REPORT OF THE SEVENTH EXPERT CONSULTATION ON INDIAN OCEAN TUNAS

Victoria, Seychelles

9-14 November 1998

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INTRODUCTION

The 7th Expert Consultation on Indian Ocean Tunas was held at the Victoria Conference Centre in Victoria, Seychelles from the 9th to the 14th November 1998. It was attended by 52 participants from 15 countries (Appendix I) and representing the International Commission for the Conservation of Atlantic Tunas (ICCAT) and the South Pacific Community (SPC), in addition to staff from the Food and Agriculture Organization (FAO) and the Indian Ocean Tuna Commission (IOTC). During the course of the deliberations, 45 descriptions of fishery developments and scientific papers and 6 information papers were presented (Appendix II).

Opening of the Meeting

Mr. David Ardill, Secretary of the Indian Ocean Tuna Commission, gave an overview of the developments in the tuna fisheries in the Indian Ocean and of the institutional developments which are occurring. He stated that the participants were expected to address the request for recommendations from the Second Session of the IOTC and other scientific issues relevant to the fisheries for tunas and tuna-like species in the Indian Ocean. He also stressed that the scientists present were attending in their individual capacity rather than as representatives of their governments or institutions.

The Meeting was then opened by His Excellency, Mr Ronny Jumeau, Minister of Agriculture and Marine Resources of Seychelles in the presence of guests from the Diplomatic Corps and the Seychelles Government. In his address, he mentioned the effects of the recent oceanographic events on tuna landings in Seychelles. He then stressed the importance of tuna fisheries for the Seychelles and the Indian Ocean in general, and thus of regional management through the IOTC. Finally, Mr. Jumeau insisted on the obligation for accurate and timely statistical reporting, stating that this should apply equally to vessels flying flags of convenience.

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 V). The Chairman, Moderators and Rapporteurs were appointed as follows:

Chairman of the Meeting: Phillipe Michaud

Agenda Item I: *Review of Fisheries*

Moderator: Pilar Pallarés

Rapporteurs: Julio Morón and Renaud Pianet

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

Moderator: Gary Sakagawa

Rapporteurs: Tom Polacheck (Yellowfin tuna)

Jacek Majkowski (Bigeye tuna and skipjack tuna)

Alejandro Anganuzzi (Southern bluefin tuna)

Sachiko Tsuji (Albacore tuna and Swordfish)

Shiham Adam (Other species)

Agenda Item III: *Environment, Tagging and Interaction Studies*

Moderator: Alain Fonteneau

Rapporteur: Francis Marsac

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

Moderator: V.S.Somvanshi

Rapporteur: Tim Lawson

Agenda Item V: *Constitution of Working Parties*

Moderator: David Ardill

Rapporteur: Jacek Majkowski

Agenda Item VI: *Conclusions and Recommendations*

Moderator: Tim Lawson

Rapporteur: Alejandro Anganuzzi

Presentation and adoption of the Report

Rapporteur: Alejandro Anganuzzi

AGENDA ITEM I - REVIEW OF FISHERIES

A summary of the papers dealing with information on fisheries presented in this Session is provided below.

Australia

The development of commercial tuna fisheries in Australia since the 1950s, involving domestic and foreign, mainly Japanese, fishing is summarised. Domestic fishing focused on southern bluefin tuna, with skipjack and yellowfin tunas taken as by-catch. More recently, longline fisheries targeting bigeye, yellowfin and swordfish have developed and are expanding. Fishing methods, which began with pole-and-live-bait fishing off SE Australia, extended to longlining, purse seining and trolling off southern and western Australia. Japan's catch targeted yellowfin, southern bluefin, albacore and bigeye tunas, as well as billfish. After 1979, Japan fished inside the Australian Fishing Zone under a series of bilateral agreements, until this was suspended in 1997, and under joint ventures from 1988-95. As the original cannery-based domestic fishery lapsed due to low profitability, the domestic southern bluefin tuna fishery changed to pole fishing for Japan's sashimi market and, in the 1990s, moved substantially to cage-reared southern bluefin tuna, fresh chilled or frozen for the Japanese market. The 1997 domestic catches in the Indian Ocean off Western Australia were 300 t (yellowfin tuna), 60 t (bigeye tuna), and 40 t broadbill swordfish - double to triple the 1996 catches. Catch data for minor catches of tunas and tuna-like species using other methods and the pelagic species caught by recreational and game fishers off Western Australia are also described.

Paper INF/98/2 comprises the tuna sections of the 1997 Fishery Status Reports of the Australian Bureau of Resource Sciences. It covers yellowfin and skipjack tunas in the eastern tuna and billfish fishery, the southern bluefin tuna fishery, and the western tuna and billfish fishery. Issues summarised include (as appropriate) fishery status, reliability of the assessment, current catch weight and value, management objectives and methods, and environmental issues.

China(Taiwan)

Taiwanese vessels caught about 92,000 t of tuna and tuna-like species in 1997, from 313 longliners (larger than 100 GRT), a decrease of about 7,000 t from 1996. The catch of yellowfin tuna decreased by about 9,500 t, that of albacore by 1,700 t, while the bigeye tuna catch increased by 4,000 t, and swordfish catches remained at the same level. Major changes for catch statistics were carefully re-examined and reported. An Observer programme, a sampling programme, and the promotion of Deep-sea Fisheries Real-time Monitoring and Transmitting System (DFRMTS) have supplemented the statistical system. The DFRMTS was completed in 1996 and successfully used in 11 experimental trips, and has been promoted to 60 vessels in the three major oceans.

Questions were raised from the participants in relation to the large proportion of swordfish in the Taiwanese longline catch. A change in part of the fleet to shallow longlines was identified as the main cause of the increase in swordfish catch.

France

The status of French tuna fishing in the Indian Ocean was presented in two parts: one referred to the purse seine fleet operating in the and other referred to the longline fleet operating from La Réunion.

From the beginning of the fishery in the early 1980s, France has been one of the main fishing nations using industrial purse seiners in the Indian Ocean. The fleet is rather homogeneous and operates in a wide area covering the western side of the Indian Ocean, centred on the Seychelles Islands. All catches are unloaded in Victoria (Seychelles) and Antsiranana (Madagascar) and then either transhipped or processed in the local canneries.

Nominal effort has remained quite stable (15-17 purse seiners) throughout the 1990s, although there has been a shift towards larger boats; the main striking fact was the arrival in 1996-1997 of two large tuna boats (2.000 GT) equipped with their own processing unit and able to process tuna at sea (loins). Catches have been quite stable since 1990, between 80,000 and 100,000 t, exhibiting a relative decrease from 1994. However, the 1997 catch shows a small increase.

Two major facts can be noticed during that period:

a) A marked shift toward log-school fishing since 1990, which now yields 75 % of the catch, up from 50 %;

b) An extension far to the East of the fishery during the last quarter of 1997 and the first quarter of 1998, in relation with the last ENSO event, particularly strong in Indian Ocean at the end of 1997; this move was associated with high catch rates (TWS/98/2).

The catch sampling shows a relatively stable size distribution for the three tropical species from 1995 to 1997, mean weights remaining stable for free schools and decreasing slightly for log schools.

Research

This period has seen the end of the second “Tuna Regional Project”, funded by European Union through the “Association Thonière”, under the Commission de l'Océan Indien (COI). The main results of this programme were presented at the “Conférence Thonière” organised by the COI (Mauritius, November 1996) and a synthesis is being edited.

This period was also characterised by two other projects funded by the European Union (EU) and run in co-operation between French and Spanish scientists on both the Indian and Atlantic oceans. The first - dealing with associated catches in relation to purse seining through an extensive observer program – had its main results presented at the “Conférence Thonière”, while the second was aimed at improving the size and species composition estimates on the European purse-seine fisheries through a thorough analysis of samples collected since 1990 (TWS/98/43). This programme lead to the design of a new sampling scheme, which has been implemented since 1998, and to the design of a new relational database and data-entry system to be used for European data.

For the last five years, the Reunion Fishery has experienced rapid growth and development in all segments (artisanal, Antarctic deep-sea, and longline fisheries) in a marked contrast to the situation experienced by the huge majority of other fishing communities in the European Union.

The most rapid of these developments is in the longlining sector, which began five years ago. The longline fishery has, since 1996, overtaken the artisanal fishery, with more than 2,300 t in 1997, and an active fleet of 21 vessels, which ranging from 9 to 33 m long. This fishery mainly targets swordfish *Xiphias gladius*, from the equator to 32° S, throughout the year, using deep-freeze conservation techniques.

The artisanal segment has also shown a rapid extension, thanks to the development of FAD-associated techniques. In Réunion Island coastal waters (up to 15 miles), more than 30 FADs now exist, exploited by local fishermen using small artisanal scale fishing units with troll and drifting handlines for the local market.

The occurrence of predation in the swordfish fishery by marine mammals is quite strong, reaching 30-40 % in certain areas. There seems to be a geographical effect, with more predation North of La Reunion. Avoiding that problem seems to be quite difficult.

Japan

Japan operates both longline and purse seine fisheries in the Indian Ocean. The longline fishery started in the early 1950s and originally targeted yellowfin and albacore tunas, but the targeting was shifted to southern bluefin and bigeye tuna after a development of deep freezer and Sashimi market in mid 1970s. This also caused a shift of the fishing grounds. In recent years, 200 to 400 boats operated in the Indian Ocean.

Commercial purse seining started in 1991 with 10 boats, after one year of experimental fishing. Purse seiners originally operated in the western Indian Ocean but then shifted to the eastern Indian Ocean with a change in the major landing port, from Seychelles to Phuket (Thailand). The number of boats has decreased gradually for economic reasons and now only three boats are operating. All boats operating in the Indian Ocean are required to complete logbook forms providing daily catch and effort information.

Longliners targeting southern bluefin tuna are also required to provide daily catch and effort information by fax, as well as size of all bluefin tuna caught . These data are compiled at the National Research Institute of Far Seas Fisheries to provide necessary data to fishery organisations. Research activities were concentrated on southern bluefin tuna, reflecting the concern of Japan on this species. The activities of Experimental Fishing Programme (EFP), Recruitment Monitoring Programme, and a proposal for this year's *Shoyo Maru* cruise were briefly presented.

India

India has two fisheries for tunas: the coastal fishery, catching small tunas, billfish and seerfish and the oceanic fishery mainly targeting yellowfin tuna.

The coastal fishery production increased to 91,780 t in 1997, comprising tunas (50.6 %), billfish (4.8 %) and seerfish (44.6 %). Oceanic tuna production was around 10,000 t from 1990 to 1997 and, thanks to the Indian government policy, there has been an increment of 1,828 t during the current year. Survey results have indicated rich longline fishing grounds for yellowfin tuna off the Northwest coast of India and in the Bay of Bengal.

India has fisheries agreements with China(Taiwan) longliners under joint-venture or as chartered vessels. Questions were raised in relation to possible double reporting of the catch in India and China(Taiwan) statistics for those vessels. It was noted that, in IOTC catch statistics, catches from chartered vessels which do not fly the Indian flag have been apportioned to the flag country. Joint-venture vessels are registered under the Indian falg and their catches are reported as Indian.

The Islamic Republic of Iran

The total tuna catch in Iran during 1996 was 72,920 t. The artisanal fleet produced a total of around 64,000 t, of which 44 % was yellowfin tuna, 26 % longtail, and the rest was skipjack and small tunas. The industrial fleet has one longline boat that caught 13 t in 1996 and 188 t in 1997. Iran operated two purse seiners in 1996 that caught 8,907 t. In 1997, three purse seiners were operating, with a total catch of 1,952 t.

Due to the sensitive fisheries conditions in the region and as a decision of the Iranian Fishery Company, the number of active vessels has not increased in recent years. As a conservation and management issue, Iranian authorities are going to require the increase of mesh size of yellowfin tuna gillnets. The Iranian Fisheries Research Organisation (IFRO) has been taking length frequency samples from artisanal fisheries for more than five years and has started covering industrial landings of purse-seiners since April 1998.

Mauritius

Mauritius has been serving as a transhipment base to Far East Asian tuna longliners. During the past four years, an annual average of 14,182 t of tuna and associated species were transhipped at Port Louis.

The Mauritian purse seine fishery has landed a yearly average of 5,279 t of tuna during the last four years. The Mauritian purse seine fleet has reduced from three boats to one. The Fishing area of the purse seiners during 1996 and 1997 was between 45°E to 85°E and 10°N to 12°S. Skipjack tuna dominated the species composition in the catch of the Mauritian purse seiners. Yellowfin tuna was caught in lesser quantities. The majority of the skipjack tuna caught by the Mauritian purse seiners during 1996 and 1997 were mature fish measuring between 43 cm and 53 cm, with a dominant size mode around 47 cm (from 32 to 72 cm). The majority of the yellowfin and bigeye tunas caught were juveniles measuring less than one metre.

Saudi Arabia

Saudi Arabia has fisheries in the Arabian Gulf and Red sea. In 1996, the reported catches of small tunas from each fishery were respectively 699 t and 392 t, while those of seerfish were 5,566 t and 2,640 t. The small tunas include kawakawa, longtail and dogtooth tunas, while the main seerfish is *Scomberomorus commerson*. The major gears used are handlines and gillnets, with some catch from traps and troll lines. Seerfish sells for 25 Rials per kilogram in Riadh, while small tunas fetch about 9 Rials.

Seychelles

Large scale industrial purse seining began in 1983 when the French and Spanish fleets moved into the western Indian Ocean from the tropical Atlantic.

The number of vessels taking licences to fish in the Seychelles EEZ has been increasing since 1984. In 1997, 58 vessels were licensed. The nominal fishing effort has increased steadily from 7,604 days fished in 1994 to 15,567 in 1997. The highest recorded catch of purse seiners fishing in the Western Indian Ocean was in 1995 when 307,135 t of tuna were caught. Since 1995, the catch has been decreasing, amounting to 272,509 t in 1997. The CPUE (t/fishing day) has been increasing steadily from 12.9 t/fishing day to reach a record level of 22.3 t/fishing day in 1994. Since 1994 there has been a constant decrease in the CPUE to 17.5 t/fishing day. Skipjack is an increasingly important part of the total catch. Since 1989 the purse seiners started to fish more on FADs.

In late 1997, most of the purse seiners moved to fish in the Eastern Indian Ocean and remained there during the fist quarter of the following year. This unusual movement was caused by the oceanographic effect of the El Niño phenomenon. Transhipment in Seychelles decreased due to purse seiners transhipping their catch in other ports.

Distant water fishing nations (DWFNs) began longlining for tuna in the western Indian Ocean in the early 1950s'. This was initiated by the Japanese and soon followed by the fleets of China (Taiwan) (1954) and Korea (1960). The number of licences issued for the Seychelles EEX and vessels licensed (vessel months) has been increasing steadily. The return rate of logbook remains poor. Japanese vessels have been reporting higher catch rates, averaging 0.6 kg/hook, than the fleets of China (Taiwan) and Korea.

A semi-industrial monofilament longline fishery started in Seychelles in October 1995. Currently, six local boats and one French longliner are fishing. Swordfish is the targeted species (around 60 %), followed by yellowfin and bigeye tuna.

One major problem of this fishery is the high rate of predation presumed to be by false killer whales and pilot whales. Two experiments were carried out by the private sector in association with a British university, to introduce electronic devices to scare marine mammals from the lines. However, the results were not very encouraging. Predation also seems to be affecting other longline fleets and some foreign fleets are forgoing to apply for fishing licences in the Seychelles EEZ because of predation.

Spain

The Spanish purse seine fishery started in the Indian Ocean in 1984, fishing for tropical tuna. Since the beginning, a logbook system has been implemented to get statistics of catch and effort, taking into account the fishing mode (in association with floating objects or free school). The coverage of the logbook system has always been 100 %. Together with the collection of catch and effort data, a two-stage sampling strategy was established to provide size and species composition information. The coverage of this type of sampling can be considered fairly good since 1991.

This system has been modified after the results of an extensive research program, conducted by the Instituto Español de Oceanografía (IEO) and the Institut de Recherche pour le Développement (IRD) from France. This analysed the tropical tuna sampling scheme and focused on improving the accuracy of the statistics. As a consequence of that programme, a new sampling scheme has been introduced in 1998 and data have been reprocessed to rebuild catch and effort data as well as size distribution of the catches. The same sampling system has been utilised to sample fleets flying flags of convenience belonging to Spanish companies.

Between 20 and 24 Spanish vessels have been fishing in the Indian Ocean since the end of the 80's. In 1997 the fleet size was 23 boats. The total catch increased continuously from 1984 to 1988. It was stable at around 100,000 t from 1988 to 1994, with a decrease in 1991 and 1992. After 1995, landings rose dramatically, due to a spectacular increase in the catch on artificial floating logs. In 1996 and 1997, the catch was close to 133,000 t.

Yellowfin tuna is the main component of catches on free schools, while fishing on logs targets skipjack tuna; in contrast, bigeye tuna is not targeted by this fishery. The relative catches of yellowfin (43 %) and skipjack (42 %) tunas are very similar and represent around 85 % of the total catch for the most recent years. The size distribution of the catch of yellowfin tuna presents a large range (30-180 cm) with three modes at 55, 110 and 130 cm. The size of skipjack tuna in the catch ranges from 30 to 78 cm, with only one mode close to 50 cm. The size range for bigeye tuna is between 30 and 164 cm, with a predominance of small fishes.

More longlining targeting swordfish has been carried out by Spanish boats in the Indian Ocean following experimental fishing in 1994 and 1995. Currently, there are about ten boats, with a provisional total catch of around 1,000 t.

A study was carried out on purse seine by-catch during 1995-96, by the IEO and IRD, financed by the EU. The species caught as by-catch in the purse seine fishery in the Indian and Atlantic Ocean were analysed through an observer programme that covered 10 % of the Spanish and French fleets.

A new one-and-a-half year project has been presented to the EU by the IEO and IRD to analyse the effect of technical improvements on fishing power for the Spanish and French purse seine fleets in the Indian and Atlantic oceans.

During 1996, one Spanish company made an agreement with Iran to fish in their waters, and extremely high catches of yellowfin tuna were obtained in a short period in the Gulf of Oman.

Sri Lanka

Over 3,000 boats are now engaged in tuna fisheries in Sri Lanka, with about 1,700 operating in offshore areas. "Multiday" operations are more frequent, producing a corresponding increase in effort. The average catch rate of the fleet operating in coastal waters is about 100 kg/fishing day, whereas in offshore waters, it ranges from 250 to 435 kg/ fishing day. Tunas and tuna-like species constitute 50 % of the total large pelagic catch in Sri Lanka.

In Sri Lanka a logbook system supplemented with port sampling programmes are used to collect fisheries statistics.

Thailand

The annual production of small tunas in Thailand varied from 4,548 to 16,845 t during 1971-1980, representing about 4 % of the total pelagic catch. The production increased rapidly, from 22,273 t in 1981 to 169,071 t in 1992 and has since fluctuated around this level. Small tuna was about 18 % of pelagic catches from 1984 to 1994.

Three main species of "small tunas" are caught commercially in Thai waters, namely longtail tuna (*Thunnus tonggol* Bleeker, 1951), kawakawa (*Euthynnus affinis* Cantor, 1850) and frigate tuna (*Auxis thazard* Lacépède, 1830). Longtail tuna is more abundant than the other two species. Small tunas of large size were found in deeper waters. Other species of tuna, including skipjack, yellowfin, bullet and dogtooth tuna are occasionally found in the Andaman Sea.

