IPTP/94/GEN/22

Report of the 5th Expert Consultation on Indian Ocean Tunas, Mahé, Seychelles, 4 - 8 October, 1993

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Bibliographic entry:

Anon, 1994, Report of the Expert Consultation on Indian Ocean Tunas, 5th. Session, Mahé, Seychelles, 4 - 8 October, 1993. 32 p.

INDO-PACIFIC TUNA DEVELOPMENT AND MANAGEMENT PROGRAMME
INT/91/025 - GCP/RAS/099/JPN
Colombo, 1994

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The 5th Expert Consultation on Indian Ocean Tunas was held at the Reef Golf Club Hotel in Mahé, Seychelles, 4 - 8 October, 1993. It was attended by 38 scientists from national and regional institutions of 17 countries (Appendix I). During the course of the deliberations, over 55 national reports and scientific papers were presented (Appendix II).

Opening of the Meeting

The meeting was opened by Mr. Jacquelin Dugasse, Minister of Agriculture and Marine Resources of the Seychelles, in the presence of guests from the Diplomatic Corps and of the Seychelles Government. In his speech (Appendix III), he emphasised the rapid development of tuna fisheries in the region and the co-operation at the national, regional and inter-regional levels which has permitted monitoring of these developments and has given some understanding of the issues involved. In particular, he indicated the strong support of the Seychelles Government for the creation of the Indian Ocean Tuna Commission.

Mr. David Ardill, Programme Co-ordinator of IPTP, thanked the Seychelles on behalf of the Director-General of FAO for having hosted this meeting and gave an over-view of the developments in the tuna fisheries in the Indian Ocean and of the institutional developments which are occurring. He emphasised that the participants to this meeting were expected to address the scientific issues and were here in a scientific capacity rather than as representatives of their governments.

Election of Officers, Adoption of the Agenda and Arrangements for the Meeting

The Provisional Agenda prepared by the Secretariat was adopted without further discussion (Appendix IV). The Chairman, Vice-Chairman, Discussion Leaders and Rapporteurs were appointed as follows:

1. Chairman of the Meeting
   Mr. Joel Nageon de Lestang
2. Vice Chairman
   Mr. Ahmed Hafiz
3. Chairmen and Rapporteurs of the Agenda Items

   Agenda Item 1: *Review of National Fisheries*
   Chairman: Mr. Joel Nageon de Lestang
   Rapporteur: Mr. Julio Morón

   Agenda Item 2: *Review of the Status of Stocks and Tuna Biology*
   Chairman: Dr. Gary Sakagawa
   Rapporteurs: Dr. Charles Anderson, (Small tunas)
   Mr. Tim Lawson, (Albacore and Bigeye)
   Dr. Francis Marsac, (Yellowfin and Skipjack)
   Dr. Renaud Pianet (Tuna biology)

   Agenda Item 3: *Interactions and Tagging Studies*
   Chairman: Dr. Renaud Pianet
   Rapporteur: Dr. Sachiko Tsuji

   Agenda Item 4: *Progress Made in Data Collection*
   Chairman: Mr. David Ardill
   Rapporteur: Dr. Michel Bertignac

   Agenda Item 5: *Any other Matters, Conclusions and Recommendations*
   Chairman: Dr. Jacek Majkowski
   Rapporteur: Mr. Guido Carrara

Agenda Item 1: *Review of National Fisheries*

1. Australia

Traditionally, Australian fishing has focussed on southern bluefin tuna (SBT). SBT quotas have been applied by Australia, New Zealand and Japan since the mid-1980s because of concern at the extent of reduction of the parental biomass and consequent reduction in recruitment. Major re-orientation of Australian SBT fisheries occurred during the early 1990s. Whereas virtually no Australian SBT quota was traditionally taken by longline, about 70% of the Australian 5,265 t quota will probably have been taken by longline during the 1992-93 quota year. Australia/Japan joint venture longlining makes up most of this catch, but there have been about 250-300 t taken in domestic small-vessel longlining. Australian SBT surface fisheries on small juveniles have been reduced to levels of the 1950s, and now concentrate on capture of fish for cage rearing, with roughly similar amounts taken for air-freight fresh-chilled to Japan. Given the extent to which surface catches were reduced, and the short time frame in which substantial reductions occurred, there was an unanticipated lag before substantial increase of juveniles in longline catches. Careful monitoring of the situation remains essential in case increased escapement is masking further decline in SBT recruitment.

Off eastern Australia, a domestic longline fishery for yellowfin tuna and a pole-and-line and purse seine fishery for skipjack take several hundred and several thousand tonnes respectively. Licensed Japanese longliners also operate in the region for the typical range of pelagics. There is no concern about the status of these resources overall, given the probability that they share, at least to some extent, the resource base of the broader central and western tropical South Pacific tuna fishery, and that this resource offers prospects for increased exploitation. However, there is some concern that localised depletion may occur in the domestic longline fishery where yellowfin and skipjack are at the southern extremes of their range.

2. Bangladesh

There are no fisheries targeting tunas in Bangladesh. Tuna and tuna-like fishes amount to 0.62% of the catch landed in Cox's Bazar from 6-7,000 drift gillnetters targeting *Hilsa*. Neritic tunas in the by-catch include *Auxis thazard* (average size 30 cm), *Euthynnus affinis* (average size 45 cm) and oriental bonito, *Sarda orientalis*. Offshore species include *Katsuwonus pelamis* (average size 50 cm) and yellowfin tuna, *Thunnus albacares* (average size 50 cm). Seerfishes, *Scomberomorus guttatus* and *S. commerson,* are also caught, as well as some sailfish (*Istiophorus platypterus*) and large pelagic sharks (mainly *Carcharinus* spp.). Seerfishes and neritic tunas have a low value locally, and commercial exploitation would only be possible if the capital investment is low. A pilot scheme may be considered to test the feasibility of fishing tunas with mechanised boats.

3. Comores

Tuna and tuna-like species make up 80% of the total artisanal catch (8,375 t). There are approximately 8,000 fishermen involved in the artisanal fishery in the Comores utilising approximately 4,500 fishing craft.

4. France

French tuna fishing activities in the Indian Ocean can be divided between the artisanal and semi-industrial fisheries conducted from La Réunion Island (France) on the one hand, and the industrial purse seine tuna fishery based in France on the other. The fisheries activities are described in more detail in Document TWS/93/1/15, while the research programme is summarised in Document TWS/92/1/12.

La Réunion artisanal and semi-industrial fisheries

A new sampling scheme is operating in Réunion island since 1991. The sampling is based on interviewing fishermen at landing sites. The small boats operating in Réunion use handlines in combination with troll lines, nearly always fishing around FADs, catching some 4-5,000 t a year. The

species composition for the small boats fishing around FADs is as follows: yellowfin 64%, skipjack 12%, wahoo 8%, marlins 7% and albacore 5%. There are 25 FADs set around the island at depths of 500 to 2,000 metres.

There was also one longliner operating until mid 1992, when nine more 16 meter longliners utilising monofilament lines, generally set at night, arrived at the island. Their catch rose from 40 t in 1991 to 170 in 1992, and is expected to exceed 300 t in 1993. The species composition is : swordfish 42%, yellowfin 27% and albacore 16%.

Recently, a fishing agreement allowed 20 Taiwanese longliners to operate in the EEZ of La Réunion outside a 50 mile limit, leading to some problems with the local fishery.

The French tropical purse-seine fleet

From the beginning of this fishery in the early 1980s, France has been one of the main fishing nations using industrial purse-seiners in the Indian Ocean. The fleet operates in a wide area, covering the western side of the Indian Ocean, centred around the Seychelles Islands. Catches are transhipped on board reefers in Victoria (Seychelles) and Antsiranana (Madagascar) harbours.

With 17-20 purse-seiners, the French fleet has been stable since 1987 (with a slight shift towards larger boats), catches remaining between 75-100,000 t per year. They reached respectively 80 and 95,000 t in 1991 and 1992, the latter being characterised by both a high production level (the second highest catch since the record in 1988) and a large proportion of yellowfin, although the area covered (5°N - 20°S, 40 - 75°E) had not significantly varied over the years. Sizes were larger in 1992 than in 1991 for all species, and fishing exploited both log and free swimming schools.

In 1991 and 1992, CPUE was high for yellowfin (respectively 10 and 13 t/fishing day) and stable for skipjack (9 t/fishing day) compared to their mean values (9 t/fishing day each) in the 1987-92 period. The strong increase of the purse-seiners efficiency as well as the rapid development of fishing on artificial FADs precludes any interpretation of these trends.

Research

French research in the Indian Ocean is mainly conducted by the Institut français de recherche scientifique pour le développement en coopération (ORSTOM) which is based in Seychelles (Victoria, Seychelles Fishing Authority), Mauritius (Petite Rivière, Albion Fisheries Research Centre), La Réunion (Saint-Denis, SEAS laboratory and Le Port, IFREMER - Institut français de recherche pour l'exploitation de la mer) and, more recently, Madagascar (Antsiranana, USTA).

Most of the studies conducted since 1991 were within the framework of the first and second Regional Tuna Projects, funded by the EEC through the *Association Thonière (Commission de l'Océan Indien)*, who's activities (including fishery statistics, biology, oceanography, population dynamics, acoustic and traditional tagging and remote sensing) are described in document TWS/93/1/12. These studies are all conducted in close relationship with other similar studies done by ORSTOM in the Atlantic and Pacific Oceans as well as with other international or regional tropical tuna organisations.

5. India

The Indian delegation presented the status of the tuna fisheries in two parts, one describing the operations of the longline charter vessels under Fisheries Survey of India (FSI) responsibility and the other reviewing the coastal fisheries under the Central Marine Fisheries Research Institute (CMFRI). Artisanal catch figures were given to IPTP. Catch and effort information by 5° square from the longline fleet is being processed and will soon be available to IPTP. The size-frequency data available from the different Indian tuna fisheries will be also collected and submitted soon to IPTP. For the catch allocation by FAO fishing area, the proposal to include Tamil Nadu state in Area 51 was agreed.

6. Indonesia

The tuna landings from the Indian Ocean (FAO Fishing Area 57) in 1991 were 106,746 t (including tuna, skipjack, small tunas and seerfishes), a 64% increase over 1990 and a 138% increase over 1988. The increase of landings is in line with the increase in fishing effort, especially the number of longliners which rose from 149 in 1988 to 536 in 1991. There was a tendency for the fishing strategy of 50 GT Taiwanese longliners to shift from using live milkfish bait, targeting yellowfin tuna, to frozen or dead bait targeting bigeye tuna. The size of the tuna caught also increased from 20 - 40 kg yellowfin tuna to 40 - 60 kg bigeye tuna.

Since early 1993, the activities of tuna longliners based in Muara Baru -- Jakarta Fishing Port have declined. Some longliners have moved to Benoa - Bali Fishing Base and Bungus -Padang Fishing Base. The catch rate of the longliners based in Bungus is better compared to Muara Baru Jakarta, but they are facing problems of availability of bait.

In the last two years, the Indonesian Government has also encouraged the development of sport fishing targeting marlin, tunas and skipjack. Several activities in conjunction with sport fishing have been carried out by the Department of Tourism, in collaboration with the Research Institute for Marine Fisheries, such as an International Sport Fishing Tournament, as well as training for the skippers of Sport Fishing Boats.

