the Japanese longline fleet, there appears to be a continuous distribution of bigeye tuna throughout the entire Indian Ocean. Based on this finding it has been postulated that there is a single stock; stock assessment studies have been based on this assumption.

6 Population parameters

No new information on population parameters was submitted to the meeting. To date stock analyses of bigeye tuna have relied on length-weight relationship and growth estimates for Pacific bigeye tuna since no estimate of biological parameters are available for the Indian Ocean.

7 Production model

Production model analysis was conducted using the most recent data. Fishing effort was estimated from the longline fishery. The relation between yield and effective effort is illustrated in Figure 1.3 together with the equilibrium yield curves for shape parameter, m=0.0, m=1.001 and m=2.1. The best fit is obtained for m=0.0; indicating that the MSY would be obtained under an infinite fishing effort condition. Any further development of surface fisheries on small bigeye may alter the estimates of this model based purely on a longline fishery. Optimum fishing effort at m=1.001 and m=2.0 was 267 and 240 millions of effective hooks, respectively. Recent fishing effort is estimated to have exceeded the calculated optimal levels reaching 300-350 millions of hooks during the 1982 - 1985 period.

Recent developments in the purse seine fishery for yellowfin and skipjack, with notable by-catch of bigeye tuna, have changed the fishing pattern exerted on the stock. These changes may have unknown effects on the production model.

With the inclusion of the new fishery data in the production model, the present MSY is estimated at a 35,000 t - 42,000 t level; the MSY is similar to that calculated in the previous study.

8 Estimation of catch by age and virtual population analysis

Estimation of catch by age and VPA were attempted by MIYABE. These analyses, however, do not include the purse seine catch by size data; therefore, the catch-by-age are very biased, especially for ages 0, 1 and 2. In a VPA study (MARSAC and HALLIER) at the last IPTP meeting purse seine data were included. The age 0 bigeye caught by the purse fishery in 1985 was estimated to be 500,000 fish which represented half of the average total number of bigeye of all ages caught by the longline fishery.

A sequential population analysis (SPA) study was conducted using Parrack's VPA method tuned by the longline CPUE of fisheries from different countries (Doc. 43). This type of method might be useful in status of stock study of tuna if the following conditions are incorporated in the study: (1) Catch by age data covering all fisheries, (2) reliable CPUE series representative of the biomass, and (3) proper SPA tuning methods and starting hypothesis. These conditions do not seem to be satisfied in the studies of Indian Ocean bigeye tuna carried out to date.

9 State of the stock

The bigeye fisheries, particularly with longlines, have been operating at a high level of effort in recent years as fleets targetted specifically on bigeye tuna with the deep-longlining technique. It appears that without a new breakthrough in fishing technology that can target on an under exploited part of the stock, further increase in fishing effort will not result in a corresponding substantial increase in catch.

The unusually high CPUE in 1977 may be due to either a real increase in adult biomass (i.e. recruitment of one or two good year classes) or to unknown factors that increased fishing power of longliners and which were not accounted for in the estimation of effective effort procedure. If it is this latter situation, then the recent estimates of effective fishing effort of longliners are underestimates and the stock is being more heavily exploited than indicated by the results of the production model analysis.

Several bigeye cohort and yield per recruit analyses were reported in the IPTP 1986 report and this year's meeting. The results of these studies must be considered preliminary and viewed with caution since they are based on very limited data.

10 Recommendations

Statistics

Collection of logbooks, catch and effort statistics from the longline fisheries have improved in recent years; however, the current need is for dedicated effort in processing the backlog of data. Furthermore, the collection of information, on whether the fishing effort is with deep longlining or standard longlining, and size of fish caught, should be collected on a routine basis in order to obtain a better standardization of the fishing effort and CPUE.

The purse seine fishery in the western Indian Ocean has attained a high level of development. Sampling of the purse seine catches for species composition and size frequency of bigeye tuna has been put into operation for more than two years. The monitoring of the catch statistics of small size bigeye which represent a large number of fish is important in determining possible interactions between fisheries and effects of exploitation on the stock.

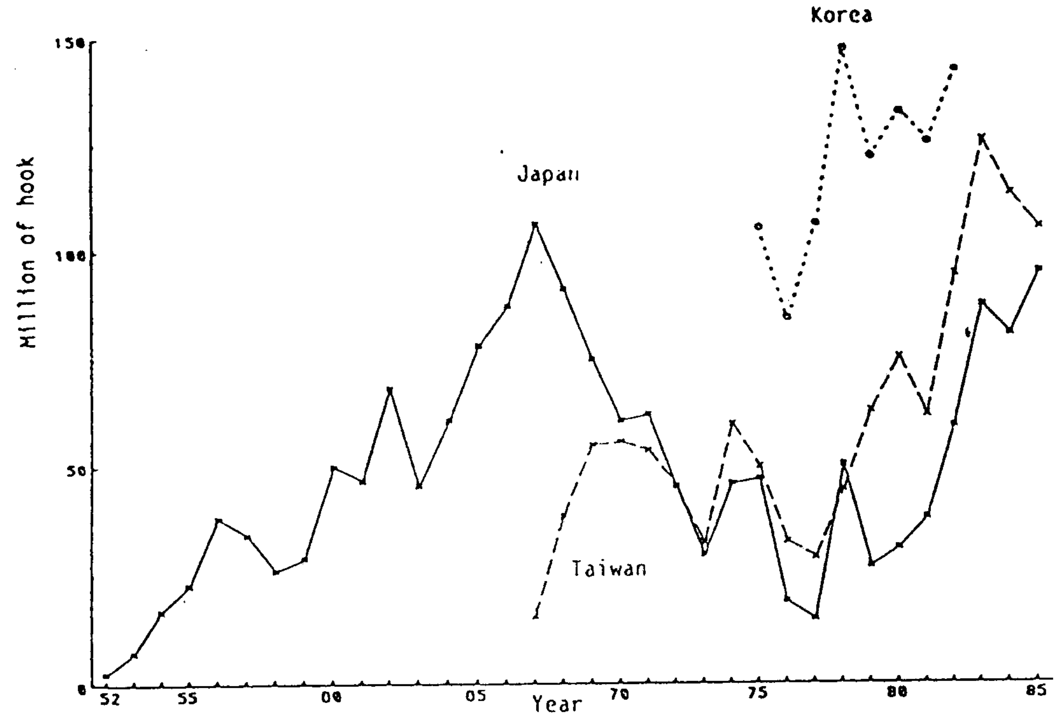


Fig.1 Estimated effective effort by country.

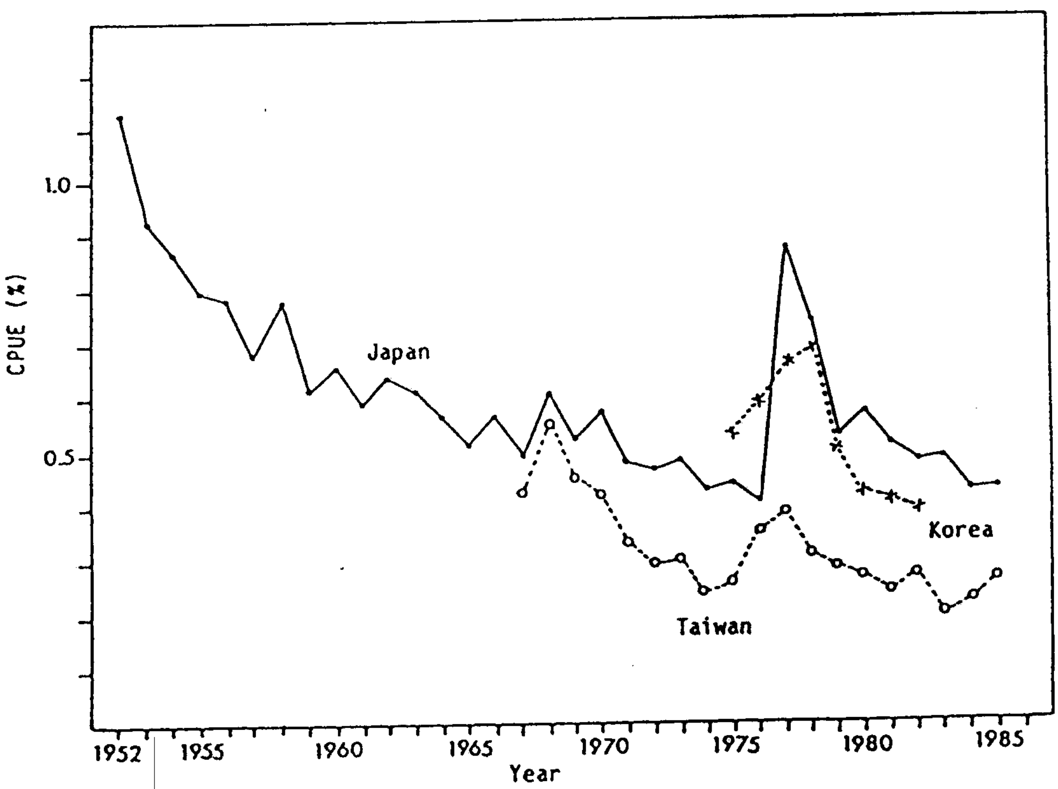


Fig.2 Standardized CPUE for longline fishery.

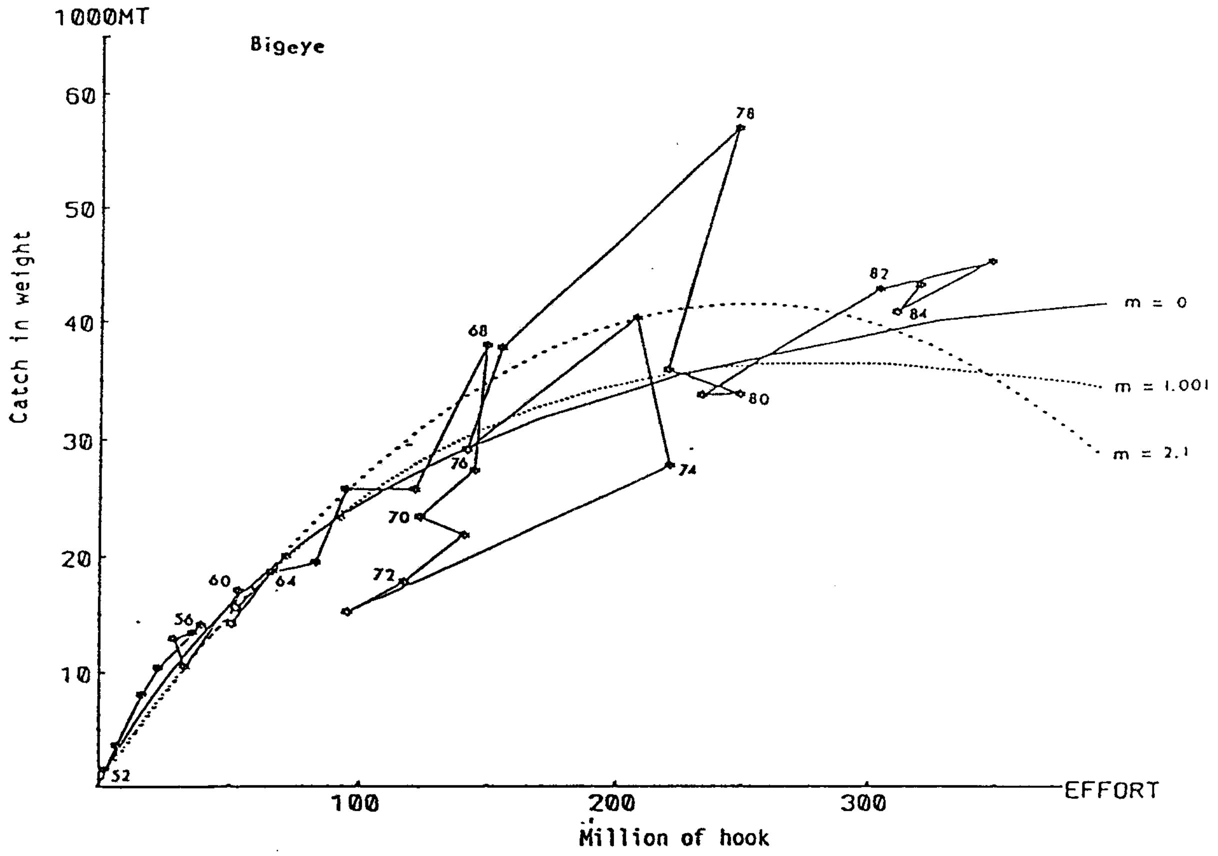


Fig.3 . Equilibrium production curve and observed catch and effort for Indian bigeye tuna.

5.2.2 ALBACORE (ALB)

Albacore (Thunnus alalunga) are widely distributed throughout the Indian Ocean between latitude 15 N and 45 S. They are caught traditionally by Japanese, Korean and Taiwanese longliners. Recently however, the amount of albacore caught by the surface fishery exceeded that by the longline fishery. Surface albacore are caught essentially by Taiwanese gillnetters and, to a less extent, by purse seiners.

1 Catch trends

Annual catches of albacore in the Indian Ocean are shwon by country and gear in Fig. 4. Total catch increased steadily from 1952 and reached 18,000 t in 1964. Thereafter, catches have fluctuated from 10,000 t to 22,000 t except from 1974 and 1986 when they reached 27,250 t and 25,600 t respectively.

Japanese catch of albacore was dominant until 1968. Since then catch by Taiwanese longliners have been much greater than either Japanese or Korean catches as Japanese vessels began to target on southern bluefin tuna, while Korean vessels targetted on bigeye and yellowfin. In 1986, albacore caught by Taiwanese gillnetters in Indian Ocean is estimated to be about 15,000 t, which is about 300 per cent higher than that of 1985.

2 Effort trends

As recommended by Honma, fishing effort for albacore may be expressed in terms of effective number of hooks spent by the regular longliners. The nominal number of hooks spent by deep longliners are thus adjusted based on the rate of fishing efficiency on albacore as compared to the equivalent regular longliners. Fishing effort for albacore by surface fishery is derived directly by dividing the amount of surface albacore catch by regular longline catch rate. This simple translation of fishing effort for albacore may cause severe bias as the catch of albacore from surface fishery becomes dominant.

Effective regular longliner effort on albacore has fluctuated between 50 million to 218 million hooks since 1962. There appears to be a decreasing trend of effective longline fishing effort since 1982. Annual effective fishing effort was 218 million hooks in 1986.

3 Trends in catch per unit effort (CPUE)

Annual catch of albacore per unit of effective effort was quite high at the beginning of the longline fishery followed by a moderate decline in the 1960s and leveling off since the 1970s, in the range from 1.0 t to 1.5 t per 10,000 effective hooks. In 1986, the CPUE is notably higher than the previous years (Fig. 5).

4 Stocks structure

Based on albacore larval distribution analysis, the main spawning area for Indian albacore is between 10 S and 25 S. Length frequency survey indicate that immature fish with fork length range from 70 cm to 90 cm occur primarily between 30 S and 40 S.

Although the distribution of albacore in Indian Ocean appears to be continuous and distinct from albacore from the Pacific Ocean, some analysis on longline CPUE in south Atlantic and Indian Oceans published during 1970s by Japanese scientists strongly indicate there may be seasonal inter-mingling of albacore between the two oceans.

Further information therefore is needed in order to classify the albacore stock structure in the Indian Ocean.

5 Population parameters

No new information was provided to the working group

6 Production model

Results of two new model analyses were received (Fig. 6). The first involved data for the period 1952 to 1984 and the second for the period 1963 to 1984. Both studies used K = 4 and m = 0, 1 and 2. Effort data used in one study was standardized for deep longlining (to regular longlining effort). A similar adjustment was not made for data used in the other. Both studies although using different approaches gave MSY estimates within the range reported in 1986, i.e., 16 - 20,000 t. The scatter of the points, as noted last year, is still present despite inclusion of Taiwanese data, which was thought to be the cause of the scatter.

In recent years the rapid development of Taiwanese gillnetters which primarily take surface albacore ranging from 70 cm to 90 cm, may have changed the characteristics of the production model. This fishery should be monitored closely since it may have an effect on a revised production curve. Similar situations may be occuring with the development of new surface fishery in the south Pacific and north Atlantic. The MSY estimated by using production model on traditional longline fishery may not be valid for the assessment of this situation.

7 Other methods

Methods such as yield per recruit analyses should also be pursued as additional methods to assess the stocks.

8 State of stock

The fishery for albacore in the Indian Ocean has been operated at a level of effort but with high variability in catches and with effective catch rate remaining at the same level in recent years. The size frequency of fish caught in the longline fishery has also remained constant in recent years. The stock thus appears to be in good condition. With the existing fishery pattern, it does not appear that further increase in fishing effort will result in a corresponding substantial increase in catch.

A continuation of current catch levels should not have much impact on the status of the stock. However, it is not yet known how delicate the relationship is between catch and effort. Therefore, the working groups recommends that statistics on catch and effort be collected and updated to IPTP in order that an assessment of the stock of albacore can be made should catches increase substantially as a result of changes in fishing operations.

9 Recommendations

Statistics

The working group took special note of the exceptional effort that was made by Taiwanese scientists in providing complete and timely statistics on their tuna fisheries and in initiating a number of important studies on albacore. The Taiwanese longline and gillnet fleets target on albacore and the catch has been substantial; consequently data from these fleets are vital for a comprehensive analysis of the state of the stock. The group urged that the scientists continue to cooperate with the IPTP and participate in future IPTP working groups meetings.

Research

The following research recommendations were made;

(1) stock structure be examined based on all available biological information;

(2) age-structure models, such as cohort analysis and yield per-recruit analysis, be used in determing the state of the stock and,

(3) production model analysis be conducted with the best method for standardizing effective effort.

Management

No management recommendations were made.

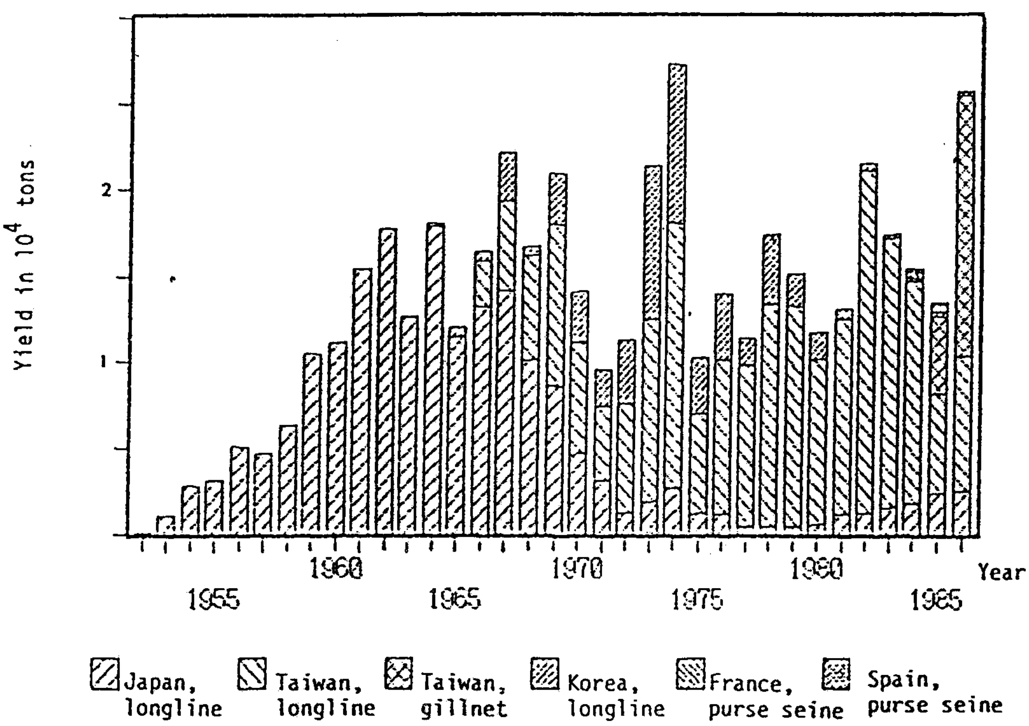


Fig.4 Trends of annual catches by country and gear for Indian Ocean albacore, 1952-1986

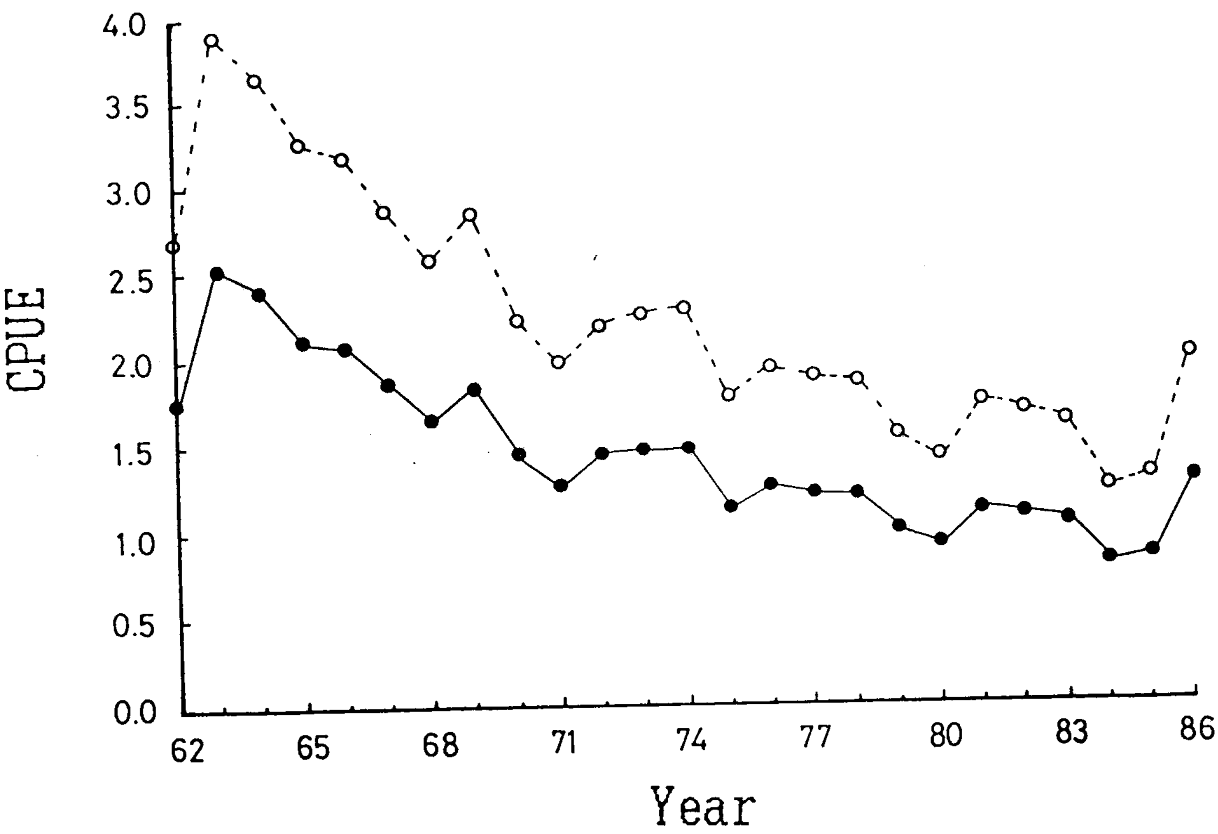


Fig. 1. The variation of yearly catch per unit effort by effective fishing effort (● : MT/10,000 effective hooks) and by overall effective fishing intensity (o :MT/100 effective hooks/5° square).