King mackerel drift gillnets and purse seines are used for catching “small tunas” in Thailand. Purse-seine fisheries were initially developed in 1982 to catch small tunas with the expansion of the tuna canning industry. The peaks of catch were affected by the monsoon seasons. The good fishing season for small tunas in the Gulf of Thailand and Andaman Sea occurs during Northeast monsoon period. This is opposite to the fishing season on the East Coast of Peninsular Malaysia, which has a limited time for fishing. Recently, pilot industrial purse seine operations have been started from Thailand.

Yemen

Yemen has a traditional artisanal fishery for tuna and tuna-like species. Wooden boats in the fishery are now being replaced by fibreglass boats with outboard motors. Handlines are generally used with live or dead bait or lures, as well as longline, driftnets, set gillnets and small purse seines.

Data were collected in three cooperatives for a range of years. These cooperatives handle about 75 % of the catch of tuna and tuna-like species marketed through the cooperative movement, averaging about 4,000 t per year. The share marketed directly has been increasing in recent years, however, and probably corresponds to three-quarters of the total catch. The main species are yellowfin and longtail tunas, kawakawa, Indo-Pacific bonito, Spanish mackerel and sailfish.

AGENDA ITEM II – REVIEW OF THE STATUS OF STOCKS

Introduction

A total of 14 papers were reviewed under this Agenda Item, covering a wide range of topics on Indian Ocean tunas and tuna-like species. The Second Session of IOTC instructed this Consultation to give priority to the identification of research needs and the formulation of recommendations that could serve as guidance for the future work of the Working Parties. Few papers analysed the condition of the stocks and crucial data, as well as the required time for conducting such analyses, were not available during the Consultation. Therefore, the participants to the Consultation concentrated mainly on reviewing fisheries statistics and in drawing general recommendations on the status of the stocks from general knowledge and experience with stocks in other oceans.

Yellowfin Tuna

Estimates of the yellowfin tuna catches in the Indian Ocean since 1987 are shown in Figure YFT-1. Purse seiners harvest approximately 47 % of the catch.

Figure YFT-2 illustrates the spatial distribution of the purse seine catches by set type. It should be noted that the yellowfin catch statistics have been revised somewhat since the last Consultation.

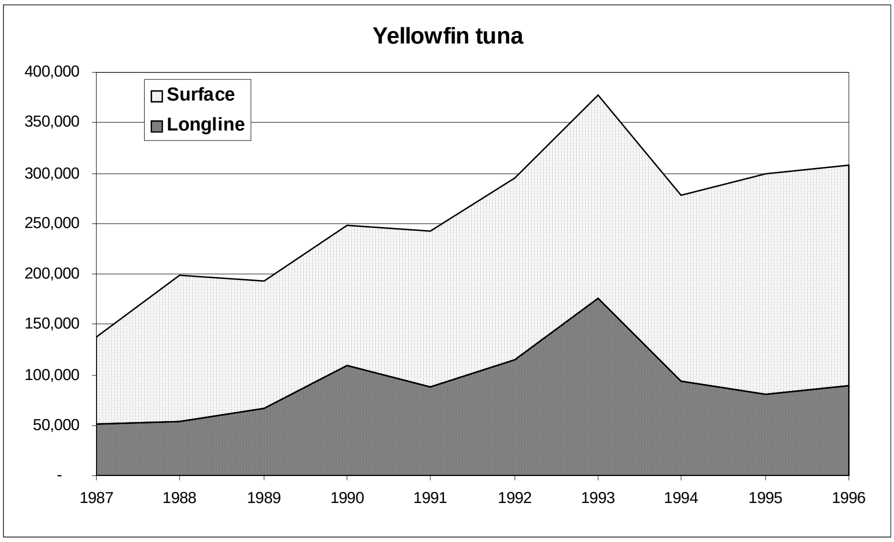

Figure YFT-1. *Recent catches of yellowfin tuna by gear type.*

Figure YFT-3 provides a CPUE index for purse seine fisheries in the Indian Ocean. The method used for calculating this index is described in Box I. In Figure YFT-4 the size distribution of yellowfin tuna in the catch of the purse-seine fleet is shown.

At the time of the last Consultation, the total yellowfin tuna catches from the Indian Ocean had been increasing steadily from 1983 to1993 largely as a result of the development of the purse seine fishery and an exceptionally large longline catch in 1993. Catches by bait boats and gillnetters were also generally increasing through this period. The 1993 catch is estimated to have been 365,000 t, which is the highest ever recorded. In 1994, total catches declined by 25 % from this peak, with drops of 54 % and 31 % in the longline and purse seine catches respectively. The decrease in catch by these two gears was partially offset by increased catches by other gear types. In 1995 and 1996 (the last year for which data were available) total catches once again increased, giving a 1996 catch of 306,000 t, 83 % of the 1993 peak. In 1993, 45 % of the yellowfin total was caught by longliners, while in the subsequent three years it was around 30 %, close to the 1991-92 level.

Box I: Method utilised for calculating a CPUE index.

An index of CPUE was calculated for yellowfin, skipjack and bigeye taken by purse seine fisheries. This index is the same as that often used for the French and Spanish tuna fisheries in the Atlantic. Those indices were estimated as explained thereafter:

Each yearly index is the average of 24 average CPUEs calculated for each fortnight. The CPUE of each fortnight is calculated as the average of all the one-degree squares in which an effort greater than 12 hours was exerted and when more than 12 one-degree squares were significantly fished. The primary goal of this averaging procedure was to eliminate the potential biases introduced by large fishing efforts often exerted in small strata of high abundance.

The CPUE values are calculated, for log-associated and free-swimming schools, as the corresponding catches of each fishing mode, divided by the total fishing effort (in each one-degree-fortnight). These fishing efforts are the standardised fishing efforts of the French fleet (expressed as a Class-5 standard purse seiner, average 400 t of capacity) and of the Spanish fleet (expressed in a Class-6 standard purse seiner, average 600 t of capacity). The fishing power of each individual purse seiner is assumed to be constant during the entire period of its activity in the fishery.

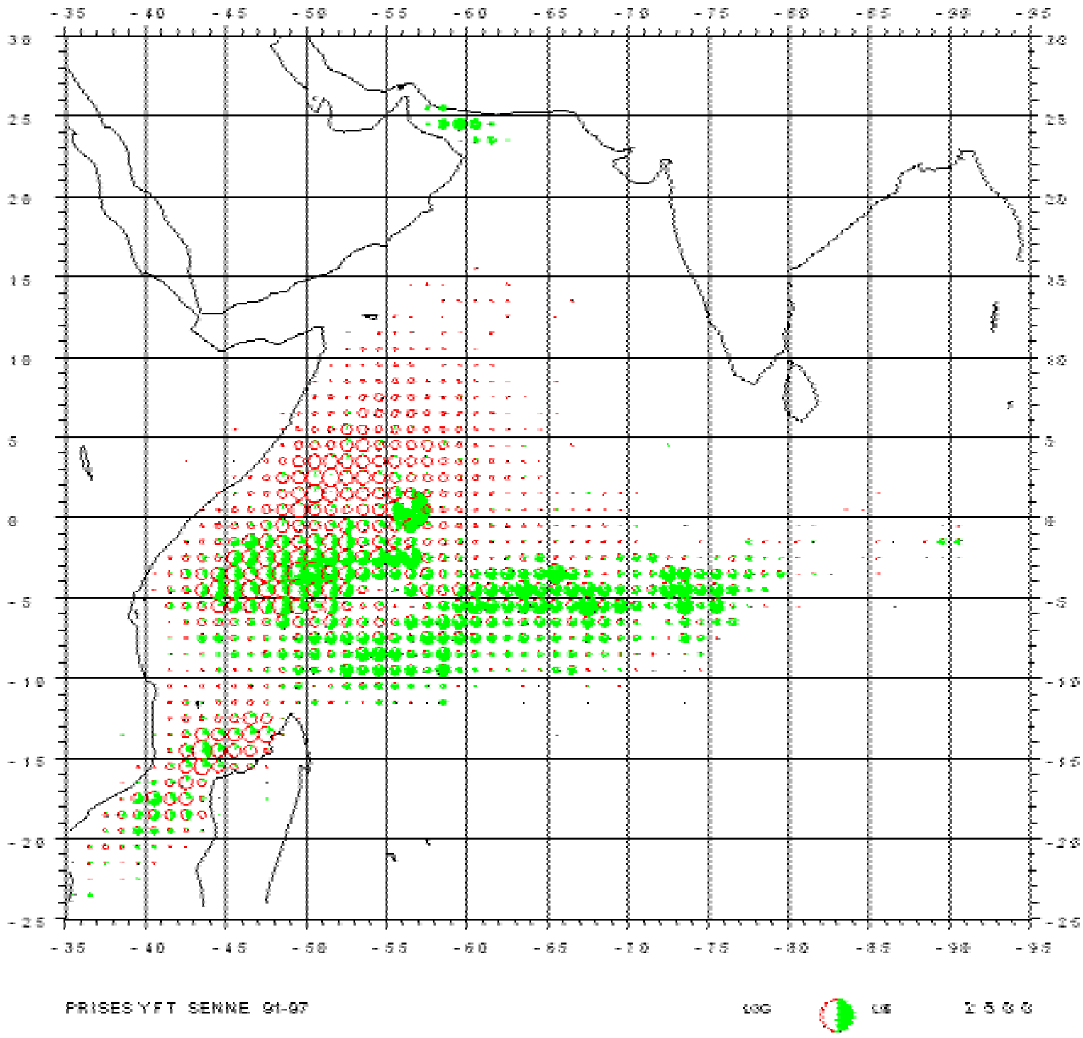

Figure YFT-2. *Average yellowfin catches on log associated (white) and on free schools (dark), all purse seine fleets based in Seychelles for the period 1991-1997.*

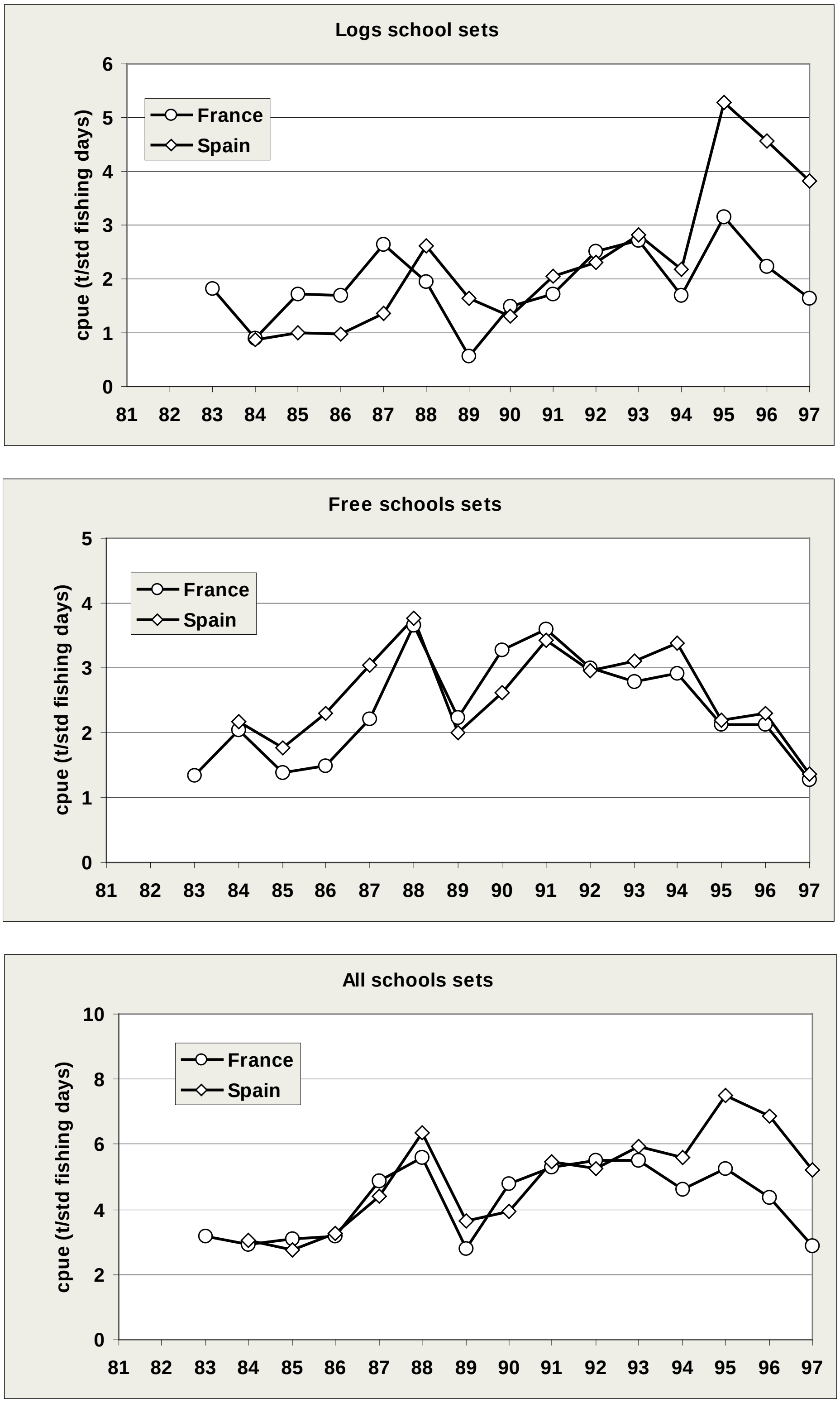

Figure YFT-3. *CPUE for the main purse-seine fleets in the Western Indian Ocean.*

Research Results

TWS/98/18 estimates a catch-at-age (CAA) matrix for yellowfin tuna fisheries in the western Indian Ocean. CAA is the most basic and important information for age structured stock assessment, thus accurate estimation is essential. Because the many different types of gears, 8 gears for some 20 countries, the gear categories used in this paper need verification by local fisheries authorities. The length-age key is estimated following the growth model by Stéquert *et al.*(1995). A slicing method is then used to estimate age compositions. Average weights are used to convert catch in weight to catch in numbers. The estimated CAA suggested that catch before 1984 was between two and five million fish and increased sharply from 1985 to now, to reach between 20 and 42 million fish. The average

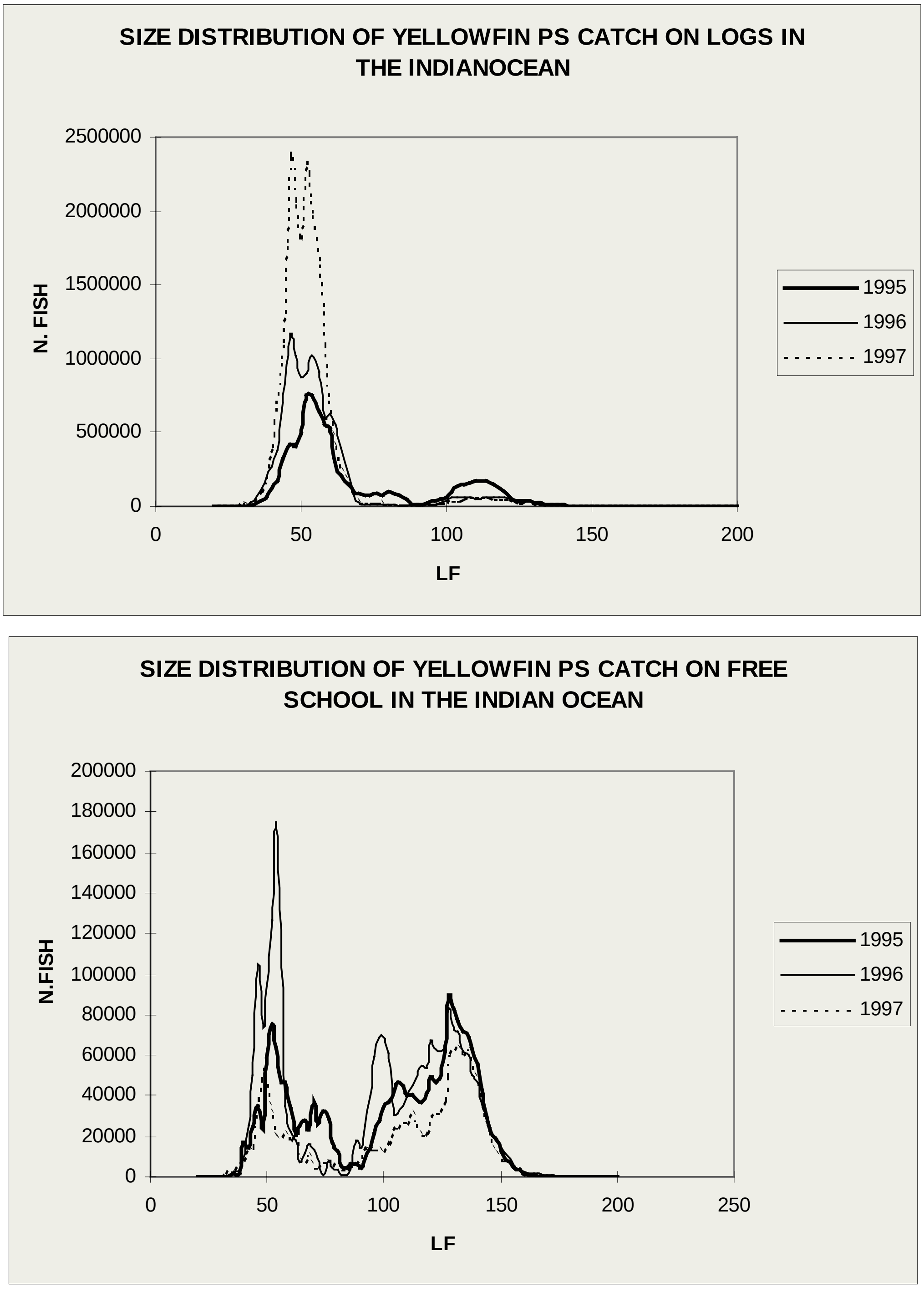

Figure YFT-4. *Length distribution of yellowfin tuna in the catches of the purse-seine fleet.*

age composition (all gears and countries combined) is approximately 70 % (Age 0), 20 % (Age 1), 5 % (Age 2) and 5 % (Age 3-5). The author suggested that only the data after 1980 should be used for the stock assessment because the catch before 1980 is likely underestimated, size data are not satisfactorily available and there is significant heterogeneity in q (catchability coefficient).

The Consultation noted that it should not be assumed that a standard catch-at-age model would be the most appropriate approach for assessing the Indian Ocean yellowfin resource. Within standard catch-at-age techniques, it is difficult to explicitly evaluate the effects of assumptions, variability, ageing errors and uncertainties on the final assessment results or to include these effects in quantitative estimates of the uncertainties (e.g. variances) in the stock status estimates. This problem is exacerbated in situations where large components of the catch are incompletely or poorly sampled, such as has been the case for many of the Indian Ocean tuna fisheries. There is a need to determine an appropriate assessment framework and it was suggested that consideration should be given to size-based models.

The Consultation noted that cohort slicing can result in substantial biases in the estimated CAA matrix, particularly for older animals and in situations where there are high exploitation rates and substantial variability in growth and year-class strength. When substantial substitution of size data is required, the estimated CAA remains highly uncertain and careful consideration needs to be given to the procedures used in substitution for strata for which no data exist.

TWS/98/15 reports that with a view to developing the oceanic tuna fisheries and increasing tuna production for the Thai canning industries, the Department of Fisheries of Thailand launched a tuna resource survey project in 1995. The fisheries research vessel *Mahidol* carried out the survey, with the purpose of collecting data on the abundance of tuna and for determining possible fishing grounds and new resources for commercial purse seine fishing though biological study of tuna and oceanographic research.