7. Iran

The tuna and seerfish catches in Iran totalled about 30,000 t in 1992. Most of the catch is taken by the artisanal gillnet fishery. There are five longliners and one purse-seiner operating under Iranian flag. Seerfish is the most valuable tuna-like species caught off Iran.

8. Japan

Japanese longliners started operating in the Indian Ocean in 1952, targeting mainly albacore and yellowfin tuna. The main target species shifted to bigeye and southern bluefin tuna after the development of deep longlining and deep freezing techniques around the mid 1970s. Purse seine operations started in the Western Indian Ocean in 1989 on an experimental basis and shifted to a commercial operation in 1991 with 11 boats. However, some of these boats decided to quit from this area in 1993.

9. Malaysia

The tuna catch in Malaysia increased by 25% during 1992 (35,000 t) in relation with 1991 (28,000 t). Most of the increase was due to the developing gillnet and purse-seine fishery in Sabah and Labuan which catches yellowfin, skipjack, kawakawa and longtail tuna.

Apart from the Malaysian tuna fleet, there is an important Taiwanese tuna longline fleet operating in the Indian Ocean targeting yellowfin and bigeye. The annual catch figures obtained by the IPTP sampling programme at Penang covering this fleet showed a constant level of catch of around 10,000 t for 1991 and 1992.

10. Maldives

The tuna catches of the Maldives have increased in recent years to a record of 73,000 t in 1992. Live bait pole and line fishing is the most important tuna fishing method. Skipjack tuna is the most important species (83% of total tuna catch in 1990 - 1992). Yellowfin tuna, frigate tuna and kawakawa are also caught in quantity.

Tuna tagging in the Maldives

The Maldives has a large, traditional pole and line tuna fishery, which catches mainly skipjack tuna. A very successful tuna tagging programme was carried out in Maldives in 1990. Nearly 10,000 skipjack and yellowfin were tagged, of which 15.7% were recaptured. Considerable information was obtained, particularly on the population dynamics of skipjack within the Maldives. Information was also obtained on tuna movements, with a total of 71 tag returns from outside of the Maldives.

A second tuna tagging programme was started in the Maldives in September 1993. It is planned to tag at least 7,000 tunas over the next 18 months. The main aim is to refine information on throughput of skipjack and population dynamics within the Maldives. A secondary aim is to validate otolith ageing. It is proposed to inject 500 skipjack with tetracycline in order to validate growth rings in hard parts. Most fish will be tagged with yellow dart tags. Tetracycline injected fish will be tagged with orange dart tags.

All fisheries workers are requested to return all tags to their nearest fisheries office or directly to the Maldives (Marine Research Section, Ministry of Fisheries and Agriculture, Malé, Republic of Maldives). T-shirt rewards are being sent for all tag returns. Particular attention should be paid to securing full details on location of capture, length and sex from any orange-tagged tunas and to collect the otoliths. It is proposed that those captured within the Maldives should be frozen and returned to the MRS by collector boats.

11. Mauritius

During each of the last three years, the three purse-seiners from Mauritius caught around 8,000 t of tunas. The species composition for this fishery during 1992 is: skipjack 65%, yellowfin 23% and bigeye 10%. The transhipment information of the Mauritian boats in Seychelles will be collected through a new agreement with the Seychelles Fishing Authority.

12. Pakistan

A traditional gillnet fishery and a longline fishery operate from Pakistan. There was an increasing the landing of tunas at Karachi during 1992, this being mainly due to better catches of longtail tuna. The total Pakistani tuna catch is much higher than recorded, as only the landing information obtained by the IPTP sampling programme at Karachi and the Fisheries Authorities of Baluchistan are included.

The longline fleet is licensed by the Pakistani Government through four companies. A data collection system is in process of execution for these vessels. A new fishery policy for marine fishery management and exploitation is soon to be implemented by the Pakistani Government.

13. Russia

Twenty-three Russian vessels have been operating in the Indian Ocean around the Seychelles and Chagos Archipelago area (10° South to 10° North) during 1992. The total tuna catch in 1992 increased from previous years to 11,123 t and is mainly composed of skipjack (62%) and yellowfin (33%), whereas the fishing effort decreased slightly during 1992 (931 fishing days).

Fisheries and biological data are collected by observers from Russian research organizations. Additional research has been conducted during two research expeditions directed to study tuna behaviour from free schools and in association with logs.

The tonnage of the different types of vessels is classified as follows: "Tibia" type 900 GRT, "Rodina" type 2,600 GRT and "Kaouri" type 2,100 GRT.

14. Saudi Arabia

Tuna fisheries in Saudi Arabia are mainly represented by the king seerfish, *Scomberomorus commerson*, landed along the Gulf coast from November through June, with peaks in January-March. The same species is caught throughout the year in the Red Sea and landed at the main site of Jizan (South), with a maximum catch in June. Total annual landings averaged about 8,500 tonnes between 1987 and 1992, of which 7,500 t were captured in the Red Sea and 1,000 t in the Gulf. Annual tuna landings for the same period averaged 250 t from the Red Sea and 50 t from the Gulf. Gillnets, in addition to troll lines, are the main gear used both in the Red Sea and the Gulf.

A one-year stock assessment study has been conducted on the king seerfish caught along the Red Sea coast in 1986-87 and the Gulf fishery is monitored regularly since 1987.

15. Seychelles

During 1992, a total of 260,000 t of tuna were caught by approximately 50 foreign purse seine vessels licensed in Seychelles. The species composition was as follows: skipjack 55%, yellowfin 40%, others 5%. Transhipment activity in Port Victoria has decreased considerably with most Spanish vessels now transhipping in Mombasa. This trend is expected to continue during 1993 and is mainly due to economic factors (high operating costs and low tuna prices) for the fleet. The Seychelles is seriously considering building up its own purse seining fleet, either through joint ventures with foreign partners, or through private entrepreneurs.

16. Spain

The Spanish delegation presented the provisional tuna statistics for 1992, with some details still to be submitted for the size-frequency distribution on log and free schools. In Victoria (Seychelles) the sampling of Spanish catches continues under Spanish responsibility in collaboration with the Seychelles Fishing Authority (SFA). In Antsiranana, the *Association Thonière* (EDF) started a tuna sampling programme that includes the Spanish catches. An agreement between the Spanish Government and the AT is expected in the future for processing these statistics. The trend for Spanish vessels to utilise Mombasa as a port of call continues and the Spanish Government is currently in the process of designing a new sampling strategy to continue the data collection initiated during the middle of 1993. The boats under flag of convenience are not under Spanish responsibility and the collection of these data is not of the competence of the Spanish scientists.

17. Sri Lanka

Tuna production in the West and South of Sri Lanka increased from 18,165 t in 1989 to 27,840 t in 1991. The tuna landed on the West coast increased by 200% in these three years, whereas the tuna landed on the South coast increased by 65%. During recent years, a longline fleet under Sri Lankan flag has been operating in the area, catching an estimated 1,427 t of large pelagics.

The operation of longlines combined with gill nets has increased shark catches to 40-45% of the total tuna fleet catch. This could be due to the high demand of shark fins, to the market and the operational area of the fleet. It was stated that 100 % of the artisanal catch is marketed for local consumption and that half the longline catch is exported as "sashimi" for the Japanese market. The other half of the catch is marketed in Sri Lanka.

18. Taiwan

The Taiwanese tuna catch in the Indian Ocean for 1992 decreased in relation with 1991 (64,220 t in 1992 and 67,191 t in 1991). The longline catch has largely increased from 48,189 t in 1991 to 61,556 t in 1992, but the gillnet catch dropped significantly from 18,001 t in 1991 to 2,664 t in 1992. This is due to the fact that the Taiwanese government has played a leading role in reconverting the Taiwanese gillnet fishery. The catch of Taiwanese longliners under joint venture or charter agreements with Indian Ocean coastal countries is not reported in the Taiwanese national statistics. The Taiwanese delegation expressed their willingness to collaborate with those countries in the compilation of that information.

19. Thailand

Tuna catches in the Andaman Sea contribute 9% of the total tuna catch in Thailand. The tuna species exploited in this area are frigate, kawakawa and longtail.

Tuna imports to Thailand increased drastically from 12,598 t in 1982 to 420,000 t in 1992. The national production contributes 160,000 t, of which 40% is consumed locally and 60% is used in the canning industry. Thailand processes longtail, kawakawa and frigate tuna originating from the national fleets.

Agenda Item 2: *Review of the Status of Stocks and Tuna Biology*

Since the 1991 consultation, many changes have occurred in the Indian Ocean fisheries for tuna and tuna-like species. In particular, the purse seine fishery for tropical tunas in the western Indian Ocean has expanded and become more dependent on log-associated schools than on free-swimming schools. Because log-associated schools consist principally of skipjack tuna, the total catch of this species has increased markedly. In 1992, the total skipjack catch for the Indian Ocean was 250,000 t which is a historically high level.

Longline and gillnet fisheries in the EEZs of coastal countries in the Gulf of Oman and Persian Gulf (e.g. Iran, Pakistan, India and Oman) have expanded and catches are increasing at a fast rate. These fisheries target respectively yellowfin and bigeye tuna and yellowfin and longtail for the fresh as well as frozen fish markets. In 1992, the total yellowfin tuna catch from the Indian Ocean was 245,500 t, a 20% increase from 1991, largely due to improved catches by the purse seine fishery as well as from the developing coastal fisheries. The bigeye tuna catch, on the other hand, decreased to 34,100 t in 1992, continuing the downward trend from a peak of 52,500 t in 1990.

The UN moratorium on large-scale driftnet fishing went into effect in January 1992. The result has been a significant decrease in total albacore catch in 1992. The catch dropped to 17,500 t (58%) in 1992 from the peak level of 32,500 t in 1990 when the driftnet fishery was very active.

Fisheries for small tunas also continue to expand. Gillnet fishing, for example, for longtail tuna, kawakawa and narrowed-barred Spanish mackerel continue to produce record high catches. In 1992, the catch of all species of small tunas was approximately 173,900 t.

These changes in the fisheries need to be closely monitored for their effects on the condition of the stocks. The participants at this 5th Expert Consultation reviewed more than 21 documents containing current information for evaluating the condition of the Indian Ocean tuna stocks. Results of the review are as follow:

1. Yellowfin Tuna

Review and update of the conclusions of the Working Group on yellowfin tuna (1991)

The conclusion of the latest Working Group on Yellowfin Tuna (Colombo, October 1991) was that the stock did not show evidence of over exploitation. Therefore, no recommendation on management was made by the group of experts.

However, there were substantial amounts of information presented at the meeting and the results of the stock analysis carried out during the workshop are contained in the report.

The major recommendations made during the Working Group meeting were reviewed by the rapporteur of that meeting, as well as the current situation *vis à vis* the more important items. This can be summarised as follows:

Statistics:

- recommendations made during the Expert Consultation held in Bangkok in 1990 are still relevant. Among those, IPTP has made great improvement in terms of cross checking catch statistics, reporting of corrected figures (instead of official flag ones) and continuing the assistance delivered to coastal countries. However, for some other recommendations regarding general purposes (data collection into as small as possible time-area strata, free and log discrimination in purse seine catches), no significant progress is noticed.
- the recommendation adopted by the Working Group regarding the extension of the area of IPTP coverage from 30°E to 15°E, as well as the reduction on the eastern side, from 150°E to 140°E, is now under review.
- For the other matters highlighted during the Working Group, no additional information on their progress has been reported.