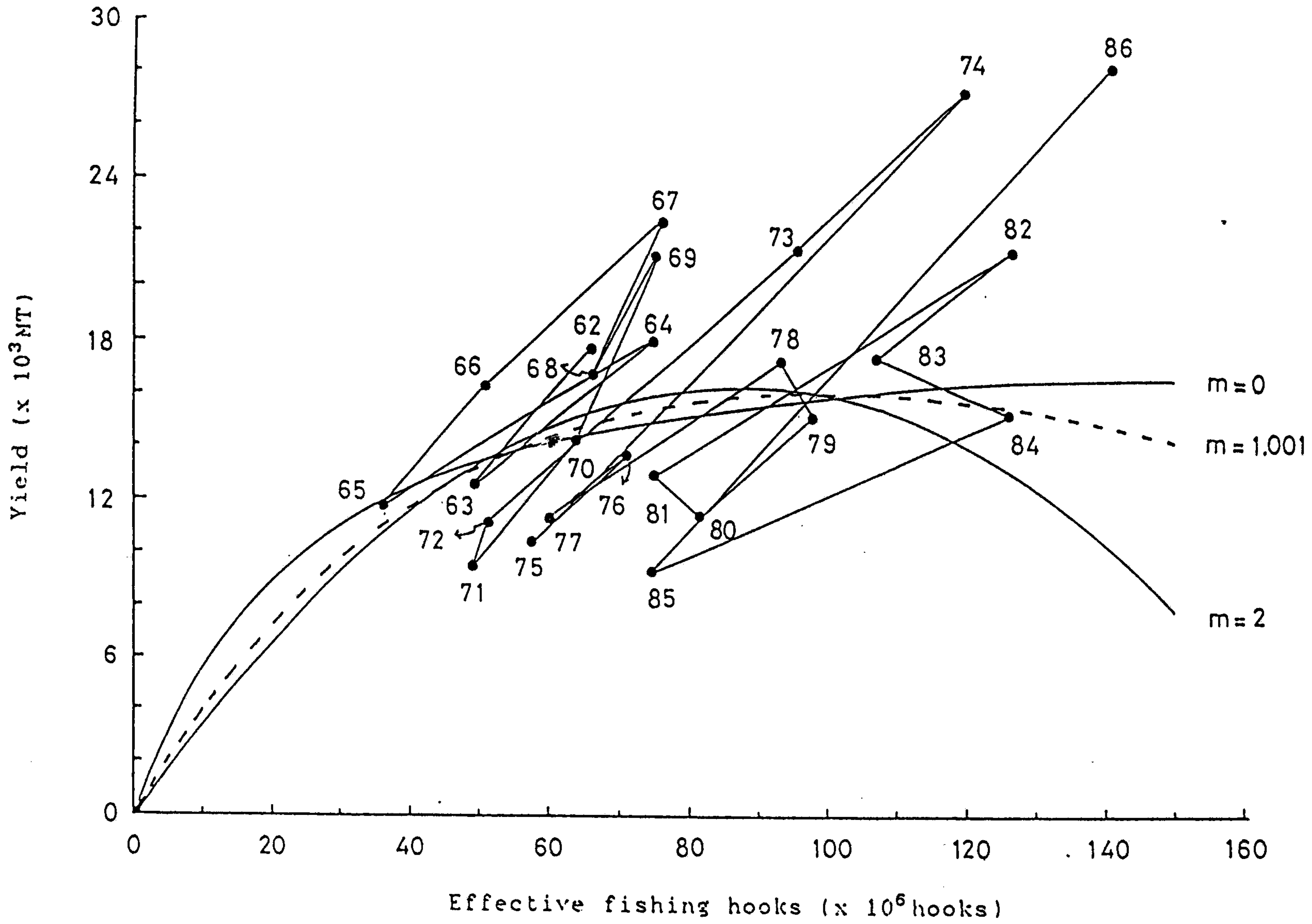


Figure 6 Equilibrium yield curve and observed data for Indian albacore fishery, assuming four significant age group contributed in the catch, and setting shape parameter coefficient m=0, 1.001, and 2, which effective fishing effort.

5.2.3 SOUTHERN BLUEFIN TUNA (SBF)

1 Description of fisheries

Southern bluefin tuna occur in the higher latitudes of the southern hemisphere. The spawning area is known only in the middle latitudes of the eastern Indian Ocean. Juveniles are found in the coastal waters around southern Australia. As they grow, they migrate highly and circumpolarly throughout the southern Pacific, Indian and Atlantic Oceans.

The stock has been exploited by Australians (poling, purse seining and, to a small extend, trolling) and Japanese (longlining) since the early 1950s. The Japanese catch increased to the maximum of 77,500 t in 1961 (Table 4). Since then it has been decreasing. The Australian surface fishery, catching mainly juveniles, has gradually grown to the extent allowing catches of 10-12,000 t in the late 1970s and the maximum catch of 21,500 t in 1982, but recently its catches have decreased due to new restrictions. Recently, New Zealand fishermen have also indicated interest in exploiting large fish by handlining and trolling but, their catches are still very small (below 200 t per year). The catches by Japanese, Australian and New Zealand fishermen in 1986 were about 17,000 t, 12,500 t and 100 t, respectively. The catch of this species predominantly comes from the Indian Ocean with the minor but significant catches from the Atlantic and Pacific Oceans.

Reference was made to the small catch of southern bluefin tuna by the longline fishing fleets other than Japan. Additionally, it was noted that a developing gill net fishery for albacore was geographically situated in the high southern latitudes of the Indian Ocean; areas which may overlap the southern bluefin distribution.

2 State of stock

At the Sixth Meeting of Australian, Japanese and New Zealand scientists held in Hobart, Australia in August, 1987, the status of the stock was re-evaluated on the basis of data on gross catches, catch length frequencies, fishing effort and tag releases and recaptures. The significant reduction in the parental biomass from the pre-exploitation level, which was identified during the past five meetings, was re-confirmed. Computer simulations as well as the continued failure of the domestic New South Wales fishery and a recent decline in abundance of 4-7 age fish suggested that the parental biomass is likely to decline further in coming years. It was pointed out that there would be a risk of recruitment decline if the current catch limits were maintained. Governments of the three countries were recommended to take immediate steps to ensure that future major reductions in catch can be implemented quickly and effectively if a continuing decline in recruitment was indicated.

3 Effects of current regulations

The first management regulations for the fishery were introduced independently by Australia and Japan in the early 1970s. Australia limited the number of purse seiners to six and their operation to the waters off southeastern Australia. This was done for both biological and economic reasons. Since 1971 Japan has voluntarily restricted fishing in areas where juveniles are abundant. This measure was introduced to increase the age at first capture to obtain a higher yield per recruit.

Since the 1984 fishing season, Australia has maintained a national quota of 14,500 t and a seasonal area closure off western Australia. Japan and New Zealand introduced national quotas of 23,150 t and 1,000 t for the 1986 fishing season, respectively. Recently, Australia and Japan reduced their catch limit to 11,500 t (from the 1986 fishing season) and 19,500 t (from the 1987 fishing season), respectively.

4 Recommendations

The Expert Consultation supported the management measures taken for southern bluefin tuna by the trilateral group (Japan, Australia, New Zealand). The stock has been monitored carefully by scientists of the trilateral group and measures have been taken to reduce the total catch. However, it was pointed out that comparison between projected and observed index of parent biomass size be made to check reliability of the assessment technique presently used.

IPTP should continue collecting catch information on southern bluefin tuna from participating countries even if its catch levels are small.

TABLE 4 SOUTHERN BLUEFIN CATCHES BY GEAR, AREA AND COUNTRY (in MT)

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
By gear													
Longline	2662	637	745	3168	4680	6203	2810	2563	11388	514	1639	1470	-
Baitboat	1	0	0	0	0	0	13	6	0	0	0	0	-
Sport	1	0	0	0	0	0	0	0	0	0	0	0	-
By country													
Taiwan (P.C.)	104	1	33	0	29	11	22	57	3	9	3	2	-
Japan	2558	636	692	3168	4651	6192	2788	2506	1135	505	1636	1468	350*
South Africa ...	2	0	0	0	0	0	13	6	0	0	0	0	-
World (all oceans)													
Longline	33924	24118	33714	29595	22974	27715	33364	28056	20809	24735	233223	20393*	17000*
Surface	12672	8833	8383	12569	12190	10783	11325	17016	21709	17807	13497	12688	12614
Total	46596	32951	42097	42164	35164	38498	44689	45072	42518	42542	36820	33081	29614

Source for "world" section Report of the Sixth Meeting of Australian, Japanese and New Zealand Scientists on Southern Bluefin Tuna (SBT), Hobart, Australia, August, 1987

*Preliminary

5.3 YELLOWFIN AND SKIPJACK TUNAS (YFT and SKJ)

The tropical tuna fisheries of the Indian Ocean are multispecie fisheries in which yellowfin and skipjack are important targets. Depending on a host of factors, including marketing conditions, a fishery will change its target species and this change will be reflected in the fishery statistics collected for stock assessment purposes. Consequently, it is important that a thorough understanding of the fisheries as well as the biology of the fish be available.

Both yellowfin and skipjack are found over a wide area of the Indian Ocean, from 20 N to 40 S latitude, but with the centre of abundance in the tropics. Fisheries for these species can be grouped into three: longline (for yellowfin only), artisanal or small-scale, and purse-seine (Fig. 7). Fishery statistics for these fisheries and biology information for each species were presented in documents reviewed by the participants.

LONGLINE FISHERY

Longline fishery for tunas in the Indian Ocean is primarily conducted by Japanese, Korean and Taiwanese vessels. Large tunas (yellowfin, southern bluefin, bigeye, albacore) are the target of this fishery. Yellowfin in the range of about 90-160 cm FL is caught with baited hooks, fished at various depths.

Catches for this fishery have been generally high (average 23,000 t) after experiencing low levels during 1973 to 1976 (Fig. 8). In 1986 there was a substantial increase to 36,000 t, owing to improved fishing efficiency in the major fleets (Doc. 60) and increased catches by minor fleets, such as those of the U.S.S.R. (Doc. 37) and Indonesia (Docs. 23 and 25). Fishing effort appears to have increased.

SMALL-SCALE FISHERIES

There are a number of artisanal or small-scale fisheries in the Indian Ocean that catch yellowfin and skipjack tuna along with other tuna-like species. Latest fishery statistics for a few of these fisheries were reviewed: Maldive's pole-and-line fishery (Docs. 27 and 28), Sri Lankan gillnet and handline fishery (Doc. 11), Zanzibar gillnet and troll fishery of Tanzania (Docs. 16 and 52),. Lakshadweep pole-and-line fishery of Indian (Doc. 17), Indonesian fisheries (Docs. 23 and 25) and Andaman Sea purse seine fishery of Thailand (Doc. 22).

The small-scale fisheries target on a variety of tunas and tuna-like species. In general, tunas caught by these fisheries are in the range of 30-80 cm FL and are primarily skipjack tuna. The yellowfin catch for these fisheries has been increasing at a slower rate than the catch of skipjack (Figs. 8 and 9). In 1986 the yellowfin catch was about 19,000 t, or 11 percent over that of 1985. The skipjack catch was a record high of 73,000 t, or about 4,000 t over the 1985 catch. Fishing effort appears to be increasing.

The Maldives pole-and-line, or baitboat fishery, which is a major small-scale fishery in the Indian Ocean, was reviewed in detail (Doc. 27 and 28). This fishery produced 5,300 t of yellowfin and 45,400 t of skipjack tuna in 1986, or 55 percent of the total yellowfin-skipjack catch of the small-scale fisheries in the Indian Ocean. In 1987, the catch was 6,700 t of yellowfin and 42,100 t of skipjack. Before the vessels converted from sail-powered to motor-powered in mid-1970, fishing effort for this fleet was in the 200,000 days fished range. Currently, the effort is about 160,000 days fished (Table 8). Along with the shift to motor-power, fishing strategy of the boats might have also changed. The proportion of large skipjack (58-80 cm FL) in the catch has increased, possibly owing to vessels fishing further offshore and being better able to locate and chase schools of larger fish.

Adequate bait for this fishery and status of the bait fish stocks have been of interest to scientists involved with this fishery (Doc. 28). Data collected indicate that about 5,000 t of baitfish are used by the pole-and-line fishery annually. Principal species involved fall into three families: fusiliers (Caesionidae), sprats (Clupeidae) and cardinal fishes (Apogonidae), of reef fishes. The species involved are largely different from reef-fish species exploited by edible reef-fish fisheries.

Use of FADs (Fish Aggregating Devices) to increase catches and reduce searching time in small-scale fisheries is increasing. Results of several experiments were reviewed (Docs. 27, 45 and 66). This trend requires close monitoring because it affects efficiency of fishing effort and the interpretation of fishing statistics for status of stocks information.

PURSE SEINE FISHERY

The purse-seine fishery is the most recent of the three types of tropical tuna fisheries in the Indian Ocean. It started in 1979 and expanded to become the principal fishery for yellowfin and skipjack tuna. This fishery is centred in the offshore area of the western region (Fig. 7) and involves purse seine vessels greater than about 400 t carrying capacity. The number of vessels participating in this area has varied, but recently has been in the 30-40 range after reaching a peak of 49 vessels in 1984 (Table 5).

This fishery targets on yellowfin tuna of 40-160 cm FL and on skipjack of 40-75 cm FL (Fig. 10). Total catch has increased steadily since the inception of this fishery (Doc. 50). In 1986, the total catch was 141,000 t (57,000 t of yellowfin and 84,000 t of skipjack). It increased to 160,000 t (62,000 t of yellowfin and 98,000 t of skipjack) in 1987 (Table 9). The trend has been to a greater proportion of skipjack in the catch, for example 44 percent skipjack in 1984 versus 61 percent skipjack in 1987 (Fig. 11). The basis for this trend may be related to shifts in type of schools being fished, for example log-associated and free-swimming, fishing areas and marketing condition. Detailed analysis of log-book data as well as observer data (Doc. 53) is required to determine the cause of this trend.

5.3.1 YELLOWFIN TUNA

1 Growth

Three documents dealing with yellowfin tuna age and growth were reviewed by the participants. Using fine structures on otoliths, Document 12 described how increments were verified as deposited daily and how increments were counted to estimate growth rate for fish 15-79 cm FL. Results indicate that fish in the 34-79 cm size range grow at 2.95 cm/month in waters of the Philippines.

Document 21 pooled length-frequency data from catches of fisheries in Maldives, Sri Lanka and southern India. An attempt was made to determine growth with the modal progression technique. Results showed growth to be consistent with estimates reported in the literature, but cannot distinguish between growth rates of about 1.5 cm per month and 2.9 cm per month.

Document 38 reported on growth of yellowfin tuna, 55-178 cm FL, from examination of rings on vertebrae. The rings were assumed to be deposited annually. Estimated growth rates ranged from 1.1 - 2.4 cm/month.

No definitive growth study of yellowfin tuna of the Indian Ocean has been undertaken. Growth curves for yellowfin tuna of other oceans have, therefore, been used for yellowfin tuna of the Indian Ocean. This assumes that yellowfin tuna of the Indian Ocean grow at the same rate as yellowfin tuna of other oceans, although there are biological characteristics that suggest this might not be so. Maximum size of fish caught in the Indian Ocean, for example, appears to be significantly smaller than fish of other oceans. A summary of information on growth rates for yellowfin tuna is provided in Tables 6 and 7.

2 Reproduction biology

Preliminary results of a study on maturity and spawning of yellowfin tuna in the area between 5-10 N were reviewed (Doc. 31). The results show mature fish present in every month of the year, but with spawning most intense during December to February and possibly later between the Seychelles and Chagos Island. Sexual maturity occurs at about 108 cm FL.

Further research on biological parameters is needed. Emphasis should be on determining frequency of spawning within a season and on determining causes for the predominance of males in fish larger than 130 cm FL.

3 Behaviour

Several documents containing information on the behaviour of yellowfin tuna were reviewed. Documents 45 and 65 showed that yellowfin are attracted to FADs (fish aggregating devices), particularly as juveniles.

4 Stock status

Documents 29, 35 and 44 contained information on status of stocks of yellowfin tuna. Results from these documents and information from other sources were not sufficient to make a definitive determination about the status of yellowfin stocks in the Indian Ocean. However, examination of catch and CPUE, indicate that the stock is currently producing higher levels of catch than in past years when there were only longline and artisanal fisheries. In 1986 total catch was 114,000 mt, the highest level recorded to date (Table 9). CPUE for the longline and purse seine fisheries, although requiring further refining, suggest that the stock is either not affected by the current level of exploitation or is increasing in size (Fig. 12 and 13). This latter conclusion needs to be verified. An in-depth study of the condition of the stock is clearly needed because the recent fishing may be well above the equilibrium level of productivity as a consequence of the very fast increase in purse seine fishing effort. Such a study should include an analysis of yield per recruit and how it might have changed with changes in fishing pattern, the level of MSY or potential yield that might be available for further expansion of the fisheries, and the trend in abundance.

5.3.2 SKIPJACK TUNA

1 Biological parameters

No documents on biological parameters for skipjack tuna were presented this year.

2 Status of stock

No documents on status of stock were submitted this year. Such studies are needed particularly in the light of increased catches of skipjack tuna by both the small-scale and purse seine fisheries. Total catch in 1986 was an all-time high of 148,000 mt (Table 10).

Nominal estimates of CPUEs for these fisheries suggest that the stocks are healthy with CPUE tending upward; however, a thorough analysis of the data should be conducted to verify this observation.

3 Behaviour

Document 58 showed that large surface schools of tuna are found in regions where there is high zooplankton concentrations, sharp thermocline gradient and high oxygen level.

4 Recommendations

Statistics

(1) Effort must be given to recording catches by tuna species. Catches for some fisheries, eg. U.S.S.R., Oman artisanal, etc., are currently reported as a species group. Special attention should be given to proper identification of small yellowfin and bigeye tunas.

(2) Size frequency data are just as important as catch and catch-effort data for monitoring fisheries and assessing the condition of the stock. They should be collected routinely and submitted to the IPTP office in a timely manner for distribution to investigators. Access should also be made available of historical size frequency data; specially, from Japanese longline fishery.

Research

(1) French, Spanish and Seychelles scientists should use purse seine logbook and observer data to estimate effective fishing effort by species and determine how changes in target species, type of schools and fishing operations have affected fishing effort measurements.

(2) Growth of yellowfin and skipjack tunas of the Indian Ocean needs to be investigated. A combination of tagging, hardparts analysis and modal progression techniques should be considered in this investigation.

(3) An in-depth evaluation and analysis of available fishery data is needed to develop an index of skipjack tuna abundance. Catch and effort data from the major skipjack fisheries should be the starting point for this evaluation.

(4) Basic biological information on age at maturity, fecundity, frequency of spawning, sex ratio by size groups, and stock differences is incomplete for yellowfin and skipjack tuna caught in the Indian Ocean. Studies need to be executed with standard techniques and for stocks in different locations throughout the ocean.

(5) The effects of environmental variability and anomalies on catch per unit effort changes should be analysed as their importance has been shown in another ocean.

TABLE 5 Number of large tuna purse seine vessels operating in the western Indian Ocean by country of registration.