Between October 1995 and September 1996, R/V *Mahidol* carried out a purse seining survey along the Ninety East Ridge in the eastern Indian Ocean and the Carlsberg Ridge in the western Indian Ocean. A total of 55 complete positive hauls were made throughout the survey in 1995-1996. Good catches were obtained in most cases. The catch was composed of 55 % skipjack, 26 % yellowfin tuna and 12 % bigeye tuna. In addition, other pelagic fish (e.g. rainbow runner and dolphinfish) constituted 7 % of the catch. Skipjack was the dominant catch and the length of fish ranged from 30 to 74 cm. It was clearly visible that there was one general size group in the region.

Yellowfin tuna occurred in the size range of 29-80 cm with a major mode at 40 cm. Another mode was also present at 52 cm. The purse seine catch of bigeye tuna in the western area was slightly higher than in the eastern Indian Ocean at the same latitude. They had a size range of 30-84 cm with a dominant mode at 56 cm. Oceanographic data were collected simultaneously with the fishing survey throughout the cruises in order to determine the possibilities of applying knowledge of the environment (i.e. of temperature, dissolved oxygen and current etc.) for describing the variation in the availability and potential of tuna resources.

The increased catch of small tuna in the Gulf of Thailand since 1982 was due mainly to the movement of the drift gillnet and purse seine fishing fleets further offshore. This movement was encouraged by higher prices offered by the Thai tuna canning industries and improvements of purse seine fishing technique and effectiveness. Thus, catches of small tuna increased rapidly, especially in the Gulf of Thailand. Under Thailand's Department of Fisheries policy to promote deep sea fishing, fishermen were organised in co-operatives to engage in tuna fishing in the Andaman Sea and Indian Ocean. This organisation was formed in May 1996 as the Thai Oceanic Tuna Fishery Co-operative (TOTFIC) and has carried out tuna fishing since October 1998.

TWS/98/31 presents information on fork length and body weight collected by IFRTO (Iranian Fisheries Research and Training Organization), on yellowfin and four other major tunas species caught by artisanal gillnet fisheries. There is, however, a need to strengthen the study by undertaking investigations throughout the Indian Ocean from research vessels as well as from commercial ones. This could include analyses of length-frequency data from Pakistan and Oman or a tagging programme.

The length-frequency analysis shows that there is a sudden drop in the average length of yellowfin from December onwards, the proportion of younger yellowfin being higher than that of older ones. For comparison, it might be necessary to review the length-frequency data from Pakistan and Oman.

It was noted in discussion that the mode (~80-100 cm) in this length-frequency data from the yellowfin catches in the Oman Sea represents a size range of fish that is almost totally absent from the purse seine fishery. Fish in this size range are approximately two years old and the Oman Sea is outside the boundary of the current purse seine fisheries. The general location and time of the Oman Sea fishery is known to be an area of upwelling and high productivity. It was speculated that the fish caught in the Oman Sea might have migrated here for feeding and which then return to breed in more southern waters one year later. It was suggested that tagging studies would provide the best approach for testing this hypothesis.

The Consultation noted that although TWS/98/8 was discussed under the previous agenda item, it contained new estimates of the growth curve for yellowfin tuna in the eastern Indian Ocean. These estimates were based on modal analyses of length-frequency data from samples collected from China (Taiwan) at their time of landing in Phuket. The growth curve derived from these samples and had a substantially higher growth rate (i.e. K) and relatively high L_∞ compared to previous estimates.

TWS/98/30 provides a review of biological studies carried out in Indian Ocean on yellowfin tuna during 1985-95. The length–weight relationship exhibited higher exponential 'b' value (3.0) for younger fish caught in coastal fishery than the larger specimens caught in Oceanic waters (2.7). Morphometric studies did not show significant variations between geographical areas in the Indian Ocean.

Estimated growth parameters for L_∞ were 144 cm for fish caught in coastal fishery and 175 cm for oceanic waters. Estimates of K varied between 0.29 and 0.32 per year and t_o from -0.3 to -0.45 per year. Estimates of natural mortality, 'M', ranged between 0.50 and 0.67. Males were dominant, with a female to male ratio of 1:2.5. The spawning season extended from November to April. Most favoured food items were squids. Due consideration should be given to the biological and population parameters when using them in yellowfin tuna stock assessment.

The Consultation noted, in relation to TWS/98/30 and the growth curves estimated in TWS/98/8, that in order to undertake a comprehensive stock assessment that it will be essential to develop a range of equations for describing growth and weight/length relationships that can be used in modelling the dynamics of yellowfin in the Indian Ocean. In doing this, it will be important to consider not only the expected values for the parameters describing these relationships, but also their variance/co-variances. In addition, it will be necessary to evaluate spatial and temporal variability in these relationships and whether these need to be accounted for within the assessment framework. It was further noted that, to facilitate evaluation and comparison of results from different studies, parameter values reported in Tables should include information on sample sizes, methods of estimation and estimates of the variances.

TWS/98/34 reviews information on the stock structure of yellowfin and bigeye tuna in the Indian Ocean from studies conducted in the past. Two major stocks of yellowfin tuna (East and West) are assumed, with some intermingling in waters between neighbouring stocks, i.e., the far western area (Atlantic and western stock), the central area (eastern and western stock) and far eastern area (Pacific and eastern stock). For bigeye tuna, a single stock is proposed. Some intermingling is generally assumed off South Africa with the Atlantic stock. To examine these hypotheses, the authors proposed a genetic study and appealed to the participants for their cooperation in the collection of samples. During the Consultation, a positive response was secured. Samples from nine basic sampling areas in the Indian Ocean, i.e., northern-west, northern-central, northern-south, central-west, mid-centre, central-east, southern–west, southern-central and southern-east, will be obtained. This research is expected to need two years for completion.

In discussing this paper, the Consultation concluded that there was insufficient information to define the stock structure of yellowfin in the Indian Ocean and that multiple hypotheses would have to be considered in assessing the yellowfin resource. Some of the difficulties in defining stock structure for yellowfin were noted, as well as some of the limitations of genetic approaches. Given what is known about yellowfin movements, the Consultation noted that any stock assessment process would most likely need to take into account mixing among "stocks" unless it was determined that there was only a single stock within the Indian Ocean. Tagging studies were identified as an important component to assist in this delineation of stock structure. Nevertheless, the Consultation recognised the important contribution that genetic studies can provide to the stock structure and recommended that the members of the Consultation, to the extent possible, help collect the necessary samples required for the genetic studies being proposed.

TWS/98/22 reports that large yellowfin tuna are regularly found in association with dolphins in Maldivian waters. The species involved are spotted dolphin (*Stenella attenuata*) and spinner (*Stenella longirostris*). Maldivian fishermen targeting large yellowfin tuna use the presence of dolphin schools to locate tuna. The yellowfin tuna are caught using simple handlines and are mostly within the length range of 70-160 cm fork length. No dolphins are caught.

In the discussion, it was noted that there are unconfirmed reports of similar tuna/dolphin association off Oman. It was further noted that this type of association is not found in the deeper, more southerly waters where the purse seine fisheries operate.

INF/98/1 reports on estimates of by-catch caught by the western Indian Ocean purse seine fishery based on observer data from Soviet purse seiners fishing in 1986-92. Observers collected by-catch data from a total of 494 sets consisting of free-swimming schools, whale shark associated schools, whale associated schools and log-associated schools. More than 40 fish species and other animals were recorded in the observations. The target species of the sets were yellowfin and skipjack tunas. The average non-tuna by-catch was 0.518 t per set or 27.2 t per 1,000 t of tuna caught.

The Consultation noted that there is an increasing recognition within the international community that there is a need for monitoring, and perhaps managing, ecosystems as a whole. Results such as those in INF/98/1 would be required in this context. Another information paper (INF/98/6) was introduced and discussed. This paper provides information about a short-term observer programme that took place in the purse-seine fishery in the Western Indian Ocean during 1995 with a coverage of about 10 %. It was noted that the results in INF/98/1 would suggest a total by-catch in the purse seine fishery which was somewhat higher then that reported for the Western Pacific and substantially lower than that for the Eastern Tropical Pacific. The Consultation noted the danger in extrapolating from a small number of observations from a limited area and time period to the entire fleet. In any extrapolation, it is important to evaluate the degree to which the sampling effort is representative. In general, estimates of total by-catch should be derived using appropriate temporal, spatial and fishery stratification, as there is often considerable variability among these factors, while sampling is unlikely to be representative across them.

TWS/98/36 described the application of neural network approaches to yellowfin tuna data in the western Indian Ocean to develop analytical and prediction techniques. Neural networking is one of the Artificial Intelligence (AI) techniques and does not require any rigid mathematical or statistical models or assumptions about the data. In recent years, it has been applied to fisheries resource analyses and fairly accurate results have been reported. As this is the first attempt for the tuna fisheries data, this research was conducted as a pilot study. The authors applied the neural network to analyse and predict the dynamics of the Japanese longline CPUE for ages 2 and older. Three types of information (catch, CPUE and the southern oscillation index) were selected as the input variables, using a total of 14 variables. Reasonable results in terms of prediction were obtained. However, the predictions in later years (1985-92) were not very accurate, probably due to the fact that there is no strong correlation between the catch and CPUE. Therefore, a new assessment of the input variables is required, including environmental data. In addition, it is suggested that standardised CPUE be used to improve the predictive capability.

The Consultation noted the objective of this study was not to provide an index of relative abundance or a measure of stock status, but to reproduce the dynamics of the observed CPUE and to be able to forecast short-term future CPUE trends.

TWS/98/21 presents an analysis of catch and effort data from longline vessels from China (Taiwan). The analyses were based on the fishery data from the longline fleet of China (Taiwan), compiled from the logbooks by month and 5° x 5° area, including both the so-called deep longline and regular longline. The standardised CPUE for yellowfin tuna using a General Linear Model (GLM) were calculated to provide an indication of stock status. The multiplicative GLM model adopted is as follows:

$$\log(CPUE + c) = \mu + Year + Quarter + Area + ALB + BET + \varepsilon$$

where the total area was divided into eight aggregated areas, according to the distribution of nominal CPUE. The constant c is adopted as 10 % nominal CPUE. μ is the overall mean. The percentage catch of albacore and bigeye tunas were divided into five intervals. ε is a normally distributed error term.

Under the hypotheses of either one stock or two major sub-stocks for Indian Ocean yellowfin tuna, the standardised CPUE estimates for the western, eastern, and overall areas were the highest in 1968. The rates gradually decreased to 1979. Since 1979, the stock status, as measured by the CPUE trends, has almost been maintained at a stable level. In addition, the three CPUE trends for the western, eastern and overall areas are very similar.

In discussion, it was noted that information on the temporal trends in the average size of fish caught could provide some additional insights for interpreting the CPUE trends. The Consultation noted that testing for significant year/area and year/season interaction is important, as variability in the spatial and temporal distribution is common in large pelagic species. If such interactions occur, they can confuse the interpretation of the year effects as estimated in a GLM analysis. The Consultation also recognised that there were limitations in using the percentage of catch composed of other species as a measure of targeting. For example, a decline in the abundance of the species of interest could easily be misinterpreted in this case as a change in targeting.

An index showing recent trends in total catches was presented to the participants of the Consultation. The index is similar to that introduced in a recent FAO publication (Grainger and Garcia, 1996[1]) in that it is based on finite rates of change in annual catches. It is defined as the ratio between the catch during a given year and the average of the catches for the three previous years. An index greater than 1.0 corresponds to an increasing trend of the catches, while an index lower than 1.0 corresponds to a decreasing trend of the catches. Under the assumption that the effort has remained approximately the same, an index value close to one over a period of several years would indicate that the catches represent an equilibrium yield for that level of effort.

This index was applied to the yellowfin, skipjack and bigeye catches in the Indian Ocean. For yellowfin tuna, the time series of indices shows a decreasing trend, the most recent year being close to the level of 1.0.

Status of Stock

While additional information relevant to the status of the yellowfin resource was presented since the last consultation in 1995, no comprehensive assessment was available that integrated the catch and effort data from the various fisheries. The Consultation noted the statements made at the last Consultation and the fact that current catches are now above the MSY level hypothesised at that meeting. However, the previous Consultation had concluded that the status of yellowfin was largely uncertain. In the absence of more complete and updated analyses, the accuracy and reliability of the hypothesised MSY level could not be determined, particularly in light of more recent information on the biology of yellowfin tuna and developments in the Indian Ocean tuna fisheries and their catches. It was not within the scope of the current Consultation to undertake the type of analyses required for performing an integrated assessment. It further noted that this is not a trivial task. The resources required to complete such an assessment are substantial and include compiling a comprehensive data set from existing sources and the development of appropriate models with the associated software. All of this can not be done within the scope of a short meeting. Therefore, the Consultation concluded that the status of the stock is currently unknown.

Research Requirements

The Consultation recommended that it was necessary to:

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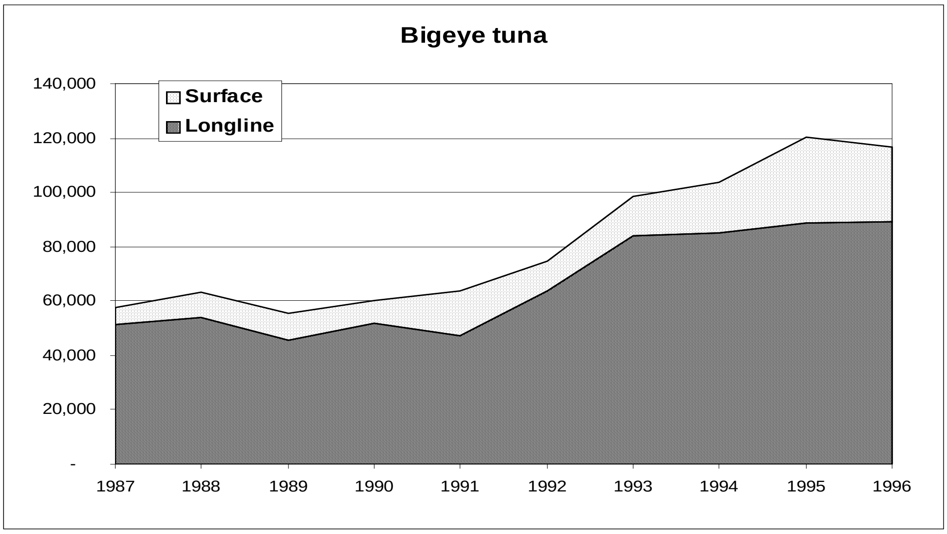
[1] Grainger, R.J.R. and S.M.Garcia. 1996. Chronicles of marine fishery landings (1950-1994): Trend analysis and fisheries potential. *FAO Fisheries Technical Paper*. No. 359. Rome, FAO. 1996. 51p.

1) Develop and apply a comprehensive framework for assessing the status of the yellowfin resources in the Indian Ocean that can accommodate data from the diverse fisheries and account for the uncertainties in stock structure, yellowfin biology and alternative interpretations/hypotheses for catch and effort data. A strategy is needed for providing the necessary resources for doing this and also for ensuring that there is sufficient review of the framework and its application.
2) Develop and implement appropriate, timely and verifiable data collection procedures for all fisheries harvesting yellowfin in the Indian Ocean. The data that need to be collected include catch, effort and size information with sufficient temporal and spatial resolution.
3) Estimate basic biological parameters for yellowfin tuna in the Indian Ocean including stock structure, movement/transfer rates between areas, growth rates, reproductive parameters and natural mortality rates. Estimates should include estimates of uncertainty and consideration of temporal and spatial variability.
4) Develop, implement and analyse the results of a large scale tagging program covering the full range of yellowfin sizes and all areas where yellowfin tuna commonly occur.
5) Take into account the recent increases in efficiency of the fleets in the calculation of indices of abundance. Further research is necessary in this area.

Bigeye tuna

The time series of bigeye catches is shown in Figure BET-1. Between 1991 and 1996, the total catch continued to increase. Initially, the longline fishery contributed most to these increases, but from 1993 to 1995, most of the increase in the catch is due to purse-seine catches of small fish (mostly non-targeted). The increase of purse seine catches of bigeye tuna is a global phenomenon, resulting primarily from the intensification of fishing around logs and FADs. The 1996 total catch was similar to that in 1995, with the purse seine catch somewhat reduced.



*F**igure BET-1**. Recent catches of bigeye tuna by gear type.*

Figure BET-2 shows the distribution of catches of purse seiners based in Seychelles in 1991 to 1997, distinguishing between those made on logs and free schools. The CPUE for the purse-seine fishery is shown in Figure BET-3, while the size distribution of such catches in 1995, 1996 and 1997 is shown in Fig. BET-4..

Research Results

Information from Paper TWS/98/8 of relevance to this Agenda was brought to the attention of the Consultation. It referred to the relationships between length and age and weight and length.

Information presented in Paper TWS/98/34 suggested that bigeye constitute a single population in the Indian Ocean.

In TWS/98/26, CPUE of bigeye caught by Japanese longliners in the Indian Ocean was standardised up to 1997 by using a GLM. Effects of the area and gear configuration significantly affect CPUE. Deep longlining is very effective to catch bigeye and it should, therefore, be taken into account during the standardisation of CPUE.

There was a substantial difference in the trend of CPUE between the tropical and southern areas. In the latter area, where the main fishing ground for southern bluefin tuna is located, the bigeye catch increased substantially after 1990. The historical changes in the relationship between the nominal CPUE and the gear configuration in the South area suggested a shift in targeting by longliners in this area. As this was not accounted for, the standardised CPUE for the tropical region was recognised as a better index of abundance of bigeye.

The standardised CPUE for the tropical areas was stable from 1979 to 1988 and then continued to decrease gradually. In 1997, the standardised CPUE was about 50 % of that in 1977 and about 33 % of that in 1954.