Yellowfin nominal catches in the Indian Ocean

Yellowfin *Surface Gears*

COUNTRY	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AUSTRALIA	8	18	41	43	42	40	12	9	71	12	121
CAYMAN ISLANDS	0	0	0	0	0	0	0	0	804	0	0
CHINA(TAIWAN)	0	0	0	0	0	52	35	38	98	6	2
COMOROS	110	120	130	140	140	140	150	3,321	3,321	3,321	3,321
FRANCE	1,224	10,773	33,611	32,231	35,519	37,118	54,149	38,411	43,079	39,411	53,529
INDONESIA	3,225	5,888	3,662	4,102	3,150	3,270	3,433	3,550	3,683	1,450	1,450
IRAN	0	0	0	0	0	0	0	250	2,280	3,238	3,238
IVORY COAST	0	0	5,107	3,046	562	0	0	0	0	0	0
JAPAN	120	198	242	75	160	261	390	883	2,973	5,061	11,482
MALDIVES	4,005	6,241	7,124	6,066	5,321	6,668	6,535	6,082	5,279	7,711	8,679
MALTA	0	0	0	0	0	0	0	0	2,845	2,381	1,625
MAURITIUS	0	1,057	1,284	914	661	1,597	1,231	1,679	1,356	2,621	2,130
MOZAMBIQUE	0	15	11	15	15	15	15	15	16	16	16
OMAN	0	0	0	0	0	5,843	15,485	16,877	14,084	8,996	13,420
PAKISTAN	0	0	0	0	2,093	1,330	2,480	8,560	3,156	2,539	2,247
PANAMA	0	0	2,441	3,236	3,432	3,831	3,597	1,941	10,569	11,594	6,351
SEYCHELLES	518	114	0	7	10	8	3	0	2	362	176
SOUTH AFRICA	0	166	0	84	0	6	4	0	0	0	0
SPAIN	55	0	13,796	15,411	17,532	20,361	43,159	33,852	35,930	45,152	42,103
SRI LANKA	7,516	8,141	5,795	6,494	7,341	7,147	7,426	6,958	5,886	9,774	9,774
UNITED KINGDOM	0	0	155	1,177	1,050	0	0	0	0	0	0
RUSSIA	0	0	0	675	2,856	3,436	4,039	2,988	2,428	3,053	3,701
YEMEN	80	80	12	511	510	399	1,252	667	667	667	10,000
SUB-TOTAL	16,861	32,811	73,411	74,227	80,394	91,522	143,395	126,081	138,527	147,365	173,365

Yellowfin Longline

COUNTRY	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AUSTRALIA	0	0	0	0	0	0	0	180	0	24	24
CHINA(TAIWAN)	3,532	4,179	4,354	5,145	12,145	15,976	14,389	13,235	10,781	7,474	18,382
FRANCE										16	62
INDIA	0	14	42	118	1,534	712	760	2,922	10,369	3,880	4,386
INDONESIA	515	0	585	441	120	0	0	8,023	12,174	11,774	11,774
IRAN	0	0	0	0	0	0	0	0	0	0	0
JAPAN	6,355	7,039	7,467	9,263	10,955	7,552	8,554	3,568	6,192	3,847	3,304
KENYA	204	322	0	0	0	0	0	0	0	0	0
KOREA	18,654	15,337	9,895	12,017	14,891	12,575	13,428	8,103	7,006	3,004	3,004
MALAYSIA-TAIWAN									7,200	9,000	8,904
MALDIVES	0	0	0	0	0	0	0	5	1	0	0
MAURITIUS	0	0	0	0	190	70	98	105	23	62	62
MOZAMBIQUE	0	0	177	0	0	0	0	0	0	0	0
OMAN	0	0	0	0	0	0	0	0	3,663	1,069	1,718
OMAN-TAIWAN											20,000
PAKISTAN	0	0	0	0	0	0	0	0	0	969	969
PAKISTAN-TAIWAN										8,000	20,000
SEYCHELLES	0	43	198	140	0	0	0	0	0	0	0
SRI LANKA	834	905	644	222	636	0	0	578	520	890	890
RUSSIA	0	0	0	0	0	0	7	2	0	0	0
SUB-TOTAL	30,094	27,839	23,362	27,346	40,471	36,885	37,236	36,721	57,929	50,009	93,479
Yellowfin TOTAL	**46,955**	**60,650**	**96,773**	**101,573**	**120,865**	**128,407**	**180,631**	**162,802**	**196,456**	**197,374**	**266,844**

Biological parameters:

- **Stock structure**: tagging remains a high priority action and the vertical heterogeneity of the stock (separated fractions between longline and surface gears) is still a pending question. On the other hand, the sex ratio according to fish age, area, season and method of capture is under study.
- Growth: the recent advance is the reading of hard parts (undertaken in the frame of the *Association Thomière* research programme), but validation by tetracycline marking has not yet been implemented. The controversy about the growth pattern for young fish (less than 80 cm), a two stanza growth with a slow growth rate for juveniles followed by a rapid increase of the growth on one side, and a fast growth on the other side, is still unresolved. This question

remains critical, since the catch-at-age table and the resultant age-structured modelling are very sensitive to the impact of this feature.

- **Maturity and spawning**: good figures are now available on that topic. The size at first maturity is between 110 and 120 cm. The evolution of gonad indices is confirmed by more advanced methods (hormone dosage in the blood): the major spawning season runs from December to March and a secondary cycle takes place in July. However, the larval survival relevant to each spawning period has not been assessed, so that the real effect on recruitment (i.e. the appearance of a second cohort in the year) remains unknown.
- **Natural mortality**: this is still an unresolved question. No progress has been made since the 1991 Working Group, when the hypothesis of a constant M=0.6 was used to comply with tradition (!).
- **Oceanographic conditions**: research has progressed in that field, in particular with respect to remote sensing. In the Western Indian Ocean, it is an important component of the research programme undertaken by the *Association Thonière*. This comprises the collection of oceanographic data and the update of the databases, the seasonal/interannual changes and their impact on fish availability to the surface gears, and local effects of sea mounts on tuna aggregation.

Population dynamics:

- **CPUE indices**:

a) for longline, a sharp decline of the Honma indices were noticed during the first five years of exploitation (1952-60), when longline was the sole gear in operation in the high seas. When the surface gears (especially purse seine) came into operation (1984...), the longline indices (already stable at a low level) did not show any trend. Several assumptions were proposed to explain this apparent lack of interaction, the first two being the more likely:

- the stock available to longlines is independent from a possible surface stock;
- the underlying population for longlines is very large;
- the development of the surface purse seine fishery has increased the productivity of the stock;
- the estimation of the longline fishing effort is biased and therefore, the CPUE estimates are not reliable.

b) for purse seines, the CPUE indices are steadily increasing. The increase of the fishing efficiency of the fleets is probably the major factor that can explain this apparently abnormal situation. Powerful radar enabling the detection of bird flocks (and consequently tuna schools) at a distance of 20 nautical miles were introduced in 1987-88. At the same time, the time for setting purse seines has decreased by 30% on the average from 1984 to 1991. Various other factors increasing the efficiency have also appeared in recent years.

From a general point of view, the use of general linear models for CPUE adjustment needs strong statistical analysis for the estimation of the relevant parameters.

- **Yield per recruit analysis** was made on the assumption of a slow growth rate for young fish (this gives the most conservative results) and 2 recruitment levels (60 and 120 million, the former being the lowest level explaining the catch), but this still cannot be conclusive on the real status of the stock. With the current exploitation rate, a low recruitment scenario gives a situation that is close to the MSY (doubling the effort is not followed by an increase in the catch), whereas a high recruitment leads to much more optimistic views. However, the lack of information does not make it possible to locate the current status between those limits.

No population analysis on an ocean-wide scale was proposed at this meeting. Two papers reporting local analyses in India (TWS/93/2/13) and Sri Lanka (TWS/93/2/24) were presented. In Lakshadweep, only young yellowfin are exploited and the mortality is overestimated; therefore no conclusive result can be reached. Anyway, the fishing pressure is still low in this area. In Sri Lanka,

the evolution of the catch rates show a rather seasonal pattern but multi-gear effects due to a combination of longline, gillnet and troll lines are also identified and tend to improve the catch rates.

Current Status

No significant additional information on stock analysis has been produced since the meeting of the Working Group on yellowfin tuna. In short, there is uncertainty about the condition of the stock, but indirect information suggests the stock is not being overfished.

2. Skipjack Tuna

Review of New Information

No recommendation on management of the skipjack tuna stock was made at the Expert Consultation held in Bangkok (1990). The catch has increased dramatically with the development of the purse seine fishery and current catch figures are rather stable at between 190,000 and 200,000 t. This remains the most represented species in the catch of tuna in the Indian Ocean.

Skipjack *Surface Gears*

COUNTRY	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AUSTRALIA	0	0	0	550	550	600	10	12	27	843	843
CAYMAN ISLANDS	0	0	0	0	0	0	0	0	704	0	0
CHINA(TAIWAN)	0	0	0	0	0	9	48	157	97	0	0
COMOROS	330	340	350	360	360	360	380	3,800	3,800	3,800	3,800
FRANCE	771	10,075	25,517	33,084	40,363	48,765	45,169	43,082	27,387	33,357	36,911
INDIA	2,399	1,801	3,488	3,276	3,195	5,550	5,855	6,430	5,012	5,012	5,012
INDONESIA	11,832	12,458	10,447	9,602	10,954	11,111	11,666	13,920	14,629	24,030	24,030
IVORY COAST	0	0	5,112	3,197	175	0	0	0	0	0	0
JAPAN	453	592	696	315	562	883	2,251	3,449	10,918	15,877	30,779
MALDIVES	15,881	19,701	32,048	42,602	45,444	42,111	58,546	58,145	59,899	58,898	58,577
MALTA	0	0	0	0	0	0	0	0	2,761	1,666	2,386
MAURITIUS	2,417	1,396	2,850	2,026	1,853	4,352	5,018	5,593	4,083	6,490	6,020
MOZAMBIQUE	0	60	154	80	80	80	80	80	87	87	87
PAKISTAN	5,156	733	694	0	105	325	1,337	7,478	7,555	2,466	1,071
PANAMA	0	0	1,462	2,990	4,606	4,210	5,111	3,644	13,118	4,618	9,353
SEYCHELLES	0	0	0	0	0	0	0	0	0	1,836	809
SOUTH AFRICA	0	13	0	4	0	0	0	0	0	0	0
SPAIN	14	0	8,079	22,854	24,877	35,399	52,863	77,632	47,321	39,168	61,853
SRI LANKA	13,250	13,972	11,619	12,118	13,737	12,896	13,398	13,955	12,235	16,690	16,690
UNITED KINGDOM	0	0	20	1,589	1,155	0	0	0	0	0	0
RUSSIA	0	0	0	825	1,883	4,129	2,692	2,118	3,932	5,400	6,956
YEMEN	400	400	12	7	10	28	0	12	12	12	12
TOTAL	52,903	61,541	102,548	135,479	149,909	170,808	204,424	239,507	213,577	220,250	265,189

Skipjack *Longline*

COUNTRY	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
CHINA(TAIWAN)	13	8	24	40	7	4	10	12	8	31	69
JAPAN	5	3	2	9	5	1	5	2	3	1	1
KENYA	1	2	0	0	0	0	0	0	0	0	0
KOREA	57	8	0	0	0	0	12	1	0	0	0
MALDIVES	0	0	0	0	0	0	0	11	0	0	0
MAURITIUS	0	0	0	0	0	0	2	1	0	0	0
SRI LANKA	0	0	0	0	0	0	0	2	2	0	0
TOTAL	76	21	26	49	12	5	29	29	13	32	70
Skipjack TOTAL	**52,979**	**61,562**	**102,574**	**135,528**	**149,921**	**170,813**	**204,453**	**239,636**	**213,625**	**220,290**	**265,259**

Some documents were presented, with respect to tagging in the Maldives (TWS/93/3/5 and 6) and local analysis in India (TWS/93/2/13) and Sri Lanka (TWS/93/2/24). A preliminary assessment of the CPUE index of the log fishing activity by purse seine in the Somali Basin was also presented (TWS/93/2/25).