Country	1984	1985	1986	1987	1988*
France	27	26	22	20	20
Ivory Coast	5	5	1	-	-
Japan	-	-	-	1	1
Mauritius	1	1	1	2	2
Panama	1	1	1	1	1
Spain	14	15	12	14	11
UK	1	1	1	-	-
USSR	-	-	-	4	2
Total	49	49	38	42	37

* Number during January to March

TABLE 6 COMPARISON OF MONTHLY GROWTH RATES, K AND L PARAMETERS ON INDIAN OCEAN YELLOWFIN

Size range			Method, location, author
52 - 92 cm	GR	3.39	Annual scale rings
			Whole Indian Ocean
			(Huang & al., 1973)
45 - 70 cm	GR	3.0	LF
			Madagascar
			(Marcille & Stequert, 1976)
35 - 39 cm	GR	1.3	LF
39 - 57 cm		1.6	W. Indian Ocean
57 - 76 cm		3.1	(Marsac &
76 - 88 cm		4.0	Lablache, 1985)
88 - 101 cm		4.3	
101 - 134 cm		3.9	
134 - 139 cm		1.7	
139 - 143 cm		1.3	
	K (>88 cm)	1.16	
	L	160.2 cm	
35 - 72 cm	GR	3.32	Tagging
to			Whole indian Ocean
54 - 106 cm			(Wang & Tanaka, 1986)
49 - 86 cm	GR	3.0	LF
83 - 114 cm		2.4	Sri Lanka
114 - 140 cm		1.1	(Maldeniya &
139 - 151 cm		1.0	Joseph, 1987)
151 - 158 cm		0.6	
	K	0.36	
	L	173 cm	
30 - 70 cm	GR	1.5 - 2.9	LF
			Maldives
			(Anderson, 1988)
56 - 84 cm	GR	2.4	Vertabrae increments
84 - 111 cm		2.3	W. Indian Ocean
111 - 132 cm		1.7	(Romanov &
132 - 146 cm		1.2	Korotkova, 1988)
146 - 160 cm		1.1	

Size length : Fork length
GR : monthly growth rate (in cm/month)
K and L : Von Bertalanffy parameters
LF : Length-frequency analysis

TABLE 7 MONTHLY GROWTH RATES, K AND L PARAMETERS FOR YELLOWFIN TUNA IN PACIFIC AND ATLANTIC OCEANS

Size range			Method, location, author
80 - 140 cm	K L	0.6 167 cm	LF (?) Eastern Pacific (Davidoff, 1963)
40 - 135 cm	GR	3.21	Otoliths daily increments Eastern Pacific (Wild, 1986)
34 - 79 cm	GR	2.98	Otoliths daily increments Central Pacific (Uchiyama & Struhsaker, 1981)
30 - 50 cm	GR K	1.3 0.55 to 0.70	LF Vanuatu (Brouard et al. 1984)
15 - 34 cm 34 - 79 cm	GR	6.98 2.95	Otoliths daily increments Philippines (Yamanaka, 1988)
29 - 86 cm 86 - 123 cm 123 - 148 cm 148 - 164 cm 164 - 174 cm 174 - 181 cm	GR	4.75 3.13 2.05 1.65 0.88 0.13	LF Eastern Atlantic (Le Guen & Sakagawa, 1973)
61 - 70 cm 61 - 142 cm 70 - 147 cm 70 - 170 cm	K	0.53 0.53 0.76 0.66	
61 - 70 cm 61 - 142 cm 70 - 147 cm 70 - 170 cm	L	175.2 cm 161.8 cm 161.0 cm 180.0 cm	
0 - 40 cm 40 - 70 cm 76 - 140 cm	GR	7.0 1.4 3.1	LF & tagging Eastern Atlantic (Fonteneau, 1980 ; Bard, 1984)
70 - 140 cm 70 - 152 cm	K	0.94 0.86	
70 - 140 cm 70 - 152 cm	L	161.2 cm 166.4 cm	

Table 8. Catch per unit effort for major skipjack tuna fisheries of the Indian Ocean

Year	Pole and line [1]	Purse seine [2]
1975	0.16	-
1976	0.22	-
1977	0.17	-
1978	0.19	-
1979	0.22	-
1980	0.26	-
1981	0.23	-
1982	0.16	-
1983	0.16	5.61
1984	0.21	5.12
1985	0.26	7.35
1986	0.28	9.18
1987	0.26	10.99

1 MT/day fished for Mechanized Masdhoni of the Maldive fishery (Doc. 27)

2 MT/days fished for the Western Indian Ocean fishery (Doc. 50)

TABLE 9 Catches of yellowfin tuna by country and gear

INDIAN OCEAN FAO AREA 51 & 57 COMBINED

UNIT : MT

SPECIES, COUNTRY	GEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
SPECIES : YFT														
AUSTRALIA	UNCL	0	0	0	3	15	28	34	0	8	18	41	43	42
CHINA(TAIWAN)	LL	800	523	425	4733	3261	2878	2723	1817	3526	4211	1369	5099	9280
	GILL	0	0	0	0	0	0	0	0	0	0	0	0	33
COUNTRY	TOTAL	800	523	425	4733	3261	2878	2723	1817	3526	4211	1369	5099	9313
COMOROS	UNCL	100	100	100	100	100	100	100	100	110	120	130	140	140
FRANCE	PS	0	0	0	0	0	0	0	260	1224	10773	33611	32231	35519
INDONESIA	LL	0	0	0	0	0	0	0	0	515	0	585	441	120
	PS	0	0	0	0	0	0	0	0	17	0	27	29	144
	GILL	0	0	0	0	0	0	0	0	0	0	0	0	21
	UNCL	1071	869	1317	2345	2811	3236	3348	3350	3208	5888	3635	4073	2985
COUNTRY	TOTAL	1071	869	1317	2345	2811	3236	3348	3350	3740	5888	4247	4543	3270
IRAN	LL	0	0	800	0	0	341	322	0	0	0	0	0	0
IVORY COAST	PS	0	0	0	0	0	0	0	0	0	0	5107	3046	562
JAPAN	LL	4415	4719	2744	2061	4024	2023	3304	4699	6355	7039	7467	9263	10955
	PS	0	0	0	0	239	0	136	0	0	193	0	109	160
	UNCL	0	0	0	0	0	0	0	2	0	0	0	0	0
COUNTRY	TOTAL	4415	4719	2744	2061	4263	2023	3440	4701	6355	7232	7467	9372	11115
KENYA	LL	0	0	0	0	0	0	67	171	204	322	0	0	0
KOREA	LL	11563	[illegible]	12848	31383	25165	17788	12537	11777	18654	15337	9895	12017	14891
MALDIVES	BB	3868	3512	4481	4123	3214	3692	3647	4740	3770	5984	6893	5797	5200
	UNCL	260	262	410	350	370	597	582	544	234	257	230	269	121
COUNTRY	TOTAL	4128	3774	4891	4473	3584	4289	4229	5284	4004	6241	7123	6066	5321
MAURITIUS	LL	0	0	0	0	0	0	0	0	0	0	0	0	190
	PS	0	0	0	0	0	0	0	0	0	1057	1234	914	661
	UNCL	0	0	0	0	15	5	1	1	0	0	50	0	0
COUNTRY	TOTAL	0	0	0	0	15	5	1	1	0	1057	1284	914	851
MOZAMBIQUE	LL	0	0	0	0	0	0	0	0	0	0	177	0	0
	BB	0	0	0	0	0	0	0	0	0	15	11	15	0
	UNCL	0	0	0	0	0	0	0	0	0	0	0	0	15
COUNTRY	TOTAL	0	0	0	0	0	0	0	0	0	15	188	15	15
PAKISTAN	GILL	0	0	0	0	0	0	0	0	0	0	0	0	2093
PANAMA	PS	0	0	0	0	0	0	0	0	0	0	2441	3236	3432
SEYCHELLES	LL	0	0	0	0	0	0	0	0	0	43	198	140	0
	UNCL	150	100	50	80	100	128	357	949	518	114	0	7	10
COUNTRY	TOTAL	150	100	50	80	100	128	357	949	518	157	198	147	10
SOUTH AFRICA	UNCL	0	0	0	0	0	0	0	0	0	166	0	84	0
SPAIN	BB	0	0	0	0	0	0	0	363	55	0	0	0	0
	PS	0	0	0	0	0	0	0	0	0	0	13796	15411	17532
COUNTRY	TOTAL	0	0	0	0	0	0	0	363	55	0	13796	15411	17532
SRI LANKA	LL	0	0	0	0	0	0	0	0	834	905	644	222	636
	BB	0	0	0	0	0	0	0	0	418	452	258	27	2
	GILL	0	0	0	0	0	0	0	0	6680	7237	5151	6145	6559
	UNCL	6070	6611	6915	5720	5369	6166	6906	7662	418	452	386	322	780
COUNTRY	TOTAL	6070	6611	6915	5720	5369	6166	6906	7662	8350	9046	6439	6716	7977
TANZANIA	UNCL	0	0	0	0	0	0	0	0	0	0	0	0	600
UNITED KINGDOM	PS	0	0	0	0	0	0	0	0	0	0	155	1177	1050
YEMEN DEM.	UNCL	0	0	0	0	0	0	0	0	80	80	12	511	510
Gear total for	LL	16770	16936	16817	38177	32450	23030	18953	18464	30088	27857	20335	27182	36072
Gear total for	BB	3868	3512	4481	4123	3214	3692	3647	5103	4243	6451	7162	5839	5202
Gear total for	PS	0	0	0	0	239	0	136	260	1241	12023	56371	56153	59060
Gear total for	GILL	0	0	0	0	0	0	0	0	6680	7237	5151	6145	8706
Gear total for	UNCL	7651	7942	8792	8598	8780	10260	11328	12608	4576	7095	4484	5449	5203
SPECIES	TOTAL	28297	28390	30090	50898	44683	36982	34064	36435	46828	60663	93503	100768	114243

TABLE 10 Catch of skipjack tuna by country and gear

INDIAN OCEAN FAO AREA 51 & 57 COMBINED UNIT : MT

SPECIES, COUNTRY	GEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
SPECIES : SKJ														
AUSTRALIA	UNCL	133	523	404	26	49	58	37	0	0	0	0	550	550
CHINA(TAIWAN)	LL	39	83	42	18	5	11	9	20	11	9	22	36	5
	GILL	0	0	0	0	0	0	0	0	0	0	0	0	24
COUNTRY	TOTAL	39	83	42	18	5	11	9	20	11	9	22	36	29
COMOROS	UNCL	250	300	250	300	300	300	300	300	330	340	350	360	360
FRANCE	PS	0	0	0	0	0	0	0	210	771	10075	25517	33084	40363
INDIA	BB *	0	0	0	0	0	0	0	0	0	0	0	2621	0
	GILL	0	0	0	0	0	0	0	0	0	0	0	31	0
	UNCL	0	0	0	0	0	0	0	1803	2399	1801	3488	624	3195
COUNTRY	TOTAL	0	0	0	0	0	0	0	1803	2399	1801	3488	3276	3195
INDONESIA	PS	0	0	0	0	0	0	0	0	284	0	356	388	1633
	GILL	0	0	0	0	0	0	0	0	0	0	0	0	287
	UNCL	4447	3925	5513	4034	4093	6524	7573	6579	11548	12458	10091	9214	9034
COUNTRY	TOTAL	4447	3925	5513	4034	4093	6524	7573	6579	11832	12458	10447	9602	10954
IVORY COAST	PS	0	0	0	0	0	0	0	0	0	0	5112	3197	175
JAPAN	LL	31	23	16	4	11	3	6	13	5	3	2	9	5
	BB	0	0	0	0	0	0	0	7	0	0	0	0	0
	PS	0	0	0	0	908	0	478	0	0	592	0	547	562
	UNCL	0	0	0	0	0	0	0	10	0	0	0	0	0
COUNTRY	TOTAL	31	23	16	4	919	3	484	30	5	595	2	556	567
KENYA	LL	0	0	0	0	0	0	0	3	1	2	0	0	0
	UNCL	0	0	0	0	0	0	0	68	96	31	45	63	49
COUNTRY	TOTAL	0	0	0	0	0	0	0	71	97	33	45	63	49
KOREA	LL	72	200	63	151	253	65	43	48	57	8	0	0	0
MALDIVES	BB	21760	14601	19603	14032	13549	17798	23074	20198	15694	19491	31714	42170	45268
	UNCL	399	257	489	310	275	338	487	419	187	210	335	432	177
COUNTRY	TOTAL	22159	14858	20092	14342	13824	18136	23561	20617	15881	19701	32049	42602	45445
MAURITIUS	PS	0	0	0	0	0	41	990	1726	2414	1396	2500	2026	1853
	UNCL	0	0	0	0	14	10	4	5	3	0	350	0	0
COUNTRY	TOTAL	0	0	0	0	14	51	994	1731	2417	1396	2850	2026	1853
MOZAMBIQUE	BB	0	0	0	0	0	0	0	0	0	60	154	80	0
	UNCL	0	0	0	0	0	0	0	0	0	0	0	0	80
COUNTRY	TOTAL	0	0	0	0	0	0	0	0	0	60	154	80	80
PAKISTAN	GILL	0	0	0	0	0	0	0	0	0	733	694	0	105
	UNCL	0	0	0	0	0	449	134	446	5156	0	0	0	0
COUNTRY	TOTAL	0	0	0	0	0	449	134	446	5156	733	694	0	105
PANAMA	PS	0	0	0	0	0	0	0	0	0	0	1462	2990	4606
SEYCHELLES	UNCL	50	10	10	20	10	10	0	0	0	0	0	0	0
SOUTH AFRICA	UNCL	0	0	0	0	0	0	0	0	0	13	0	4	0
SPAIN	BB	0	0	0	0	0	0	0	179	14	0	0	0	0
	PS	0	0	0	0	0	0	0	0	0	0	8079	22854	24877
COUNTRY	TOTAL	0	0	0	0	0	0	0	179	14	0	8079	22854	24877
SRI LANKA	BB	0	0	0	0	0	0	0	0	1987	2095	1510	1757	517
	GILL	0	0	0	0	0	0	0	0	10600	11178	8714	10070	13187
	UNCL	12321	15243	12222	11399	10994	8309	12700	13758	663	699	1395	291	33
COUNTRY	TOTAL	12321	15243	12222	11399	10994	8309	12700	13758	13250	13972	11619	12118	13737
UNITED KINGDOM	PS	0	0	0	0	0	0	0	0	0	0	20	1589	1155
YEMEN DEM.	UNCL	0	0	0	0	0	0	0	0	400	400	12	7	10
Gear total for	LL	142	306	121	173	269	79	58	84	74	22	24	45	10
Gear total for	BB	21760	14601	19603	14032	13549	17798	23074	20384	17695	21646	33378	46628	45785
Gear total for	PS	0	0	0	0	908	41	1468	1936	3469	12063	43046	66675	75224
Gear total for	GILL	0	0	0	0	0	0	0	0	10600	11911	9408	10101	13603
Gear total for	UNCL	17600	20258	18888	16089	15735	15998	21235	23388	20782	15952	16066	11545	13488
SPECIES	TOTAL	39502	35165	38612	30294	30461	33916	45835	45792	52620	61594	101922	134994	148110

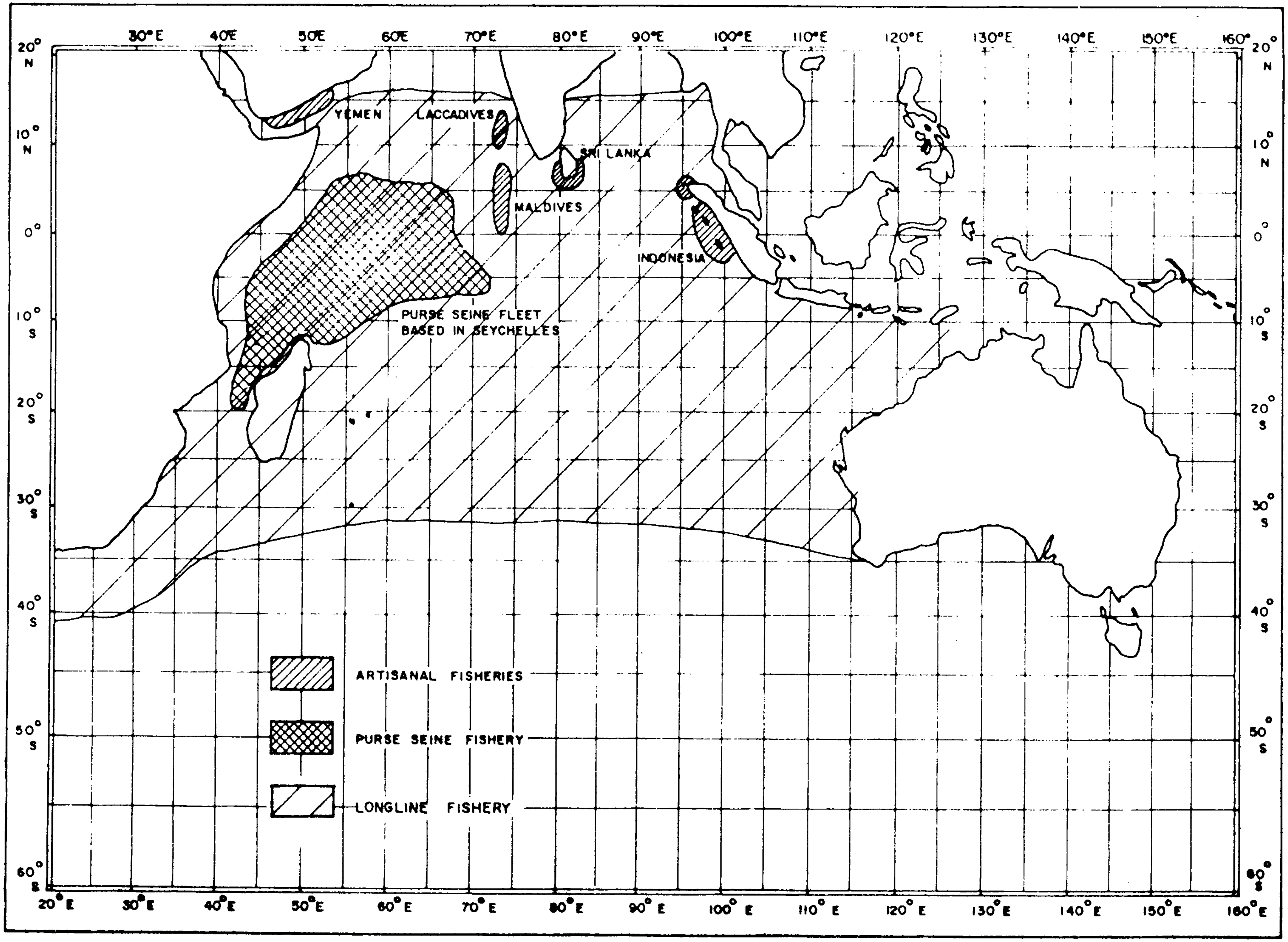


Fig. 7 Location of major artisanal and industrial fisheries for yellowfin and skipjack tuna in the Indian Ocean

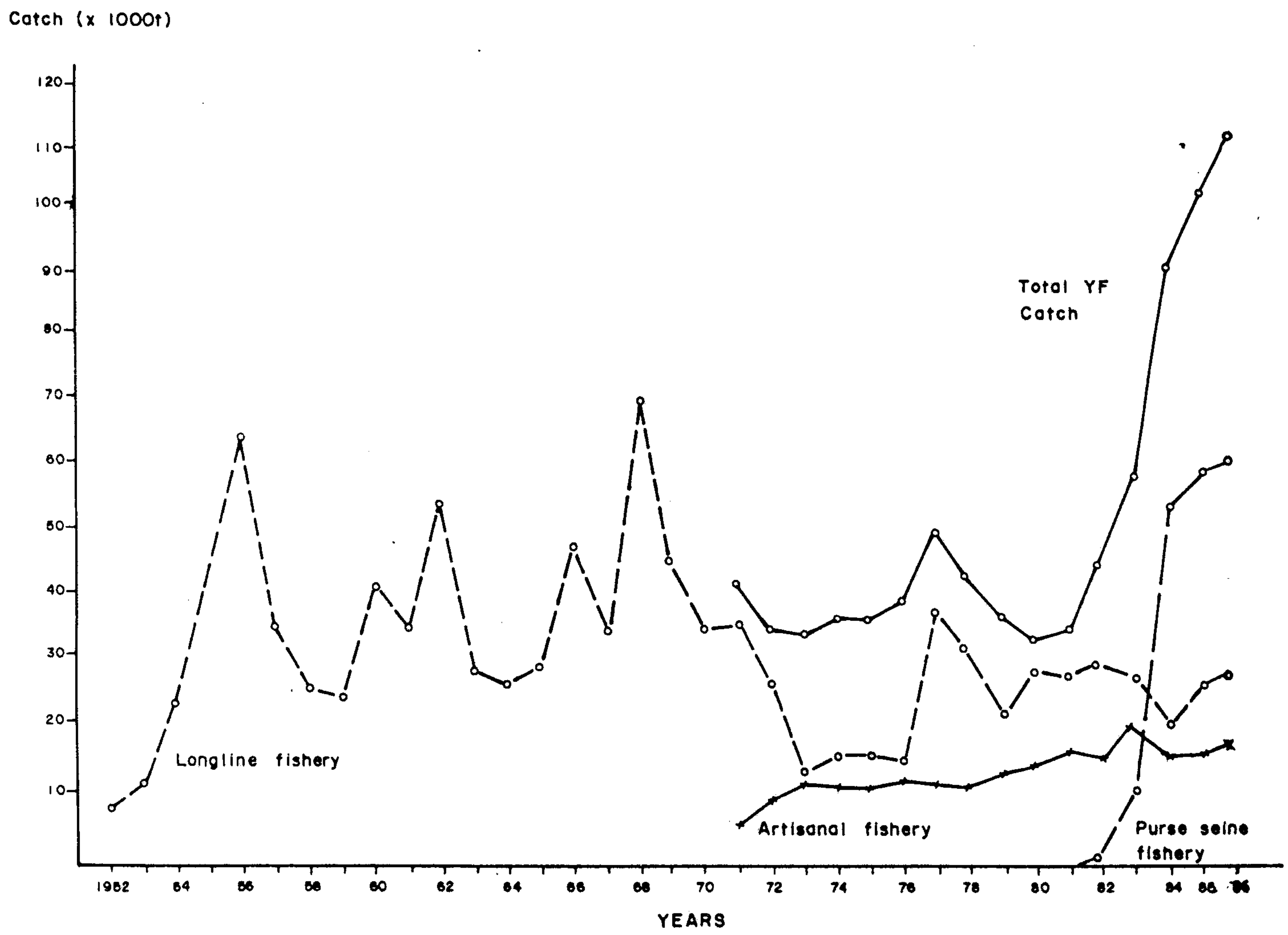


Fig. 8 Trends in Yellowfin catch by the different fisheries of the Indian ocean (1952-1986)