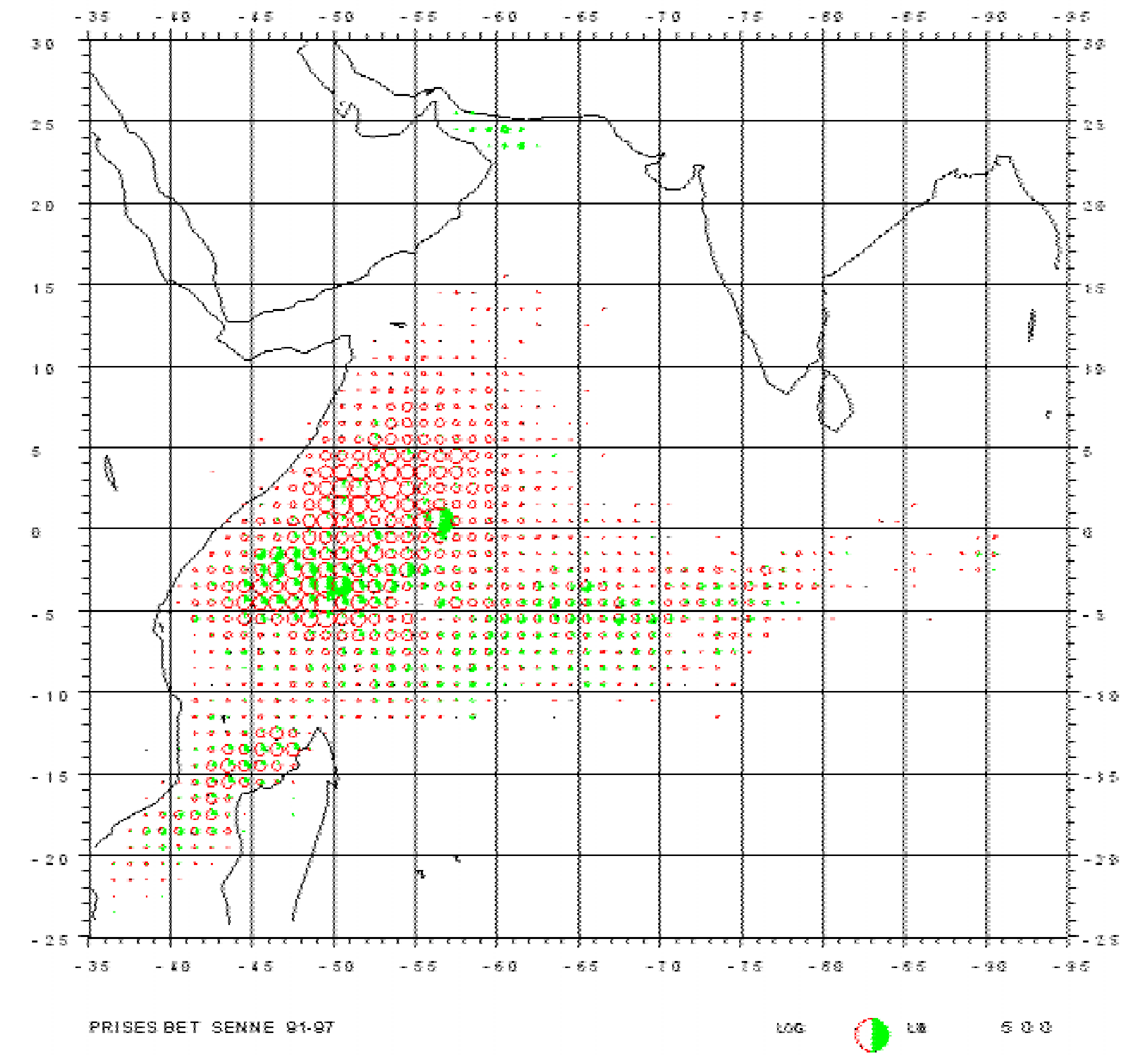


Figure BET-2. *Average bigeye tuna catches on log associated (white) and on free schools (dark), all purse seine fleets based in Seychelles for the period 1991-1997.*

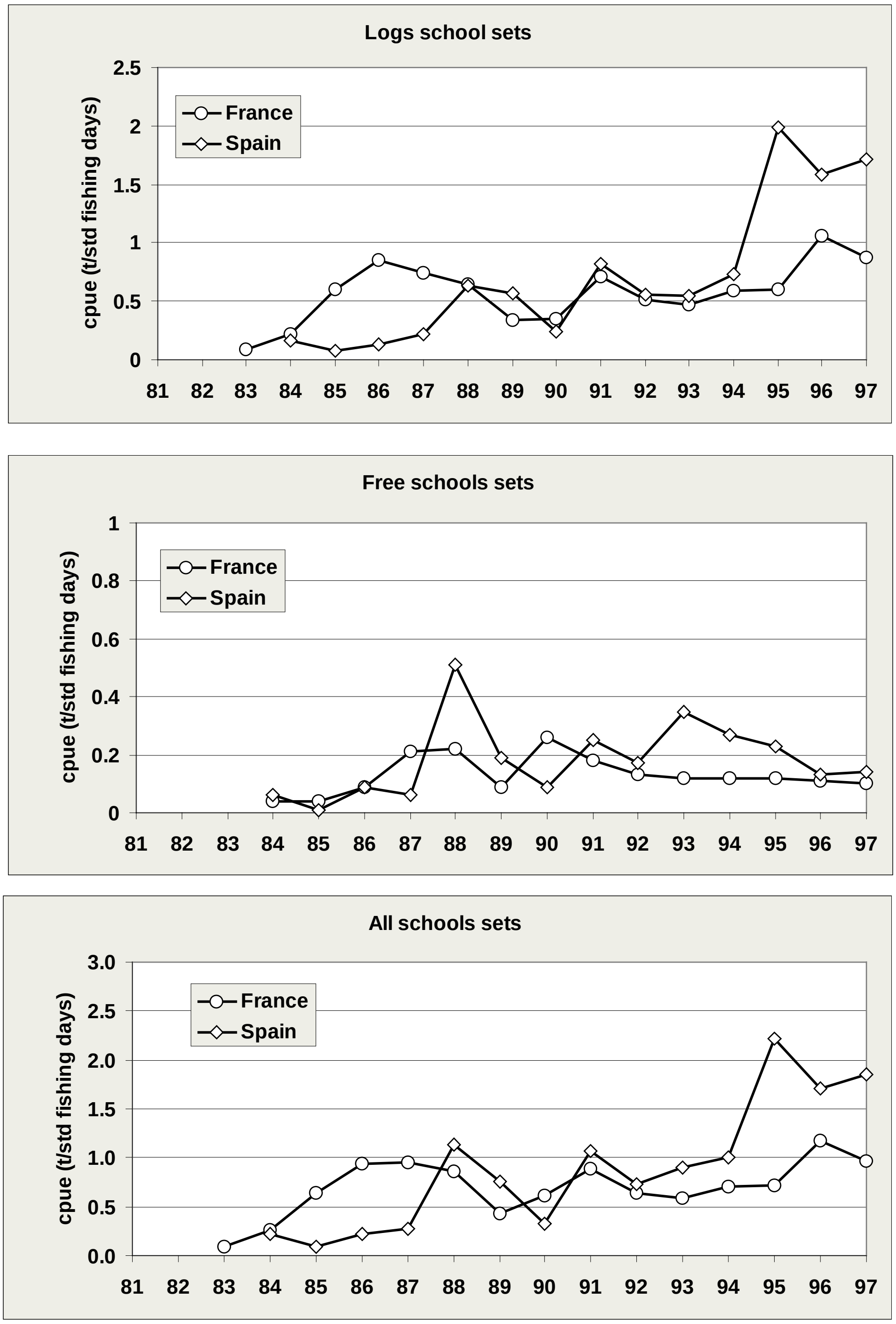


Figure BET-3. *CPUE of bigeye tuna for the main purse-seine fleets in the western Indian Ocean.*

Results of an analysis of annual catches (Grainger and Garcia, 1996) similar to that undertaken for yellowfin was brought to the attention of the Consultation. The results for bigeye suggest that catches in recent years are still increasing.

Status of stock

The information on CPUE given above was a cause for concern of the Consultation. However, as was the case during the previous Consultation, the participants felt that status of the stock is uncertain due to the limited scope of the information presented.

Concerns regarding increases in catches, especially of small fish, were expressed by the previous Consultation in 1995. It was also noted then that the nominal CPUE seems to be stable or increasing. The analysis presented this year reinforced the concerns expressed during the previous Consultation.

The Consultation regarded MSY estimates reported to the previous Consultation (between 53 and 61 thousand tonnes) as not applicable to the present fishery because they were based on data from a longline fishery catching only large fish. The Consultation also noted that the longline CPUE shows a decline, with the lowest value in 1997, and that the current catch is more than double the previous estimate.

Research requirements

The Consultation, therefore, recommended that:

1. The status of the stock should be more precisely determined, and that a comprehensive stock assessment be urgently carried out to that effect.
2. A long-term collaborative research program including more basic biological research, improvements in the data collection and tagging needs to be designed and implemented.

Skipjack tuna

Catches of skipjack have been increasing between 1987 and 1994 (Figure SKJ-1). In recent years, the total catch mainly that from industrial fisheries, was decreasing.

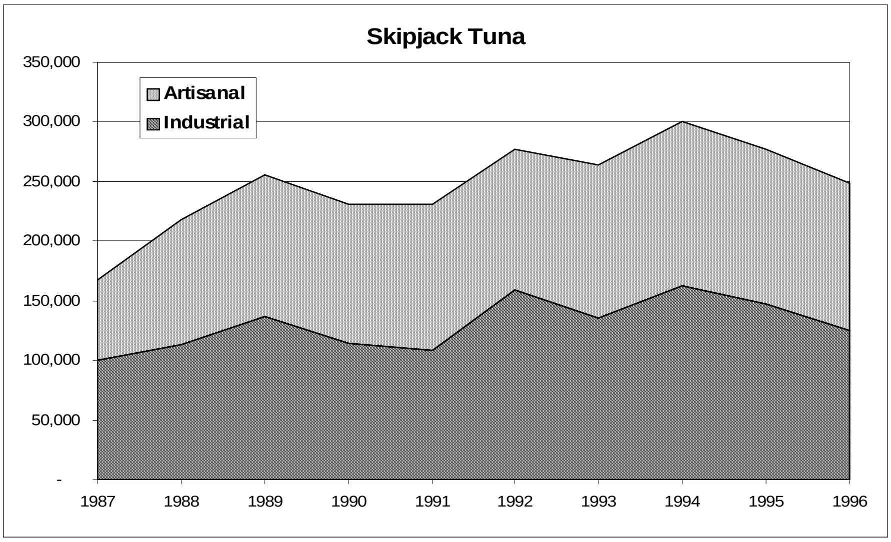


Figure SKJ-1. *Recent catches of skipjack tuna by gear type*.

Figure SKJ-2 shows the distribution of catches of purse seines based in Seychelles from 1991 to 1997, distinguishing those made on logs and free schools. The CPUE for the purse-seine fishery is shown in Figure SKJ-3, while the size distribution of the catches in 1995, 1996 and 1997 is shown in Figure SKJ-4.

Research Results

An understanding of growth rates is a prerequisite for stock assessment. Estimation of skipjack growth parameters from Maldivian size frequency data is not feasible. This is due to the prevalence of modal stasis, which results from their year round spawning and migration patterns. Similarly, direct estimation of ages from microincrement deposition on otoliths has also proved impossible, as the increment depositions are irregular and vary greatly between individuals. Length increment and time-at-liberty data from tag-recapture experiments provide direct measurement of growth, provided that tagging procedure itself does not affect the growth of individuals.

In Paper TWS/98/23, five variations of von Bertalanffy growth models were fitted to the tagging data available from the Maldivian pole and line fishery. On the basis of likelihood ratio tests, a model incorporating individual variability in growth through normally distributed variation in L_∞ amongst individuals best described the data. The parameter estimates obtained were mean L_∞ = 64.3 cm, var(L_∞) = 61.6 cm^2, and K = 0.55 per year.

Fitting these models to simulated data sets suggest that biased parameter estimates may result if process error is not explicitly incorporated into the von Bertalanffy models, even if allowance has been made for individual variability in growth. Attempts to obtain comparable parameter estimates by fitting to data from an earlier tagging experiment in the Maldives suggest that biased parameter can also be obtained if the release lengths approach the average maximum length of the fish. This problem is exacerbated if the data contain apparent negative growth increments.

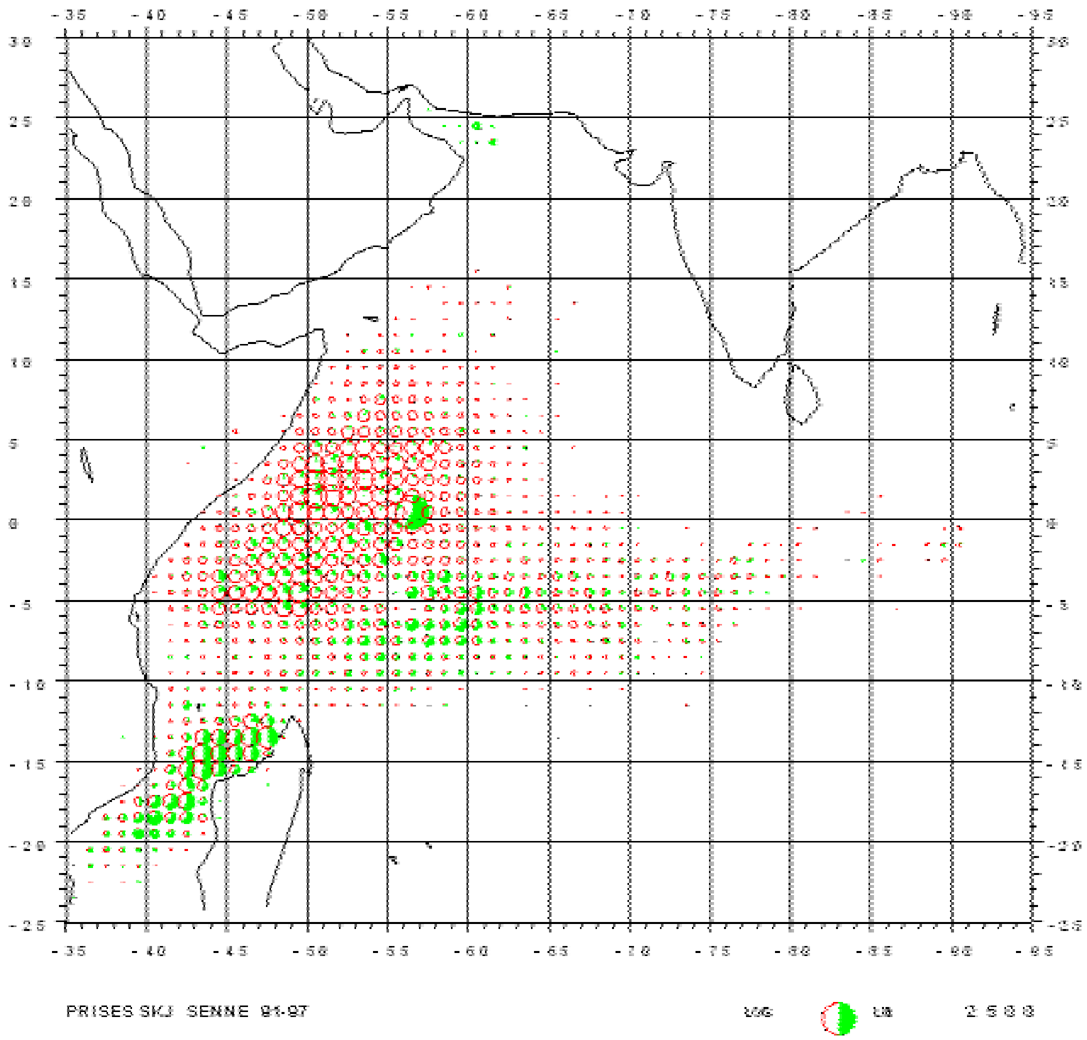
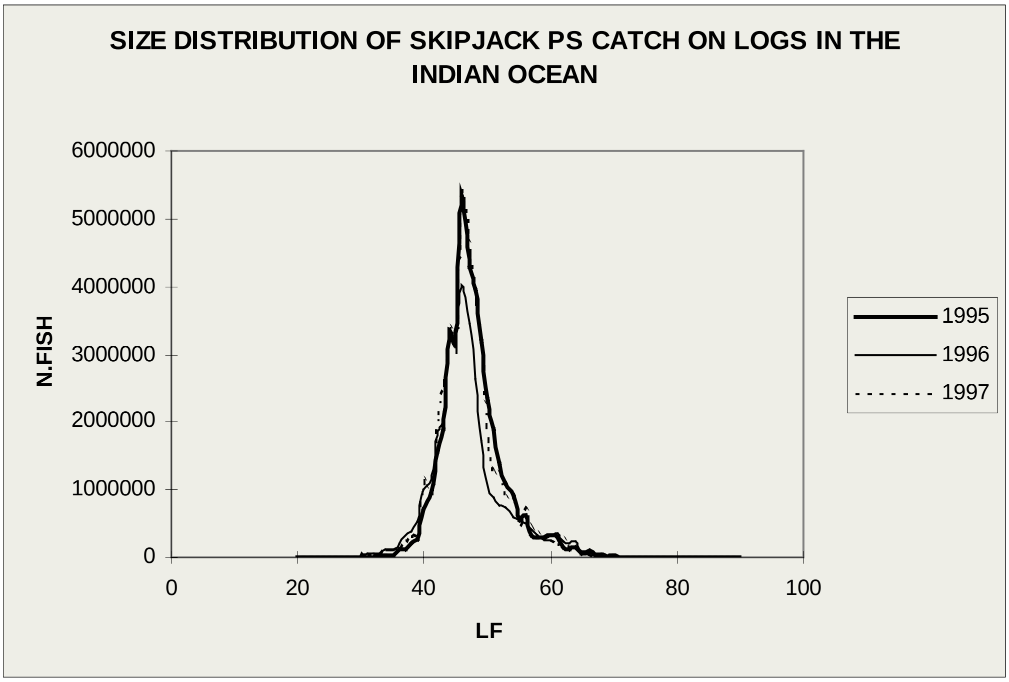


Figure SKJ-2*. Average skipjack tuna catches on log associated (white) and on free schools (dark), all purse seine fleets based in Seychelles for the period 1991-1997.*



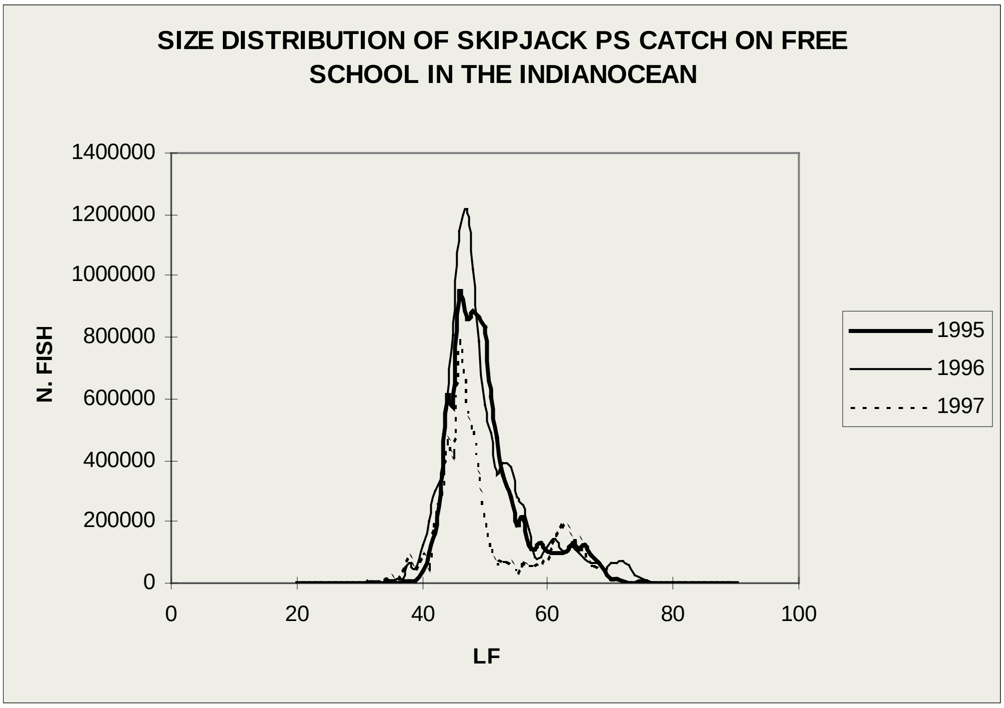


Figure SKJ-4. *Length-frequency distribution by school type for the main purse-seine fleets in the western Indian Ocean.*

The results for skipjack, of the indices of relative change in the catches resulted in values lower than one for recent years, indicating a decreasing trend in the total catches.

Status of stock

The Consultation again regarded the status of stock as uncertain. Similarly, as previously, on the basis of the life history of skipjack and experiences from other Oceans, the Consultation recognised that recruitment overfishing of skipjack is unlikely to occur in the near future. However, concerns were expressed regarding recent decreases of catches, including those of Maldives, which may be due to:

- environmental effects,
- fisheries interactions, i.e., other fisheries catching skipjack and/or
- Reduction in the abundance locally or in the scale of the entire stock.

Research recommendations

The Consultation, therefore, recommended that:

1. The status of the stock should be more precisely determined, and that a comprehensive stock assessment be urgently carried out to that effect.
2. A long-term collaborative research program involving more basic biological research, improvements in the data collection and possibly tagging needs to be designed and implemented.

Albacore tuna

Recent catches by gear type are shown in Figure ALB-1.