The analysis of the tagging data of the Maldives (8,033 skipjack tagged, 1,420 recovered) was carried out, in a first step, with a spatially aggregated attrition model (TWS/93/3/5). The conclusion is that the stock is still under exploited. Actually, the real exploitation rate cannot be estimated precisely, but even taking pessimistic values for one critical parameter used in the model, the

exploitation rate remains under 0.5. Emigration is taken into account in the natural mortality coefficient since this local fishery exploits a globally distributed population. A more sophisticated model, incorporating the movement component of the fish, was used in a second step (TWS/93/3/6). The results confirm the low exploitation rate suggested in the previous study, but provide additional information on emigration which was initially combined with the *M* parameter. The diffusion rates are lower than those estimated in other areas, especially for fish close to the atolls. On the other hand, when considering an open area (allowing fish to escape from the Maldives area), the emigration rate becomes high. The further the fish from the shore, the faster it moves away. Movement appears to be mainly southerly during the north-east monsoon and northerly during the south-west monsoon.

A comprehensive explanation would be a local stock with high exchange rate with outer populations. These considerations allow further development of the fishery.

The stock analysis made in Lakshadweep (TWS/93/2/13) may be somewhat controversial as the size of the fishery is very small compared to the geographical distribution of the stock. In any case, further development of the current fishery can be envisaged.

The evolution of the catch rates in Sri Lanka (TWS/93/2/24) does not show a clear trend. The changes are likely a consequence of seasonal effect and fishing strategy, since the vessels combine gillnet and longline gears.

The definition of an abundance index relevant to log fishing by purse seine is the aim of paper TWS/93/2/25. Although the paper does not make a distinction between species, skipjack is the main target species in that fishery (70% of the catch). The classic CPUE expressed in catch/searching day is not realistic in the case of log-fishing. Once a log is located and "tagged" with a radio beacon, there is no real searching time to catch a school. A single set per day is made (at dawn) for one log. The result of this preliminary study undertaken in the main fishing grounds on logs (Somali Basin) proposes the number of sets per 100 searching days as an abundance index for that kind of fishing activity. During the discussion, some points were noted:

- data on the fishing effort during the period studied (1984-91) would be useful to estimate the possible relationship with the changes depicted on the catch/set. It is likely that the catch/set will decrease if there is a strong increase of the fishing effort in this limited area;
- fluctuations of the catch/set are a consequence of multiple factors (immigration and emigration rates of the fish in the area, transfer rates between logs, environmental changes);
- regarding secondary species (yellowfin and bigeye) the CPUE index is relevant to small fish only.

This new approach is promising and should be investigated further in relation with other classical indices and areas.

Current Status

On the basis of available information, the skipjack stock of the Indian Ocean seems to be in good condition. Therefore, no limitation of fishing effort on this species is recommended. This is consistent with current information on the life history and population dynamics of skipjack tuna, i.e. ability to spawn at small sizes, extended spawning area, rapid turnover and large population.

3. Bigeye Tuna

At the fourth Expert Consultation, it was concluded that there was not enough information on stock assessment to provide the participants with a clear basis to evaluate the state of the Indian Ocean bigeye stock. The participants at that meeting felt that catch, size and effort data from all countries needed to be integrated in a comprehensive analysis of the status of the stock. It was noted, however, that the recent increase of effective longline effort suggested that further increases in effort may not result in an appreciable increase in catch.

An analysis of bigeye CPUE based on ASPIC, a surplus production model incorporating covariates (Prager 1991), was presented (TWS/93/2/12). Three time series of CPUE data, including Japanese

longline, Korean longline and Taiwanese longline, 1975-1990, were standardised with a general linear model. Factors included in the GLM included year, season, area, and interactions between year and season, year and area, and season and area. The standardised CPUE for the Japanese and Korean fleets were not found to be significantly different when tested with a Student-Newman-Keuls test, while standardised CPUE for the Taiwanese fleet was significantly lower than standardised CPUE for the Japanese and Korean fleets. MSY was estimated to be 37,850 t, compared to estimates based on conventional production models of over 40,000 t.

It was noted that the ASPIC analysis used data from 1975 to 1990 only, during which time CPUE has not varied greatly, particularly since 1979. It was therefore felt that there may not be enough information in the data to obtain reliable estimates of MSY. Further, the analysis did not take surface catches into account, which were low until 1990, but which accounted for half of the total catch in 1991.

Nevertheless, the meeting considered that the estimate of MSY of 37,850 t was indicative and that the bigeye stock was probably at or near optimal exploitation. Unrecorded catches from longliners, which were considered to have been significant in recent years, may indicate that MSY has even been exceeded.

4. Albacore Tuna

The fourth Expert Consultation noted that longline CPUE for albacore had declined and appeared to have stabilised at a low level. The influence of large catches by the drift gillnet fishery, which began in 1984, on longline CPUE had not then been observed. It was noted that the extent of an interaction between the surface and longline fisheries would depend on the difference in size of fish exploited by the two gear types.

Table 4 of TWS/93/2/10 presents the average weight of albacore caught by Taiwanese longline and gillnet fisheries. The mean weight of longline-caught albacore ranged annually from 13 to 14.6 kg, whereas the mean size of gillnet-caught albacore ranged from 8 to 9.8 kg.

An ASPIC analysis (TWS/93/2/9) was presented that utilised seven CPUE time series (Japanese longline for 1952-1989, Korean longline for 1975-1987, Taiwanese longline for 1967-1991, French purse seine for 1982-1990, Spanish purse seine for 1984-1989, Ivory Coast purse seine for 1983 and 1985-1986 and Taiwanese drift gillnet for 1986-1991). The Taiwanese longline CPUE time series was further segregated into deep and regular longline. CPUE was standardised on season and area. The study indicated that regular Taiwanese longline CPUE has declined considerably since 1986. The estimate of MSY was 14,550 t, which is much lower than estimates of albacore MSY from ten previous studies (which ranged from 16,000 t to 22,000 t (Table 1 of TWS/93/2/9).

The 1991 catch was 31,400 t, which was considerably in excess of MSY. However, the gillnet fishery declined dramatically in 1991 and ceased completely in 1992. The 1992 catch thus decreased 17,300 t, which is within the range of past estimates of MSY.

A virtual population analysis (VPA) of albacore catch, effort and size data was presented (TWS/93/2/10). Input data included catch and effort data covering Japanese longline, 1955-1989, Korean longline, 1975-1987, deep and regular Taiwanese longline, 1967-1991, Taiwanese gillnet, 1986-1991, and French and Spanish purse seine, 1984-1990, and size frequencies from Taiwanese longline, 1980-1991, and Taiwanese gillnet, 1986-1991. An error in the estimate of the purse seine catch for 1991, which was taken from the IPTP Data Summary for 1991, laid doubt on the results of the analysis which, however, showed a considerable increase in longline CPUE during 1989-1991, in contrast to the decline in regular Taiwanese longline CPUE indicated by the ASPIC analysis. It was also felt that variable catchability for the younger age classes through time indicated that the analysis needed to be tuned.

A study of Japanese longline CPUE, standardised on quarter, area and deep/regular longline, was presented (TWS/93/2/18). The resulting time series showed that CPUE exhibited a variable decline from 1960 to 1978, then increased until 1987, and then declined through 1991. Interpretation of the results of the study varied among the participants. On the one hand, it was felt that the standardised CPUE did not show a significant decline after 1984, when the drift gillnets were introduced. On the

other, it was felt that although CPUE increased until 1987, the decline since 1987, though not as steep as the decline in regular Taiwanese longline, could be interpreted as a response to increased drift gillnet catches.

5. Small Tunas, Seerfishes and Billfishes

Introduction

The most important small tunas and seerfishes in Indian Ocean catches are:

Longtail tuna	*Thunnus tonggol*
Kawakawa	*Euthynnus affinis*
Frigate tuna	*Auxis thazard*
Bullet tuna	*Auxis rochei*
Narrow-barred Spanish mackerel	*Scomberomorus commerson*
Indo-Pacific king mackerel	*Scomberomorus guttatus*

Three general points apply to all these species:

1. Virtually the entire Indian Ocean catch is made by coastal countries.
2. The fisheries statistics available are generally rather poor. In some cases even basic catch information by species is lacking. In many cases detailed catch breakdown by gear and size is lacking.
3. Despite the statistical deficiencies, it is clear that catches of these species are significant (in some cases exceeding those of albacore and bigeye tuna). Recent annual catch estimates for the entire Indian Ocean are:

	1990	1991
Longtail tuna	35,400 t	38,500 t
Frigate & bullet	14,100 t	14,200 t
Kawakawa	46,600 t	48,800 t
Tunas NEI (mostly small spp.)	53,200 t	81,000 t
Seerfishes	87,200 t	104,900 t
Billfishes	14,000 t	15,800 t

Papers dealing with the biology of four species (longtail tuna, kawakawa, frigate tuna and narrow-barred Spanish mackerel) were presented at the Expert Consultation and are summarised below. No new information was presented on billfishes.

Longtail Tuna

Recent recorded catches of longtail tuna are of the order of 37,000 t per year. Major catching countries include India, Iran, Malaysia, Oman, Pakistan, Thailand and UAE. Gillnets are the most important fishing gear used.

A preliminary assessment of the biological parameters of longtail tuna in Iranian waters based on analysis of length-frequencies was presented (TWS/93/2/4). Results are summarised below. No conclusion was drawn as to the status of the longtail tuna stock.

L_∞	k	t_0
149.5	0.3	-0.06

In the northern Arabian Sea, Gulf of Oman and Persian Gulf, longtail tuna is exploited by Oman, Iran, Pakistan, UAE, Yemen and probably Qatar and Saudi Arabia. The fisheries show marked seasonality, clear length modes and major size differences (e.g. Iranian catches are mainly of large fish, while those in Oman are mainly of small fish). Longtail tuna in this area might therefore prove to be amenable to stock assessment, provided reliable information on size frequencies, catch and effort are obtained from all the fisheries concerned.

Frigate Tuna

Recent recorded catches of Frigate tuna are of the order of 14,000 t per year. This is probably a serious underestimate of true catch, as a result of under reporting and not reporting by species. Major catching countries include India, Indonesia, Malaysia, Maldives, Pakistan and Sri Lanka. A wide range of fishing gears are used, including livebait pole-and-line, gillnet, handline, trolling, purse seine and ring net.