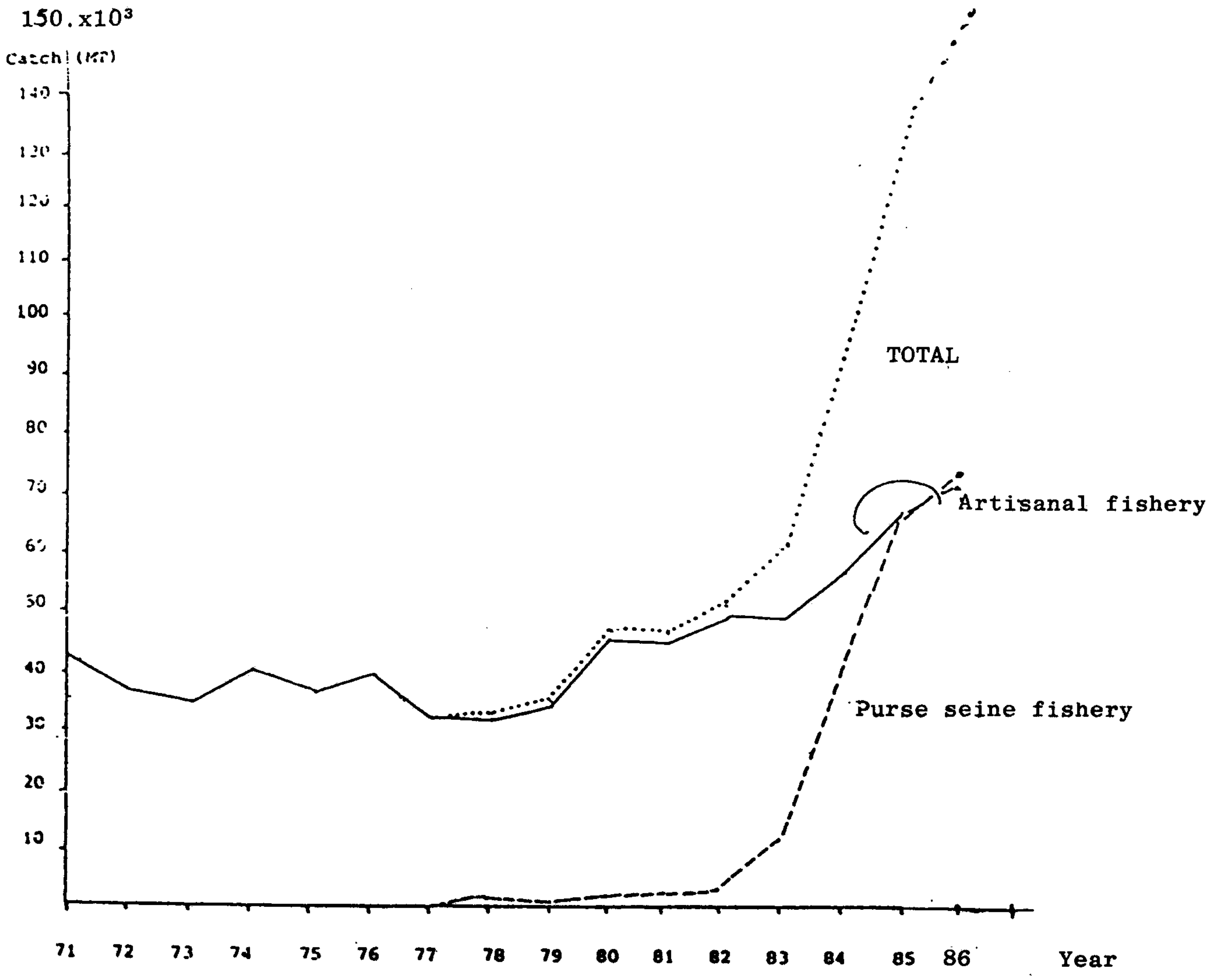
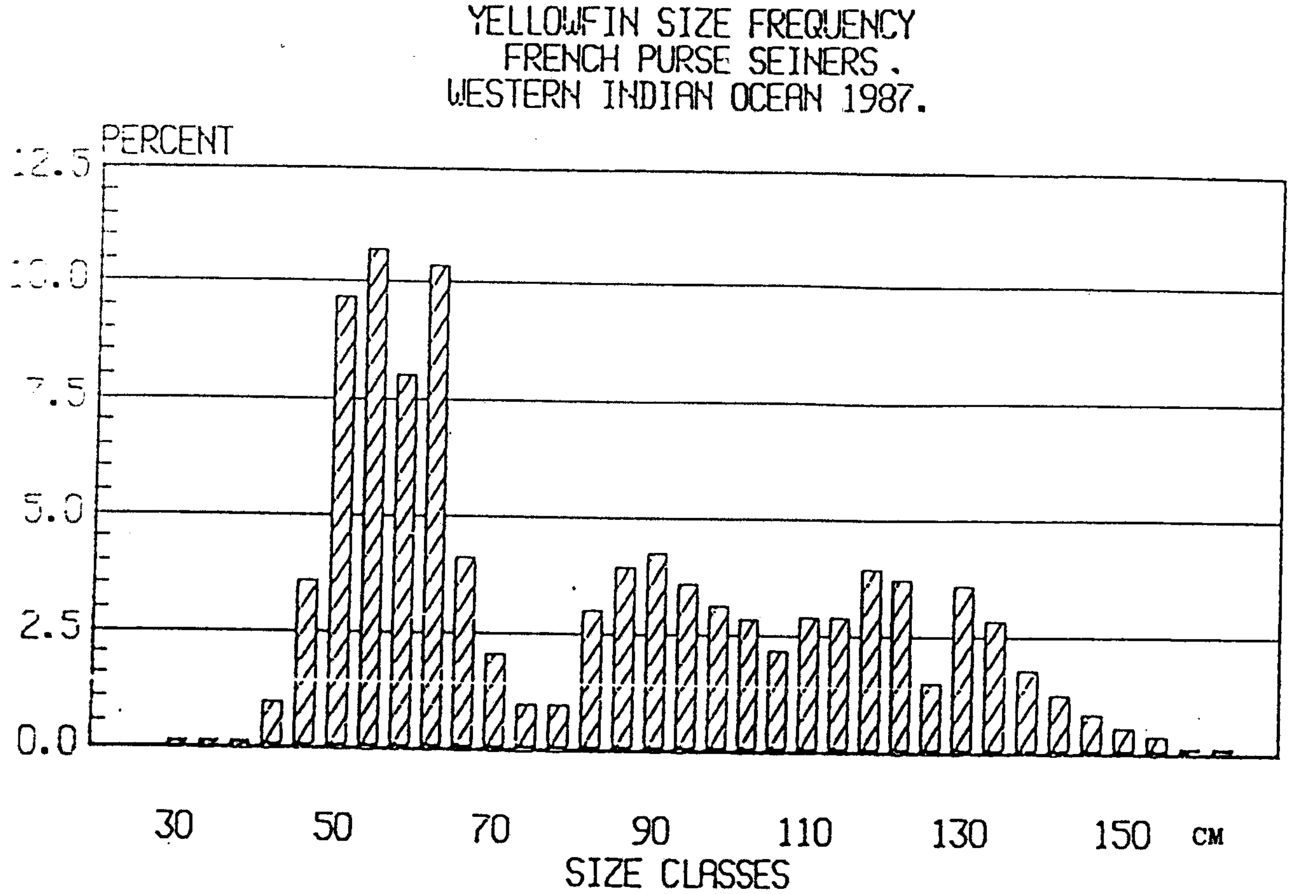


Figure 9 Catch of skipjack by fishery

FIGURE 10 Length frequency distribution of yellowfin tuna and skipjack tuna caught in the purse seine fishery of the western Indian Ocean



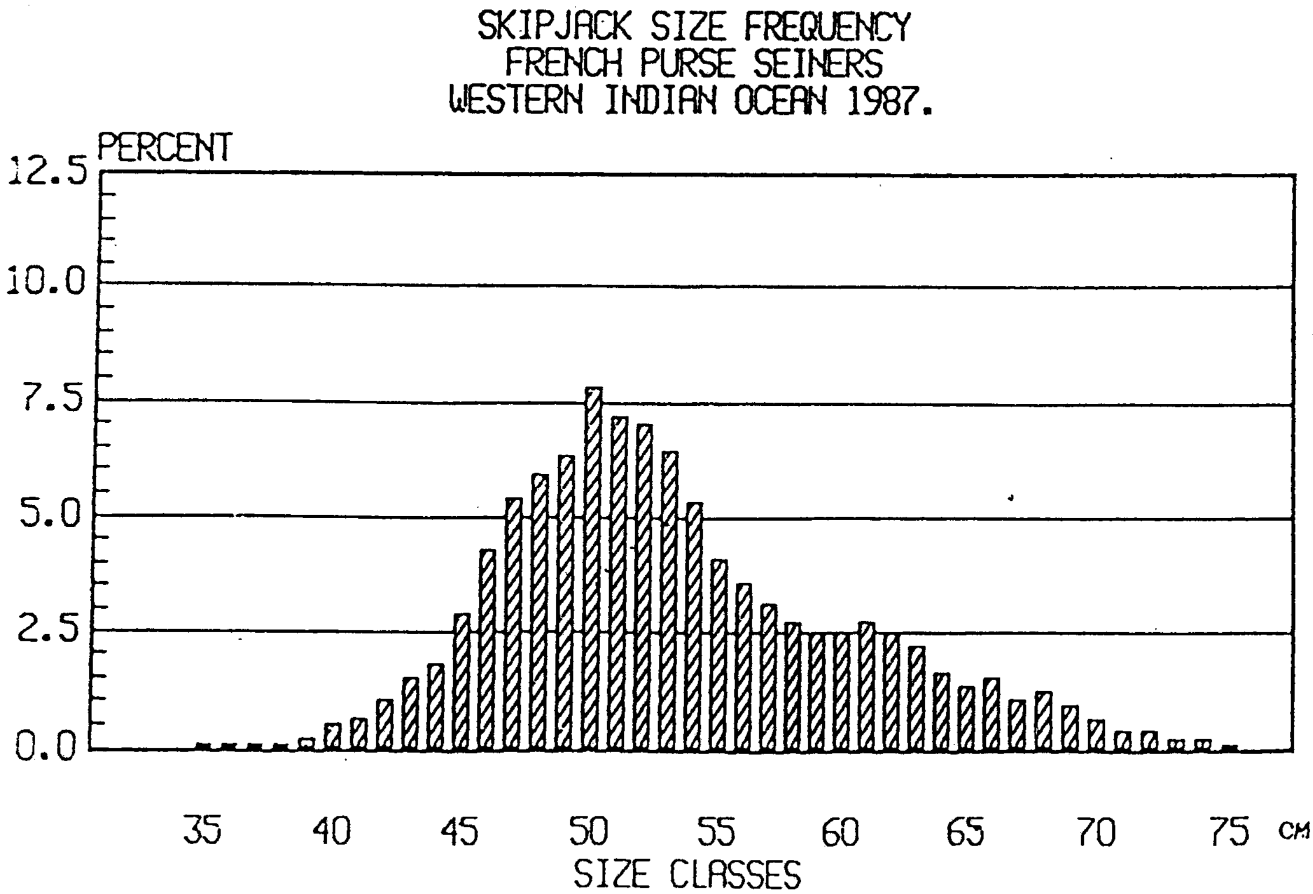
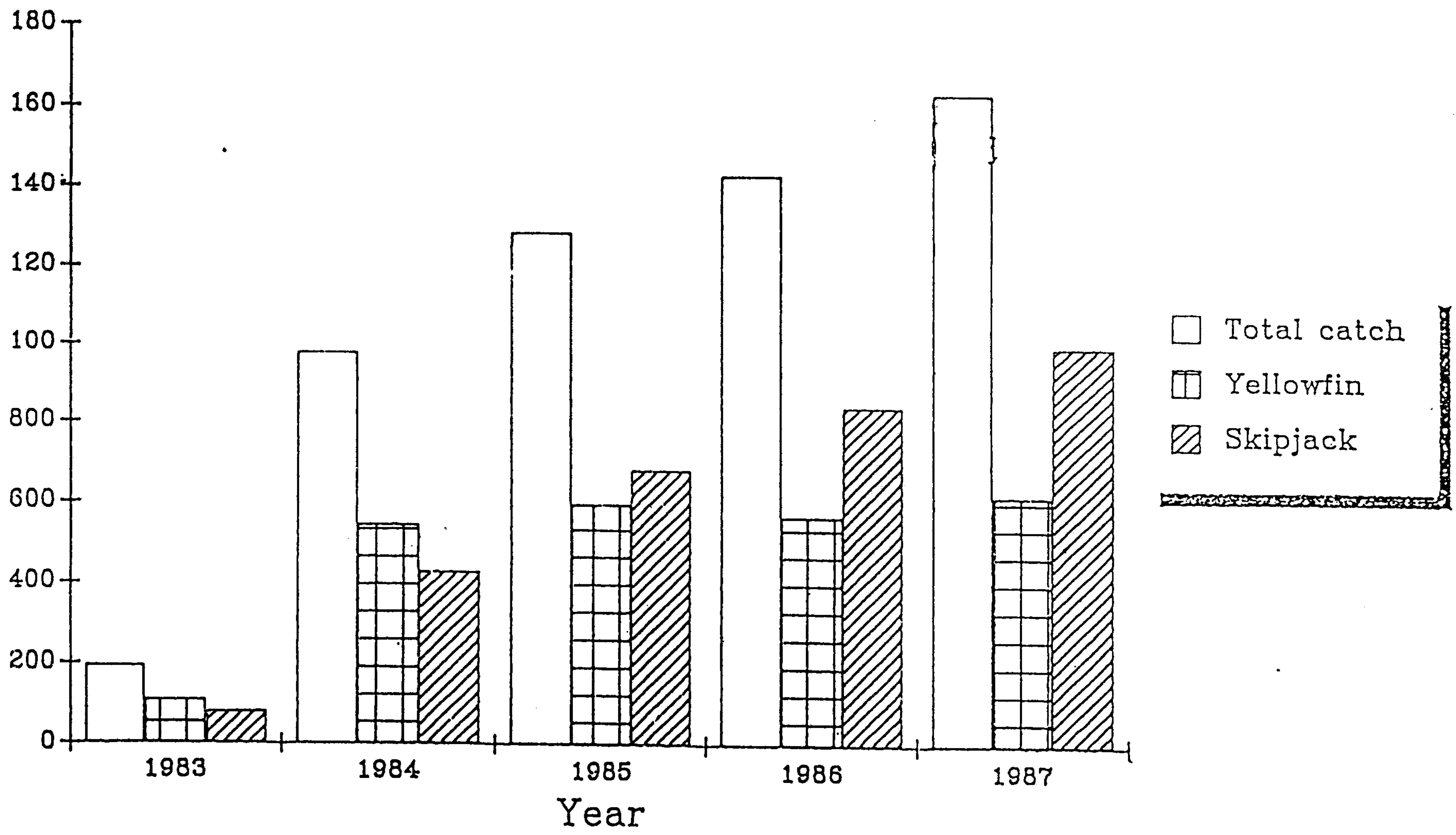


FIGURE 11 Tuna catches by purse seiners in the western Indian Ocean (thousand mt)



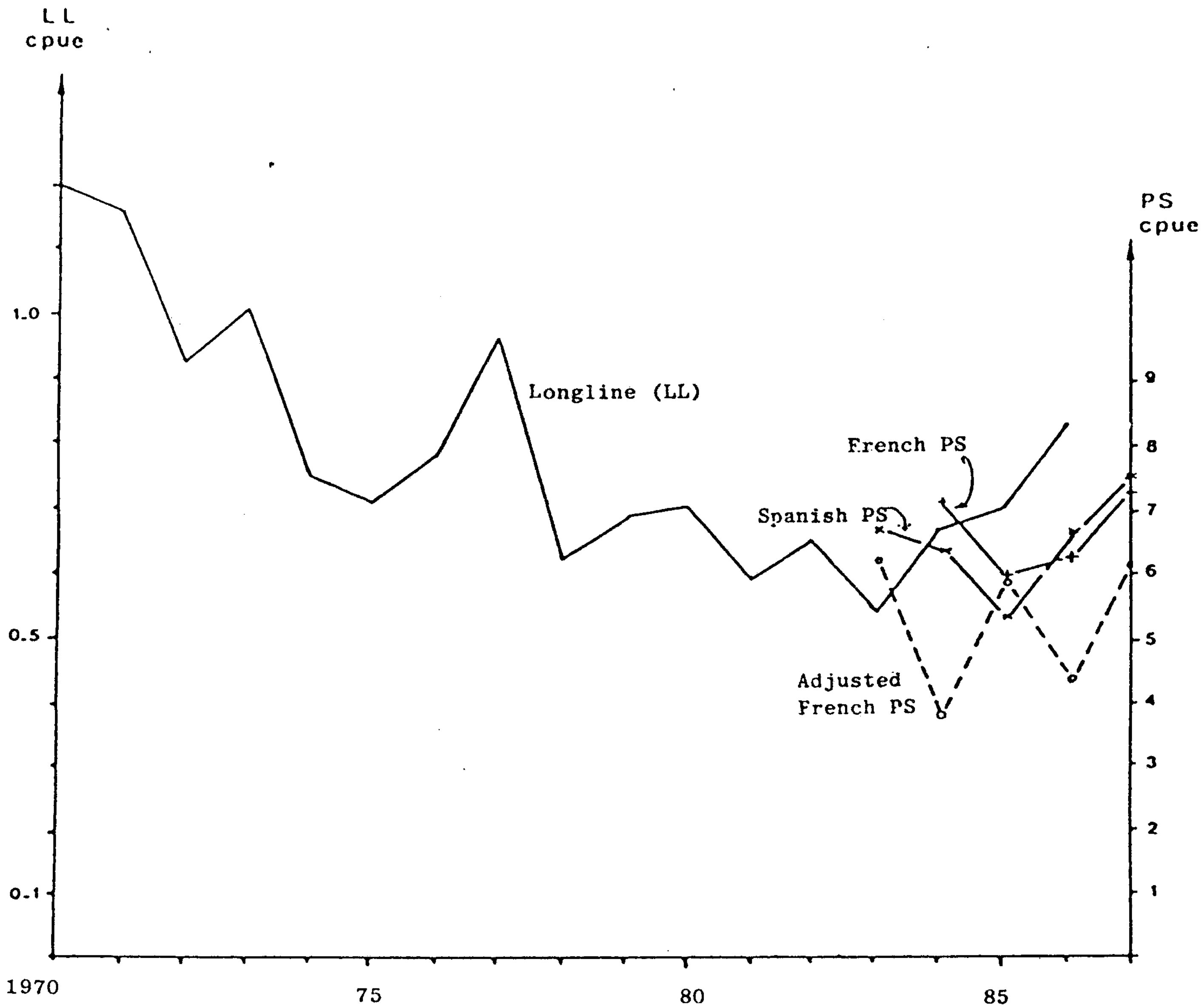
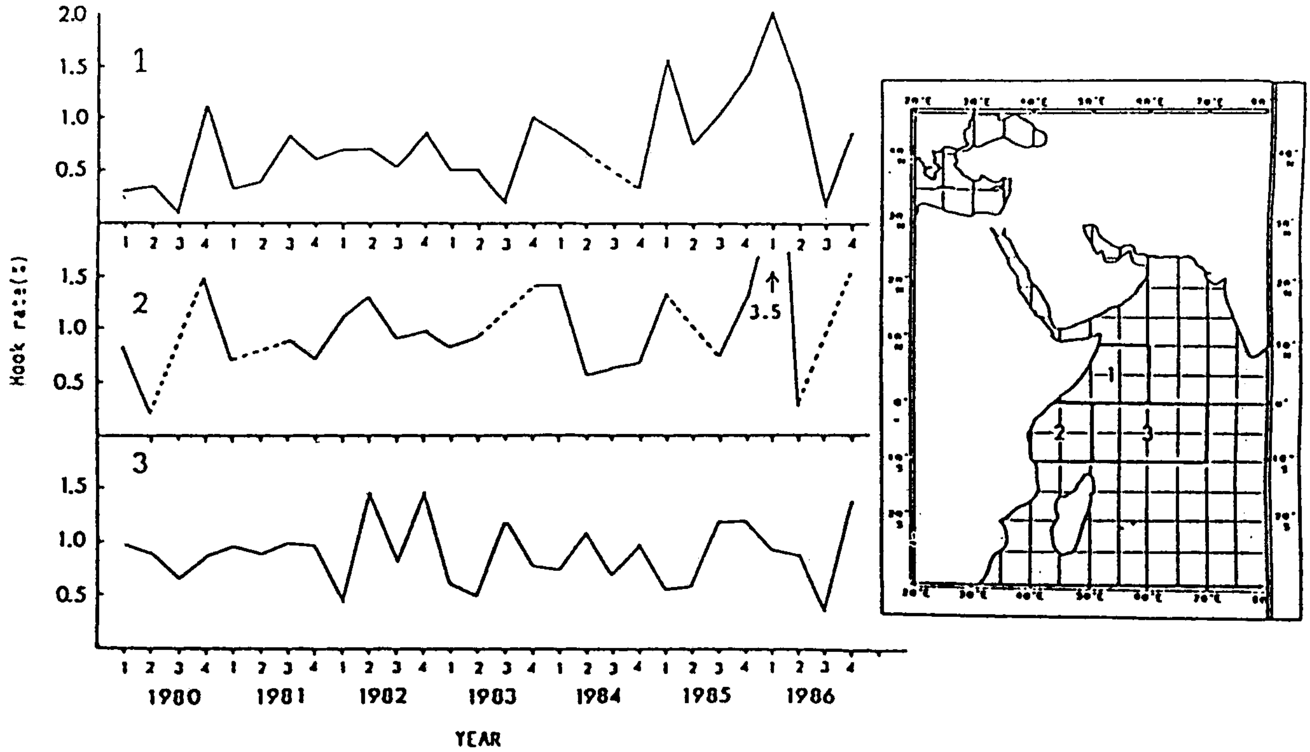


FIGURE 12 CPUE of yellowfin tuna for the longline and purse seine fisheries of the Indian Ocean. The longline index is based on data from the Japanese longline fleets for the area 20° N- 20° S lat. and 35° E- 130° E long. The French and Spanish indices are based on data for the respective fleets for the area centred in the Seychelles

FIGURE 13 CPUE of yellowfin tuna for Japanese longline fishery. Areas correspond to the central fishing area for the western Indian Ocean purse seine fishery



6. INTERACTION BETWEEN FISHERIES INCLUDING TUNA FISHERIES INTERACTION PROGRAMMES (TAGGING PROGRAM)

This problem generated much interest at the meeting. The dramatic development of the industrial purse seine fishery in recent years has led coastal states to express their concern on the possible effects of this fishery on their artisanal fishery, i.e., the small-scale pole-and-line and gillnet fisheries with respect to yellowfin tuna and skipjack tuna. This scientific problem on possible interaction between fisheries in the Indian Ocean was discussed based on similar experiences in other oceans. Several papers were presented dealing with this issue.