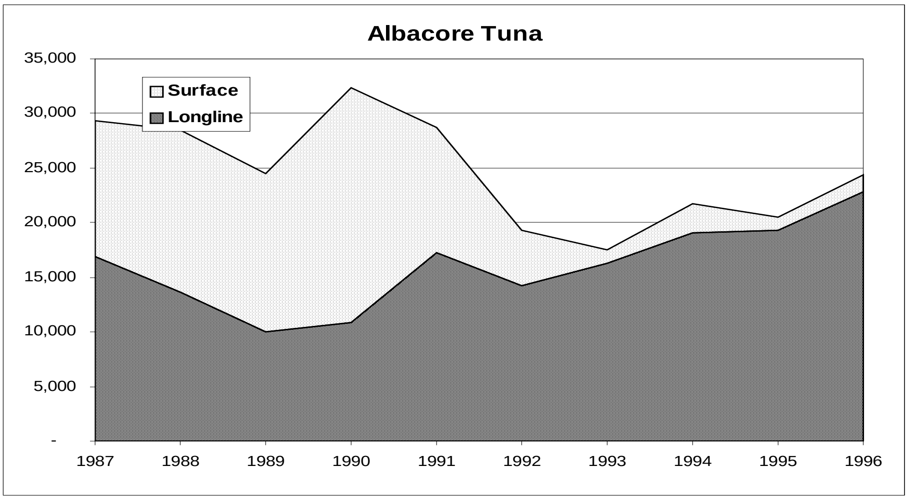


Figure ALB-1. *Recent catches of albacore tuna in the Indian Ocean.*

Research Results

TWS/98/24 describes a standardisation of longline CPUE from fleets from China(Taiwan) for albacore and primary estimate of MSY. Data employed in this study are the daily catch records of longliners from China(Taiwan) operating in the Indian Ocean dating back to 1979. It was assumed that the deep longline fishery started in mid-1980s, say 1985, and an attempt was made to segregate the statistics of regular longline from that of deep longline. A GLM was adopted to standardise the CPUE for time periods of 1979-1985 and 1985-1996. A surplus production model was employed to estimate the maximum sustainable yield and optimum effort. Estimated results were 30,500 t for MSY and 319 x 10^6 effective hooks for optimum effort.

During the discussion, it was clarified that total catch rather than the catch from China(Taiwan) was used for calculation of MSY after standardising effort by a proportion of nominal to effective effort in the fleet from China(Taiwan). Replying to a suggestion to include interaction terms of year/area and year/season into the model, it was pointed out that those terms were examined during model selection but did not have significant effects. It was also pointed that daily catch rate used as input data were not independent for each other, i.e. CPUE of the same vessel of successive days were inter-related.

The Meeting also noted the existence of a purse-seine fishery that occasionally catches albacore in the tropical region of the western Indian Ocean, outside of traditional albacore fishing area of the longline fleets (Figure ALB-2).This purse-seine catch is made of large albacore caught on free-swimming schools.

Status of Stock

Although a stock assessment was not conducted during the Meeting, information relevant to the stock status was presented to the participants. The termination of large-scale driftnetting in the Indian Ocean resulted in albacore catch being drastically reduced to about half the 1993 level. The longline catch and CPUE have shown a steady and continuous increase for several years since then. This time lag probably reflects the recruitment of fish to the longline fishery after the cessation of the driftnet fishery. The current catch is still below the level observed when the driftnet fishery operated and the Consultation agreed that the stock is probably under less fishing pressure than before.

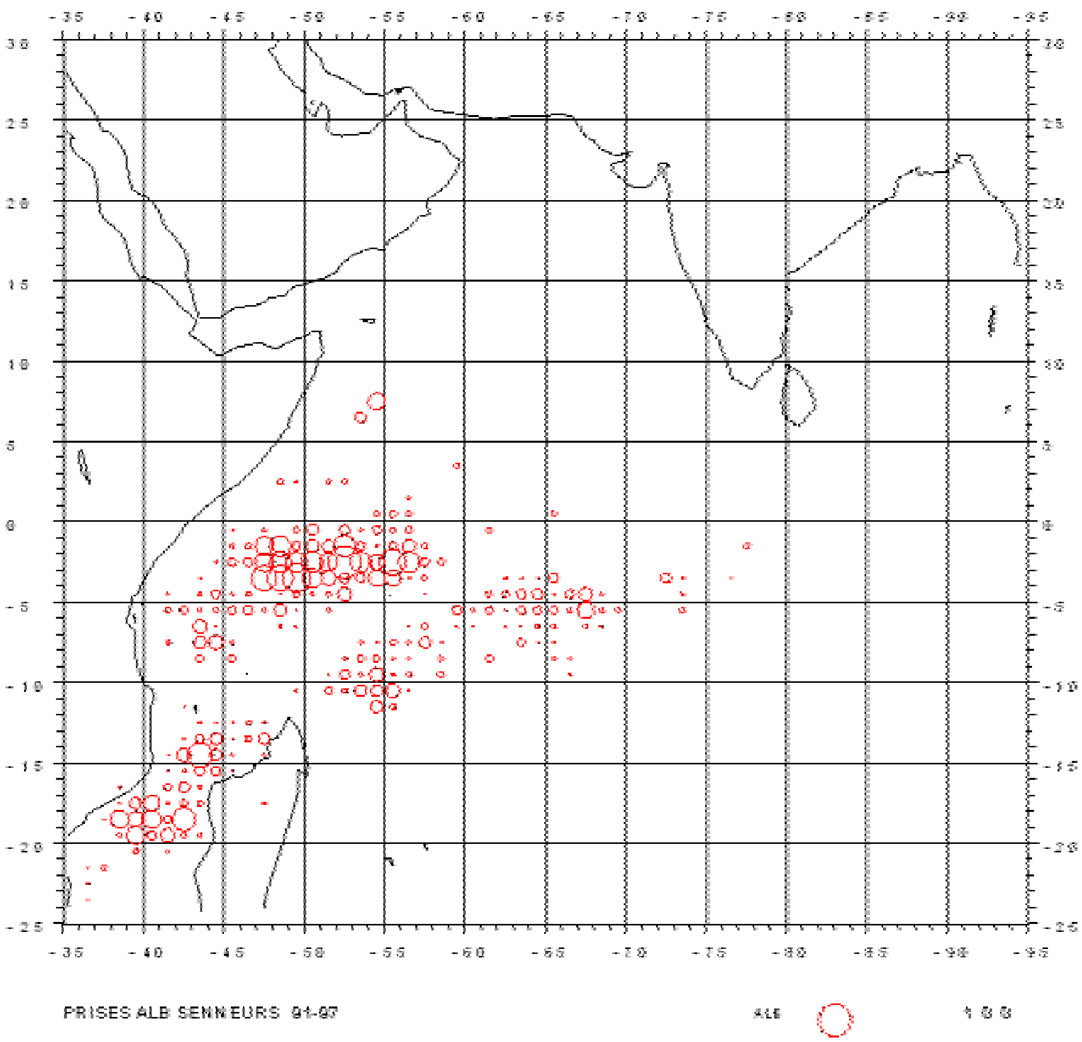


Figure ALB-2. *Average catches of albacore tuna, all purse seine fleets based in Seychelles for the period 1991-1997.*

Southern Bluefin Tuna

Catches from all fisheries as listed by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), taken from TWS/98/32 are listed in Table SBT-1, and catches from the Indian Ocean, as available in the IOTC databases, are shown in Figure SBT-1.

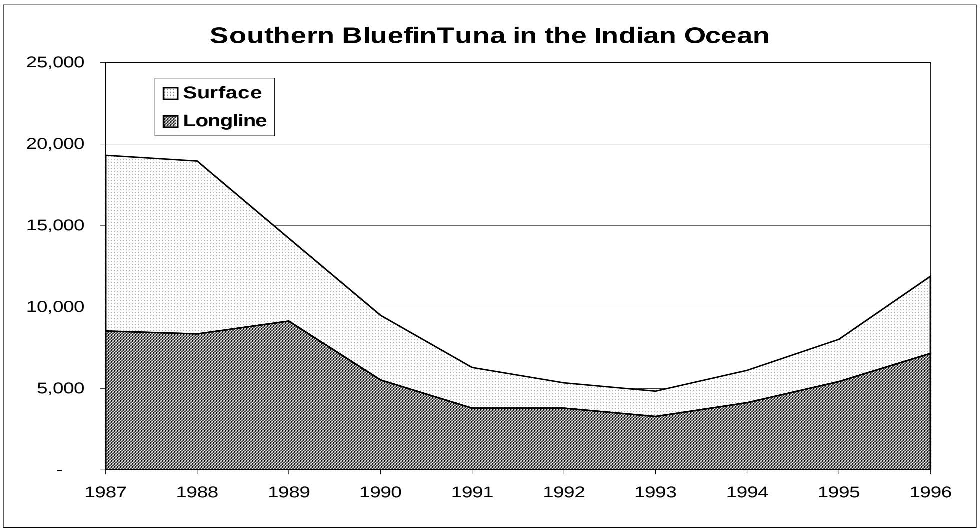


Figure SBT-1. *Recent catches of southern bluefin tuna in the Indian Ocean*

Research Results

TWS/98/32 briefly reviewed the biology, fisheries, and management scheme of southern bluefin tuna as well as reported stock assessment results obtained at the CCSBT Scientific Committee, held in Japan in July and August of 1998. Southern bluefin tuna is distributed in the Southern Hemisphere of three oceans. Only one spawning ground is known and fish are considered to be mature at age 8 (155 cm). Age-specific natural mortality vectors, with high mortality for young fish and low for adults, were adopted. The growth rate was considered to have increased during 1970s, probably corresponding to a decrease in density due to exploitation. Australia and Japan have been major fishing nations since the early 1950s and China(Taiwan) catches bluefin tuna as a by-catch. Indonesia, Korea and New Zealand also exploit this species. Australia mainly catches juveniles by surface gears and the others take larger fish utilising mainly longline gear. The portions taken by surface gears, as well as that of the Indonesian fleet exploiting exclusively the spawning aggregation, have steadily increased since 1992 to account for more than 50 % of global catch in 1997. The current level of parental stock is estimated as 25–53 % of the 1980 level. The probability of recovery to the 1980 level, the management target, before 2020 ranged from 6–87 %. The difference in estimates is mainly derived from different treatment of the "plus" group and different interpretations of Japanese CPUE used as major tuning indices. Japan initiated an Experimental Fishing Program in 1998 with the intention of resolving the latter problem.

Table SBT-1. *Catches of southern bluefin tuna in all oceans, as estimated by CCSBT (taken from TWS/98/32)*

	Australia	China (Taiwan)	Indonesia	Japan	(Indian Ocean)	Korea	New Zealand	Others
1986	12,531	514	7	15,182	(10,935)		82	2
1987	10,281	710	14	13,964	(10,285)		59	7
1988	10,591	856	180	11,422	(9,173)		94	2
1989	6,118	1,395	568	9,222	(7,606)		437	102
1990	4,586	1,177	517	7,056	(4,206)		529	4
1991	4,189	1,460	759	6,774	(3,947)	214	165	77
1992	4,448	1,222	1,232	6,937	(5,190)	36	60	141
1993	4,723	959	1,369	6,970	(2,707)	117	217	18
1994	4,430	1,111	926	6,334	(3,264)	147	277	55
1995	3,858	1,474	832	6,338	(3,145)	317	436	201
1996	5,128	1,610	1,609	6,373	(4,351)	1,179	139	291
1997	5,316	640	2,241	5,588	(4,532)	1,325	334	333

This species has been managed through quota regulations involving Australia, Japan and New Zealand. These were formalised in 1994 with the establishment of CCSBT. Currently, only 71 % of the global catch is controlled by the CCSBT, as a result of the rapid increase of non-member parties' catch in the 1990s. The stock is in a state requiring careful and thorough management of all segments of exploitation. This document also expresses the view that, as a responsible management body of tuna species in the Indian Ocean, it should be recommended to the IOTC to closely monitor fishery, stock status and management of this species, and to consider taking appropriate actions if necessary, in collaboration with other organisations.

TWS98/35 presents an overview of the recently completed SBT stock assessment undertaken by the CCSBT Scientific Committee. It noted that the Scientific Committee of CCSBT and its predecessor have been conducting annual stock assessments since 1982 The most recent meeting of the CCSBT Scientific Committee was held in July/August of 1998 and 23 representatives from CCSBT members attended, plus scientists from Indonesia, Korea and China(Taiwan). Extensive documentation was presented and reviewed at the CCSBT Scientific Committee and the meeting produced an agreed on report summarising its conclusions on the status of the southern bluefin tuna resource.

TWS98/35 notes that in all the VPA assessments presented at the 1998 CCSBT meeting, the estimates of recruitment indicate a long term declining trend since the 1960s. Recent CPUE, tagging and aerial survey results indicate that recruitment continued to be low for the more recent cohorts that cannot be estimated in the VPA assessments. Estimates of parental biomass indicate that the current parental biomass is well below the 1980 level (the target minimum rebuilding level established by the CCSBT). VPA results based on an assumed age 8 at maturity showed a long-term decline in the parental biomass, but estimates of the most recent trends are variable. Some results show an upturn since 1994, while some a continued decline. In those results with an apparent increase, the increase is driven by recent large increases in the estimated numbers of 8-11 year olds. However, this increase is not consistent with the recent trends seen in the CPUE series used for tuning these VPAs. Recently collected data suggests that the age of maturity is older than age 8. If age 10 or 12 maturity is used in the assessments, all VPA results suggest parental biomass has continued to decline. Two of the three VPA assessments at the 1998 CCSBT Scientific Meeting included estimates that extended back to 1960. For these two, the estimates of the 1997 parental biomass relative to 1960 ranged from 7 % to 15 %. Projection results for two of the three national delegations indicate a low probability of recovery under constant current catch scenarios, while those for a third suggest a relatively high probability. Projection results for SBT appear to be consistently upwardly biased (i.e. overly optimistic). The 1998 CCSBT Scientific Committee concluded that the continued low abundance of the SBT parental biomass is cause for serious biological concern. The parental biomass in 1997 remains at historically low levels, while catches on the spawning ground have increased since 1989, largely due to the expanding Indonesian longline fishery.

Following the presentation of these two papers, and in response to a request for clarification whether the Expert Consultation has a mandate to consider the respective roles of the IOTC and CCSBT, the Secretariat reminded the participants that, at its First Special Session, IOTC recognised that CCSBT had the prime responsibility for conservation and fisheries management for southern bluefin tuna. Furthermore, the Secretariat reminded the participants that the Consultation had received no instructions to discuss management arrangements.

It was noted that the catches listed in TWS/98/32 as coming from fleets not identified by flag or catches estimated from records of imports to Japan represented a relatively small amount. However, the sampling programme in place in Indonesia suggests that these catches might be underestimated.

There seems to be no evidence of density-dependence responses in age-at-maturity, in spite of the large reduction of population relative to historic levels. In any case, there is large uncertainty regarding the age-at-maturity. The age composition of the catch from Indonesia indicates no presence of fish less than 10 years old in the spawning grounds.

Retrospective patterns occur in the VPA results although the pattern is not consistent over the various VPA methods.

Status of the stock

Following procedures in previous Expert Consultations, the Consultation did not conduct a stock assessment, but results of research carried out under other organisations was presented for the consideration of the participants. The Consultation did not have the opportunity to conduct an in-depth review of the assessments carried out on this stock. However, it noted that all results indicate that the stock is far from a healthy condition.

Swordfish

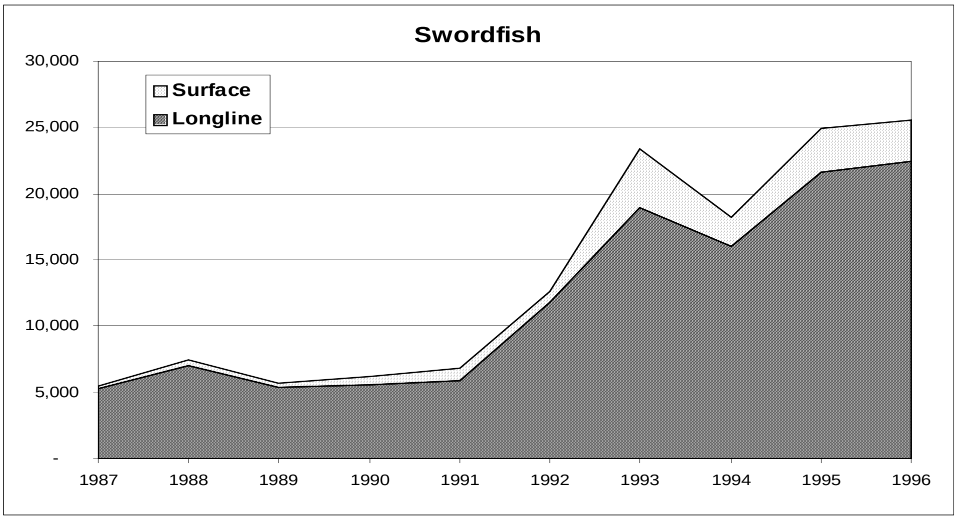


Figure SWO-1. *Recent catches of swordfish in the Indian Ocean.*

Recent catches of swordfish are shown in Figure SWO-1.

Research Results

The Meeting noted that TWS/98/1 included some information on conversion factors involving several length and weight measurements and size composition of swordfish caught by the member of the Indian Ocean Commission.

Two documents, TWS/98/27 and TWS/98/28, presented CPUE analyses of this species.

TWS/98/27 describes the CPUE for swordfish, standardised using the Japanese longline statistics by a GLM method. Data used in this analysis are fine-scale catch-and-effort data aggregated by month, 1° x 1° area and gear configuration. The results show that the gear configuration has a significantly high effect on the CPUE. CPUE of the gear with 14-20 branchlines between floats is about 50 % higher than the gear with 5-6 branchlines. Standardised CPUE was relatively higher level from 1967 to 1975 and decreased in the mid-1970s. It was stable during the mid-1980s then decreased in the late 1980s, but increased in the late 1990s to a level similar to that of the mid-1980s.

To the question whether it is possible that an increase in standardised CPUE in the 1990s does not reflect a real trend of density by failing incorporating a change of operation pattern, it was replied that Japanese longline data used in this document did not targeted swordfish as a primary species. The line is set in shallow water at night with light sticks when directly targeting swordfish. However, the document showed that catch rates increase with the number of hooks per basket when swordfish are not directly targeted. This contradiction was explained by daily migrations demonstrated by bio-telemetry, the fish staying in deep water during the day and moving to shallow water at night. The need was noted to collect further information on operations and gear configuration, such as time of set, material used (monofilament, braided nylon, etc.), and use of light sticks. It was recognised that the number of hooks per basket would become more difficult to use as a indicator of operational pattern in near future. Other species caught by operations directly targeting swordfish, i.e. shallow night sets with light sticks, were discussed. While shark was reported as a major catch in the US operations in the Pacific, Réunion reported that the species composition changed from bigeye and albacore to swordfish by operating area from North to South.

TWS/98/27 shows the fishing areas for broadbill swordfish in the Indian Ocean and notes that the more southerly fishing for these species in quarters 2 and 3 is likely to be linked to the targeting of southern bluefin tuna. There have been no stock assessments of Indian Ocean broadbill swordfish. Conservative estimates show catches increasing from around 2,000 to 3,000 t up to the mid 1980s to around 18,000 t by the mid 1990s. There is evidence, particularly from data from China(Taiwan), of a major shift (with corresponding gear changes) towards targeting swordfish. The paper suggests that, notwithstanding the views of the 6th Expert Consultation and although the stock status is unknown, the wide geographic distribution and low historical catches suggest the stock could withstand increased exploitation. The slower growth rate, lower fecundity and later age-at-maturity of broadbill swordfish compared to marlins needs to be taken into account in a more cautious assessment of potential yields.