A biological study of frigate tuna in Sri Lanka, based on analysis of length frequencies, was presented (TWS/93/2/5). Results are summarised in below. It was suggested that despite the recent rapid development of a ringnet fishery for frigate tuna, this species is still not fully exploited in Sri Lankan waters.

L_∞	K
59.5 cm	1.53

Kawakawa

Recent recorded catches of kawakawa are of the order of 47,000 t per year. Major catching countries include India, Iran, Malaysia, Maldives, Oman, Pakistan, Sri Lanka, Thailand and UAE. A wide variety of fishing gears are used, including livebait pole-and-line, gillnet, handline, purse seine and trolling.

A biological study of kawakawa in Seychelles and Oman, based on length-frequency analysis, was presented (TWS/93/2/3). Seychelles data were from 1981 research survey trolling catches, when commercial catches were low and are believed to represent an unexploited stock. Oman data are from 1988-89 commercial gillnet landings. No conclusions were made on the status of the Oman stock. However, the high *M* values obtained for both kawakawa and frigate tuna (combined with earlier trophic studies which suggest high levels of abundance of these species in the Indian Ocean), were thought to indicate that these species could sustain relatively high levels of exploitation.

Narrow-barred Spanish mackerel

Recent recorded catches of narrow-barred Spanish mackerel are of the order of 45,000 t per year. Major catching countries include India, Indonesia, Iran, Malaysia, Oman, Pakistan, Saudi Arabia, Sri Lanka and UAE. Gillnets are the major fishing gear for this species. Preliminary assessments of narrow-barred Spanish mackerel biological resources were presented for India (TWS/93/2/2), Oman (TWS/93/2/7) and Saudi Arabia (TWS/93/2/6). Results of the biological parameters are summarised below. All three assessments were based on length-frequency data and were regarded as preliminary statements only, since they all suffered from a number of recognised shortcomings (see below). Nevertheless, all three assessments concluded that narrow-barred Spanish mackerel was being exploited at or above the optimum level.

	L_∞	K
TWS/93/2/2	146 cm	0.78
TWS/93/2/6	186.6 cm	0.26

General Considerations

It is commendable that six papers dealing with stock assessment issues in four species of small tuna and seerfish were presented. These assessments are only considered to be preliminary for a number of reasons, including the following:

1. In most, if not all cases, detailed catch and effort data are not available. Where effort data are available, they may be from several gears and/or fisheries, creating problems of standardisation.
2. As a result, the assessments are all length-frequency based. This itself can introduce a number of problems, for example:

a. Separation of modal size groups by particular methods (e.g. Bhattacharya, slicing) may introduce some bias into the analysis.

b. In cases where there is only a limited size range represented in the catch, or modal progression is not apparent, analysis is not likely to produce robust results.

c. In many of these species, the gillnet is the major gear used. Due attention must be paid to the consequences of gear selectivity.

d. Length-frequency data from all fishing gears needs to be included in any analysis.

3. It is likely that most, if not all, the stocks under consideration are fished by more than one country. Stock assessment therefore needs to be carried out on a suitable regional basis.

Recommendations

1. Statistics

As reported at the Fourth Expert Consultation, there continues to be a need for fishery statistics for small tunas, seerfishes and billfishes to be greatly improved. A first priority is that all catches should be reported to IPTP by species, not species group. A second priority is the collection of catch and effort data.

2. Research

a. The Fourth Expert Consultation recommended consolidation of the understanding of the biology of kawakawa, longtail tuna and narrow-barred Spanish mackerel. Much progress has been made. However, many information gaps still need to be filled. Therefore, it is again recommended that work on the biology of these species (particularly age validations, reproductive studies and migration studies) be carried on.

b. The Fourth Expert Consultation recommended that an assessment of the potential for a swordfish fishery in the Indian Ocean be carried out. No work has been carried out, so this recommendation is retained.

Narrow-barred Spanish Mackerel

Preliminary studies suggest that the northern Arabian Sea and Persian Gulf stock of this species may be exploited at a very high level. It is recommended that IPTP convene a regional workshop to pool information from the several national fisheries in order to obtain a better understanding of the status and migration of the entire stock.

Longtail tuna

Longtail tuna is fished at quite a high level in the same areas as the narrow-barred Spanish mackerel in the northern Arabian Sea and Persian Gulf. Although there is at present no indication of over fishing of longtaill tuna in this area, it is recommended that IPTP take advantage of the proposed regional workshop on stock assessment of narrow-barred Spanish mackerel to consider the status of longtail tuna on a regional basis as well.

Other species

No recommendations are offered at this time.

Summary of growth and mortality parameter estimates for small tunas and seerfishes presented at Fifth Expert Consultation

		von Bertalanffy growth parameters		Annual mortality parameters			Reference
Species	Area	L_∞	K	Z	M	F	
Longtail tuna	Iran	149 cm	0.30	3.13		-	TWS/93/2/4
Frigate tuna	Sri Lanka	59 cm	1.53	-	1.95	1.72	TWS/93/2/5
Kawakawa	Seychelles	107 cm	0.32	2.24	2.24	0	TWS/93/2/3
Kawakawa	Oman	84 cm	0.56	-	-	-	TWS/93/2/3
Narrow-barred Spanish Mackerel	India	146 cm	0.78	3.29	0.78	-	TWS/93/2/2
Narrow-barred Spanish Mackerel	Oman	182 cm	0.30	-	-	-	TWS/93/2/7
Narrow-barred Spanish Mackerel	Saudi Arabia	183 cm	0.26	1.59	0.36	1.34	TWS/93/2/6

6. Tuna biology

Eleven papers were presented on tuna biology : six on "Distribution and behaviour" (TWS/93/2/14, 15, 21, 22, 23 and TWS/93/3/6), two on "Ageing and Growth" (TWS/93/2/8 and 20), one on "Sex ratio and Reproduction" (TWS/93/2/15) and two on "Stock structure" (TWS/93/2/17 and 19).

Distribution and behaviour

TWS/93/2/14 makes a comparison of the general features of the tuna fishery between EPO (eastern Pacific Ocean), EAO (eastern Atlantic Ocean) and WIO (western Indian Ocean): spatial distribution of the fishery, size composition of the catch, tuna-environment relationship, etc. It emphasises the similarity between WIO and EAO: seasonal fishing pattern, yellowfin size distribution pattern, yellowfin/skipjack catch ratio, etc. The importance of the problem with intermediate sizes which are not currently exploited by commercial fisheries was emphasised, as well as the differences in the fishery "maturity" and its consequences (the EPO having the oldest fishery, with no further changes expected, the WIO the youngest with probable further expansion, and the EAO being in an intermediate situation).

TWS/93/2/16 deals with the distribution patterns of yellowfin tuna in the Andaman and Nicobar seas (about 30% of the Indian EEZ), where yellowfin is the most important pelagic species and higher CPUE were observed than in other Indian regions. A study on the influence of remote-sensing sea surface temperature on the distribution of yellowfin indicates a positive relationship between surface thermal boundaries and CPUE.

TWS/93/2/21 analyses the feeding conditions of surface tunas in the WIO from a data set collected during the first Regional Tuna Programme of the *Association Thonière*. The main results shows that:

1) yellowfin and skipjack tunas are able to adapt their feeding strategy according to environmental conditions;
2) they are day-feeders;
3) they take advantage of a short food chain (copepods 1mm → fishes 30 mm → tunas);
4) their abundance is linked with that of plankton.

This kind of study was considered very useful to understand tuna behaviour, and the role and importance of "turnover" (which can be very rapid in tropical areas) versus "biomass" was stressed, and may be an explanation of the tuna abundance in areas often assumed to be poor.

TWS/93/2/22 examines the school size - fish size issue from the detailed information of individual sets on free pure schools in the French purse-seiner logbook data (1984-91): with regard to the yellowfin-albacore-bigeye mixing, one can observe an increase in the tonnage and a decrease of the number of individuals when the fish size increases; the situation is similar for skipjack, except for the larger sized individuals. Some assumptions were made to explain this result for yellowfin, which seems to be linked to the access to new types of prey of larger tunas (this size corresponding to the change in feeding behaviour). The possibility of bias linked to the behaviour of skippers (who tend

often to avoid very small or large schools) was mentioned. This preliminary study is part of a larger one aiming to understand tuna schooling behaviour using an "ideal free distribution" model.

TWS/93/2/23 describes the diurnal vertical behaviour of yellowfin tuna observed from sonic tagging experiments in the western Indian Ocean, respectively in off-FAD and FAD-associated situations. The major finding is that a set of reliable vertical temperature and oxygen profiles can predict the potential distribution of young yellowfin by depth, using a probability density function. This allow the assessment of variable vulnerability of the fish to surface gears in different oceanic areas. The agreement with results obtained with sonic tagging data from the Pacific suggests a common behaviour world-wide which has, however, to be confirmed by additional experiments planned in early 1994 (Comoros, La Réunion, Seychelles).

Ageing and Growth

TWS/93/2/8 presents the main results from an analysis of length-frequencies of yellowfin tuna in Iranian waters, where systematic size sampling (including sex discrimination) has been carried out since 1990, with the exception of 1992, on the gillnet fishery of the Gulf of Oman. This data set allowed an estimate of growth rates for both males and females separately, the modes being separated by the Bhattacharya method. A sexual discrepancy is observed, males growing faster (2.1 cm/month) than females (1.7 cm/month) for fishes from 60 to 110 cm, as well as a marked growth difference between smaller and larger individuals for both sexes, with a net acceleration of growth above 75 cm.

The interest of this kind of studies was stressed, and their development on a systematic basis (already recommended at the yellowfin tuna stock assessment workshop in Colombo) encouraged. However, the problems raised by the selectivity of the fishing technique (gillnet) and its possible bias on growth studies was outlined.

In TWS/93/2/20, the age of yellowfin tuna from the western Indian Ocean was estimated by counting daily increments on otoliths from a set of 159 fishes ranging from 28 to 144 cm (of which 1/3 were larger than 1m); it shows a rapid homogeneous decline of growth with size : 6 cm/month for small fishes (30 cm FL), 4 cm/month for intermediate sizes (60-80 cm FL) and 3 cm/month for larger fishes (110 cm FL), with no difference between males and females. The problem of validation of the method (presently only available on juvenile yellowfin tuna in the eastern Pacific Ocean) was outlined, and an analysis taking into account the geographical heterogeneity which may have introduced a bias by pooling estimates from non-homogeneous areas suggested. Nevertheless, the continuation of this alternative type of studies was encouraged, and it should strongly benefit from the results of the future proposed tagging programme. The new ORSTOM-IFREMER ageing laboratory in Brest (France) was presented, as it may strongly help the continuation of such studies.

Sex ratio and Reproduction

From TWS/93/2/8, the sex-ratio analysis of yellowfin tuna in the Gulf of Oman shows a preponderance of females in the intermediate length and a higher proportion of males for the larger fishes. This phenomenon was highlighted, as such an accumulation of females in the intermediate ages could be an index of the differential growth between sexes. The gonad index (GI) analysis does not show any spawning activity in this area during the fishing season (August to February).