Document 10 describes the distribution of skipjack tuna during different stages of its life cycle. This is demonstrated by using size composition of the catch of various small-scale and industrial fisheries in the Indo-Pacific region, as well as longline incidental catches. It shows that skipjack are not randomly distributed in the whole ocean but more associated with coastal areas. However, while juveniles (less than 30 cm length) or older fish (larger than 55 cm) are found close to land masses or shoals, the intermediate size would migrate offshore and conduct extensive movements in the open ocean.

Document 44 compares the fishing performance by longliners and purse seiners for yellowfin tuna in Indian Ocean. The fishing zones overlap for these two fisheries, however the high increase in the yellowfin catch from purse seiners does not seem to have had any effect on the fishing performance of longline fleets. No evidence was found of interaction either global at the entire Indian Ocean level, or local in the limited geographical areas commonly exploited by both gears.

Document 46 highlights the major points of interaction between Atlantic and Pacific Oceans. These considerations might be of interest for similar analysis in the Indian Ocean. It was hypothesised that surface and deep water stocks intermingle from extensive analysis, fishing effort, CPUE and maturity study.

In Eastern Pacific (CYRA), the strong decrease in catch observed was not explained by the increase in fishing effort. At the same time, the purse seine fishing effort drastically increased, this being attributed as the main cause in the longline catch and CPUE decrease. In the Western Pacific however, there was no evidence of an adverse effect of purse seine increasing effort on longline CPUE. In Eastern Atlantic, a slight decline of the longline catch rate was noted after the arrival of the purse seine fleet in the mid 70's, but it was preceded by a larger decrease before the purse seiners started operating. It was therefore suggested that an interaction did occur but was of minor importance. In this analysis, the catch from bait boats was not considered although this was composed of a large percentage of juveniles, and that some changes in this fishery may have occured. A more comprehensive study should therefore include this component.

It was stated that there does not appear to be direct competition between the fisheries whilst an indirect one might occur since purse seine catch could reduce the recruitment through the longline fishery. The effect of the environmental conditions could explain the variability of the strength of the cohorts.

Recommendations

An ad hoc workshop on interaction was to be organized by FAO but was cancelled due to unavailability of fundings. The participants were of the opinion that this project was still very crucial and the suggestion was made that external fundings should be sought to overcome this problem.

TUNA TAGGING PROJECT

The initial tagging proposal covering a wide area of the Indian Ocean has been scaled down to a smaller region comprising the waters around Maldives, India and Sri Lanka, as described in Document 13. Tagging operations would take place in the Maldives whilst India and Sri Lanka would participate in the recovery of the tags. IPTP proposed to carry out this program in 1990. An external funding agency would still have to be identified.

It was however pointed out that, although this project could be useful in establishing growth parameters as well as migratory patterns in the area, it would not provide a full picture of interaction between the purse seine and the coastal small-scale fisheries. It would therefore be necessary to formulate a tagging programme for both fisheries.

Document 33 is relevant to the tuna tagging programme carried out in the southwest Indian Ocean under the EEC funded regional tuna project. Up to the present time, two tagging cruises have been effected but with disappointing results. This is mainly due to crew inexperience and inadequate facilities for pole-and-line fishing on the vessel. So far, 110 fish have been tagged but it is hoped that by the end of the year, the scientists would have a better idea of the future of the operations. It was noted that the FAO/UNDP project would start a small scale tagging programme in Mozambique waters by next year and assistance was requested from the EEC project.

Recommendations

The Committee supported the following points:

- the tagging proposal planned in the Maldives should be carried out but recommended that this should be extended to cover also industrial surface fishing areas in order to have a better understanding of possible interaction between these fisheries;

- in view of the large area to be covered, it was proposed a great number of tags would be necessary so as to have significant number of tag returns;

- coastal countries should bring active collaboration in tag recoveries from the EEC project if such recaptures occur in their waters.

7. PROGRESS MADE IN THE COLLECTION OF STATISTICS

Country reports were made by the participants of Taiwan, Japan and Seychelles, describing the data collected, the method of collection and processing, and problems encountered (Docs. 63, 56 and 51). The first two countries deal only with flag vessels, while the Seychelles collects data from all vessels licenced and trans-shipping. In all the cases, logbook data are collected from the fishing vessels. In two of the countries, radio reporting was stated to be useful to verify logbook reports; in Seychelles logbook data are collected from trans-shipment statistics.

The delay in the collection of logbooks has resulted for the distant water fleets in delays of up to two years in some cases in the availability of the data. Problems have also arisen with this delay in attributing the catch between different oceans. Attempts are now being made to obtain data by mail from trans-shipment ports. In the Seychelles, data are published on a regular three monthly basis. It was noted by SFA that there is close agreement between the data collected by the flag state and by SFA.

Size frequency of the fish is sampled in different ways. On the Taiwanese vessels, the first 30 fish in each catch are sampled by length and species. In Japan, sampling is carried out by training vessels, at fish markets, and increasingly on commercial vessels. Longline catch data are collected in numbers of fish, and are subsequently converted to weight using length-weight relationships in Japan.

Reporting on the progress achieved by IPTP in data collection, processing and dissemination, the Programme Leader of IPTP (Doc. 6) stated that there are liaison officers providing data now in 31 countries and communications with 6 countries through UNDP/FAO offices. The data available in the IPTP database for catch, fishing craft, catch and effort and size frequency, updated in the meeting, are listed in Annex 1.

Improvements are noted for Oman and Seychelles in catch statistics and for India, Japan, Pakistan and Sri Lanka in species classification. Fishing craft statistics are available for purse seiners due to the SFA quarterly Statistical Bulletin, and Japan now has a method of counting longline vessels operating in the Indian Ocean. In other countries, however, little progress is noted, some countries making no distinction, for example, between registered and active vessels.

Catch and effort statistics are available for most of the major industrial fishing countries up to 1986, and for some to 1987. Size-frequency data have been provided by Taiwan and France, up to 1986 and for Spain for 1987. Japan has provided data for yellowfin for 1982 to 1985 but bigeye and albacore data have not yet been provided. Difficulties in processing data were also mentioned by the participant from Korea, who however undertook to provide size-frequency for 1983 to 1985. For artisanal fisheries, several coastal tuna fishing countries including Indonesia, Malaysia, Pakistan, Philippines, Sri Lanka and Thailand have introduced sampling schemes in major landing centres to obtain data on catch/effort and size frequency with IPTP assistance. These data collected from the sampling schemes are now available in the IPTP database.

Many coastal countries have problems in the classification of species. In many cases, more than two species are reported together as a single species or species group. Similarly, artisanal gears are not always classified, but as it is known that these are surface gears, this is not an issue. For some countries, industrial gears are not specified, which is more serious. Longline catches reported in numbers have led to gaps between estimated catches and landings in weight.

Annex 1

PRESENT STATUS OF IPTP DATA COLLECTION

as of May 1988

	COUNTRY	CATCH STATISTICS	FISHING CRAFT STATISTICS	CATCH/EFFORT STATISTICS	SIZE FREQUENCY
1.	AUSTRALIA	SPECIES/GEAR - 1986	PS/BB - 1986	-	-
2.	BANGLADESH	SPECIES (TUN)/ GEAR 1985/1986	GILL 1985/1986	-	-
3.	BAHRAIN	FAO STATISTICS	-	-	-
4.	CHINA (TAIWAN)	SPECIES/GEAR - 1986	LL/GILL SIZE CLASS - 1986	LL $5^o \times 5^o$ MONTHLY GEAR/SPECIES 1967 - 1986	LL $5^o \times 5^o$ MONTHLY GEAR/SPECIES 1985/1986
5.	COMOROS	FAO STATISTICS	-	-	-
6.	DJIBOUTI	FAO STATISTICS	-	-	-
7.	EGYPT	FAO STATISTICS	-	-	-
8.	FRANCE	SPECIES/GEAR 1981 - 1986	PS/SIZE CLASS 1981 - 1986	PS $5^o \times 5^o$ MONTHLY GEAR/SPECIES 1983 - 1986	PS $5^o \times 5^o$ QUARTER GEAR/SPECIES 1984-1986
9.	INDIA	SPECIES - 1986 (GEAR-BREAKDOWN ONLY FOR 1985)	GEAR/BOAT TYPE 1984/1986	2 SAMPLING SITES GILL/HAND 1970-1982	-

	COUNTRY	CATCH STATISTICS	FISHING CRAFT STATISTICS	CATCH/EFFORT STATISTICS	SIZE FREQUENCY
10.	INDONESIA	SPECIES/GEAR - 1986	PS/LL/TROL 1984/1986	SAMPLING SITES MONTHLY GILL/BB/TROL PS/SEINE 1980 - 1986	SAMPLING SITES MONTHLY GEAR/SPECIES 1980 - 1986
11.	IRAN •	SPECIES/GEAR - 1986	GILL/SIZE CLASS 1983 - 1986	-	-
12.	ISRAEL	FAO STATISTICS	-	-	-
13.	IVORY COAST	SPECIES/GEAR 1984 - 1986	PS/SIZE CLASS 1984 - 1986	PS $5^o \times 5^o$ MONTHLY GEAR/SPECIES 1983 - 1986	-
14.	JAPAN	SPECIES/GEAR - 1986	LL/SIZE CLASS 1985 - 1986	LL $5^o \times 5^o$ MONTHLY GEAR/SPECIES 1962 - 1986	LL $10^o \times 20^o$ QUARTERLY GEAR/YFT 1982 - 1985
15.	KENYA	SPECIES/GEAR 1980 - 1983 FAO STATISTICS 1984 - 1986	LL/SIZE CLASS 1980 - 1984	-	-
16.	KOREA REPUBLIC	SPECIES/GEAR - 1986	LL - 1986	LL $5^o \times 5^o$ MONTHLY GEAR/SPECIES 1968 - 1969 1975 - 1985	-

	COUNTRY	CATCH STATISTICS	FISHING CRAFT STATISTICS	CATCH/EFFORT STATISTICS	SIZE FREQUENCY
17.	KUWAIT	FAO STATISTICS	-	-	-
18.	MADAGASCAR	FAO STATISTICS	-	-	-
19.	MALAYSIA	SPECIES/GEAR - 1986	GEAR 1984 - 1986	SAMPLING SITE MONTHLY TROL/SPECIES 1983 - 1986	SAMPLING SITE MONTHLY TROL/SPECIES 1983 - 1986
20.	MALDIVES	SPECIES/GEAR - 1986	BOAT TYPE/GEAR - 1986	ATOLL MONTHLY BB/TROL SPECIES 1970 - 1986	SAMPLING SITES MONTHLY BB/TROL SPECIES 1983 - 1986
21.	MAURITIUS	SPECIES/GEAR - 1986	PS/TROL 1979 - 1986	-	-
22.	MOZAMBIQUE	SPECIES/GEAR 1983 - 1985 FAO STATISTICS FOR 1986	BB BOAT TYPE 1983 - 1985	-	-
23.	OMAN	SPECIES (TUN/KGX) 1985/1986	-	-	-
24.	PAKISTAN	SPECIES/GEAR - 1986	GILL SIZE RANGE 1983 - 1986	SAMPLING PROGRAMME STARTED IN 1987	SAMPLING PROGRAMME STARTED IN 1987
25.	PANAMA	SPECIES/GEAR 1984 - 1986	PS SIZE CLASS 1984 - 1986	-	-

	COUNTRY	CATCH STATISTICS	FISHING CRAFT STATISTICS	CATCH/EFFORT STATISTICS	SIZE FREQUENCY
26.	PHILIPPINES	SPECIES/GEAR - 1986	GEAR/SIZE CLASS - 1986	SAMPLING SITES GEAR/SPECIES 1980 - 1986	SAMPLING SITES GEAR/SPECIES 1980 - 1986
27.	QATAR	FAO STATISTICS	-	-	-
28.	REUNION	FAO STATISTICS	-	-	-
29.	SAUDI ARABIA	SPECIES (TUN/KGX) 1982 - 1986	-	-	
30.	SEYCHELLES	FAO STATISTICS 1970 - 1982 SPECIES/GEAR 1983 - 1986	-	1) LL GEAR/SPECIES MONTHLY 5° x 5° 1983 - 1985 2) ARTISANAL FISHERIES GEAR/SPECIES MONTHLY 1985 - 1986 3) FOREIGN FISHING VESSELS PS/LL GEAR/SPECIES MONTHLY 5° x 5° 1983 - 1986	-
31.	SOUTH AFRICA	FAO STATISTICS	-	-	-
32.	SPAIN	SPECIES/GEAR 1981 - 1986	GEAR/SIZE CLASS 1981 - 1986	PS GEAR/SPECIES MONTHLY 5° x 5° 1984 - 1987	PS GEAR/SPECIES MONTHLY PORT 1984 - 1987

	COUNTRY	CATCH STATISTICS	FISHING CRAFT STATISTICS	CATCH/EFFORT STATISTICS	SIZE FREQUENCY
33.	SRI LANKA	SPECIES/GEAR - 1986	GEAR/SIZE CLASS 1983 - 1986	GILL/TROL GEAR/SPECIES MONTHLY SITES 1985 - 1987	GILL/TROL GEAR/SPECIES MONTHLY SITES 1982 - 1987
34.	TANZANIA	SPECIES - 1986	GEARS COMBINED - 1985	-	-
35.	THAILAND	SPECIES/GEAR - 1986	GEAR/SIZE CLASS - 1985	GILL/PS GEAR/SPECIES MONTHLY LOCAL AREA 1972 - 1985	SAMPLING PROGRAMME STARTED IN 1987
36.	U.A.E.	FAO STATISTICS 1981 - 1985 SPECIES 1986	-	-	-
37.	U. K.	SPECIES/GEAR 1984 - 1985	PS GEAR/SIZE CLASS 1984 - 1985	-	-
38.	U.S.S.R.	FAO STATISTICS	-	-	-
39.	YEMEN ARAB REPUBLIC	FAO STATISTICS 1970 - 1984 SPECIES 1985/1986	GEARS COMBINED 1984/1986		
40.	YEMEN DEMOCRATIC REPUBLIC	SPECIES 1982 - 1986	-	-	-

Catch and effort statistics have not as yet been provided by Indonesia, Philippines and Mauritius for their industrial fisheries, due to the lack of logbook systems.

The participants from France and Seychelles noted their appreciation of the IPTP's prompt action in sending the required statistical information stored in the IPTP database.

Recommendations

The following recommendations were made:

- to improve reporting on separate species in catch statistics;
- to cross check catch statistics with landings for industrial longline fishery to improve its accuracy in weight;
- to introduce logbook systems for the industrial purse seine and longline fisheries of Indonesia, Mauritius and Philppines;
- to assist coastal countries by IPTP to maintain and improve sampling programmes;
- to establish a sampling programme at Port Louis, Mauritius for the purse seine and longline fisheries, and in Indonesia for the longline fisheries based in Jakarta and Bali;
- to obtain Japanese size data of yellowfin, bigeye and albacore caught by longliners;
- to obtain Korean size data of major species caught by longliners and catch and effort statistics on a more timely basis;
- in the IPTP database, to record catch and effort statistics and size frequency data each in a single format;
- finally, it was recommended that, as is the case for ICCAT, IPTP should, in lieu of official flag figures, report statistics corrected for inconsistencies between reporting countries in data collection and processsing.

8. REVIEW OF KEY RESEARCH AREAS

Since this was the third meeting of the Expert Consultation on the Stock Assessment of Tunas in the Indian Ocean, the Expert Consultation considered it appropriate to review (1) the methodology and data used to assess the tuna resources of the Indian Ocean; (2) identify inadequacies in methodology and data and (3) to recommend future research needs.

In view of the dramatic changes which have taken place in the tuna fisheries of the world and especially in the Indian Ocean, it became apparent that scientists will be faced with a need for various types of data from the fisheries; data in addition to the conventional catch and effort statistics. The substantial increase in tuna landings from the Indian Ocean in recent years has resulted from (1) improved data collection, (2) increased production by artisanal or small-scale fisheries (3) introduction of purse seine fishing, and (4) introduction of deep longline fishing. Further the complex arrangements to move tuna from the fishing vessels to shore side bases, for example trans-shipment, has made collection of data and samples on size and sex of fish, maturation and spawning extremely difficult.

Adequate assessment of the tuna resources of the Indian Ocean will require close cooperation and sharing of data by scientists from within and outside the region; the latter involving scientists from countries with distant water tuna fleets fishing in the Indian Ocean.

The topics reviewed included (1) assessment, (2) stock structure, (3) movement and migration, and (4) biology.

1 Assessment

The methods utilized to date to assess the tuna stocks in the Indian Ocean include the surplus production method and cohort analysis. Production model studies for the Indian Ocean resources have suffered from the lack of complete longline statistics and data required to correct for changes in catchability with the deep fishing longline gear. Concern was expressed by some participants that the longline catch per unit of effort did not appear to be a good index of abundance of the several species of tuna caught with this gear.

The few cohort studies of the Indian Ocean tunas undertaken to date used age and growth parameters taken from studies of tunas from other oceans. Since growth differences may exist for tunas from different oceans there is a need to obtain these data specifically for the Indian Ocean.

The Expert Consultation recommended that research utilizing the current production and cohort analytical techniques should be continued and efforts made to obtain the needed data to improve the quality of the analyses. These include catch, effort, size frequency data and data necessary to make adjustments for the shift from standard to deep fishing longline gear. Although tagging has been used effectively in other fisheries for population estimates, the western Pacific skipjack tuna resource is the only tuna species for which population estimates are based on tag data.

The Expert Consultation recommended as a high priority tagging experiments for all species of commercially important tunas for stock assessment, stock structure, age and growth, and interaction information.

The Expert Consultation discussed several alternative methods of stock assessment which do not require the use of fishery generated data. One technique which is still in the experimental stage is assessment based on aerial surveys. While problems exist with this technique, the development of long range high sensitivity radar appears to be promising. Efforts in developing new techniques should be pursued actively.

While the egg production method for assessing fish populations has been carried out successfully for the California anchovey, the technique does not appear to be feasible for the pelagic tunas. Principal problems include the inability to identify tuna eggs in the ocean environment, the extended spawning period which exists for most tuna species and the wide geographical spawning grounds of tunas. The possibility of using this technique for coastal tuna species was discussed as a possible alternative to other methods: however, the problem of egg identification was noted as a key problem.

2 Stock structure

Several methods of defining stock structure of tuna populations were reviewed. These included: (1) morphometric and mersitic counts; (2) parasites; (3) genetics, and (4) tagging.

An extensive study of stock structure of Pacific yellowfin tuna based on morphometric data was undertaken in the fifties. While the results did not appear to be sufficiently conclusive, the method may warrant a reassessment in the light of recent developments of new and more powerful statistical techniques, example cluster analysis.

A discussion of genetic techniques as a means of identifying stock structure of tunas elicited reservations with the techniques by several participants. It was noted that there appears to be a lack of communication between the fishery scientist and the geneticist. While the geneticist is seeking to identify genetically isolated populations, the fishery scientist is accepting the assumption that some mixing occurs between 'populations'. Any consideration of using genetic methods for stock identification should be preceded by a thorough evaluation of the technique.

It was generally accepted by the Expert Consultation that tagging may be the most effective method to provide information on the stock structure of tunas.

3 Movement/Migration

Recent developments in tracking tunas using acoustic tags have added considerable knowledge to the short-term movements of tunas. This information will be useful in understanding the time/space movements of tunas, and in interpreting fishery generated data for stock assessment.

There was general agreement that tagging experiments will provide substancial information toward the understanding of the movement patterns of tunas in the Indian Ocean.

4 Biology

While there is much to be known about the biology and life history of the several tuna species occuring in the Indian Ocean, the highest priority for research in the biological area was to obtain good age and growth information on all tuna species of the Indian Ocean. This data is fundamental toward understanding the resource base.

5 Summary

There is a high priority need to carry out tuna tagging studies in the Indian Ocean to obtain information on assessment, stock structure, age and growth and migration. While information is lacking on all tuna species, the yellowfin and skipjack tuna should be given prime consideration since the two species are important to the large and small-scale commercial fisheries and the artisanal fisheries of the region.

A second high priority focus of research should be to obtain age and growth data from other methods for all tuna species in the Indian Ocean. High priority species include yellowfin, skipjack, bigeye, albacore, longtail tuna and kawakawa.

9. FOLLOW-UP TO THE EXPERT CONSULTATION

9.1 Future acrivities of IPTP

The Programme Leader of IPTP briefly explained the future activities of IPTP with reference to Document 70.

He explained that IPTP will continue activities of the inter-regional tuna data centre of the Indian Ocean and Southeast Asian regions which are to collect data from participating countries, disseminate data/information and analyse data as in the past. IPTP will also continue to organize workshops and/or expert consultations on stock assessment of tunas and on topics relating to tuna resources in the region.

He noted that under the Japan Trust Fund project, IPTP will continue its assistance in implementing and supervising tuna sampling programmes in Malaysia, Pakistan, Philippines, Sri Lanka, Thailand and the United Arab Emirates. IPTP will also consult and coordinate with scientists in India, Iran, Maldives and Oman in tuna research and data collection. IPTP will also provide assistance in implementing tagging programmes in the Philippines, Indonesia and in waters off Thailand/Malaysia and Maldives/India/Sri Lanka. The Tuna Biologist outposted to Jakarta (Indonesia) will continue to assist the Research Institute for Marine Fisheries in improving sampling programmes and the data collection system, developing tagging experiments and in initiating relevant biological investigations.