It was noted that neither information on use of light sticks nor on number of hooks per basket, indicators of change of targeting, were incorporated in the analysis. It was also clarified that the huge increase observed in 1994–1995 was mainly due to increase of catch by the fleet from China(Taiwan). China(Taiwan) and Japan hold some data size data by sex, but coverage is low. Thailand also holds processed weight data for longline landings, but without sex data. The need to improve statistics held by IOTC was emphasised by noting that the 1996 total catch derived from the IOTC database (14,000 t) was lower than the reported catch by Taiwan (17,000 t).

It was reported that the Indian Ocean Commission (COI) countries, the Comoros, Madagascar, Mauritius, Réunion/France, and Seychelles, are preparing a common programme to collect biological and ecological information on species caught by longline, especially of swordfish, to develop local fishing capacity in longlining. It is also intended to develop a MCS (monitoring, control and surveillance system) for the EEZs of the region. These programmes will be financed by the participating countries and the European Union. La Réunion (France) has also started a three years research programme financed by Réunion and the EU. The following six actions areas have been defined:

- collection of data including catch and effort, and technical and geographical evolution of the fleet,
- biological study focusing on age, growth and reproduction based on regular sampling on board as well as landing sites,
- investigation of small-scale behaviour of swordfish through monitoring of catch depth/time with hook-timers and depth/temperature recorders, as well as tagging with ultrasonic, pop-up and/or archival tags,
- investigation of relationship between stock and environment using satellite information through GIS analysis and multi-agent individual based modelling,
- study on predation by marine mammals on swordfish and other tuna and tuna-like species, and
- biological study of growth and reproduction of bigeye tuna.

Stock Status

No stock assessment has been conducted for swordfish in the Indian Ocean. The stock is distributed over a wide geographical area. Because only few fisheries directly target this species and catches are mainly from fisheries targeting other species, the fishing pressure is considered to be at moderate level. Interest in developing swordfish fisheries, however, is increasing and the stock is facing a substantial and rapid increase in levels of exploitation. Consequently, the Meeting took note that adequate effort is needed to monitoring the longline fleets, especially as longline vessels can easily switch their targeting to swordfish.

Recommendations

The Consultation recommended that action be taken to:

1. Collect size information by sex,
2. Improve understanding of biology and ecology of swordfish, with a specific emphasis on encouraging collaboration with the proposed Programme of the COI, recognising the importance of collaboration at regional or wider levels because of the wide distribution of this species,
3. Collect information reflecting targeting, including time of set, materials used for gear (monofilament, braided nylon, etc.), and use of light sticks,
4. Improve the database held by the IOTC and recuperate exiting data,
5. Conduct a stock assessment with best available information and
6. Conduct a specific programme to address the question of predation of hooked fish by marine mammals, with a view to possible prevention.

Billfish

Recent catches for the species in this category are shown in Table BIL-1.

Table BIL-1*. Recent catches of several species of billfish in the Indian Ocean.*

Year	Indo-Pacific Blue Marlin	Black Marlin	Striped Marlin	Indo-Pacific Sailfish	Swordfish	Billfish NEI
1987	5,907	1,518	5,174	1,332	5,462	6,653
1988	7,736	2,251	3,548	3,712	7,400	6,462
1989	5,468	1,632	2,693	2,661	5,657	12,319
1990	7,257	1,737	1,565	3,700	6,196	12,538
1991	7,817	1,424	2,430	4,861	6,776	10,219
1992	8,656	2,391	2,665	4,252	12,645	10,548
1993	7,851	3,472	5,683	6,303	23,421	10,650
1994	10,365	899	3,406	8,839	18,227	15,028
1995	4,386	1,035	4,251	6,706	24,901	18,147
1996	4,281	837	3,637	8,068	25,563	20,858

Research Results

In TWS/98/27, the CPUE for swordfish, striped marlin, blue marlin, black marlin, and the sailfish and spearfish combined group were standardised using Japanese longline statistics by a GLM method. Data used in this analysis are fine scale catch and effort data aggregated by month, 1° x 1° area and gear configuration (number of hooks between floats). The results of primary GLM analysis shows that the CPUE for all species concerned inside 200 mile EEZs is significantly higher than it is in high seas. There are large discrepancies in distribution and fishing effort because these species are caught as by-catch. The area used for the present analysis does not cover the main distribution areas of billfishes, especially those of striped marlin, black marlin and sailfish.

The fit of the model for each species is bad, especially for blue marlin, black marlin and the SS group. The results of this analysis therefore need to be treated with some caution. The gear configuration has a significantly high effect on the CPUEs for all species concerned. The incorporation of this effect is essential for the standardisation of CPUE for swordfish and billfishes. The standardised CPUEs for all species show the declining trend. The CPUE in 1997 is about 50 % of the level in the late 1960s and 70s for striped marlin, blue marlin, and black marlin, and 30 % for the sailfish/spearfish.

It is very difficult to monitor abundance trends adequately through the fishery, which does not target the species concerned. It is strongly recommended that the abundance indices based on the coastal fisheries that target billfish should be developed as soon as possible.

Nevertheless, significant quantities of billfish are caught annually in the Indian Ocean and, being generally long lived, these species remain vulnerable to overfishing. In TWS/98/28, preliminary analyses of stock availability are presented for the main billfish species, based on the catch and effort data pertaining to the Japanese and Indian Ocean longline fisheries from China(Taiwan). While the indices need to be treated with caution (due to problems relating to the accuracy of the catch and effort data, and the fact that changes in catchability have not been factored into the analyses), the declines observed in the indices for black marlin, striped marlin and sailfish/spearfish warrant further investigation. In particular, further effort needs to be put into accounting for changes in targeting practices and the other changes in the fishing gears used.

Status of the Stock

Due to the general lack of targeted studies on billfish, the resource status of these species within the Indian Ocean has not been analysed in any previous study and currently remains unknown. Therefore, the status of the billfish stocks is unknown. In the light of the two studies that were presented to the Consultation, however, concern was raised on the sharp decline in catch rates accompanying the increase in catches in the recent years.

Recommendations

The Consultation recommended that:

1. Data collection be strengthened and improved, especially on obtaining accurate catches, as it was felt that catches were underreported due to discarding practices.
2. By-catch of billfish in the purse seine fishery be reported separately, although not considerable in quantity.
3. Available data be compiled compilation and a stock assessment conducted with the best available data.
4. Sports fishery catch and effort data should be collected and reported to IOTC in a timely manner as developments in localised sports fisheries, which are known to have apparently high catch rates, were noted in many countries. At present catch statistics from these fisheries are not systematically reported to the IOTC.

Other Tuna Species

The most important species of other tunas in the Indian Ocean catches are longtail tuna (*Thunnus tonggol*), kawakawa (*Euthynnus affinis*), frigate tuna (*Auxis thazard*) and bullet tuna (*Auxis rochei*). Recent annual catch estimates for the entire Indian Ocean are shown in Table OTH-1.

Table OTH-1. *Recent catches of small tuna in the Indian Ocean.*

Year	*Longtail*	*Frigate and bullet*	*Kawakawa*	*Tunas NEI (mostly small spp)*
1987	*41,742*	*5,224*	*28,749*	*41,980*
1988	*47,613*	*7,942*	*35,519*	*34,165*
1989	*37,988*	*8,658*	*40,867*	*44,211*
1990	*36,303*	*8,818*	*53,472*	*37,774*
1991	*40,145*	*8,527*	*40,363*	*36,305*
1992	*33,994*	*11,044*	*48,890*	*35,563*
1993	*50,567*	*6,485*	*45,832*	*47,154*
1994	*68,656*	*15,609*	*45,160*	*39,889*
1995	*83,859*	*9,063*	*52,039*	*41,250*
1996	*75,493*	*14,264*	*64,439*	*54,945*

Three general comments apply to all these species:

1. Coastal countries, notably Indian, Indonesia, Iran, Maldives, Oman, Pakistan, Sri Lanka, Thailand and UAE, make almost the entire catch in the Indian Ocean.
2. Fisheries statistics are improving but 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 small tunas, in particular of longtail tuna, are significant.

No new information regarding status of the stocks was presented during this Expert Consultation. Therefore, it was agreed that the recommendations from the 6th Expert Consultation were still valid.

Research requirements

1. There continues to be a need for small tuna fishery statistics to be improved. All catches should be reported to IOTC by species, rather than by species groups. It is also necessary to collect information on the fishing effort associated to these catches.
2. There is need to consolidate the understanding of the biology of kawakawa and longtail tuna. In particular, age validation , reproduction and migration studies should be carried out.

Seerfish

Catches of seerfish in the Indian Ocean are shown below.

Table SER-1: *Catches of seerfish in the Indian Ocean*

Year	*Narrow-barred Spanish Mackerel*	*Indo-Pacific king mackerel*	*Streaked seerfish*	*Wahoo*	*Seerfishes NEI*
1987	*83,810*	*14,867*	*70*	*49*	*16,362*
1988	*85,083*	*25,009*	*535*	*64*	*13,416*
1989	*78,154*	*31,229*	*81*	*309*	*10,782*
1990	*69,973*	*20,781*	*27*	*175*	*12,504*
1991	*66,152*	*26,482*	*50*	*675*	*16,136*
1992	*77,112*	*20,949*	*1,030*	*172*	*13,702*
1993	*78,468*	*30,864*	*79*	*2,190*	*11,163*
1994	*82,158*	*23,122*	*46*	*302*	*14,513*
1995	*95,686*	*29,749*	*87*	*157*	*13,322*
1996	*79,025*	*30,758*	*120*	*223*	*19,052*

Research Results

A major fishery exists for seerfishes, mainly the narrow-barred Spanish mackerel (*Scomberomorus commerson*), in the northern Arabian Sea, Red Sea and the Gulfs. However, no papers on Indian Ocean seerfishes were presented for the consideration of this Consultation.

However, the participants noted that the recommendations formulated in the 6th Expert Consultation are still valid and, therefore, they should be renewed.

Status of the stocks

The Consultation was not provided with sufficient information to assess the current status of these stocks.

Research requirements

The Consultation recommended that:

1. Collection of biological data should be improved and extended to all fishing areas.
2. Estimated growth rates of *Scomberomorus commerson*, in particular, be validated.
3. Catch-and-effort data collection be improved.
4. A study on gear selectivity be conducted.

AGENDA ITEM III: ENVIRONMENT, TAGGING AND INTERACTION STUDIES

The Moderator for this Agenda Item proposed four main items to cover : 1) the physical and biological environment, and its effect on fisheries, 2) the effect of fisheries on the ecosystem, 3) interactions between fisheries and 4) tagging.

Physical and biological environment

The Moderator introduced the subject by a brief presentation of the environmental context of the tuna fisheries. The importance of the physical and biological environment is known to be important. Both abundance and catchability may be affected by environmental variability and integrating appropriate environmental indices in stock assessment models is seen as an important task to improve tuna assessments. It is likely that there is not a single equilibrium in the production curve of many tuna stocks, but different levels controlled by changes of regimes in the environment. The biological production of the ocean is also a keystone topic to consider. At an ocean-wide scale, for instance, the ecobiological areas proposed by Longhurst could provide a rather good framework to understand the distribution of most tuna species and tuna fisheries. Taking the environment into account in fisheries studies requires the identification of main processes, from the physics of the ocean, coupled with the atmosphere, to the first levels of the trophic pyramid.

The first presentation (TWS/98/19) focused on the physical oceanography of the Indian Ocean, with emphasis on the large-scale changes induced by the El Niño – Southern Oscillation (ENSO) events. The ocean-atmosphere coupled system can explain how anomalies generated in the Pacific warm pool can be transferred to the Indian Ocean. However, it seems possible that, in some cases, an ENSO signal might originate from anomalies occurring in the Central and North Indian Ocean. The main response of the Indian Ocean to ENSO is the development of a westward wind anomaly in the equatorial zone, resulting in a rise of the thermocline in the Eastern basin (particularly along the Sumatra, Indonesia coast) and a deepening in the western basin. This situation is highly developed in the beginning of the year, that is, during the ENSO peak phase. The latest ENSO (1997-98) appears to be at a record intensity for the Indian Ocean. The dynamics are well described by shallow-water circulation models (forced only by the wind). Although rather simple compared to reality, they can be useful in identifying quickly the main changes of the mixed layer depth, a critical factor to control the efficiency of most fishing gears. Other sources of data are available and should also be very useful for diagnosing the environmental changes, such as the TOPEX-POSEIDON satellite altimetric data.

The effects of the ENSO on tuna fisheries were addressed by the second presentation (TWS/98/16). The first goal of the study was to explore functional relationships between environment, recruitment and catchability. This was undertaken using detailed French purse seine catch and effort data. Emphasis was laid on yellowfin tuna, but considerations developed in this study could be widened to other tropical tunas. A non-linear statistical method was used to analyse the relationship between the turbulence and a recruitment index. Increasing turbulence appears to be detrimental to recruitment, a result that can be explained through the ecology of the first larval stages, as described in the concept of the 'optimal environmental window' developed on small pelagic fish populations. The effect of environment on catchability was studied in relating the adult CPUE and the depth of thermocline. CPUE decreases as the thermocline deepens, and a non-linear effect could be identified, with a rapid decrease of CPUE within a short range of thermocline depth. The second goal of the study, e.g. the potential effects of ENSO, could then be addressed using the previous relationships. The physical characteristics of ENSO events might favour the success of reproduction, and therefore of recruitment. ENSO years produce poor fishing conditions for purse seiners in the Western basin due to the deepening of thermocline in the traditional fishing grounds. Conversely, the shallow thermocline prevailing in the East; during ENSO, increases the vulnerability of yellowfin to the purse seine gear.

The tropical tuna which spawn over large oceanic areas might not be very sensitive to recruitment variability, because the negative effects on larval ecology in some climatic situations do not occur in the whole ocean at the same time. The case of southern bluefin tuna was briefly discussed, and it was noted that its recruitment was showing little year-to-year variability. Spawning occurs in a restricted area South of Java, during almost 6 months; during this quite long period, southern bluefin tuna could take advantage of the local variability to compensate the detrimental effects of particular environmental conditions.

The third document (TWS/98/20) presented a multidisciplinary approach integrating the environment (mainly from satellite imagery) and the dynamics of the longline fleet targeting swordfish from La Réunion. The final goal of this project was to implement a dynamic GIS approach, integrating sea surface temperature, Ekman pumping, dynamic topography, sea colour and bathymetry. Individual based and multiple-agent modelling will be developed to build a decision-making framework of the fish versus its environment. Fishery statistics and pop-up tagging will provide *in situ* validation. The Artificial Intelligence technique allows identification of emerging processes that are used to propose hypotheses on the behaviour of the population.

The document TWS/98/39 was presented as a software demonstration of GAO, outside of the plenary session. GAO is software that handles multi-parameter oceanographic database for the use of fisheries biologists who want to undertake combined analyses between pelagic resources and their physical environment. The database covers both Atlantic and Indian oceans, and a standardised version of this product should be made available by mid-1999.

Effect of tuna fisheries on the pelagic ecosystems

There were no papers available on this topic. It was therefore covered by a general discussion on different points:

- **By-catch and discards**: the need was recognised to monitor the discards that occur in some fisheries. It was agreed that observer programmes represent a good approach to obtain more information about this problem. The problem of organising such programmes was raised. It was recommended that this should be done at the national level. However, in practice, there is very poor sampling on by-catch and, when available, some countries are reluctant to release their data.
- **Predation by mammals**: the longline fishery is much affected by predation of the fish hooked by marine mammals (often *Pseudorca* spp.). Very high rates are observed in the equatorial area (as much as 27 % per year in the Seychelles). There was also a discussion concerning the opposing trends of the biomass of tunas (showing significant decrease world wide) and of mammals, showing an increasing trend (taking benefit of international ban on their exploitation). The potential effects of those changes in biomass would need further studies. Predation adds a bias in the estimation of removals from the population due to fishing.

Other points to consider include the effect of intense fishing on floating objects and seabird and turtle mortality caused by some longline fisheries. All are important in relation to the conservation of natural resources and responsible fishing behaviour, but all cannot be handled at the same time. Moreover, it appears that the need is now more to manage ecosystems rather than fish stocks considered separately. This ecosystem approach could require the organisation of an *ad hoc* working group, gathering scientists from a wide community (ecologists and fisheries scientists). Recently developed tools, such as the ECOPATH/ECOSIM models, could allow the exploration and some quantitative estimation of the complex interactions between different segments of the pelagic ecosystem.

Interaction between fisheries

No working documents were available, but various papers on this subject have been recently published by FAO (targeting primarily the Pacific Ocean). Few interactions between tuna fisheries have been demonstrated so far in the World tuna fisheries, despite a clear overlap of exploited species, sizes and area in various major fisheries. The problem is very complex. However, there is now a large amount of data documenting the fisheries and the sizes caught. Simulation models have been designed in other oceans and could be used in the Indian Ocean. Tagging remains a necessary technique to tackle this interaction problem, but it is not obvious whether this objective should be the priority for the Indian Ocean tagging programme. This is further discussed in the following item.

Tagging

The report of the Working Group on the Yellowfin Tagging Programme held in Colombo in 1995 was summarised to the Consultation. The first set of guidelines of a tagging programme was produced by the 1991 Workshop on Stock Assessment of Yellowfin tuna. At that time, emphasis was placed on yellowfin tuna, and tagging was recommended in the western basin where most of the fishing effort was located. Since then, the conditions have changed significantly: the industrial purse-seine fishery has extended eastwards and the priorities are no longer the same. The top-ranked priority is the determination of stock structure and estimation of exchange rates between the East and West basins. Therefore, tagging must now be carried out at an ocean-wide scale and requires substantial preparatory work.

It was also recognised that yellowfin tuna is no longer the only species of interest and the programme should also cover bigeye and skipjack, and possibly other species such as swordfish. A wide range of sizes must be tagged because the large-scale movements are probably size-dependent. A large number of tags should be released and the appropriate number should be estimated for each species and size.

The problem of the tagging platform was also addressed. The most appropriate is the pole-and-line bait boat as many fish in optimum condition can be tagged. However, the limited bait resources in most of the coastal countries might be a strong limitation to using this gear, as is the fact that large fish are seldom caught by this method. Therefore, alternative gears must be envisaged, such as handlines, troll lines, longlines and purse seines. Handlines and troll lines can easily be operated from artisanal fisheries. Pilot studies are necessary to test the feasibility of tagging from longline and purse seine caught fish. These could also address various points, such as training personnel, assessing operational costs, estimating local recovery rates and carrying out some OTC tagging. A pilot study was planned by IPTP in 1996-97 but could not be executed due to lack of funds. The reinforcement of the statistical collection system is also a critical point, as it ensures the success of the tag recovery. Moreover, simulation studies must be undertaken to better plan the development of the programme.

Recommendations

There was a general consensus on the following points:

1. There is no substitute to a conventional tagging programme for a better assessment of the resources, even if tagging with electronic devices is also recommended;
2. Other species must be tagged if opportunities arise;
3. A limited number of taggers should be involved to limit the biases due to individual variability;
4. Double tagging has to be carried out to estimate the tag shedding rate, and tag seeding experiments carried out when possible to estimate recovery rates;
5. For the validation of growth, the strontium-chlorine technique should be preferred to OTC tagging;
6. To be fully successful, a tagging programme requires substantial resources in the recovery procedures, which can represent large investment;
7. An awareness programme targeting all the fishermen and canneries active in the Indian Ocean must be launched before operations are started.