TWS/93/2/15 presents some biological studies on yellowfin tuna in three areas of the Indian EEZ based on samples obtained in oceanic longline surveys from mid 1991 to mid 1993; it puts into evidence a spawning season from November to April, depending on the area, the higher reproductive potential being in the Andaman-Nicobar area, while the north-west area exhibits a lower and later potential. Sex-ratio studies based on samples from 1989 up to mid 1993 indicated a strong predominance of males at all sizes from 60-180 cm length. Some information was also given on stomach contents in the different areas.

Stock structure

TWS/93/2/17 estimates the stock structure of yellowfin tuna from three data sets (CPUE, age-specific CPUE and coefficient of variation for size) from the Japanese, Taiwanese and Korean

longline fisheries, time series being compiled in six sub-areas dividing the ocean along longitude lines every 20°. A covariance analysis was used, assuming that homogeneous stocks exists longitudinally and overlap in adjacent waters, and that the pattern of the time-series trends are similar. It was concluded that the Indian ocean could be divided into two major stocks (East, 40-90°E and West, 70-130°E), surrounded by a far western (West of 40°E) and far eastern (East of 130°E) stocks. The validity of the historical Japanese size series used was questioned, and a second similar study using those new areas suggested.

Further developments of the model developed by Nishida taking into account separately the juvenile and adult segments of the fisheries and including biological information (size at first maturity and sex-ratio) was very briefly presented (TWS/93/2/19).

Review of recommendations concerning tuna biology

Recommendations were made concerning tuna biology during the workshop on stock assessment of yellowfin tuna in the Indian Ocean (Colombo, Sri Lanka, 7-12 October 1990) on the following topics:

1- **Stock structure** : investigate both horizontal and vertical heterogeneity (spatio-temporal analysis of longline CPUE, mathematical modelling, sex-ratio heterogeneity): this recommendation was partially followed and several papers presented on this topic (TWS/93/2/8, 15, 17, 19);

2- **Growth** : estimate the growth heterogeneity for both male/female and juvenile/adult tunas: some studies were presented with divergent results (TWS/93/10 and 20);

3- **Reproduction** : improve the knowledge and variability of reproduction modes: here too, some papers were presented (TWS/93/2/8, 15) and new studies are underway;

4- **Natural mortality** : estimate the rate of natural mortality, and its changes with age and/or sex as well as its limits of uncertainties: nothing was done in this particularly difficult field;

5- **Oceanographic conditions** : examine the impact of oceanographic conditions on the availability of fish to different fishing gears as well as on the productivity of the stock (fish availability and environment, impact of the interannual variability): several studies have been presented in this general field (TWS/93/2/14, 16, 21, 22, 23 and 3/6); a general western Indian Ocean oceanographic database is available and the software tool developed by ORSTOM for its use was presented.

No new general recommendations were made during the meeting, except the encouragement to continue and develop the national studies on growth and reproduction.

Agenda Item 3: *Interactions and tagging studies*

Three papers on interactions and four papers on tagging studies were presented in this section.

All three papers on interactions utilised a simulation technique. TWS/93/3/1 examined what would happen to the catch distribution between fisheries when increasing or decreasing catch by one gear for small tunas off the South China Sea coast. The model assumed an equilibrium status and changed the *F*-value of individual fisheries to examine the effects. The analysis suggested active interactions between the main fishing fleets and predicted small gains of total production by changing fishery patterns.

It was noted that the model included only a small local area and did not cover the whole distribution of the stocks examined. The difficulty of managing these fisheries was also noted because most of the juvenile small tunas were taken as by-catch of other small pelagic species in the main fisheries analysed.

TWS/93/3/2 applied the same type of analysis as TWS/93/3/1 to yellowfin tuna in the Indian Ocean. Two different models were used, aggregated and non-aggregated in space. Several hypotheses were examined: high and low recruitment hypotheses presented at the last Yellowfin Stock Assessment Workshop held in Colombo, 1991, and two levels of movement between areas. All

models showed significant interaction between longline and purse seine fisheries, although the extent of interaction was reduced when utilising the high recruitment hypothesis and when introducing seasonal and spatial distribution patterns.

The meeting recognised that the interaction predicted by the model was not observed following the rapid development of purse seine fishery. Corresponding to this comment, Dr. Tsuji presented a case where an insignificant interaction could be simulated when the relative size of habitat and fishing ground were introduced into a model. It was pointed that the total *F* level should be incorporated in the model for further work.

Three tagging activities were introduced: two carried in the Maldives in 1990 and 1993/94 (TWS/93/3/3), and the other under Soviet-Mozambique cooperation (TWS/93/3/7). The former project released 9,941 fish and 1,560 fish have been recaptured so far, while the latter released 260 fish with no recovery reported. The second phase of tagging started in the Maldives in 1993. This puts more emphasis on yellowfin and offshore skipjack tuna, as well as introducing tetracycline injection and double tagging.

The meeting affirmed the importance of improving publicity on tagging projects to increase the reporting rate. The need to specify objectives was suggested in order to obtain the best results under the constraint of financial resources, noting that tagging was a useful exercise but required huge budgets.

Dr. Majkowski introduced the research activities on tuna interactions in the Pacific, referring to the FAO brochure distributed. The Kiribati project, one of the FAO interaction projects, was introduced by Mr. Lawson, This addresses interaction between distant water industrial fisheries, local pole and line fisheries and artisanal fisheries, incorporating CPUE and tagging information.

The large scale yellowfin tagging proposal in the Western Indian Ocean was presented (TWS/93/3/4) for the consideration of the meeting. A long discussion ensued, especially on the objectives of the project.

The meeting strongly recommended the need for a large scale tagging project on yellowfin tuna in order to improve the understanding on stock structure, biological characteristics and stock status in the Indian Ocean. It was also agreed to concentrate activities in the Western Indian Ocean.

The meeting basically agreed to follow the objectives proposed at the last Yellowfin Stock Assessment Workshop in 1991, the first being to focus on stock structure and biological parameters and the second to address interactions between various fisheries, including coastal artisanal fisheries. It was suggested more emphasis be given on small scale stock structure such as sub-stocks, and also to incorporate national and regional tagging activities into the project. It was noted that, if only the offshore area was covered, there was high possibility of failing to cover the overall stock distribution. It was also noted that the cost-efficiency of the project would be improved significantly by involving national and regional tagging activities in the project.

The meeting also agreed not to restrict the possible methodologies used to fulfil the objectives. A baitboat is the most probable means of catching many fish for tagging, but the use of other methods including handline, purse seine, longline and coastal artisanal gears should be explored when appropriate for the objectives.

The meeting requested IPTP to organise a small working group within the next year to develop a final document of the proposal based on the discussions in this Consultation.

Agenda Item 4: *Progress Made in Research and Data Collection*

1. Tuna fishery statistics in the western tropical Pacific

A presentation on tuna fishery statistics in the western tropical Pacific (TWS/93/4/3) highlighted work conducted at the South Pacific Commission concerning the collection of daily catch and effort data, catch and effort data aggregated by time-area strata and annual catches by vessel nationality and gear type. Issues discussed included institutional arrangements, coverage of domestic and

distant-water fishing nation fleets, port sampling, observer programmes, by-catch and discards, data confidentiality and high seas catch statistics.

2. Catch and landing statistics of the Mauritian tuna fisheries

Document TWS/93/4/5 presents a summary of tuna landings of longliners and Mauritian purse seiners tuna and catch statistics of the Mauritian artisanal fishery from 1987 to 1992, and an analysis of the catch and effort statistics, spatial distribution and size-frequencies of skipjack from the purse seine fishery. Each boat uses 10 to 12 artificial drifting payaos. At the end of each cruise, they are left at sea to concentrate fish which the vessel will catch during the following trip.

3. The second regional tuna programme of the "*Association Thonière*" (*Commission de l'Océan Indien*)

The second phase of the Regional Tuna Programme (PTR2) of the *Association Thonière* was presented (TWS/93/1/12). This has been funded for three years by the EDF for ORSTOM execution in collaboration with national support centres in Comoros, Madagascar, Mauritius, Seychelles and La Réunion. Eight scientific projects cover, for the western Indian Ocean tropical tunas, the collection and analysis of statistics, population dynamics, behaviour and migrations, biology, oceanographic and biological environment and fish aggregation around logs, FADs and sea mounts. The feasibility of starting an albacore fishery is also being evaluated from historical and environmental data.

4. Purse seine fishery trends in the western Indian Ocean from data collected in Victoria (Seychelles), 1984 - 1992

This paper (TWS/93/1/13) compares 1992 purse seine fishery data with the results from 1984. Total catches increased by 14%, with an increase in effort of 11%. Most of the additional catch came from non-EEC fleets, in particular the Japanese. The shift from fishing on free to associated schools seems stable. Yellowfin catches declined strongly in the first semester then recovered, but skipjack catches increased by 50% over the year. On the whole, CPUE remained stable, with a weak first semester and a strong ending to the year.

5. Status of the IPTP database

The status of the IPTP database was presented (TWS/93/4/2). Data are collected on 19 species of tuna and tuna-like fish, covering the catch of 41 countries, mainly through liaison officers or sampling programmes. The IPTP data are in five major databases, with an additional database for tagging data.

The nominal catch database is currently being verified. Problems were identified with landings reported instead of nominal catch and with non-calendar year time frames in which several national statistical systems are reporting. Further problems exist with respect to national statistical systems which do not record information at the species level. Indonesia, for example, has only 4 categories of species covering respectively the large tunas and billfishes, skipjack, the neritic tunas and the seerfishes. Sampling schemes thus have to be set up at the fishery-type level to provide the necessary raising factors. Furthermore, despite the fact that fisheries are ranging further afield, few national statistical systems record the catch locations. Finally, the number of gear types is too large and includes gears which do not normally catch tunas.

There is thought to be substantial non-reporting of data from longliners under flags of convenience, Taiwanese longliners of less than 50 GT which do not report to their national statistical systems and chartered vessels which report neither to the flag country nor to the coastal country. These situations are known to exist in Bali, Jakarta, Penang, Colombo, and Oman. In India, catches from chartered vessels are reported in the national statistics. Pakistan will also send the data to IPTP. In Penang there is an IPTP sampling scheme. IPTP has sent forms to cover transhipments to liaison officers. A major problem is to avoid double reporting and it is thus vital, both in the transhipment data and from flag state data to identify precisely the fleets covered. It is hoped to eventually

constitute a registry of vessels fishing tuna in the Indian Ocean. In the absence of detailed catch figures, estimates of non-reported catches could thus be made, based on the production of similar vessels for which data are available.

The problem of modification of the boundaries of FAO fishing areas was discussed in relation to South Africa, Australia, Indonesia and India, either because the boundaries chosen do not correspond to state/province boundaries used in the national statistical systems, or because they straddle known fisheries or stocks. This could be a relatively slow process. Furthermore, the new boundaries could be appropriate for tunas, but inadequate for other species. This question will be followed up by FAO in consultation with the countries concerned.

In relation to size-frequency data, many scientists and institutes are reluctant to provide data to IPTP, presumably because they intend to use them at some later date. It may be necessary to provide some guarantees in these cases that data supplied to IPTP will not be used without prior reference to the "owners".

Finally, it was proposed that all tagging data should be centralised at IPTP as recommended during the Yellowfin workshop.