All the above future activities of IPTP were endorsed by the participants.

9.2 Other recommendations

- It was strongly recommended that an organization such as IPTP be maintained in the Indian Ocean region beyond 1989, to continue to collect relevant statistical information and to coordinate research between scientists on tuna stock status.

- It was also strongly recommended that the present activities of IPTP in the Southeast Asian region be continued by the future organization as this is one of the richest areas for tunas in the world.

- It was vigorously recommended that FAO fill the vacant post of tuna specialist in headquarters to coordinate research activities throughout the world.

10. ADOPTION OF THE REPORT

The report of the Expert Consultation was adopted on 27 June 1988.

Appendix 1

Inaugural Address by Mr. M. Munbodh,
Divisional Scientific Officer (Fisheries)
Ministry of Agriculture, Fisheries and Natural Resources
at the Expert Consultation of Stock Assessment of Tuna
in the Indian Ocean
Mauritius, 22 - 27 June 1988

Distinguished participants, ladies and gentlemen,

It gives me great pleasure on behalf of the Ministry of Agriculture, Fisheries and Natural Resources to welcome you all to the opening of the Expert Consultation on Stock Assesssment of Tuna in the Indian Ocean which will be held here from 22 to 27 June.

Previous meetings of this Expert Consultation were held in Colombo, Sri Lanka in 1985 and 1986 the seat of the Indo-Pacific Tuna Programme and this is the first time it is being held in another member country of the Programme and we are thus very much honoured by the gesture of FAO to hold this Meeting in Mauritius. We hope you will find the arrangements we have made suitable for the very important discussions and deliberations you will have on Tuna Stock Assessment in the Indian Ocean.

Mauritius has served as a base for tuna transhipment by longliners from far-eastern countries since 1965. Tuna canning started in 1972 with imported raw material from Madagascar. Fishing operations which had a brief start in 1971 - 1972 with a longliner was resumed in 1979 through the launching of a purse-seiner.

The industry is gradually expanding as investment in both the purse-seine and longline fishery is being made. The artisanal tuna fishery is also receiving a boost through fishing around Fish Aggregating Devices and sport fishing for bill-fishes continues to be an attraction specially for the tourism industry.

Together with Comoros, Madagascar, Reunion and Seychelles, Mauritius is also participating in the EEC - funded Regional Tuna Project. The objectives of this project are: collection and processing of tuna statistics, biological data and environmental data in relation to tuna fisheries, tuna tagging for stock assessment purposes, training of scientists in these disciplines and a core of purse-seine fishermen in tuna fishing, demonstrate the feasibility of fishing by small-sized vessels and exploratory fishing in areas not yet prospected by the commercial fishery.

The subject of this meeting gains all its importance when we view it in the perspective of recent developments in the tuna fishing industry in the Indian Ocean and South-east Asian Regions. Total tuna catches in thee regions doubled between 1978 and 1986. In the Indian Ocean alone total catches doubled between 1980 and 1986 when it stood at 568,000 t. We, therefore, note the very rapid increase in catches in these regions in less than a decade. In fact closer to Mauritius and more specifically in the South-west Indian Ocean the last few years have witnessed a tremendous increase in purse-seine catches of tuna.

The need for the rational development and management of tuna stocks is felt by all countries of the Indian Ocean and those distant-water fishing nations involved in its tuna fisheries. The very fact that tuna species are highly mobile bring about distribution of stocks which can spread ocean-wide beyond exclusive economic zones into neighbouring ones and in the high seas. No single coastal country can have complete control over tunas throughout their life-history. This state of affairs necessarily calls for international collaboration and cooperation and Indo-Pacific Tuna Programme is being instrumental in bringing this about in the Indian Ocean.

The state of tuna stocks in the Indian Ocean were reviewed in previous meetings and a number of recommendations made to improve on the level of knowledge of the stocks. The basis for much of the work of the programme still remains adequate data collection and reporting systems by countries at the national level. However, the study of the interaction of the different tuna fisheries as the different components develop are still to be pursued in depth whilst stock distribution and sizes, among other parameters, using tagging methods, are still to be elucidated.

We note with great interest that a number of papers dealing with the various tuna species and stocks will be presented at this meeting by scientists from the region and from outside it thus upgrading our knowledge in these areas. Together with the information prepared by the IPTP there is no doubt that the presentations will being about very interesting and fruitful discussions on the subject to be reviewed by this meeting.

We wish you success in your delibrations and look forward to your valuable findings and recommendations on tuna stocks in the Indian Ocean to be submitted to the Committee for the Management of Indian Ocean Tuna for the continued benefits of all countries participating in its tuna fisheries. I seize this opportunity to wish you all a pleasant stay in Mauritius and hope you will also find some free time to visit our island.

Thank you.

Appendix 2

List of Participants

Dr. Charles Anderson
Fisheries Biologist
Ministry of Fisheries
Ghaazee Building
Male
REPUBLIC OF MALDIVES

Dr. P. Bourret
ORSTOM
Bois Court Ste Marie
97438 REUNION

Mr. Rashid Ahmad Al Barwani
Directorate General of Fisheries
Ministry of Agriculture and Fisheries
Muscat
OMAN

Dr. Patrice Cayre
Scientist
ORSTOM
MAURITIUS

Mr. Veenay Mitre Chooramun
Fish Technologist
Ministry of Agriculture, Fisheries and Natural Resources
Albion Fisheries Research Centre
Petite Riviere
Albion
MAURITIUS

Mr. Young Sik Chun
Assistant Director
International Cooperation Division
National Fisheries Administration
Seoul
REPUBLIC OF KOREA

Mr. Jose Luis Cort
Fisheries Biologist
Instituto Oceanografico
APDO 240 Santander
SPAIN

Mr. Peter K. Chisara
Co-ordinator
Marine Fisheries Research & Training Institute
Ministry of Rural Resources & Tourism
Dar-es-Salaam
TANZANIA

Dr. Mrs. N.P.J. Dayaratne
Senior Scientific Officer
National Aquatic Resources Agency
Crow Island
Mattakkuliya
Colombo 15
SRI LANKA

Mr. Nageon de Lestang
Director Resource Management
Seychelles Fishing Authority
P. O. Box 449
Victoria
SEYCHELLES

Mr. J. A. De Silva
Research Officer
National Aquatic Resources Agency
Crow Island
Mattakkuliya
Colombo 15
SRI LANKA

Mr. Ed. Egorov
Scientific Officer
International Fisheries
Organization Section
All-Union Research Institute of Marine
Fisheries and Oceanography (VNIRO)
17, V. Krasuoselskaya
Moscow 107140
U.S.S.R.

Mr. A. Fonteneau
Centre de Recherche Oceanographiques
de Dakar-Thiaroye
B.P. 2241
Dakar
SENEGAL

Mr. Ahmed Hafiz
Fisheries Research Officer
Marine Research Section
Ministry of Fisheries
Male
REPUBLIC OF MALDIVES

Mr. J. P. Hallier
ORSTOM Team Leader with Fishing Laboratory
B.P. 570
Mahe
Victoria
SEYCHELLES

Mr. Koichi Ishida
Staff of Japan FAR
Purse Seine Fishing Association
Tokyo
JAPAN

Mr. Mohammud Ismet Jehangeer
Scientific Officer
Ministry of Agriculture, Fisheries and Natural Resources
Albion Fisheries Research Centre
Petite Riviere
Albion
MAURITIUS

Mr. Phosun Kallee
Technical Officer
Ministry of Agriculture, Fisheries and Natural Resources
Albion Fisheries Research Centre
Petite Riviere
Albion
MAURITIUS

Mr. Yuji Kawai
Section Chief
Federation of Japan Tuna Fisheries Co-operative Associations
2-721, 2-42-2, Tenno-Cho
Hodogaya-ku
Yokohamaya-shi
JAPAN

Dr. Chin Lau Kuo
Researcher
Taiwan Fisheries Research Institute
199 Hon-In Road
Keelung
TAIWAN

Mr. Jean Li Kam Tin
Manager
Happy World Marine Limited
40 Jummah Mosque
Port Louis
MAURITIUS

Mr. Jen-Chyuan Lee
Deputy Director
Fisheries Department
Council of Agriculture
37 Nanhai Road
Taipei
TAIWAN

Miss Marine
Engineer at IRe Direction de la peche
Et de L'Aquaculture
MPAEF
MADAGASCAR

Mr. F. Marsac
Centre ORSTOM
B. P. 70
29263 Plouzane
FRANCE

Mr. Munesh Munbodh
Divisional-Scientific Officer
Ministry of Agriculture, Fisheries & Natural Resources
Albion Fisheries Research Centre
Petite Riviere
MAURITIUS

Dr. Nurzali Naamin
Director
Research Institute for Marine Fisheries
Jalan Krapu No.12
Sunda Kelapa
Jakarta 14430
INDONESIA

Mr. Ali Reza Nikouyan
Fisheries Scientist
Ministry Gehad
Research Department
Fisheries Company of Iran
Tehran
IRAN

Mr. M. Okuno
Assistant Director
International Affairs Division
Oceanic Fisheries Department
Fisheries Agency
Chiyoda-ku
Kasumigaseki 1-2-1
Tokyo
JAPAN

Mr. Said Omar Ouirdane
Director Executif
Association Thoniere C.O.I.
B. P. 1068
Antananarivo
MADAGASCAR

Mr. Dhammasak Porreyanond
Chief
Exploratory Fishing Sub-Division
Department of Fisheries
Ministry of Agriculture & Co-operatives
Rajdamnern Avenue
Bangkok 10200
THAILAND

Mr. Yeong Chull-Park
Senior Scientist
Deep-Sea Resources Division
National Fisheries and Development Agency
16, 2GA, Namhang-Dong
Yeoungdo-ku
Pusan 606-032
REPUBLIC OF KOREA

Mr. Boodhun Ramcharrun
Technical Officer
Ministry of Agriculture, Fisheries &
Natural Resources
Albion Fisheries Research Centre
Petite Riviere
MAURITIUS

Mr. C. Roger
ORSTOM
97420 Le Port
REUNION

Mr. Pasquale Raimondo
Counseiller CEE
Delegation
EEC
MAURITIUS

Dr. Gary Sakagawa
Chief, Pelagic Fisheries Resources Division
Southwest Fisheries Center
National Marine Fisheries Service
P. O. Box 271
La Jolla, CA 92038
U. S. A.

Mr. Chandrashen Ramjee Samboo
Scientific Officer
Ministry of Agriculture, Fisheries &
Natural Resources
Albion Fisheries Research Centre
Petite Riviere
MAURITIUS

Dr. James Scullion
Team Leader
ODA Fisheries Project
P. O. Box 273
Lindi
TANZANIA

Mr. Soondron Seeneevassen
Technical Officer
Ministry of Agriculture, Fisheries &
Natural Resources
Albion Fisheries Research Centre
Petite Riviere
MAURITIUS

Mr. Richard Shomura
Department of Commerce
NOAA, National Marine Fisheries Service
SWFC Honolulu Laboratory F/SWC2
2570 Dole Street
Honolulu, Hawaii 96822-2396
U. S. A.

Dr. V. Sokolov
Chief of Laboratory
VNIRO
Moscow
U. S. S. R.

Mr. B. J. Stequert
Scientist
ORSTOM
MAURITIUS

Dr. Ziro Suzuki
Senior Biologist
Far Seas Fisheries Research Laboratory
Fisheries Agency
5-7-1 Orido
Shimizu
JAPAN

Dr. Konstantinos Vamvakas
Principal Administrator
Directorate General for Fisheries
Commission of the European Economic Community
200 Rue de la Loi
1049 Brussels
BELGIUM

Mr. Atmanund Venkatasami
Scientific Officer
Ministry of Agriculture, Fisheries &
Natural Resources
Albion Fisheries Research Centre
Petite Riviere
MAURITIUS

Mr. Abdol Hamid Yazdani Jahromi
Research Officer
Iran-Tehran Fisheries Organization
Ministry of Jahad Sazandege
Tehran
IRAN

Mr. Amini Ali Yahya
Responsable de Jahad
Tehran
Jahad
IRAN

Dr. Shean-Ya Yeh
Professor
Institute of Oceanography
National Taiwan University
P. O. Box 23-12
Taipei
TAIWAN

Mr. R. Yulgushev
Chief Engineer
Department of Fisheries
USSR Ministry of Fisheries
15 Rozhdestvensky Building
Moscow 103031
U. S. S. R.

FAO HEADQUARTERS

Via delle Terme di
Caracalla
00100 ROME

Mr. E. Kohigashi
Associate Professional Officer
International Institutions and Liaison Unit
Fishery Policy and Planning Division

FAO FIELD STAFF

INDO-PACIFIC TUNA DEVELOPMENT AND MANAGEMENT PROGRAMME (IPTP)

Mr. T. Sakurai, IPTP
Programme Leader
P. O. Box 2004
Colombo
SRI LANKA

Mr. M. Yesaki
Tuna Biologist, IPTP
P. O. Box 2004
Colombo
SRI LANKA

REGIONAL FISHERIES DEVELOPMENT AND MANAGEMENT PROJECT FOR THE SOUTH WEST INDIAN OCEAN (SWIO)

Mr. D. Ardill
Project Manager, SWIO
Unity House
P. O. Box 487
Victoria
Mahe
SEYCHELLES

Appendix 3

AGENDA AND TIME TABLE

Wednesday, 22 June 1988		
Morning	1	Opening of the meeting
	2	Election of Chairman
	3	Adoption of agenda and arrangements for the meeting
	4	Review of national fisheries and research programmes
Afternoon	4	Review of national fisheries and research programmes (cont'd)
	5	Review of status of stocks - Group 1: Small tunas, billfishes and seerfishes
Thursday, 23 June 1988		
Morning	5	Review of status of stocks - Group 1: Small tuna, billfish and seerfish (cont'd) - Group 2: Bigeye, albacore and southern bluefin tunas (cont'd) - Group 3: Yellowfin and skipjack tunas
Friday, 24 June 1988		
Morning	5	Review of status of stocks - Group 3: Yellowfin and skipjack tunas (cont'd)
Afternoon	6	Interaction between fisheries including tuna fishery interaction programmes (tagging programme)
Saturday, 25 June 1988		
Morning	7	Progress made in the collection of statistics (a) Progress made by national officers (b) Progress made by IPTP
	8	Review of key research areas
Afternoon	9	Follow-up of the Expert Consultation (a) Future activities of IPTP (b) Other recommendations
Sunday, 26 June 1988		F r e e
Monday, 27 June 1988	10	Adoption of the report

Appendix 4

LIST OF DOCUMENTS

TWS/88/1	Provisional agenda and time table
TWS/88/2	Provisional list of documents
TWS/88/3	Provisional list of participants
TWS/88/4	IPTP Data Summary No. 8 - Indian Ocean and Southeast Asian Tuna Fisheries Data Summary for 1986
TWS/88/5	IPTP Data Catalogue No. 5
TWS/88/6	IPTP Tuna Data Collection, Processing and Dissemination (Its present status and problems)
TWS/88/7	Atlas of the tuna fisheries in the Indian Ocean and Southeast Asian regions - IPTP
TWS/88/8	Atlas of industrial tuna longline and purse seine fisheries in the Indian Ocean - IPTP
TWS/88/9	Summaries of papers presented at workshop on small tuna, seerfish and billfish in the Indian Ocean
TWS/88/10	Simulations on interactions between small-scale and industrial skipjack tuna fisheries - M. Yesaki
TWS/88/11	Results of the tuna sampling programme at 3 sites in the west coast of Sri Lanka - R. T. Forster
TWS/88/12	Estimates of age growth and spawning of yellowfin tuna - K. L. Yamanaka
TWS/88/13	Tuna tagging proposal in Maldives, India and Sri Lanka - IPTP
TWS/88/14	Review of national fisheries for the Sultanate of Oman - Rashid Bin Amour Al Barwani
TWS/88/15	Tuna fisheries and its distribution along Iranian coast - A. Nikouyan
TWS/88/16	Small craft _Thunnus albacares_ fishery in the Zanzibar channel - P. K. Chisara
TWS/88/17	Skipjack tuna fishery of Lakshdweep - P.S.B.R. James and P. P. Pillai
TWS/88/18	Status of tuna fishery in India - P.S.B.R. James and A. A. Jayaprakash

TWS/88/19	Status of tuna fisheries in Sri Lanka - P. Dayaratne and R. Maldeniya
TWS/88/20	A study of licensing arrangement for foreign fishing boats in the EEZ of Sri Lanka and the analysis of their catch data - A. R. Atapattu
TWS/88/21	Growth and migration of juvenile yellowfin tuna (<u>Thunnus albacares</u>) in the central Indian Ocean - R. C. Anderson
TWS/88/22	Size group of skipjack and yellowfin tuna from exploratory fishing survey in the Andaman Sea 1988 - D. Poreeyanond
TWS/88/23	Recent trend of tuna fisheries in Indonesia with special reference to Indian Ocean side - N. Naamin
TWS/88/24	Study on the operation of tuna longline for catching fresh tuna in Indonesia - Sofri Bahar and Batchiar Gafa
TWS/88/25	Progress made in the collection of tuna statistics and research highlight on tuna in Indonesia - N. Naamin and B. Gafa
TWS/88/26	Not issued
TWS/88/27	The Maldivian tuna fishery and update - A. Hafiz and R. C. Anderson
TWS/88/28	The Maldivian live-bait fishery - A. Hafiz and R. C. Anderson
TWS/88/29	Yellowfin and bigeye stock status in the Indian Ocean - ORSTOM
TWS/88/30	Analysis of data collected during observer's trips on board purse seiners - ORSTOM
TWS/88/31	Preliminary results of yellowfin spawning in the Western Indian Ocean - B. Karpinski and J. P. Hallier
TWS/88/32	Some biological measurements of tuna caught by the Western Indian Ocean purse seine fishery - ORSTOM
TWS/88/33	Tuna Association : A research programme - J. P. Hallier
TWS/88/34	Tunas and their food : A view from a lower link of the food chain - C. Roger
TWS/88/35	Recent trends in the Atlantic tropical tuna fisheries. The recovery of yellowfin stock - A. Fonteneau
TWS/88/36	Sportive fishing of marlins in Mauritius 1976 to 1978 - B. Stequert and P. Cayre
TWS/88/37	Review of tuna fishing in the Indian Ocean and the main results of Soviet investigations of tunas - V. F. Demidov and E. V. Romanov

TWS/88/38	Age and growth rates of the yellowfin tuna (Thunnus albacares) (Bonnaterre 1788) (Pisces, Scombridae) in the north western part of the Indian Ocean determined by counting of the rings of the vertebrae - E. V. Romanov and L. P. Korotkova
TWS/88/39	Not issued
TWS/88/40	Not issued
TWS/88/41	Not issued
TWS/88/42	Stock assessment of Indian Ocean albacore 1988 - T. Shiohama
TWS/88/43	Production model analysis and preliminary application of virtual population analysis of the Indian bigeye tuna - N. Miyabe
TWS/88/44	Comparison of fishing performance by longline and purse seine fisheries on yellowfin tuna in the Indian Ocean - Z. Suzuki
TWS/88/45	Results on the experimental fishing of purse seine with FADs in the Indian Ocean by R. V. 'Nippon Maru' - Y. Watanabe, T. Tsunekawa, M. Takahashi, M. Tabuchi and T. Sugawara
TWS/88/46	Study of interaction between longline and purse seine fisheries on yellowfin tuna, Thunnus albacares (Bonnaterre) - Z. Suzuki
TWS/88/47	Warning issued on global catch limits - A. Caton and J. Majkowski
TWS/88/48	Fishermen recapture 40 percent of tagged southern bluefin tuna - G. J. Eckert and J. Majkowski
TWS/88/49	Tuna longline in Seychelles 1984 - 1988 - J. Nageon De Lestang (SFA)
TWS/88/50	The tuna purse seine fishery of the Western Indian Ocean (1983 - 1987) - G. Lablache and J. Nageon De Lestang (SFA)
TWS/88/51	Seychelles tuna bulletin - 1st quarter 1988 (SFA)
TWS/88/52	Small craft tuna fishing trials in southern Tanzania - J. Scullion
TWS/88/53	Seychelles Research Observer Program - G. Lablache and B. Karpinski
TWS/88/54	National report - Japan
TWS/88/55	SCRS reports - Southern bluefin tuna
TWS/88/56	Japanese systems for collecting and processing tuna catch and fishing effort of longline fishery - T. Yonemori
TWS/88/57	National report - Spain

TWS/88/58	Purse seine tuna fishing and environmental conditions in the Somali basin (0^{o}-12^{o}N, 43^{o}-60^{o}E) at the cessation of the south-west monsoon - F. Marsac
TWS/88/59	JAMARC's activities on tagging of tunas in the Indian Ocean - M. Takahashi, T. Urakawa, F. Kasahara and A. Kanda
TWS/88/60	Distribution of yellowfin and bigeye tunas by the Korean longline fishery in the Indian Ocean - Won Seok Yang and Yeong Chull-Park
TWS/88/61	Age characters of albacore Thunnus alalunga, in the Indian Ocean - Ying-Chou Lee and Chin-Lau Kuo
TWS/88/62	Estimation of effective fishing effort and overall fishing intensity and stock assessment of Indian Ocean albacore (Thunnus alalunga) 1962 to 1986 - Ying-Chou Lee and Hsi-Ching Liu
TWS/88/63	The data compilation system for catch statistics of Taiwanese distant water tuna fisheries in Indian Ocean - Shean-Ya Yeh and Hsi-Ching Liu
TWS/88/64	Taiwanese tuna fisheries in Indian Ocean and undergoing research on the resources - Jen-Chyaan Lee, Shean-Ya Yeh and Chin Lau Kuo
TWS/88/65	Captures de grands pelagiques autour des dispositifs de concentration de poissons a l'ile Maurice - J. Roullot, A. Venkatasami and S. Soondron
TWS/88/66	The tuna fisheries of Mauritius (1988) - M. Munbodh and R. Ramcharrun
TWS/88/67	On Soviet fishery and studies of tunas in the Atlantic Ocean - V. V. Ovchinnikov
TWS/88/68	Main results of realization of the Soviet program of tuna tagging in the Atlantic Ocean - V. V. Ovchinnikov, V. Z. Goikov, Yu.P. Fedoseev and V. G. Shcheglov
TWS/88/69	Country report - Korea
TWS/88/70	Report of the activities of the Indo-Pacific Tuna Development and Management Programme (IPTP) - IOFC:TM/88/4

Appendix 5

COUNTRY REPORTS

China (Taiwan)

France

India*

Indonesia

Iran

Japan

Republic of Korea

Republic of Maldives

Mauritius

Oman

Seychelles

Spain

Sri Lanka

Tanzania

Thailand

USSR

*Country report prepared by the Secretariat

CHINA (Taiwan)

1. Overview of the Fisheries

Two types of gear, i.e., longline and gillnet, were used by Taiwanese fishermen in Indian Ocean. The 1986 production totalled 30,971 mt (about 30% increase over 1985) by 153 longliners (about 20% increase over 1985); and 13,777 mt (about 195% increase over 1985) by 74 gillnetters (about 28% increase over 1985).