Many technical points must be reviewed in detail in order to plan efficient large scale tagging, but these are outside the scope of the present Consultation. Therefore it is strongly recommended that an *ad hoc* Working Group be organised by the IOTC to plan and to conduct those tagging operations efficiently.

AGENDA ITEM IV: PROGRESS IN DATA COLLECTION SYSTEMS AND RESEARCH

Eleven presentations were made under this Agenda Item. A review of data collection and processing for long range longliners from China(Taiwan) was given in TWS/98/33. In 1996, when data processing was transferred from National Taiwan University to the Overseas Fisheries Development Council, the system was reviewed by scientists from China(Taiwan), in collaboration with experts from ICCAT. Major changes in estimates of total catches resulted from updating estimates of bigeye and yellowfin tuna landings based on data on Japanese imports, the recovery of sales records of swordfish and the conversion of processed weights to whole weights. Catch-and-effort data were modified by screening logbook data and by recalculating coverage rates. Size data for albacore, yellowfin, bigeye and swordfish were also reviewed. It was noted that, after 1993, Japanese imports of bigeye and yellowfin tunas were considerably greater than the revised estimates of landings. This is probably due to the fact that the Japanese import data may cover vessels from China(Taiwan) chartered in Indonesia, which are not covered by the revised estimates of landings and that the data includes purse-seine catches.

Of the high seas fleet of about 600 longliners, VMS is currently used on 60 longliners from China(Taiwan) world-wide, while 55 vessels are expected to finalise installation of the system in 1998.

The meeting considered that widely used data standards for VMS would increasing the ease of use for the fishermen and reduce the complexity of data processing. It was expected that the Coordinating Working Party on Fisheries Statistics (CWP) may address this issue at their next meeting, in July 1999.

The problem of collecting data from vessels fishing under flags of convenience was discussed. There is a limit on the number of longliners from China(Taiwan) that are licensed to fish in the Indian Ocean; hence, many vessels operate under flags of convenience. Unfortunately, the Administration from China(Taiwan) does not obtain data covering these vessels because it has no legal authority to do so. IOTC has attempted to estimate the catches of vessels fishing under flags of convenience from landings data collected from ports around the region; however, certain countries, such as South Africa, do not systematically collect transhipment data covering foreign vessels. It was noted that it was not difficult to obtain data for purse seiners owned by Spanish companies which operate under flags of convenience.

Double reporting may occur when data covering vessels fishing under bilateral access agreements are provided by the fishers to the coastal state, as well as to their flag state. It is sometimes impossible to determine whether vessels fishing under flags of convenience have or have not been covered. The meeting considered that fishing nations should do their utmost to obtain data covering vessels owned by their nationals that operate under flags of convenience, since in most cases there are no other sources of data.

Tuna research and data collection activities in Sri Lanka were presented in TWS/98/38. Continuous monitoring of the commercial tuna fisheries for the collection of data needed for the assessment of fish stocks and biological studies of the major tuna species is some of the work presently being conducted by the Marine Biological Resources Division (MBRD) of the National Aquatic Resources Research and Development Agency (NARA). Experiments have been carried out with fish aggregating devices to exploit under-utilised large pelagics. NARA has completed a two-year offshore resource survey utilising three local, multi-day fishing boats. The survey concluded that the offshore gillnet fishery has already achieved its maximum economic benefit and that a further increase in the gillnet fleet should be prevented. Rather, further expansion should be in tuna longlining.

The collection of national fishery statistics in Sri Lanka is carried out by the Department of Fisheries and Aquatic Resources (DFAR). NARA has a parallel data collection system for biological data and catch and effort data for tuna and other large pelagics. In 1994, NARA strengthened this system and extended sampling towards the East coast. As the collection of detailed information related to the offshore multi-day boats has become increasingly difficult, a logbook system was introduced to this fleet in 1995. Logbooks have been distributed to a total of 350 boats. Improvements have been proposed for the collection of data from foreign longliners, 44 of which land their catch in Sri Lanka.

Estimation of and total catch and effort for tuna and tuna-like species depends mainly on the data collected through an island-wide sampling programme and does not use the data from the logbook system. The situation is complicated by the fact that many vessels use several gear types during the same trip. In the ensuing discussion, it was noted that the coverage of vessels reporting through logbooks was incomplete and that the sample may not be representative.

Recent catch, effort and catch composition data collection in Australian tuna and billfish fisheries were presented in TWS/98/42. The subject areas covered included commercial tuna fishing operations within the Australian Fishing Zone, Commonwealth and State monitoring responsibilities, logbook design and usage and the Australian Fishing Zone Information System. New logbooks were introduced in 1997 for the small vessel monofilament longline fleet, pole and purse seine vessels and minor line vessels, including troll, rod-and-reel and handline vessels. Percentage coverage of the domestic fisheries has varied and has been related to the extent of field support. Under-reporting is a common feature, although over-reporting due to anticipation of the use of catches to establish rights for Individual Transferable Quotas (ITQs) may also occur. Discards of large swordfish in the early years of the longline fishery due to marketing problems related to mercury content may not have been covered by logbooks. Other components of the data collection system include observer programmes, pre- and post-fishing inspections of foreign vessels and port sampling of domestic vessels. The use of VMS by domestic vessels is being considered on a gear-by-gear basis.

It was considered by the Consultation that, in general, logbooks forms must be made easy to use, that the quality and coverage of logbook data is greatly increased through personal interaction between the data collection agency and the fishers and that financial incentives, such as deposits which are returned upon submission of logbooks, can be useful. In Australia, a second copy of the logbook can be retained by the vessel for its own use, which is another incentive to the fisher for providing good quality data.

The problems with size data that have been collected by the crew while at sea, wherein sizes are often rounded, was discussed and it was concluded that observer data is the only reliable source of size data collected at sea.

It was suggested that the IOTC Secretariat update the IPTP manual of sampling methods which was based on a similar manual prepared by ICCAT. However, it was considered that this could be addressed if and when a statistics working party is created.

Notes on the maximum daily search time for purse seiners were presented in TWS/98/44. The maximum search time, i.e. the time between sunrise and sunset that is available for searching, is related to latitude and month. In the past, a maximum search time of 12 or 13 hours has usually been assumed. A correction factor which adjusts the value from 12 hours depending on latitude and month was found to range from 0.994 (December) to 1.021 (June) at 0–5° latitude and from 0.904 (January) to 1.124 (June) at 20–25° latitude. Similar correction factors were provided for a base value of 13 hours.

In this regard, the need to note the time zone as well as the time on logbooks was noted, in order to properly determine the timing of a vessel's activities. Vessel crew frequently record time in the home port time zone rather than in GMT or in the zone they may be in.

A new sampling strategy for estimating the species composition and length frequency of catches of tropical tunas was discussed in TWS/98/43. Data from the French and Spanish purse-seine fleets in the Atlantic and Indian Oceans, from 1991 and 1995, were used in a GLM analysis to examine the effect of geographic area (six zones), school association (log and free schools), vessel nationality (French and Spanish), vessel size category, and time period (year, quarter, two months, month). New sampling areas and sampling protocols were adopted, based on the results. It was found that the combination of school association, zone and quarter explained 42 percent of the variance in the species composition. A greater amount of variance can be explained with more highly resolved time periods (one or two months) or grid area (5° or 1°); however, the corresponding sampling protocols, which involve a much greater number of strata and require a larger number of samples per strata, were considered impractical. Similar results were found for the size distribution. On examination, it was found that the use of five areas would be optimal, compared to the three which have been used in the past. As a result, a new sampling protocol for two types of school association, five areas and four quarters was designed. An examination of data from total enumeration of a single well indicated that the species composition varies with the time of sampling. Therefore, it was recommended that sampling of a well occur in at least two stages, at different times, to reduce bias.

Implementation of a revised sampling strategy for estimating species composition and size frequency, based on the analysis referred to above, was discussed in TWS/98/43. Since March 1998, the Oficina Española de Pesca (OEP) and IRD have introduced the strategy in three of the four most important transhipment ports of the region, i.e. Victoria, Antsiranana and Mombassa. Sampling may also be introduced in Phuket in the future. The strategy includes strata for two types of school association, ten areas and four quarters. A target of 15 to 30 samples per strata has been established. The sampling protocol depends on the size of fish in the well. If there are no fish below 10 kg, 75 fish are sampled in each of the morning and afternoon rounds. If there are fish less than 10 kg in the well, all fish over 10 kg are sampled and 300 and 200 fish under 10 kg are sampled in the morning and afternoon rounds respectively. During each round of sampling with fish under 10 kg, the first 25 small tunas (e.g. skipjack, frigate tuna, bullet tuna or kawakawa) are measured; the remaining small tunas are only counted. All longtail tuna are measured.

The sampling of French and Spanish purse seiners in ports in the region was commended as an excellent example of cooperation, and the meeting agreed that the fisheries agencies of all fishing nations which tranship in the region should advise their nationals to cooperate with port sampling.

The Deputy Secretary of the IOTC presented information on the status of databases managed by the Secretariat. Although the Secretariat began functioning in February 1998, it was fully functional only in August when full staffing was realised. Nevertheless, after only three months, the computer system has been installed and the transition has been smooth. The database system has been transferred from FoxPro to Access, and database structures and naming conventions have been normalised. Extensive tests of referential integrity have also been conducted and some minor problems that were discovered have been rectified. The database consists of separate tables of nominal catches (stratified by country, year, gear and area); effort; catch by time-area strata; size-frequency data; and various tables which define codes used in the other tables. Purse-seine catch data prior to 1993 are not stratified by school association, whereas size-frequency data are stratified by school association and this continues to present problems. IRD undertook to provide the missing fully stratified purse seine data.

A data tracking system is used to monitor all changes made to the database. This includes tables recording any correspondence received by the Secretariat which concern revisions to the data; a table which records every revision made to the database; a table which records who sent, received, entered and verified the revisions; and hyperlinks to the document which contains the revision.

IOTC Data Summary No. 18 (1987–1996), which had just been printed, was distributed to the participants. It includes a catalogue of data held by the Secretariat and the Secretariat intends to extend the catalogue to cover the sources of the data. The Deputy Secretary noted that the programmes which produce the tables in the Data Summary were rewritten for the new system. The meeting congratulated the Secretariat on producing an excellent document.

It was noted that some data are received by the Secretariat in raised format and other data in unraised format. If possible, the Secretariat will raise the unraised data, and when it does so, the original unraised data are always archived. The raising factors are not currently stored in the same files as the data. It was suggested that doing so would greatly assist in assigning variances to the data when the data are used in assessments.

The proportion of the catch for which the figures in the Data Summary were estimated by the Secretariat, rather than being provided by the fishing nation, has increased from 15–30 percent for the early years in the time series to about 50 percent for the past four years. The proportion is not uniform across species, with a higher proportion being estimated by the Secretariat for species which are common in artisanal fisheries and a lower proportion for those which are common in industrial fisheries. This has resulted partly from the loss of contact with data correspondents in several countries during the transition from IPTP to IOTC. One the highest priorities of the Secretariat is to re-establish those contacts. It was also noted that much of the missing data actually exist in national agencies, but that these data have not yet been made available to the Secretariat. Another priority of the Secretariat is therefore to locate those data.

It was explained that the 'unclassified' gear category usually refers to data which have been provided for two or more gear types or to estimates that are derived from FAO statistics, which are not available by gear type.

The proportion of the catch which is covered by size-frequency data is 70–80 percent for skipjack, 60–70 percent for yellowfin, 25–40 percent for bigeye and less than 20 percent for other species, e.g. 10 percent for kawakawa.

The Secretariat will adopt a new version of the FAO FISHSTAT software that has been developed for Windows and use it as a prime tool for diffusing data. Data will also be released on the Internet as soon as the problem of low bandwidth has been resolved and a web site developed for IOTC. The Secretariat informed the meeting about software being developed for the mapping of catch and length-frequency data. The software is fast enough to permit dynamic viewing of maps, which is useful in detecting patterns in the data. Dissemination of data on hardcopy is expensive and time-consuming; therefore, the Secretariat is reviewing the need to distribute data in that format, bearing in mind that most users of the data have e-mail and access to the Internet. The Data Summary is currently available in an Adobe Acrobat PDF file. The Acrobat Reader, which is required to view the PDF file, is in the public domain and is available through the Secretariat.

The Secretariat sought feedback on the need to include data on numbers of vessels in its database. It was considered that these data would be useful, although it was recognised that the compilation of such data was problematic, particularly since these data are often collected by harbour, provincial or municipal authorities, rather than national fisheries agencies. Given that the problem is often to identify the individual who is responsible for information on vessel numbers, it was suggested that IOTC members should assign persons to be contacts for these data and advise the Secretariat. The problem of obtaining data covering longliners which fish under the flags of convenience was discussed. Countries were encouraged to record the identifiers of such vessels which are licensed or land catches in their ports and provide these data to IOTC. This would permit the constitution of a registry of vessels from which a crude estimate of catch could be made.

The minimum requirements for data submission to the Secretariat were considered and a small working group met outside the main sessions of the Consultation. Its conclusions, which included a recommendation for the creation of a statistics working party, are summarised in the Conclusions and Recommendations of the Consultation, and were further discussed under Agenda Item 6 below.

Research priorities for tuna fisheries in the Indian Ocean were discussed in TWS/98/41. Because of the large increase in catches during the past 15 years, it is necessary to assess the stocks of all of the target tunas. The lack of a large-scale tagging project in the Indian Ocean has been a major impediment to stock assessment and such a programme should be a priority. Studies on those biological parameters which are fundamental to stock assessment should also be conducted. Purse-seine sets made on floating objects should be studied, as well as the increase in the efficiency of purse seining over time. In order to conduct a large-scale tagging programme and stock assessment, international cooperation through the IOTC will be essential. Sources of funds to conduct a large-scale tagging programme will need to be identified.

Information concerning the development of software by FAO for database systems covering artisanal fisheries was presented. ARTFISH, which at present handles sample and frame surveys, is multilingual and can be customised for many types of survey data. It will be extended to include a socio-economic module (with the collaboration of IRD) and an aquaculture module (with the collaboration of SEAFDEC). Census (logbook) survey modules are still to be developed. It was suggested that new statistical recording systems be made compatible with this in order to facilitate data aggregation.

The collection of statistical and biological information on the swordfish fishery in Réunion was presented in TWS/98/45. During the last five years, the local swordfish longline fishery has experienced rapid growth and development. Longline catches reached more than 2,300 t in 1997. Responsibility for collecting data for the fisheries of Réunion for reporting to FAO lies with the local fisheries office, the Direction Départementale des Affaires Maritimes (DDAM). Moreover, since 1993, IFREMER has been collecting and compiling scientific and technical information on longline fisheries operating in the French EEZ and international waters. The use of voluntary logbooks is encouraged through contacts made during regular port sampling and through contacts with scientific observers. The recently-developed longline fishery and data collection procedures set up by DDAM and IFREMER were discussed. Initial results regarding conversion factors and the guidelines for IFREMER's programme were also presented.

Developments concerning statistics, research and management of tuna fisheries in the western and central Pacific Ocean were presented. This information can be found in the Report of the Eleventh Meeting of the Standing Committee on Tuna and Billfish, 28 May – 6 June 1998, Honolulu, Hawaii, which is available on the web site of the Secretariat of the Pacific Community (SPC) at the URL http://www.spc.org.nc/oceanfish/docs/index.htm.

The meeting was informed that FAO is organising the Expert Consultation on Implications of the Precautionary Approach: Tuna Biological and Technical Research, in collaboration with CCSBT, IATTC, ICCAT, IOTC and SPC. The objective of the Consultation is to assist in the implementation of the precautionary approach for tuna fisheries by preparing guidelines on the implications of the precautionary approach for tuna biological and technological research. In addition to tuna and tuna-like species, the guidelines are intended to cover associated bycatch and ecologically-related species, and the associated physical environment.

Recommendations

It was recognised that the IOTC Secretariat will need greater resources, particularly additional staff, to carry out its work programme in an efficient and effective manner. Several ways in which additional staffing could be made available were discussed, including additional staff funded by the IOTC; staff recruited as FAO Associate Experts; staff detached from national agencies; training of staff from national agencies through attachments with the Secretariat; and the FAO Partnership Programme, wherein academics might work with the Secretariat during a sabbatical.

AGENDA ITEM V: CONSTITUTION OF WORKING PARTIES

For budgeting purposes, the Secretariat of IOTC has proposed in its Programme of Work and Budget, the creation in 1999 of Working Parties (WP) on:

1) Data,
2) Tagging,
3) Tropical Oceanic Tunas (bigeye, skipjack and yellowfin) and
4) Billfishes.

The rationale for a Working Party on billfish came from the rapid expansion of fisheries targeting swordfish and the importance of this species to coastal fisheries. The Secretariat suggested the creation of WP's on Neritic and Temperate Tunas might be considered in the following year, provided the necessary resources were provided. Progress with the collection and collation of data is necessary before a comprehensive stock assessment can done for neritic tunas.. Finally, IOTC, in a decision at the First Special Session, recognised that CCSBT has a prime responsibility for southern bluefin tuna, while albacore is targeted mainly by a single country.

The Secretariat indicated that for financial and logistic reasons, meetings of WP are likely to be held in Victoria, Mahé, Seychelles. Due to the very limited capacity of the Secretariat and limited number of tuna experts in the region, it would be not practical to hold meetings of several WPs simultaneously. As the membership of WPs and the Scientific Committee are likely to be significantly different, there is no reason to organise them to follow each other back-to-back.

The Consultation, in earlier agenda items, confirmed and reinforced the concerns on the quality and timeliness of data submissions. It also confirmed that tagging was a priority in obtaining a snapshot of tropical tuna resources.

There were discussions on the mode of functioning of the WPs dealing with stock assessment. Two possibilities were envisaged: in the first, a major part of the work of constituting detailed databases and of running previously agreed stock assessment models would be undertaken by the Secretariat. This did not preclude scientists working individually at the national level. Under this approach, the meetings would concentrate on the analysis of results and on the definition of further studies.

In the second approach, all the work would be conducted in the WPs, including constitution of databases and running of stock assessment models.

Depending on the chosen mode, the duration of these meetings could vary, but would in any case be over one week. This might make it impracticable to envisage working on several species concurrently or sequentially.

The Consultation pointed out that, to account for very large uncertainties in the information available, the complexity and sophistication of models may require substantial work to be done, out-of-session, by experts with very specialised quantitative skills. This is likely to require substantial contracts for the development of such models and travel of consultants to meetings.

It was decided that the specific model to be followed should be decided by the Scientific Committee and the WPs themselves, as should the priorities on the species to be assessed.

External experts

In response to the request of the Second Session of IOTC to provide advice on the participation of independent scientists in the Working Parties and Scientific Committee process, the Consultation recognised significant advantages of technical input from experts from other regions. It was recognised, however, that this notion should not be restricted to scientists, as input from specialists in other areas might be needed. It was suggested that they should be referred to as external experts. The Consultation noted that their participation may require substantial funds.

The Consultation felt that providing names of selected experts to IOTC through the Scientific Committee may not be appropriate because the need for their specific involvement is not known and their affiliation may change from year to year, so they may not be regarded as external experts later on. The Consultation felt that it would be practical for the Secretariat of IOTC to select them at its discretion, possibly in consultation with the Chairman of the Scientific Committee, if appropriate.

Recommendations

The Consultation recommended that:

1. For the first year, in view of the limited staff and financial resources of the Secretariat, the constitution of WPs on Data Collection and Tagging, and of no more than two stock assessment working parties.
2. Participation in WPs should be open to all competent scientists, whether or not from member entities. This would ensure transparency in the scientific process and contribute scientific expertise.