6. Tuna research activities of the Seychelles

Document (TWS/93/4/9) presents the SFA research programme. SFA is now recording logbook data from the purse seine and longline fleets with a package prepared by ORSTOM. IPTP is currently installing a processing package designed to produce custom reports, as well as the confidential monthly reports, the SFA Tuna Bulletin, *Association Thonière* reports, and IPTP reports. Catches by European Community (EC) and Japanese purse seiners are sampled for size and species composition. A research observer programme based on foreign purse seiners licensed in the Seychelles was started in November 1985. This operation is aimed at collecting biological data, in addition to that found in logbooks and at transhipment. In early 1993, 16 FADs where anchored within the Seychelles Exclusive Economic Zone (EEZ) . This programme is under the Regional Tuna Project 2 and is financed and technically assisted by the *Association Thonière*.

7. Statistiques et estimateurs des pêcheries thonières tropicales à la senne

The report of this Working Group (TWS/93/4/4) was first presented at a meeting organised to review the ORSTOM statistical systems on tuna in the Atlantic and Indian oceans and goes deeply into the manner in which sampling should be conducted. Some recommendations were made concerning the classification of boats for fishing power and the importance of separating catch made on log or free schools. In sampling the catches of purse seiners in the Indian Ocean, it was found preferable to first sample for species composition, then sample each species for size composition, rather than attempting to sample for both features simultaneously. During the meeting, a statistician worked on the comparison of sampling rates in the Indian and Atlantic oceans. The importance was underlined of conducting an analysis of the sources of variability before building any stratification.

8. Artisanal tuna fishery statistics in Hormuzgan, Islamic Republic of Iran

This document (TWS/93/4/1) presents the seasonal variations in the species composition of the catch along the coast of Iran. Those variations were related to a possible change in fishing strategy and migration of neritic tunas between the Persian Gulf (winter) and the Gulf of Oman (summer) and switch in species caught in the Gulf of Oman in winter when the yellowfin tuna moves in and replaces longtail tuna as the major component of the catches. Further analysis of the length-frequencies and tagging experiments could help to clarify the relationships.

Agenda Item 5: *Any other matters, Conclusions and Recommendations*

The dissemination of information on the activities of IPTP and on new developments in tuna fishing activities, statistics and research was discussed and several options were reviewed, including a newsletter or a the production of circular letters containing information on important developments.

The necessity of a newsletter was recognised, but the uncertainty on the future of IPTP had prevented its immediate production. Participants highlighted the need to include information on progress in data collection, on current research and on meetings. Lists of new publications from within and outside the region could also be included. For a newsletter to be produced, it is essential that contribution of articles and other information should come from scientists and institutions active in tuna research and development in the region. The requirement to better integrate research activities through sub-regional meetings was also recognised.

It was suggested that the Expert Consultation should be held as an annual event, as tuna fisheries were developing at such a pace that it was not possible to cope with the volume of information and to react to management needs with a two-to three year gap between meetings. It was decided, nevertheless that this would not be possible within the staff and budgetary constraints of IPTP, but that sub-regional meetings of species working groups on specific subjects should be organised. The biology and stock assessment of seerfishes and longtail tunas, particularly in the Arabian Sea and the Gulfs, were identified as an urgent subject priority.

The secretariat stressed that a workshop could be organised only if the countries concerned were ready to provide the necessary data. Pakistan, India, Iran and Sri Lanka announced their readiness to provide all information available on seerfish and longtail tuna and declared their interest in participating in a workshop.

The problem incurred by IPTP in obtaining length-frequency data on a regular basis was then discussed. It appears that several scientists are reluctant to provide such data before this material is used in publications. A possible solution to this would be the introduction of a clause of confidentiality, for a period of around five years, so that the data could be used only with the permission of the scientist having generated the data set. Another solution to this problem would be the possibility of using the data freely but in a collapsed format.

Appreciation was expressed on the positive effect of the activities of the *Association Thonière* in the field of tuna research. The recent efforts by IPTP in reviewing the data time series in its database in relation to the most reliable sources of information were strongly endorsed. Furthermore, the emphasis placed on acquiring biological and statistical information on small tunas in the Arabian Sea and the Gulfs was judged to be appropriate and timely.

Finally, the participants reaffirmed the necessity of reviewing the recommendation made by previous Expert Consultations at each subsequent meeting.

Recommendations

General

1. FAO, UNDP and the Committee for the Management of Indian Ocean Tuna of the Indian Ocean Fishery Commission should, until the proposed Indian Ocean Tuna Commission becomes fully operational, ensure the continuation of operation of IPTP with sufficient manpower and operational funds for the continuation of its activities in:

   (i) data collection, and processing,

   (ii) coordination of biological and stock assessment research and

   (iii) assistance to developing countries in such research

Statistics

1. All countries should provide IPTP with timely statistics, using the IPTP formats, including transhipment data by foreign vessels, providing details on how this information was generated.

2. IPTP should be provided with the necessary funds and personnel to design and operate tuna sampling schemes in those countries where national statistics do not provide suitable information on tuna fishing.

3. The countries in which tuna sampling programmes are organised should take the necessary steps to take over these sampling schemes after the first year of full implementation.
4. IPTP should document all changes and amendments of statistical time series, and this process should be open to peer review.
5. IPTP should implement a revision of the present statistical areas, taking into consideration the suggestion presented in working document TWS/93/4/2, and FAO should examine the possibility, in relation with the countries directly concerned, of revising these areas.
6. The countries should undertake to provide IPTP with updated length-frequency data on the major tuna and tuna-like species.
7. All countries should ensure that data provided to IPTP conform to the standards contained in the report of the Workshop on Yellowfin Tuna held in Colombo, Sri Lanka in 1991 (Appendix V).
8. All countries and IPTP should compile available data on by-catch, including that of sharks, and accidental catches of non-tuna species.

Tagging

Recognising the necessity for further information on the stock structure, biological parameters, stock turnover and migration, the participants recommended that IPTP should :

1. facilitate the revision, by a small group of experts, of the tagging proposal submitted to this Expert Consultation and
2. investigate sources of funding for the execution of proposal for large-scale tagging,

taking into account that

(i) tagging should concentrate on yellowfin tuna in the areas fished by industrial purse seiners,

(ii) the bulk of tagging should be undertaken using live-bait vessels, not excluding a possibility of using other gears that would permit to tag large fish and

(iii) the project should encourage and integrate national coastal tagging operations, making maximum use of national research vessels and local commercial vessels, including also species other than yellowfin tuna.

Small Tunas, Seerfishes and Billfishes

1. Countries should provide catch statistics separately for each species rather than grouped by broad species groups and should also supply fishing effort data.
2. The work on the biology of these species should be continued, particularly for age validation, reproduction and migration.
3. IPTP should convene a regional workshop to pool and analyse data and other information on seerfishes and longtail tuna caught in the northern Arabian Sea.
4. The potential for increasing the catch of swordfish should be examined.

Stock Status

Noting the considerable uncertainties in the assessment of the status of Indian Ocean stocks of tuna and tuna-like species and the lack of a mechanism for effective management of fisheries targeting these species, the participants were of the opinion that:

1. Caution should be exercised with large uncontrolled increases in fishing effort directed at albacore, bigeye and yellowfin tuna (oceanic tunas) as well as longtail tuna and narrow-barred Spanish mackerel (neritic species).
2. They recognised that for yellowfin, the intensity of fishing is largely unknown (low to close to maximum sustainable).

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Appendix II

List of Documents

Agenda Item 1: *Review of National Fisheries*

TWS/93/1/#	Author(s)	Title
1	Leontiev, Sergey	Russian tuna fisheries in the Indian Ocean
2	James, P.S.B.R.	Review of the National Tuna Fishery in India
3	Sudarsan, D and M.E. John	Oceanic Tuna Fishery in India - Recent Trends
4	Naamin, N.	Review of tuna fishery in the western part of Indonesian waters - Indian Ocean Side
5	Raja Bidin B. Raja Hassan	The recent trend for Malaysian tuna fisheries in the Indian Ocean
6	Dayaratne, P.	Tuna Fisheries in Sri Lanka - Present Trends
7	Dayaratne, P.	Observations on the changes in species composition of the large pelagic fisheries in Sri Lanka
8	Hsu, C.C. and H.C. Liu	Recent Taiwanese tuna fisheries in the Indian Ocean
9	Poreeyanond, Dhammasak	Review of tuna fisheries of Thailand in the Andaman Sea, 1991-1992
10	Hafiz, A and Anderson, C.	The Tuna Fishery of Maldives - An update
11	Majid, A. and A. Imad	Present status of tuna fisheries in Pakistan
12	Pianet, R.	The second Regional Tuna Programme of the "Association Thonière" (Commission de l'Océan Indien)
13	Pianet, R.	Purse seine fishery trends in the western Indian Ocean from data collected in Victoria (Seychelles), 1984 - 1992
14	Anon	National report of Spain
15	Firoozi, A. Reza	The Status of tuna and seerfishes in Iran
16	Pianet, R.	National Report of France

Agenda Item 2: *Review of Status of Stocks and Tuna Biology*

TWS/93/2/#	Author(s)	Title
1	Poreeyanond, Dhammasak	Catch and size groups distribution of tunas caught by purse seining survey in the Arabian Sea, Western Indian Ocean, 1993
2	Pillai, P.P., N.G.K. Pillai, T.V. Sathianandan and M.N. Kesavan Elayathu	Fishery Biology and Stock Assessment of *Scomberomorus commerson* (Lacepede) from the South-West Coast of India
3	Yesaki, M. and G. Carrara	Age, growth and natural mortality of Kawakawa (*Euthynnus affinis*) from the western Indian Ocean
4	Khorshidian, K. and G. Carrara	An analysis of length-frequencies of *Thunnus tonggol* in Hormuzgan waters, Islamic Republic of Iran
5	Dayaratne, P.	An assessment of frigate tuna (*Auxis thazard*) stocks in the southern waters of Sri Lanka
6	Kedidi, S. M., N. I. Fita and A. Abdulhadi	Dynamics of the king seerfish *Scomberomorus commerson* along the Saudi Arabian Gulf coast
7	Bertignac, M., and M. Yesaki	Preliminary assessment of the narrow-barred Spanish mackerel stock off Oman using catch-at-age data from length-frequency distributions by the Bhattacharya method