The level of CPUE in terms of catch (in mt) per vessel per year increased from 187.0 mt per vessel in 1985 to 202.4 mt per vessel in 1986 for Taiwanese longliners; and also increased from 80.8 mt per vessel in 1985 to 186.2 mt per vessel in 1986 for gillnetters.

Albacore, yellowfin, bigeye, bluefin, swordfish and skipjack were the most important species caught by Taiwanese longliners. In the last two years, bigeye became the dominant species in the catch of Taiwanese longline fishery. Yellowfin followed and albacore ranked third. Albacore, bigeye, skipjack and sharks were the most important species caught in Taiwanese gillnetters. Albacore was still the dominant species which occupied about 95% of the total catch.

2. Statistics

The Tuna Resources Research Centre (TRRC) at Institute of Oceanography of the National Taiwan University has been carrying out the task on compilation of catch and effort data of Taiwanese tuna fisheries. Since 1986, catch statistics of Indian tunas caught by Taiwanese fleet were regularly submitted to IPTP for exchange of information. Length composition data in accompany with logbook were also collected. Every captain is requested to measure the first 30 individuals caught in a set of fishing operation. These length measurements were mailed through Taiwan Fisheries Bureau to the TRRC for compiling of length composition. Catch statistics and size frequency data were also mailed to IPTP for exchange of information.

3. Research

Honma's method was adopted to estimate the effective fishing effort and fishing intensity for a better assessment of the stock condition of the Indian albacore resource. Surplus production models were used to revise the assessment of the Indian albacore resource by using catch statistics from 1967 to 1986.

A research program funded by the Council of Agriculture of the Executive Yuan was carried out since last year in order to study the age and growth characteristics of Indian albacore resource. Albacore samples have been taken at Kaohsiung Fish Market drawn from the landings of gillnetters returned from Indian Ocean. Results of the research should provide more detailed information for further analysis of the Indian albacore resource.

FRANCE

After the first French purse seine trials conducted from 1980 to 1983 in the Western Indian Ocean brought successful results, an important purse seine fishery was developed in this region. In 1987, purse seine vessels under French flags still represented 50% of the total number of purse seiners operating in the Indian Ocean (20 vessels against a total of 40 purse seiners).

The total catch of French purse seiners in the Western Indian Ocean is still increasing despite the fact that the fishing effort has decreased since 1985. In 1987, the total catch reached 91,000 t, 9% higher than the 1985 total catch, with a nominal fishing effort of 4,900 fishing days, 25% lower than the 1985 effort. This, of course, represents an important increase of the CPUE which from 12.7 t/fishing day in 1985 reached 18,5 t in 1987.

Species composition of this catch has remained more or less stable since 1985 with 43 percent yellowfin, 52 percent skipjack and 5 percent bigeye.

Fishing area covered by the purse seiners after an important increase from 1983 to 1985, has since slightly decreased and stabilised.

Collaboration between French and Seychelles scientists within the Seychelles Fishing Authority has been recently strengthened with the signature of a new convention.

France has also increased its scientific involvement in Indian Ocean tuna research by posting a second French scientist at the Fisheries Research Centre of Albion, Mauritius and another scientist in La Reunion. This is in relation with the EEC funded Regional Tuna Programme for which an agreement was signed last May between the Tuna Association and ORSTOM.

INDIA

The 1986 tuna production in India was 45,606 mt, the highest recorded to date. A preliminary estimate for 1987 shows a decline of 3,900 mt. Approximately 72% and 12% of the total is produced on the west and east coasts, respectively. There are an estimated 135,000 non-mechanized and 20,000 mechanized vessels. The non-mechanized vessels accounted for 52% and the mechanized vessels for 48% of the tuna landings for the mainland. Tuna are captured on the mainland primarily in the drift gillnet, purse-seine and handline fisheries targetting on an variety of species. Kawakawa (*Euthynnus affinis*) and *Auxis* species are the most important species, accounting for 59% and 28% respectively, of the mainland catch.

Fourteen percent of the total tuna production comes from the Lakshadweep Islands, where pole-and-line is the principal fishing gear. There are about 120 mechanized pole-and-line vessels. Skipjack (*Katsuwonus pelamis*) is the dominant species followed by yellowfin tuna (*Thunnus albacares*) in the Lakshadweep Islands.

Two percent of the total tuna production is made in the Andaman and Nicobar Islands. Skipjack tuna is the dominant species.

INDONESIA

Tuna fishery plays an important role in Indonesian fisheries. It ranks second after shrimp as non oil and gas export commodity. The total marine fish catch in 1987 was 2,029,000 tons, of which 291,865 tons or 14 percent were tuna and tuna-like species. And 57,639 tons or 20 percent of tuna and tuna-like species were from the western part of the Indonesian waters bordering the east Indian Ocean. The catches have increased approximately 18 percent in volume annually during the period of 1979 to 1986.

Export of fisheries commodities amounted 135,100 tons in volume or US$ 480 million in value, of which 29,000 tons or US$ 26 million were tuna and tuna-like species. The export of tuna have increased 22 percent in volume and 18 percent in value annually during the period of 1979 to 1986.

There are more than 19 species of tuna, tuna-like species, skipjack, seerfish and billfish caught in the western part of the Indonesian waters (Indian Ocean side) by various kinds of fishing gears (purse seine, danish seine, gillnet, troll line, handline, pole and line and long line). Those species are grouped into four in the national fisheries statistics, i.e., (1) tuna group, which includes yellowfin tuna, bigeye tuna and other big tuna; (2) Cakalang or skipjack group, only for skipjack; (3) tongkol group which includes tuna-like species, longtail tuna, dogtoothed tuna, double-lined tuna and bonito; and (4) mackerel group, which includes spanish mackerel.

In the Indian Ocean side, there are eight landing centers for tuna fisheries, i.e., Banda Aceh (purse seine), Padang and Pariaman (troll line); Jakarta (longline), Pelabuhan Ratu (Danish seine and gillnet), Prigi (mini purse seine and gillnet), Benoa (troll line and longline) and Maumere (pole-and-line). Those fisheries are small scale except tuna longline is industrial fisheries run by state and private enterprises.

Since 1985, a new business for fishery to produce fresh tuna has been flourishing in Indonesia. Those fresh tuna are mostly caught in the western part of Indonesia in the Indian Ocean, which are shipped to Japan and Hawaii by air. Species exploited are yellowfin tuna, bigeye tuna and southern bluefin tuna. Albacore is also caught by longline, but it is not used for the fresh tuna market.

Fishing grounds are west coast of Sumatara, south coast of Java and south of Lesser Sunda islands, with its fishing bases Bungus (west Sumatara), Jakarta, Pelabuhan Ratu and Benoa (Bali). The gears used are long line (deep long line, conventional/regular long line and mini long line) and handline. Milkfish is the bait used for tuna long line. The volume of export of fresh tuna for the years of 1985, 1986 and 1987 were 70, 650 and 1236 tons, respectively.

Research activities for tunas consist of two major activites: (1) research activities on board of fishing vessels and (2) tuna sampling activities at landing places. Research on board of fishing vessels are mostly conducted collaboratively with commercial fishing vessels. For tuna sampling activities, five landing sites have been chosen, i.e., Bungus-Padang, Pelabuhan Ratu, Bitung, Ambon and Sorong.

JAPAN

Japanese longline fleet has operated since 1952 in the Indian Ocean. In its early years, the main target species were yellowfin, albacore and bigeye in the tropical waters. The total catch of all species combined reached the peak of 124 thousand tons in 1962. After then, the catch has decreased remarkably because most of the fleet has shifted to the target species to southern bluefin tuna in the higher latitudes in the southern hemisphere. The lowest catch of about 19 thousand tons were recorded in 1979. Recently the catch has tended to slightly increase and the 1986 catch from the Indian Ocean was 38,700 t : 14,800 t of bigeye, 10,300 t of yellowfin, 2,200 t of albacore, 7,300 t of southern bluefin tuna and 4,100 t of billfishes. Bigeye and yellowfin have played an important role in the increased catch in recent years. About 300 Japanese longline boats operated in 1986, 85% of which fished in the southern bluefin fishing ground in the higher latitudes. Catch, effort and size data of the longline fishery have continuously been collected by the Fisheries Agency of Japan, and processed and compiled by the Far Seas Fisheries Research Laboratory (FSFRL).

One purse seiner (Nippon-Maru of the Japan Marine Fishery Resource Research Center) operated on the experimental basis in the western and central Indian Ocean in 1986-87. She tested the fish aggregating efficiency of several types of 'payao', besides collecting catch and biological data by purse seining. She also tagged 799 of yellowfin, 75 of bigeye and 401 of skipjack. Of them 15 yellowfin, 11 bigeye and 3 skipjack were recovered up to now, indicating very random movements.

Scientists of Australia, Japan and New Zealand have been analysing the stock state of southern bluefin tuna under close cooperation. The most serious concern derived was that the parental biomass would continue to decrease remarkably till 1990 and a recruitment failure might occur. The tripartite scientific meeting recommended to their administrator's meeting to decrease substantially the present level of the catches for both the small fish and large fish. Thus, catch quotas for 1987-88 fishing season were set within 11,500 t for Australia, 19,500 t for Japan and 1,000 t for New Zealand.

Japan presented six working documents on stock assessment and research activities for this meeting:

1. Japanese systems for collecting and processing tuna catch and fishing effort of longline fishery ... T. Yonemori

2. Results on the experimental purse seine fishing with FADs in the Indian Ocean by R/V 'Nippon Maru' ... Y. Watanabe, T. Tsunekawa, M. Takahashi, M. Tabuchi and T. Sugawara.

3. Stock assessment of Indian Ocean albacore, 1988 ... T. Shiohama

4. Production model analysis and preliminary application of virtual population analysis on the Indian bigeye tuna ... N. Miyabe

5. Comparison of fishing performance by longline and purse seine fisheries on yellowfin tuna in the Indian Ocean ... Z. Suzuki

6. Study of interaction between longline and purse seine fisheries on yellowfin tuna, *Thunnus albacares* (Bonnaterre) ... Z. Suzuki

KOREA

In the Indian Ocean, Korean tuna longline catches peaked in 1978 at 70,000 mt by 151 vessels, then decreased to about 28,200 mt by 62 vessels in 1985. Korean catches in 1986 amounted to 30,600 mt by 66 vessels, more than 86 percent of which was comprised of yellowfin and bigeye. Albacore tuna and billfishes were caught incidentally.

Catch and effort statistics, and size frequency data for the Indian tuna and tuna-like species have been collected continuously from the Korean fishing vessels. The NFRDA has been in charge of collecting and processing the tuna fishery data. Catch and effort statistics by time-area strata for 1983 to 1985 were submitted to IPTP.

Distribution of yellowfin and bigeye tunas in the Indian Ocean were studied by catch per unit effort based on the data from the Korean longline fishery.

MALDIVES

The Republic of Maldives has a major artisanal tuna fishery. Tuna catches exceeded 50,000 mt in each year 1985 - 87. The most important gear is livebait pole-and-line, followed by trolling. Virtually all the pole-and-line catches are now landed by mechanized vessels, while most of the trolling vessels are still sail powered. Minor tuna catches are also made by handlining. Skipjack accounts for some 80% of the tuna catch. Yellowfin is the next most important species; nearly all the catch is of surface swimming juveniles. The other species landed in substantial quantities are kawakawa and frigate tuna. Small catches of dogtooth tuna, wahoo and sailfish are also made. The Republic of Maldives has a total enumeration system for the collection of catch and effort statistics, covering all of the 202 inhabited islands. Length frequency sampling is carried out regularly at Male fish market. These data are reported annually to IPTP. Some length frequency data from landing sites other than Male' are collected by field officers, but their sampling is not ideal. The Govenment's State Trading Organization is carrying out major upgrading of canning, freezing and collection facilities. A large proportion of the tuna caught is consumed locally, but most is exported, in canned, frozen, or dried form. The Ministry of Fisheries is carrying out a number of tuna research and development projects including the deployment of FAD's, investigations on baitfish biology, and exploratory offshore fishing.

MAURITIUS

The artisanal tuna fishery is going through a marked change with increasing numbers of fishermen going to fish around fish-aggregating devices placed under the advanced artisanal pelagic fishery project. Fishing for billfish continues to be an attraction especially for the tourism industry.

Mauritian participation in the purse-seine fishery in the South-west Indian Ocean has increased in 1987 with the coming into operation of a second purse-seiner of 1039 gt. Total catch in 1987 was 7244 t composed of about 70% of skipjack. Further development is expected during the coming year when three more purse-seiners of 510-725 gt will join the fishery. There is also renewed interest in the longline fishery. A vessel of 298 gt commenced fishing in 1986. Tuna unloaded for transhipment in Mauritius by Taiwanese and

Japanese longliners averaged 790 t per year during the last two years. Species composition is dominated by albacore which comprises more than 80% of the catch.

Mauritius is participating in research on tuna through the EEC-funded Regional Tuna Project. It will be responsible for carrying out biological studies, implementation of a tagging programme, and will be the centre for collection and processing tuna statistics for the South-west Indian Ocean. Two scientists from ORSTOM are assisting Mauritius in these programmes.

OMAN

The Sultanate of Oman has approximately 1,750 km of coast line. Traditionally, Oman has always been a fishing and trading nation, but only over the last 18 years has there been tremendous progress in the development of its fishery industry. This progress has been achieved through various programmes such as:

1. Construction of ice-plants, cold stores and landing facilities;
2. Initiation of extension services;
3. Collection, processing and analysis of catch statistics;
4. Loan and grant schemes for boats and motors;
5. Engine repair facilities;
6. Establishment of a national fishing company (Oman National Fisheries Co.);
7. Support in establishing of several fish trading companies along the coast;
8. Construction of the Marine Science Center to facilitate studies on biology and assessment of important commercial species.

Status of tuna stocks

Tuna stocks in Omani waters are not well defined and therefore their migratory nature makes stock assessment within a single country, such as Oman, unrealistic. This is why we have cooperative arrangement for exchange of data through IPTP. Nevertheless, an examination of the available information in Oman will help us to understand better the overall tuna situation.

Yellowfin

Although Oman tuna catches are dominated by longtail tuna (Thunnus tonggol) during most of the year, substantial catches of yellowfin tuna (Thunnus albacares) are made from November through February from Sur northward to the Muscat area. During this period in 1987-88 up to 100 per day were landed. Fish sold to the Oman National Fisheries Company averaged 30 kg and most were between 25 to 36 kg. Some fish weighed up to 65 kg.

During early 1988 the Oman National Fisheries Company conducted a brief (five days) aerial survey to assess the feasibility of purse seining for yellowfin. The conclusion was that insufficient schools were sighted to make purse seining a viable proposition. However, the survey personnel felt that pole-and-line boats or longlining might be successful. Limited trials with a small longline by Oman's fishery extension team yielded hooking rates of 30 to 50 percent. This indicates that there is a substantial concentration of yellowfin tuna in this area during the winter.

Although Oman has yellowfin in this area every year, there may be a substantial fluctuation in yellowfin abundance from year to year. As a fishery develops for these fish we will learn more about possible year to year fluctuations.

Oman expects that its yellowfin tuna fishery will continue to grow. Information from this fishery will be valuable in aiding stock estimates for the Indian Ocean area.

Longtail

Longtail tuna (Thunnus tonggol) accounts for the largest share of tuna landed in Oman and are present in catches throughout the year. Small longtail (with a mode of 36 cm) first appear in catches in October. By May this group has reached a mode size of 46 cm. This group then virtually disappears from the catches. Another size group, which comprises most of the longtail catch, is made up of fish between 55 to 80 cm long. Longtail account for about 75 percent of the tuna catch.

Kawakawa

Kawakawa (Euthynnus affinis) are also caught throughout the year but larger fish tend to be more abundant during the summer months. This species accounts for about 10 percent of Oman's tuna catch.

Future catches of these two species in Oman will probably not exceed about 35,000 t. The 1987 landing of all tuna species was recorded as 26,000 t.

SEYCHELLES

From modest beginnings in the early eighty's the industrial tuna fishery in the S.W. Indian Ocean has developed into a major fishery. In 1987 the 40 purse seiners based in the Seychelles landed a total of 167,000 t of tuna (comprising of 61% skipjack and 38% yellowfin).

The fishery is exclusively foreign dominated with vessels operating under licence agreements. The fleet is now mostly of French (20) and Spanish nationality (14) with two Mauritians, four USSR purse seiners, one Japanese and one Panamanian vessel.

With the termination of the EEC Agreement in 1986 and the entry of Spain in the EEC, a new Fishing Agreement came into force in January 1987. Also in 1987, two other fishing agreements were signed, one with USSR fishing company and the other with JAMARC (Japan Marine Fishery Resource Research Centre). Licence fees for purse seiners are mostly calculated on the basis of the catch caught inside the EEZ as in the case of the EEC Agreement which also includes assistance through research grants.

In addition since 1979, the Seychelles also grants licences renewable on a monthly basis, to longliners from S. Korea and Japan longliners since an agreement was signed with the Japan Tuna Association. In the recent three years there has been an increase in longlining activity in Seychelles (vessels, transhipping, calling and licenced) despite the increase in the surface tuna fishery.

The catch rates from the small artisanal tuna fishery operating near shore, using mostly handline and troll lines has however declined drastically in the last two years, to less than 100 tonnes (mostly Euthynnus affinis and Thunnus albacares).

Research

In view of the crucial role of the tuna fishery to Seychelles an important effort is being undertaken by the Seychelles Fishing Authority to design and implement an adequate research program.

A computerized data processing system has been set up for the purse seine and longline fishery. This data which provides important information on the fishery, total catch, fishing effort and catch rates is published on a quarterly basis.

An observer programme was initiated in November 1985 to generate data for constructing reliable indices of abundance and biological studies for stock assessment purposes.

A port and cannery sampling programme was set up in cooperation with ORSTOM, again to gather more biological and size-frequency data on the purse seine fishery.

In addition, Seychelles has participated in two research surveys in collaboration with foreign vessels. The first campaign with the ORSTOM vessel 'R/V Alis' investigated environmental phenomena in areas of upwelling off the Somali Coast and the second survey carried out with JAMARC vessel 'Nippon Maru' investigated the biology and availability of tuna resources in and around Seychelles waters.

Hence the development of the tuna fishery in the Western Indian Ocean is being closely monitored by the Seychelles both in terms of catch statistics and biological analysis. These studies are being carried out by the Seychelles Fishing Authority (SFA) with the assistance of foreign and international organizations such as ORSTOM and the Spanish Institute of Oceanography with the close collaboration of the various fishing companies and fishing operators based in Seychelles.

SPAIN

The Spanish freezer fleet fishing for tuna in the Indian Ocean reduced its number in 1986 relative to 1985.

During 1987 this fleet increased to 15 vessels within the framework of the fishing agreements concluded between the EEC, on the one hand, and Seychelles, Madagascar and Mozambique, respectively on the other.

Number of Spanish vessels fishing in the Indian Ocean

Year	1984	1985	1986	1987
No. of vessels	(*)	17(**)	12(')	15(")

* Initially 4 (in March); 16 in December
** Only 6 vessels fished in the area the whole year. The rest of them

fished in the Atlantic Ocean for part of the year.
' One vessel fished in the area for two months only
" Five vessels fished in the area of the year only

Total catches per species (t)

	1984	1985	1986	1987
Yellowfin	13,796	15,411	17,532	20,361
Skipjack	8,079	22,854	24,877	35,399
Bigeye	809	161	550	1,925
Albacore	217	59	227	13
Totals	22,901	38,485	43,186	57,698
CPUE t/day	16,00	13,68	14,06	13,12

Although the average CPUE for the last 4 years (1984-1987) was 14,2 t/day fishing, the highest CPUE was obtained during the monsoon: 24 t/day in September 1986 and 16,6 t/day in August 1987 to the north of the Equator and Seychelles.

The new fishing grounds in Mozambique channel provided, as well, good CPUE in April 1978 (16,8 t/day). See Figure 1.

The establishment of a permanent Spanish fisheries office in Seychelles, under the responsibility of a biologist aided by a Seychelles sampler, allows for both control and follow-up of this fishery. The data so collected are subsequently processed in Spain by the experts in the Instituto Espanol de Oceanografia.

SRI LANKA

In Sri Lanka tunas are caught by a multi-species multigear fishery. The relative importance of the gears have changed considerably during the past decades as a result of development activities of the Sri Lankan fishing industry.

The present sampling programme covers 12 major landing sites in the Northwest, West, South-West and South coasts. This programme is carried out jointly with the Indo-Pacific Tuna Programme (IPTP).

Four main fishing gears are being used in Sri Lankan tuna fishery. They are the drift gillnet, longline, troll line and pole-and-line. Handline fishing for tunas has been increasing since 1986. The major portion of the fishing fleet is composed of the 9 meter class of boats. Some fishing is also carried out by the traditional crafts in the southern coast. Gillnets are the dominant gear in all areas and in the South, troll and pole-and-line fisheries are also relatively important. Since 1986 there has been an increase in use of combination gears specially in the South-west, probably due to high catch rates obtained by these gear combinations.