AGENDA ITEM VI: CONCLUSIONS AND RECOMMENDATIONS

The participants agreed that it would best to structure the discussion by addressing recommendations directly to the Secretariat, to the Scientific Committee and through this body to the Commission. In particular, the meeting was requested by the Second Session of the IOTC to formulate specific recommendations to the Scientific Committee relative to the constitution of Working Parties and to the selection of external expertise.

The participants also noted that more detailed recommendations were formulated in specific sections of the report.

General recommendations to the Secretariat

The Consultation recommended that:

1. The Secretariat cooperate with the National Research Institute of Far Seas Fisheries of Japan and other institutions participating in such research in coordinating the collection of DNA samples for genetic studies of bigeye and yellowfin tuna.
2. The Secretariat identify transhipment points for vessels flying flags of convenience in order to improve the collection of statistics for these fleets.

General recommendations to the Scientific Committee

The Consultation recommended that Scientific Committee consider addressing the following recommendations to the Commission:

1. In view of the increasing global concern about the incidental catches of non-target species, the Commission should consider re-interpreting its current mandate to include collection of data on catches of non-target species, associated and dependent species.
2. The Commission should increase current staffing of the Secretariat to further improve its current capacity for statistics and coordinate proposed research.
3. With reference to Rule VI 2. of the Rules of Procedure of IOTC, the Consultation considered that an efficient and transparent scientific process was possible only if participation in Working Parties were open to all interested and competent parties. The Consultation therefore recommended that these be considered open meetings.

Mandatory statistical requirements for IOTC members

The Expert Consultation received the report of a small *ad hoc* Working Party that met to discuss what should be the mandatory requirements for the submission of data by IOTC Members. After reviewing the report, the Consultation decided to strongly recommend that catch, effort, and size data should be made available routinely to IOTC at the finest possible time and area resolution for stock assessment purposes. The minimum standards of data requirements are discussed next in detail.

Catch and effort data

a) **Surface fisheries**: catch and effort data of the surface fisheries, catch weight and fishing days at least (purse seine, baitboat, troll, drift nets) should be provided to the IOTC by 1° grid area and month strata. Purse seine fishery data should be stratified by type of school. Those data should preferably be extrapolated to the national monthly catches of each gear. The raising factors used, corresponding to the logbook coverage, should be given routinely to the IOTC.

b) **Longline fisheries**: catch and effort data of the longline fisheries should be provided to the IOTC by 5° grid area and month strata, preferably in numbers and in weight. The fishing effort should be given in numbers of hooks. Those data should preferably be extrapolated to the national monthly catches. The raising factors used, corresponding to the logbook coverage, should be given routinely to the IOTC.

c) The catches, efforts and sizes of the **artisanal, small scale and sport fisheries** should also be submitted on a monthly basis, but using the best geographical areas used to collect and process those data.

Size data

Considering that size data are of key importance for most tuna stock assessment, length data should be routinely submitted to the IOTC on a 5° grid area and month basis, by gear and fishing mode (e.g. free/log schools for the purse seiners). Size data should be provided for all gears and for all species covered by the IOTC. Size data sampling should preferably be run under strict and well described random sampling schemes which are necessary to provide unbiased figures of the sizes taken. The exact recommended level of sampling could vary between species (as a function of various parameters), but the specific level of recommended sampling needs to be established by the working party on statistics. More detailed size data, for instance size by individual samples, should also be made available to the IOTC when requested by specific working groups, but under strict rules of confidentiality.

Timeliness of data submission to the IOTC

It is essential that all the fishery data be available in due time to allow the monitoring of stocks and analysis of the data. It is thus recommended that the following rules should be applied as standard obligation:

a) **Surface fleets and other fleets operating in coastal zone** must provide their fishery data at the earliest possible date but **no later than the 30th of June each year** (previous year data).

b) **Longline fleets operating in the high seas** must provide the **provisional** fishery data at the earliest date, but **no later than before June 30th** (for the previous year data). They must provide the **final estimate** of their fishery data **before December 30th each year** (for the previous year data).

The delays presently required to submit statistics could be reduced in the future because of the development of communication and data processing technologies, which should reduce the present data processing delays.

Dissemination of catch, effort and size data

It is recommended that the catch, effort and size data aggregated at finer level than the minimum described above can be disseminated to the scientists of its members countries in order to facilitate their scientific analyses at a fine level of resolution. The Working Party on statistics (which is recommended thereafter) should determine and formulate clearly the practical rules of confidentiality, allowing an efficient use of those data by scientists while keeping an adequate degree of confidentiality when necessary.

Tag and release data and other biological data

The Consultation recommended that the data collected on tuna biology in the Indian Ocean by national research programmes be submitted to the IOTC and managed by its Secretariat under strict rules of confidentiality. This recommendation should, for instance, concern the biological data such as length-weight data or other biometric data (such as the data used to establish length relationships as well as various other measurements), which may be of primary importance in the data handling. This could also include the submission of data on the dumping of by-catch species, which are of great potential scientific interest.

The archiving by the IOTC of such data would have two primary goals:

(1) the IOTC Secretariat would act as the "institutional memory" for the data collected on tunas in the Indian Ocean, as a safeguard against the accidental loss of those files, and

(2) those data could easily be made available to *ad hoc* Working Groups under well defined rules of confidentiality.

Working party on Statistics

It should be a permanent responsibility of the IOTC Working Party on Statistics to precise, revise and modify the presently proposed basic requirement, for instance, following the scientific requirement expressed by the various Working Groups.

Constitution of Working Parties

1. Taking account of the limited resources available to the Members and the Secretariat, the Consultation recommended that the following Working Parties be established in 1999,

a) A permanent Working Party on Data Collection and Statistics, to coordinate collection, compilation and dissemination of data.

b) A Working Party on Tagging, to formulate a comprehensive plan of action to implement tagging programmes for tuna and tuna-like species and to coordinate its execution and follow-up activities.

c) No more than two other Working Parties concerned with stock assessment of individual species. The Consultation considered that the choice of species and the priority given to them should be the prerogative of the Scientific Committee.

2. Recognising that the size of the task ahead, it was recommended that enough resources be allocated to adequately address the data and methodological requirements necessary for a sound assessment of the resources.

Recommendation about the participation of China(Taiwan) in IOTC

The Expert Consultation noted the following points:

(a) Large catches are taken by the China(Taiwan) tuna fisheries in the Indian Ocean (an average of 100,000 t taken annually during the last 10 years).

Excellent cooperation of scientists from China (Taiwan) to provide their catch and effort statistics to the IPTP was noticed in the past. Those data are of key importance and they will continue to be necessary to allow the monitoring of various important Indian Ocean tuna stocks (such as albacore, bigeye, yellowfin, swordfish, billfishes and others).

(b) In the past scientific work of the IPTP, it is recognised that the full participation of scientist from China(Taiwan) was extremely useful in order to obtain a reliable stock assessment. This situation should be continued to ensure complete and effective stock assessment in the future of the Indian Ocean tuna stocks.

(c) In the opinion of the Expert Consultation, the lack of the China(Taiwan) data and scientific participation would have very negative potential effects on most assessment done by the IOTC, having then potential deleterious consequences for the future management and conservation of the Indian Ocean tuna stocks.

Taking into account these scientific and technical factors, the Expert Consultation strongly recommended that the issue of associating China(Taiwan) appropriately within the IOTC process should be seriously addressed.

APPENDIX I: AGENDA

Monday 09 November

Opening Ceremony (Room 2, Conference Centre)	09:00 - 10:30
Adoption of the Agenda and Arrangements for the Meeting	10:30 - 11:00
Agenda Item 1: *Review of Fisheries*	11:00 - 12:30
Agenda Item 1: (Continued)	14:00 - 15:30
Agenda Item 1: (Continued)	15:45 - 17:30

Tuesday 10 November

Agenda Item 2: *Status of Stocks and Tuna Biology*	08:00 - 10:00
Agenda Item 2: (General; Yellowfin)	10:15 - 12:30
Agenda Item 2: (Yellowfin)	14:00 - 15:30
Agenda Item 2: (Yellowfin; Bigeye)	15:45 - 17:30

Wednesday 11 November

Agenda Item 2: (Skipjack, Albacore)	08:00 - 10:00
Agenda Item 2: (Albacore, Southern Bluefin, Billfishes)	10:15 - 12:30
Agenda Item 2: (Southern Bluefin, Billfishes, Small Tuna)	14:00 - 15:30
Agenda Item 3: *Progress in Data Collection Systems and Research*	15:45 - 17:30

Thursday 12 November

Agenda Item 3: (Continued)	08:00 - 10:00
Agenda Item 4: *Progress in Data Collection Systems and Research*	10:15 - 12:30
Agenda Item 4: (Continued)	14:00 - 15:30
Agenda Item 4: (Continued)	15:45 - 17:30

Friday 13 November

Agenda Item 5: *Constitution of Working Parties*	08:00 - 10:00
Agenda Item 6: *Conclusions and Recommendations*	10:15 - 12:30
Visit of tuna seiners, Victoria fishing port and IOTC headquarters.	14:00

Saturday 14 November

Presentation and Adoption of the Report	08:00 - 10:00
Presentation and Adoption of the Report	10:15 - 12:30

APPENDIX II: LIST OF PAPERS

TWS/98/ 1	-	René François, François Poisson and David Guyomard, 1998, The status of Réunion Island (France) - based tuna fisheries in the Indian Ocean
TWS/98/ 2	-	Pianet, Renaud, 1998, The French purse seine tropical fishery in the Indian Ocean
TWS/98/ 3	-	Kaymaram, Farhad and S.A.Talebzadeh, 1998, The status of tuna fisheries in the Islamic Republic of Iran
TWS/98/ 4	-	Maldeniya, R. and D. Amarasooriya, 1998, Tuna fisheries in Sri Lanka, an update
TWS/98/ 5	-	Norungee, Devanand and M. Munbodh, 1998, Transhipment of tuna in Mauritius and Analysis of the Mauritian purse seine fishery (1994-1997)
TWS/98/ 6	-	Somvanshi, V.S., N.G.K. Pillai and M.E.John, 1998, Current status of fisheries for tunas and tuna-like fishes in India
TWS/98/ 7	-	Al-Yahya, Abdulaziz, 1998, The Saudi Arabian fishery for small tunas and seerfish
TWS/98/ 8	-	Praulai, Chantawong, 1998, Tuna fisheries in the eastern Indian Ocean, 1993-1998
TWS/98/ 9	-	Okamoto, Hiroaki, Sachiko Tsuji and Naozumi Miyabe, 1998, Japanese Tuna Fisheries in the Indian Ocean
TWS/98/ 10	-	Dhammasak, Poreeyanond, 1998, Review of tuna fishing in Thailand
TWS/98/ 11	-	Bargain, Rose-Marie, 1998, Trends in the Seychelles tuna fishery
TWS/98/ 12	-	Robins, Carolyn M. and Albert Caton, 1998, Review of Australian tuna fisheries in the Indian Ocean
TWS/98/ 13	-	Pallares, Pilar, Alicia Delgado de Molina and Miguel Herrera, 1998, Statistics of the Purse Seine Spanish Fleet in the Indian Ocean
TWS/98/ 14	-	Al-Haj, Hamba S., 1998, The Artisanal Fishery of Tuna in Yemen
TWS/98/ 15	-	Dhammasak, Poreeyanond, 1998, Catch and size group distribution of tunas caught by purse seining survey in the eastern Indian Ocean, 1995-1996
TWS/98/ 16	-	Marsac, Francis and Jean-Luc Le Blanc, 1998, Dynamics of ENSO events in the Indian Ocean : to what extent would recruitment and catchability be affected
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APPENDIX IV: SPEECH OF THE MINISTER OF AGRICULTURE AND MARINE RESOURCES

Ministers

Excellencies

Distinguished delegates

Ladies and Gentlemen

It gives me a great pleasure to welcome you to Seychelles for this 7" Expert Consultation on Indian Ocean Tunas. I am happy to note the presence of many top tuna scientists from the region and from so many other parts of the world.`

We are living today in a world which is constantly evolving and we are experiencing upheavals in various fields such as finance, technology, health and climate. The recent El Niño phenomenon followed by La Niña have altered fishing patterns in the Indian Ocean with some tuna purse seiners moving very Far East for the first time. Other phenomenon such as the rise in sea water temperature which is the main cause of death of many of our corals have been observed. Many more of these events go unnoticed and even more important are the long term impacts on the environment and on our marine resources.

It is for the scientific community to be in the forefront so as to assess, monitor and as far as possible predict what will be the consequences of climatic conditions and fishing effort. The collection of comprehensive and reliable fishing statistics is a pre-requisite for proper fisheries management. Information needs to be collected not only at national but at a regional level. All the fleets exploiting the tuna fishery have a moral if not a legal obligation in providing accurate statistical information required for management purposes. This applies also to vessels flying flags of convenience and registered in countries that are not members of the Indian Ocean Tuna Commission. We should all be reminded of our obligations under the United Nations Convention on the Law of the Sea and various subsidiary agreements such as the agreement on the Conservation and Management of straddling fish stocks and highly migratory fish stocks.

IOTC as the successor of the Indo-Pacific Tuna Programme (IPTP) will continue to play the crucial role of gathering, analysing and disseminating scientific information, catch and effort statistics and other data relevant to the conservation and management of tuna stocks. It also has a role in helping developing countries in building up their own tuna database.

At this point allow me to speak very briefly on the situation in Seychelles. Tuna is our most important fisheries resource and it is likely that with the completion and operation at full capacity of the canning factory, Indian Ocean Tuna, fisheries and fisheries related activities will overtake tourism as an earner of foreign exchange. This situation did not happen on its own. Government invested considerably in providing the necessary infrastructure in port and port related facilities to allow the industrial development to take off. It did not neglect the scientific management aspect of the fishery. Since 1984, Government through SFA, has encouraged the development of the tuna purse seine fishery and set up a comprehensive tuna database from scratch. We were fortunate to be assisted by various organisations such as ORSTOM, FAO and IPTP but we also had to invest considerably in human and financial resources. We are proud of our achievements even though more consolidation and improvements remain to be done. We urge other countries no to neglect the data collection and management aspects of the fishery as it is a good investment in the long run.

I understand that this may be the last expert consultation on tunas. I wish to place on record our appreciation for all the work carried out by the various consultations which have taken place over the years since the first meeting which took place in Sri Lanka in 1985.

I wish you all an enjoyable stay among us.

I now declare this 7" Expert Consultation on Indian Ocean Tunas open.

APPENDIX V: OPENING REMARKS OF THE SECRETARY OF IOTC

Ministers

Your Excellencies, members of the Diplomatic Corps

Ladies and gentlemen

Fellow participants

I will start this address with an apology : the official languages of the Indian Ocean Tuna Commission are both French and English. Commission meetings are held with simultaneous interpretation but, as we have to bring in interpreters from abroad, the cost of this service is too high for a technical meeting. Presentations in the meeting will be made in the language chosen by the speaker and all of us in the Secretariat will do our best to help anyone with language difficulties.

I would like to welcome all the participants to Seychelles and to the 7th Expert Consultation on Indian Ocean Tunas. This is a special occasion as it is the first Meeting of a technical nature organised by the Indian Ocean Tuna Commission. The previous six EC were held under the auspices of the Indo-Pacific Tuna Programme (IPTP), which was IOTC's direct predecessor and operated from Sri Lanka from 1982 to 1997.

The Indian Ocean Tuna Commission Agreement entered into force three years ago and the Secretariat occupied its headquarters in Seychelles early this year. Getting the Secretariat fully functional has taken most of this year, but I am happy to inform you that we are now up to speed. I wish to express our profound appreciation to the Seychelles Fishing Authority and to the Government of Seychelles in facilitating this process.

I am also pleased to inform you that, with the accession of the People's Republic of China to the Agreement on 14 October, 1998, IOTC now has 17 Members. Several other countries have expressed the intention to join. We should soon be in a position, therefore, to seriously tackle the management of the tuna stocks in this ocean, as and when this is deemed necessary.

This week's meeting is likely to be the last of its type. While IPTP had a purely advisory mandate, IOTC has management powers. Exercising these powers will require a more focussed scientific process than would be possible in such a large meeting. It is intended to achieve this by convening, in the future, a number of scientific Working Groups dedicated to deal with a restricted set of issues. The WGs will thus, it is hoped, provide IOTC members with the research recommendations, analyses of resources and management options Commissioners will need to determine how best to ensure the continued prosperity of Indian Ocean tuna fisheries.

One of the tasks of this Consultation will be to advise the Scientific Committee and, through it, the Commission, which will meet here in the second week of December, on the number of WGs and on their terms of reference.

Another important task for this Consultation is to provide advice to the Commission on the mandatory standards for the submission of data by Members. The availability of timely and accurate data is fundamental to our ability to manage tuna resources.

We are in a fortunate position, in the Indian Ocean, in that IPTP ensured that data are available from the very beginning of the industrialised exploitation of tunas. However, in most countries fishing for tunas, funds available to collect statistics have not kept pace with technological advance and expansion of the fisheries. This has resulted in data which are now, in many cases, inadequate in quality. Furthermore, these data are reaching the Secretariat with considerable delay. While this was not of crucial importance when we were merely monitoring resource status, it will not do for management.

In dealing with this question, issues of confidentiality will also have to be addressed. It is increasingly being recognised that statistical data have considerable commercial, as well as scientific value. Those providing the data must have an absolute assurance that sensitive information will not fall into the wrong hands. If this were not the case, there would be a powerful inducement to provide inaccurate or even misleading information.

A worrying trend, which is outside the direct sphere of influence of the Commission, is the movement of fishing capacity to flags of convenience. We hope, in this meeting, to better appreciate the dimension of this problem and to find ways of estimating the catches these non-reporting fleets might have.

All this sound very administrative: It is three years since the last Expert Consultation on Indian Ocean Tunas, during which time fisheries have progressed rapidly. The scientific community has not been inactive in this period, either, as we can see from the 40 or so papers which will be presented to this meeting.

A large portion of this meeting will thus be devoted to updating our knowledge of developments in Indian Ocean tuna fisheries and in the research which has been conducted on the biology and stock status of Indian Ocean tunas. We might not be able to directly address management issues for any tunas this time, but the scientists here, from their collective wisdom, are expected to alert the Commission on areas of concern and of activities which might be needed to deal with them. The Precautionary Approach, adopted by the Earth Summit, no longer permits us to accept lack of information on stock status as an excuse for delaying the implementation of management.

Hopefully we will also be able to address questions which are increasingly preoccupying the international community: those relating to the whole ecosystem, rather than to the target species only. In our case, bycatch and discards are the issues which might influence management of tuna resources. Two weeks ago, an Expert Consultation was organised in Rome, largely as a result of a CITES resolution, on catches of sharks and seabirds, and also on excess fishing capacity. The international interest this meeting has attracted indicates clearly that we also must adopt the wide view.

The global events of the last two years have forcefully reminded us of the influence of the environment on the distribution of fish and their vulnerability to fishing gears. We are glad to note that physical oceanographers have contributed to the debate this time. This will complement and strengthen the input from biologists and fisheries specialists.

Prior to closing, I would like to thank all the participants to this Consultation for the time and effort placed in preparing the documentation which will be presented and for the resources allocated to attending this meeting.

The issues we have to deal with justify these efforts – let us not forget that the Indian Ocean catch of tuna and tuna-like species is now over one million tonnes, with a producer value of the order of two thousand three hundred million dollars annually. Where better than the Seychelles to address these issues : tuna fisheries are fundamental to the economy of this country. A visit is planned to the fishing port and to the Indian Ocean Tuna cannery and this will forcefully illustrate the point.

We have a busy week ahead of us. I will therefore call on the Honourable Mr. Ronny Jumeau, Minister of Agriculture and Marine Resources, to open the meeting.