TWS/93/2/#	Author(s)	Title
8	Firoozi, A. and G, Carrara	An analysis of length-frequencies of *Thunnus albacares* in Iranian waters
9	Chang, S.K. and C.C. Hsu	An updated assessment of Indian albacore stock by ASPIC
10	Lee, Y.C. and H.C. Liu	The virtual population analysis of Indian albacore stock
11	Hsu, C.C.	The status of Indian albacore stock - A review of previous work
12	Hsu, C.C. and H.C. Chang	An ASPIC analysis of Indian bigeye tuna stock
13	Yohannan, T.M. and P.P. Pillai	Status of Stocks of Skipjack Tuna and Yellowfin Tuna at Minicoy (Lakshadweep)
14	Roger, C.	On feeding conditions for surface tunas (yellowfin, *Thunnus albacares*, and skipjack *Katsuwonus pelamis*) in the Western Indian Ocean
15	Sudarsan, D. and M.E. John	Further Studies on Biological Aspects of Yellowfin Tuna in the Indian EEZ
16	John, M.E. and D. Sudarsan	Distribution Pattern of Yellowfin Tuna in Andaman and Nicobar Seas (India) as Observed in Tuna Longline Surveys with a Note on Influence of Thermal Boundaries on the Stock Distribution
17	Nishida, T.	Considerations of stock structure of yellowfin tuna (*Thunnus albacares*) in the Indian Ocean based on fishery data
18	Uozumi, Yuji	The CPUE trend for albacore in the Indian waters caught by Japanese longline fishery
19	Nishida, T.	Analysis of yellowfin tuna in the Indian Ocean by the Immature-adult dynamic model
20	Stequert, B., B. Ramcharrun, J. M. Dean and J. Hansbarger	Preliminary studies of age and growth of yellowfin tuna (Thunnus albacares) in the western Indian Ocean
21	Marsac, F.	Yellowfin tuna fisheries in the past decade: Indian Ocean versus eastern Atlantic and eastern Pacific Oceans
22	Dagorn, L., M. Petit, J-P. Hallier, P. Cayré and M. Simier	Does tuna school size depend on fish size?
23	Cayré, P. and F. Marsac	Modelling the yellowfin tuna (*Thunnus albacares*) vertical distribution using sonic tagging results and local environmental parameters
24	Maldenyia, R.and P. Dayaratne	Changes in catch rates and size composition of skipjack (*Katsuwonus pelamis*) and yellowfin tuna (*Thunnus albacares*) in Sri Lanka
25	Hallier, J-P.	Purse seine fishery on floating objects : what kind of fishing effort? what kind of abundance indices?
26	James, P.S.B.R. and P.P. Pillai	Current Research on Tunas in India

Agenda Item 3: ***Interactions and Tagging Studies***

TWS/93/3/#	Author(s)	Title
1	Bertignac, M. and J. Morón	Preliminary assessment of interactions in the fishery for small tunas off the South China Sea coast of Thailand and Malaysia
2	Bertignac, M.	Preliminary assessment of interactions between Indian Ocean yellowfin tuna fisheries
3	Waheed, A. and C. Anderson	The Maldivian tuna tagging programme
4	Ellway, C. .	Yellowfin tuna tagging proposal for the western Indian Ocean
5	Bertignac, M., P. Kleiber and Ali Waheed	Analysis of Maldives Islands tuna tagging data with a spatially aggregated attrition model
6	Bertignac, M.	Analysis of skipjack (*Katsuwonus pelamis*) tagging data in the Maldive Islands using a spatial tag attrition model
7	Romanov, E. V., R. de P. e Silva	Preliminary results of tuna tagging during Soviet-Mozambican tagging programme in Indian Ocean

Agenda Item 4: ***Progress made in Research and Data Collection***

TWS/93/4/#	Author(s)	Title
1	Razmjoo, H.	Artisanal tuna fishery statistics in Hormuzgan, Islamic Republic of Iran
2	Morón, J. and Ardill, D.	Status of the IPTP database
3	Lawson, T.	Tuna Fishery Statistics in the Western Tropical Pacific: the Agony and the Ecstasy
4	Pianet, R.	Statistiques et estimateurs des pêcheries thonières tropicales à la senne - Compte rendu de la réunion du groupe de travail ORSTOM, Paris, 2 - 5 juillet, 1991
5	Norungee, D. *et al.*	Catch and landing Statistics of the Mauritian tuna fisheries (1987-1992) and an analysis of the skipjack catch of the Mauritian purse seine fishery.
6	Hastings, R. E. and R. Jacques	Tuna research activities of the Seychelles

Appendix III

Speech of the Hon. Jacquelin Dugasse, Minister of Agriculture and Marine Resources of Seychelles at the opening of the 5th. Expert Consultation on Indian Ocean Tunas

Your Excellencies

Distinguished participants

Ladies and Gentlemen

It gives me great pleasure on behalf of the Government of Seychelles and on my personal behalf to welcome you to this Expert Consultation on Indian Ocean Tunas. It is indeed a privilege to host this fifth session in Seychelles.

I am delighted to note amongst us, the representatives of so many countries and especially of distinguished scientists from within and outside our region.

Tuna is not only one of the most important marine resources of the Indian Ocean but it is also a unifying force in view of its regional dimension due to its migratory nature. For some of our countries it is a vital resource, a source of food, employment and revenue.

Until very recently although tuna were always plentiful in Seychelles waters, it was exploited mostly by foreign longliners. Hence its impact in the economy was very limited. it is only with the advent of French and, shortly afterwards, Spanish purse seiners in the early 80's that saw a complete transformation of the fisheries scene. In 1980 there was only one purse seiner licensed in Seychelles; by 1985 this number had increased to 50. The transhipment activity increased in the same proportion to reach 212,000t in 1989, making Port Victoria the most important tuna port of the region.

Fortunately for Seychelles and for the scientific community in general, this development-it was closely monitored. The Seychelles Government at an early stage realised the importance of setting up comprehensive tuna database. We were fortunate to receive the assistance of the French research organisation, ORSTOM and of the FAO. The assistance of ORSTOM is still very active and that of the FAO though IPTP is sought from time to time. Through the Association Thonière's Regional Tuna Project, scientific support is given to the countries of the Commission de l'Océan Indien. In fact at this moment, an IPTP staff member is assisting SFA in writing a new tuna programme. This mission is partly being financed by the regional tuna project of the Association Thonière.

We believe that research and development should go hand in hand. Your research work should enable governments at a national as well as regional level to better manage tuna stocks. It is for this reason that the Seychelles Government strongly supports the creation of the Indian Ocean Tuna Commission (IOTC) and is anxious to see the finalisation of the arrangements for its establishment.

IOTC will reinforce the research work being carried out at present. We also believe that national research institutes have to be strengthened in order for IOTC to become effective and truly regional. Though human resources development is a key factor, it is a very costly and long term investment, in particular for developing countries and more especially small island states with so many priorities and needs.

Through earning a fair return from these tuna resources, coastal countries will be able to gradually build up the infrastructure necessary, not only for fisheries development, but also for fisheries research. On their own, some countries might not be able to attain these objectives, but regional or international organisations can play a great role and act as a catalyst. For instance, several countries of the Western Indian region agreed on a Convention for the establishment of the Western Indian Ocean Tuna Organisation (WIOTO). With the ratification of the Convention by 3 countries the organisation is now effective and will become operational by early 1994.

While the papers and the meeting room discussions will form the backbone of the meeting, informal discussions and exchanges in corridors and at social gatherings are as important as the formal presentations. I am confident that informal interactions among participants will enable existing relationships to be strengthened and new relationships to be established as well as increasing our knowledge of the tuna stocks of our region.

Last but not least, whilst I am certain that this conference will be a learning experience for some of you, I hope you can find time to enjoy our island as well as our culture.

May I now, with great pleasure, declare this 5th session officially open.

Appendix IV

Provisional Agenda

Monday 4 October

Opening Ceremony	0900-0930
Adoption of the Agenda and Arrangements for the Meeting	1000-1015
Agenda Item 1: *Review of National Fisheries*	1015-1230
Agenda Item 1 (Continued)	1400-1545
Agenda Item 1 (Continued)	1600-1730

Tuesday 5 October

Agenda Item 2: *Review of Status of Stocks and Tuna Biology*	0900-1045
Agenda Item 2: (Continued)	1100-1230
Agenda Item 2: (Continued)	1400-1545
Agenda Item 2 (Continued)	1600-1730

Wednesday 6 October

Agenda Item 2: (Continued)	0900-1045
Agenda Item 2: (Continued)	1100-1230
Agenda Item 3: *Interactions and Tagging Studies*	1400-1545
Agenda Item 3 (Continued)	1600-1730

Thursday 7 October

Agenda Item 4: *Progress made in Research and Data Collection*	0900-1045
Agenda Item 4: (Continued)	1100-1230
Agenda Item 5: *Any other Matters, Conclusions and Recommendations*	1400-1545
Agenda Item 5: (Continued)	1600-1730

Friday 8 October

Field Visit: *SFA and Victoria Fishing Harbour*	0900-1230
Agenda Item 6: *Presentation of Report*	1400-1545
Agenda Item 6: (Continued)	1600-1730

Appendix V

Recommendations on statistics from the report of the Workshop on Stock Assessment of Yellowfin Tuna in the Indian Ocean (7-12 October 1991)

The Workshop was greatly impressed with the marked improvement in the yellowfin tuna statistics collected by IPTP during the past 10 years. They stressed the importance of IPTP bridging the interval until a permanent tuna body is established, to assure continuity in the statistical information: disruption of this statistical collection system would be disastrous for the scientific community, and extremely costly to all countries and organizations involved to implement another system to take its place.

The Workshop noted that the following recommendations made at the Expert Consultation on Tunas in the Indian Ocean held in Bangkok in 1990, were still relevant:

- countries should improve reporting of the main tuna species in catch statistics; countries should cross check catch statistics with landings for industrial longline fisheries, to improve accuracy;
- Indonesia should introduce a log book system for its industrial purse-seine and longline fisheries;
- IPTP should continues to assist coastal countries to maintain and improve sampling programmes;
- IPTP should, as ICCAT, report statistics corrected for inconsistencies between reporting countries in its data summaries, in lieu of official flag figures;
- every country should continue to collect reliable statistics in the smallest time-area strata possible, and to submit them to IPTP on a timely basis; the largest recommended strata is 5° square by month;
- countries with historical data sets that have not yet been submitted to IPTP should check those data and submit to IPTP in the required format as soon as possible;
- the recommendation to record separately free and log school catches made at the Expert Consultation has been implemented for the French and Spanish purse-seine vessels; this system should be continued and adopted by the other purse-seine fleets operating in the Indian Ocean.

The Workshop made the following additional recommendations:

- IPTP should encourage countries implementing statistical collection systems to adopt standard codes and recording forms as set up for the workshop to facilitate data exchange and analyses; the area of IPTP coverage should be extended from 30°E to 15°E to include yellowfin catches made off South Africa as these fish are part of the Indian Ocean stock; IPTP should also consider reducing the coverage area from 150°E to 140°E to exclude Pacific Ocean yellowfin tuna captured off the east coast and south-east corner of Australia;
- Maldives should expand their sampling programme to other sites to obtain size data for yellowfin tuna more representative of the catches;
- Indonesia should initiate a sampling programme to collect size data of catches made by national and foreign flags vessels based in Jakarta and Bali;
- India should investigate means of initiating a sampling programme to collect size data of catches made by chartered vessels operating in its EEZ;
- free and log school purse-seine size frequencies should be recorded separately in the same way as with catches.

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WHITE, T. F. and M. YESAKI, The status of tuna fisheries in Indonesia and the Philippines. September, 1982. 62p.

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YONEMORI, T., J. C. B. UKTOLSEJA, and G.S MERTA, . Tuna tagging in Eastern Indonesian waters. February, 1985. 33p.

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LEWIS, A. D., Review of national tuna tagging experiments in the Philippines, Indonesia and Malaysia. December, 1992. 54p.

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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.

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IPTP/90/GEN/18	Report of the Expert Consultation on Stock Assessment of Tunas in the Indian Ocean, Bangkok, Thailand, 2-6 July, 1990. September, 1990. 96p.
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Volume 3	Collective Volume of Working Documents presented at the Expert Consultation on Stock Assessment of Tunas in the Indian Ocean, held in Mauritius, 22-27 June, 1988. October, 1988. 418p.
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Volume 5	Collective Volume of Working Documents presented at the Fourth Southeast Asian Tuna Conference, held in Bangkok, Thailand, 27-30 November, 1990. June, 1991. 230p.
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