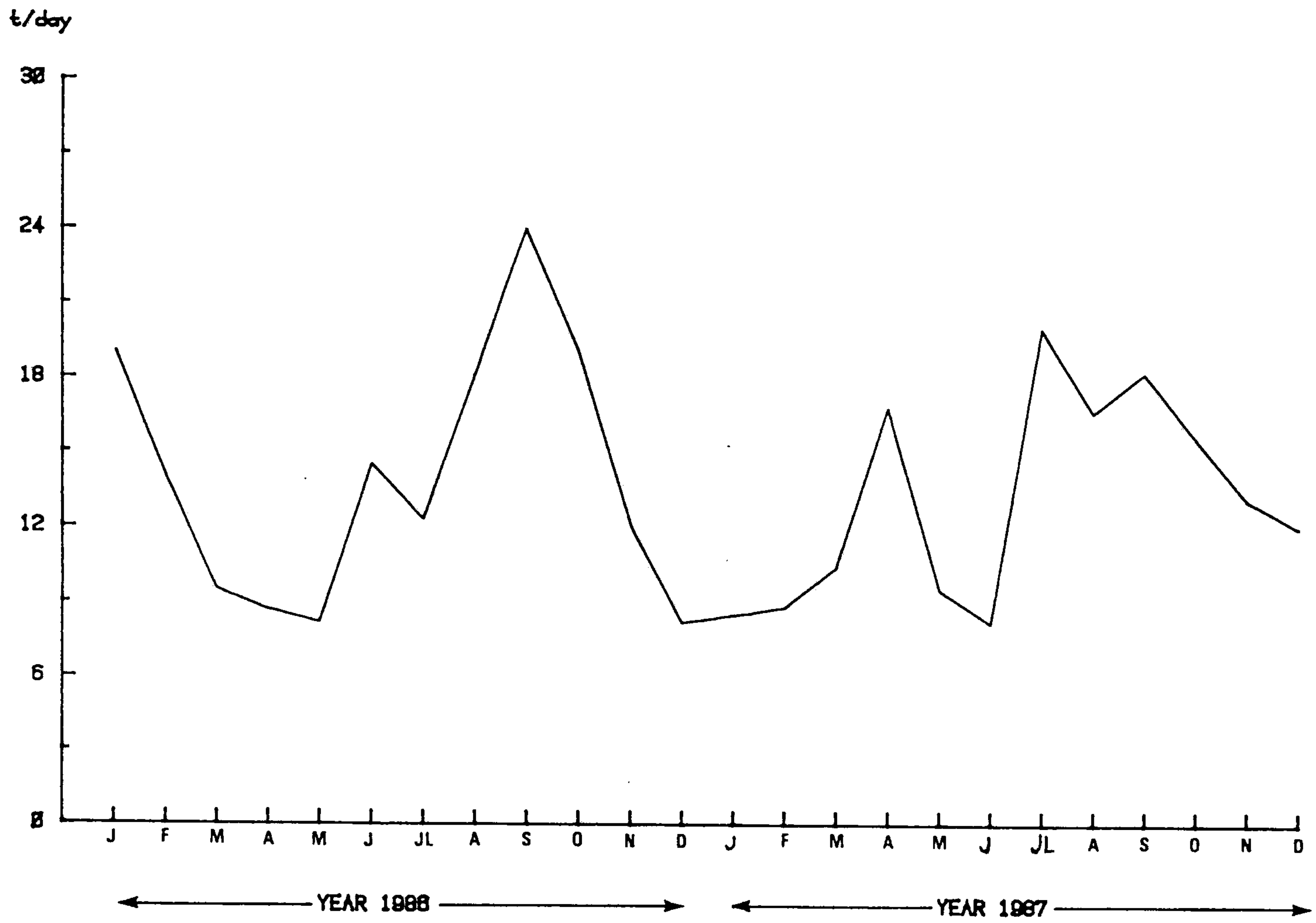


FIGURE 1. VARIATIONS OF CPUE FOR SPANISH TUNA VESSELS IN INDIAN OCEAN

There was a drop in catch rates of the gillnet fishery in 1987 but the gill/longline combination catch rates have remained more or less unchanged.

Tuna production in Sri Lanka has remained around 25,000 mt/annum during the past two years. Yellowfin and skipjack are the dominant species contributing about 65-70% of the total large pelagic fish production. The percentage contribution by sharks has increased while that of small tunas have decreased during the past two years.

The development programmes in Sri Lanka have been directed towards extending the coastal fisheries into the off shore fisheries. The duration of the fishing trips of the 9 metre class of boats continues to increase. A fleet of 11 metre class of boats have been introduced to carry out fishing in offshore areas.

TANZANIA

Tanzanian coastline extends for 800 km. Although the coastline is very extensive, yield from marine waters stands at 20% of the total catches.

Tuna and seerfish production trends have been showing a decline from 1978 up to 1986. In 1977 tuna catches reached a maximum of 2728.7 t as opposed to only 640 t in 1986. The same trend has been observed in the seerfish production trend, in 1977 a maximum of 2240 t was recorded compared to 700 t in 1986. While the tunas and seerfishes have been showing a decline in production trends, there has been an increase in the billfishes production for the same period. In 1977 the billfishes production stood at 283 t while in 1986 it reached 477 t. The reasons for the above fluctuations are not known though the shortages of gillnets could contribute to the decline.

Currently there is only one research activity being carried out in the Southern Tanzania on live bait pole-and-line fishery. Trials are going on and results of which will be out in the near future.

THAILAND

The total annual small tuna production increased from 5,500 mt in 1972 to 93,772 mt in 1986. Most of the catches are caught by purse-seiner and supplied to the rapid growth of tuna canning industry. The Department of Fisheries Thailand has launched a project of tuna resources survey by R/V 'Chulabhorn' based on the experimental tuna purse-seining and longlining in the ocean area with a view to develop the oceanic fisheries and increase tuna production due to the high demand of tuna for canning industry. In 1987, oceanic purse-seine survey was first carried out in the Andaman sea and successfully operated along the continental slope area of over 400 m depth.

In 1988, R/V 'Chulabhorn' carried out purse-seine survey with the experimental employment of different anchored Fish Aggregating Devices (FAD) along the area of 270-650 m depth. The result of survey showed a possible commercial trend in the southern part which the catch mainly composed of yellowfin tuna and skipjack.

Besides resource survey, Thailand also has the active intention to make a joint survey with other coastal states for the purpose of studies on fisheries science and oceanography.

USSR

The Soviet Union has begun longline tuna fishing in the Indian Ocean in 1964 and since that time 1 or 2 factory ships fish tunas in this area. The Soviet longline catch of tunas didn't exceed 5000 t per year.

Our country began to fish tunas using purse nets in the Indian Ocean high seas in 1983. In 1984-85 such fishing was conducted in the North-west part of the Indian Ocean. This area proved to be quite promising for the fishing of little tunas. Regular fishing of these tunas has begun in the North-west part of the Indian Ocean and is still conducted there. The total purse net catches of tunas in the Indian Ocean in the last 3 years are the following:

1985	-	1,200 t
1986	-	5,000 t
1987	-	8,000 t

Soviet Union has been conducting investigations of tunas in the Indian Ocean since early 60's. Investigations have been conducted practically over the whole area of the ocean, but from the end of 70's main efforts were concentrated in the North-western part, where the most favourable conditions for tuna fishing outside of 200-mile EZ existed.

Investigations were conducted in the following main directions:

1. Study of the dynamics of tuna number;
2. Age and growth rate studies;
3. Study of feeding of yellowfin and bigeye tunas;
4. Reproduction biology and early ontogenesis studies;
5. Study of the parasitic fauna.

Appendix 6

EXECUTIVE SUMMARY REPORT
EXPERT CONSULTATION ON STOCK ASSESSMENT OF TUNA IN THE INDIAN OCEAN

The third meeting of the Expert Consultation on Stock Assessment of Tuna in the Indian Ocean was held at the Mahatma Ghandi Institute, Mauritius from 22 - 27 June 1988. Participants included 45 scientists from coastal countries and from outside the region. A total of 66 papers were reviewed. Topics covered during the meeting included (1) review of the fisheries, (2) status of stocks, (3) interaction, (4) statistics (5) review of research needs and (6) recommendations.

The following provides a summary of the meeting:

CATCH

Total catch of tuna and tuna-like species from the Indian Ocean for 1976 was 234.2 kmt; for 1986 the catch increased 2.4 fold to 568.8 kmt. A general breakdown by species and group of species for 1976 and 1986 are provided as follows:

	1976	1986	
Small tunas, billfish and seerfish	109.0	216.3	kmt
Bigeye	23.6	43.0	
Albacore	6.1	25.3	
Southern bluefin	26.8	21.9	
Yellowfin	30.1	114.2	
Skipjack	38.6	148.1	
TOTAL	234.2	568.8	

THE FISHERIES

The purse seine fishery in the Indian Ocean continues to be active; forty two vessels operated in the western Indian Ocean in 1987. The total tuna catch for 1987 was 160.0 kmt (62.0 kmt of yellowfin and 98.0 kmt of skipjack). Thailand reported conducting experimental purse seine trials in the Andaman Sea.

Japanese, Korean and Taiwanese longliners continued to be active throughout the Indian Ocean. Recent emphasis by the Japanese and Korean longline vessels has been to focus on bigeye tuna using deep longline gear; the Taiwanese fleet continues to focus on albacore tuna. Additionally, the Japanese longline fleet also focussed for southern bluefin from the Indian Ocean. Indonesia has increased its longline fishing effort in the Indian Ocean for 'sashimi' quality fish.

Note: This report was prepared by Mr. R. Shomura, Chairman of the Expert Consultation and presented at the Tenth Session of the IOFC Committee for the Management of Indian Ocean Tuna, Mauritius, 28 June - 1 July 1988.

A new development in the Indian Ocean has been the start of a gillnet fishery for albacore in the high southern latitudes. The 1986 Taiwanese gillnet catch of albacore was 15.0 kmt; an increase of 300% over the previous year.

The pole-and-line tuna fishery of Maldives continues to be active; the 1987 skipjack tuna catch was reported to be 42.1 kmt. Other small scale tuna fisheries were also active; especially in the coastal waters of the northern Arabian Sea and its adjacent gulfs.

STATUS OF STOCKS

Although small tunas are important to the coastal countries of the Indian Ocean, none of the principal resources of small tunas has been assessed properly. Traditional assessment methods cannot be applied due to the lack of adequate fishery statistics (catch, effort and size of fish) and information on life history parameters (age and growth, fecundity). Additionally, the multi-gear, multi-species problems make assessment of this group extemely difficult. There is no information on the stock structure of any small tuna species.

The billfish catch in the Indian Ocean is predominantly taken by the longline gear. To date adequate assessments of the several species of billfishes have not been undertaken. Life statistics and parameters are lacking; no information is available also on stock structure of any billfish species.

Similar to the small tunas the basic information needed for stock assessment of the several species of seerfish are lacking. No information is available on the stock structure of any of the seerfish species.

The bulk of the bigeye tuna is taken with longline gear. Production model estimates of the bigeye stock range from 35.0 to 42.0 kmt. The estimates should be viewed with caution since several shortcomings in the data were noted. Further, the use of age and growth data from other oceans applied to assessment of Indian Ocean bigeye may introduce errors. A critical element in future assessment studies on bigeye will be the integration of bigeye catch from the purse seine fishery; these are principally small size fish. A single population of bigeye is hypothesized for the Indian Ocean based on geographical distribution of the species.

Maximum sustainable yields of Indian Ocean albacore based on the production model have been estimated to range from 16.0 to 20.0 kmt. Reference was made to the estimate being based on longline data and that the introduction of the surface gillnet fishery will probably have a major impact on a revised production model. Based on a catch/effort study there is an indication of movement of albacore between the Atlantic and Indian Ocean.

The status of stocks of tunas in the Indian Ocean is best known for the southern bluefin tuna. Based on biological information and tagging results there appears to be single stock of southern bluefin tuna. Assessment studies to date suggest the parental biomass is extremely low and cause for serious concern. Catch quotas have been established by principal countries harvesting this resource. Reference was made to the need to monitor other fisheries for catch of southern bluefin.

There is currently no good estimate of the yellowfin resource base in the Indian Ocean. Catch and catch-per-unit effort results suggests the stock is producing at a high level; however, it may be too soon to observe the impact of the purse seine fishery on the population. There is no information available on the stock structure of Indian Ocean yellowfin tuna.

The skipjack tuna in the Indian Ocean faces a similar situation as the yellowfin tuna; the total catch has increased markedly due to the development of purse seine fishing in the region. There are no firm stock assessment estimates of the skipjack resource in the Indian Ocean. Trends in catch-per-unit effort suggest the skipjack tuna resource is healthy; however, similar to the yellowfin, it may be too soon for the impact of the purse seine fishery to be reflected in catch.

Interaction

A preliminary study of purse seine-longline interaction in the Indian Ocean concluded that there did not appear to be interaction between the two fisheries. However, it was noted that similar studies in other oceans suggested that interaction between surface and subsurface fisheries did exist; possibly the introduction of purse seine fishing in the Indian Ocean is too recent to be reflected in the analysis. There is continued concern about the possible interaction of the large scale tuna fisheries on the small scale fisheries of coastal countries.

Recommendations

Research and statistics

1. Continue collection of fishery-generated data for information on status of stock and an understanding of the resource.

2. Continue using traditional assessment techniques, for example, production models and cohort analyses to assess the tuna resources of the Indian Ocean; obtain added necessary data, example, size frequency data from the several tuna fisheries.

3. Conduct tagging experiments involving coastal and high seas fisheries to gain information on assessment, stock structure, interaction and age and growth. While there is a need for this information for all species of tuna, high priority should be given to yellowfin and skipjack tuna.

4. Conduct biological studies which will provide information for assessment purposes, for example, age and growth, maturation, spawning and early life history.

5. Conduct environmental studies which will lead to better understanding of the changes in availability in time and space.

Others

1. Maintain an Organization such as IPTP to act as a central point for data collection, coordinate research and conduct various types of workshops.

2. Fill the vacant post of tuna specialist in FAO.

PUBLICATIONS OF THE INDO-PACIFIC TUNA DEVELOPMENT AND MANAGEMENT PROGRAMME

WORKING PAPERS

IPTP/82/WP/1 SCS/80/WP/90	**SKILLMAN. R.A.** Tuna fishery statistics for the Indian Ocean and the Indo-Pacific. June, 1982. 86p.
IPTP/82/WP/2 SCS/82/WP/111	**DE JESUS. A.S.** Tuna fishing gears of the Philippines. June, 1982. 47p.
IPTP/82/WP/3 SCS/82/WP/112	**WHITE. T.F. and YESAKI M.** The status of tuna fisheries in Indonesia and the Philippines. September, 1982. 62p.
IPTP/82/WP/4 SCS/82/WP/113	**YESAKI. M.** Illustrated key to small and/or immature species of tuna and bonitos of the Southeast Asian region. October, 1982. 16p.
IPTP/82/WP/5 SCS/82/WP/114	**WHITE. T. F.** The Philippine tuna fishery and aspects of the population dynamic of tunas in Philippines waters. December, 1982. 64p.
IPTP/83/WP/6 SCS/83/WP/6	**YESAKI. M.** The Pelagic Fisheries of the Philippines. March, 1983. 15p.
IPTP/82/WP/7 SCS/82/WP/119	**YESAKI. M.** Observations on the biology of yellowfin (*Thunnus albacares*) and skipjack (*Katsuwonus pelamis*) tunas in the Philippine waters. July, 1983. 66p.
IPTP/83/WP/8	**WHITE T.F. and MERTA G.S.** The Balinese Tuna Fishery. October, 1983. 15p.
IPTP/83/WP/9	**WHITE T.F. and UKTOLSEJA J.C.B.** The West Java Tuna Fishery. 1983. 25p.
IPTP/84/WP/10	**JOSEPH B.D.L.** Review of tuna fishery in Sri Lanka. July, 1984. 29p.
IPTP/84/WP/11	**SAKURAI T.** Major Findings from the Indo-Pacific historical tuna fisheries data summary. September, 1984. 11p.
IPTP/85/WP/12	**YONEMORI T., UKTOLSEJA J.C.B. and MERTA G.S.** Tuna tagging in Eastern Indonesian waters. February, 1985. 33p.
IPTP/85/WP/13	**HONMA M. and YONEMORI T.** Manual for storing tuna tagging data in computer readable form. February, 1985. 19p.
IPTP/86/WP/14	**ANDERSON, C.** Republic of maldives Tuna catch and effort data 1970-1983.
IPTP/86/WP/15	**LAWSON, T., LABLACHE, G., SIMOES, F. and ALI, FARAH A.** The Western Indian Ocean tuna fishery from 1980 to 1985: A summary of data collected by Coastal States. October, 1986. 30p.
IPTP/87/WP/16	**YESAKI M..** Synopsis of biological data on longtail tuna, *Thunnus Tonggol*. July, 1987. 56p.

WORKING PAPERS contd.

IPTP/88/WP/17 **MALDENIYA, R., JOSEPH, L.** Recruitment and migratory behaviour of yellowfin tuna (Thunnus albacares) from the western and southern coasts of Sri Lanka.

GENERAL REPORTS

IPTP/82/GEN/1 SCS/GEN/79/24 Report of the consultation meeting on management of tuna resources of the Indian and Pacific Oceans, Manila, Philippines, 26-29 June 1979. September, 1982. 155p.

IPTP/82/GEN/2 SCS/GEN/82/32 A selected bibliography of tuna fisheries in the South China Sea region. September, 1982. 24p

IPTP/82/GEN/3 SCS/GEN/82/42 Report of the consultation meeting of the joint Indonesian/Philippine tuna working group. Manila, Philippines. 21-23 October 1981. Manila, South China Sea Fisheries Development and Coordinating Programme. December, 1982. 64p.

IPTP/83/GEN/4 Report of the workshop on Philippine and Indonesian research activities Manila, Philippines. 3 - 8 February, 1983. February, 1983. 16p.

IPTP/84/GEN/5 Report on the expert consultation on establishing and maintaining a regional data base for tuna fisheries in the Pacific and Indian Oceans. March, 1984. 27p.

IPTP/84/GEN/6 Report on the ad hoc workshop on the stock assessment of tuna in the Indo-Pacific region. September, 1984.

IPTP/85/GEN/7 Report on the preparatory expert meeting on tuna longline data for stock assessment in the Indian Ocean. April, 1985. 12p.

IPTP/85/GEN/8 Report on the joint tuna research group meeting of Philippines and Indonesia. 21 - 23 October 1985. November, 1985. 85p.

IPTP/85/GEN/9 Report on the expert consultation on the stock assessment of tunas in the Indian Ocean. 28 November - 2 December 1985. December, 1985. 78p.

IPTP/85/GEN/10 Report on the meeting of tuna research groups in the Southeast Asian Region. Phuket, Thailand. 27 - 29 August 1986. August, 1986.

IPTP/86/GEN/11 Report on the Expert Consultation on the stock assessment of tunas in the Indian Ocean. 4 - 8 December 1986. December, 1986.

IPTP/87/GEN/12 Report of the second meeting of the tuna research groups in the Southeast Asian Region. Manila, Philippines. 25 - 28 August 1987. December, 1987. 154p.

IPTP/87/GEN/13 Report of workshop, on small tuna, seerfish and billfish in the Indian Ocean. 9 - 11 December 1987. February 1988. 123p.

DATA SUMMARIES

IPTP Data Summary No. 1	Indo-Pacific Tuna Fisheries Data Summary (Draft). September 1983. 184p.
IPTP Data Summary No. 2 (Revised Edition)	Indo-Pacific Historical Tuna Fisheries Data Summary. September 1984. 142p.
IPTP Data Summary No. 3	Indian Ocean Tuna Fisheries Data Summary. March 1985. 62p.
IPTP Data Summary No. 4	Western Pacific Ocean Tuna Fisheries Data Summary. May 1985. 73p.
IPTP Data Summary No. 5	Indian Ocean Tuna Fisheries Data Summary for 1984. April 1986. 67p.
IPTP Data Summary No. 6	Western Pacific Ocean Tuna Fisheries Data Summary. April 1986. 88p.
IPTP Data Summary No. 7	Indian Ocean Tuna Fisheries Data Summary for 1985. April 1987. 79p.
IPTP Data Summary No. 8	Indian Ocean and Southeast Asian Tuna Fisheries Data Summary for 1986 April 1988. 103p.

MANUALS

IPTP Manual No.1 SCS Manual No. 2	Manual for the collection of historical statistical data on tuna and tuna-like species in the Indo-Pacific region. January, 1983.
IPTP Manual No.2	Manual for collecting statistics and sampling on tuna and tuna-like species in the Indian Ocean and Southeast Asian Region. May, 1987. 157p.

DATA CATALOGUES

IPTP/85/CAT/1	IPTP Data Catalogue, November 1985. 29p.
IPTP/86/CAT/2	IPTP Data Catalogue, November 1986. 49p.
IPTP/87/CAT/3	IPTP Data Catalogue, May 1987. (attached to IPTP Data Record - Vol. 1).
IPTP/87/CAT/4	IPTP Data Catalogue, December 1987. 54p.
IPTP/88/CAT/5	IPTP Data Catalogue, May 1988.

DATA RECORD

VOL.1 IPTP Data Record, May 1987. 346p.

COLLECTIVE VOLUMES

VOL.1 Collective Volume of Working Documents presented at the Expert Consultation of Stock Assessment of Tunas in the Indian Ocean held in Colombo, Sri Lanka, 28 November - 2 December 1985. 364p.

VOL.2 Collective Volume of Working Documents presented at the Expert Consultation on Stock Assessment of Tunas in the Indian Ocean held in Colombo, Sri Lanka, 4-8 December 1986. May 1987. 374p.

ATLASES

1. Atlas of Industrial Tuna Longline and Purse-seine Fisheries in the Indian Ocean. April 1988. 59p.

2. Atlas of the Tuna Fisheries in the Indian Ocean and Southeast Asian Regions. May 1988. 62p.