EXECUTIVE SUMMARIES OF THE STATUS OF THE MAJOR INDIAN OCEAN TUNAS AND BILLFISH (ALBACORE, BIGEYE, YELLOWFIN, SKIP JACK AND SWORDFISH)

Executive summary of the status of the albacore tuna resource

(As adopted by the IOTC Scientific Committee 10 November 2006)

Marked changes are factual changes related mainly to the inclusion of the latest fisheries statistics. All changes are suggestions only for the consideration of the SC in Nov07

BIOLOGY

Albacore (*Thunnus alalunga*) is a temperate tuna living mainly in the mid oceanic gyres of the Pacific, Indian and Atlantic oceans. Indian Ocean albacore is distributed from 5°N to 40°S. In the Pacific and Atlantic oceans there is a clear separation of southern and northern stocks associated with the oceanic gyres that are typical of these areas. In the Indian Ocean, there is probably only one southern stock because there is no northern gyre.

Albacore is a highly migratory species and individuals swim large distances during their lifetime. It can do this because it is capable of thermoregulation, has a high metabolic rate, and advanced cardiovascular and blood/gas exchange systems. Pre-adults (2-5 year old albacore) appear to be more migratory than adults. In the Pacific Ocean, the migration, distribution availability, and vulnerability of albacore are strongly influenced by oceanographic conditions, especially oceanic fronts. It has been observed on all albacore stocks that juveniles concentrate in cold temperate areas (for instance in a range of sea-surface temperatures between 15 and 18°C), and this has been confirmed in the Indian Ocean where albacore tuna are more abundant north of the subtropical convergence (an area where these juvenile were heavily fished by driftnet fisheries during the late 1980's). It appears that juvenile albacore show a continuous geographical distribution in the Atlantic and Indian oceans in the north edge of the subtropical convergence. Albacore may move across the jurisdictional boundary between ICCAT and IOTC.

The maximum age reported for Indian Ocean albacore is eight years. However, this may be an underestimate as albacore have been reported live to at least 10 years in the Pacific Ocean.

Little is known about the reproductive biology of albacore in the Indian Ocean but it appears, based on biological studies and on fishery data, that the main spawning grounds are located east of Madagascar between 15° and 25°S during the 4th and 1st quarters of each year (Figure 1). In the Pacific Ocean, albacore grow relatively slowly (compared to skipjack and yellowfin) and become sexually mature at about 5-6 years old. Like other tunas, adult albacore spawn in warm waters (SST>25°C). It is likely that the adult Indian Ocean albacore tunas do yearly circular counter-clockwise migrations following the surface currents of the south tropical gyre between their tropical spawning and southern feeding zones. In the Atlantic Ocean, large numbers of juvenile albacore are caught by the South African pole-and-line fishery (catching about 10.000 t yearly) and it has been hypothesized that these juveniles may be taken from a mixture of fish born in the Atlantic (north east of Brazil) and from the Indian Ocean.

Overall, the biology of albacore stock in the Indian Ocean is not well known and there is relatively little new information on albacore stocks.

FISHERIES

Albacore are caught almost exclusively under drifting longlines (98 %), and between 20° and 40°S (Table 1, Figure 1), with remaining catches recorded under purse seines and other gears (Table 1).

A fleet using drifting gillnets targeting juvenile albacore operated in the southern Indian Ocean (30° to 40° South) between 1985 and 1992 harvesting important amounts of this species. This fleet, from Taiwan,China, had to stop fishing in 1992 due to a worldwide ban on the use of drifting gillnets. Albacore is currently both a target species and a bycatch of industrial longline fisheries and a bycatch of other fisheries.

The catches of albacore increased rapidly during the first years of the fishery, remaining relatively stable until the mid-1980s, except for some very high catches recorded in 1973, 1974 and 1982. The catches increased markedly during the 1990's due to the use of drifting gillnets, with total catches reaching around 30,000 t. Catches have steadily increased since 1993, after the drop recorded in 1992 and 1993 as a consequence of the end of the drifting gillnet fishery. Catches between 1998 and 2001 were relatively high (ranging from 37,700 t to 40,600 t). By contrast, the average annual catch for the period from 2002 to 2006 was 24,900 trecent catches have been much lower at 25,000 t, 22,800 t and 19,300 t (for 2003, 2004 and 2005, respectively).

Longliners from Japan and Taiwan,China have been operating in the Indian Ocean since the early 1950s and they have been the major fishers for albacore since then (Table 1). While the Japanese albacore catch ranged from 8,000 t to 18,000 t in the period 1959 to 1969, in 1972 catches rapidly decreased to around 1,000 t due to changing the target species mainly to southern bluefin and bigeye tuna, then ranged between 200 t to 2,500 t as albacore became a bycatch fishery. In recent years the Japanese albacore catch has been around 2,000 to 4,000 t. By contrast, catches by Taiwanese longliners increased steadily from the 1950’s to average around 10,000 t by the mid-1970s. Between 1998 and 2002 catches ranged between 21,500 t to 26,900 t, equating to just over 60 % of the total Indian Ocean albacore catch. Since 2003 the albacore catches by Taiwanese longliners have been less that 13,200 t .

The catches of albacore by longliners from the Republic of Korea, recorded since 1965, have never been above 10,000 t. Important albacore catches of around 3,000 t to 5,000 t have been recorded in recent years for a fleet of fresh-tuna longliners operating in Indonesia (Figure 3).

Large sized albacore are also taken seasonally in certain areas (Figure 5), most often in free-swimming schools, by the purse seine fishery.

A feature of Indian Ocean albacore fisheries is that it is the only ocean where juvenile albacore are rarely targeted by fisheries. In the Atlantic and Pacific oceans surface fisheries often actively target small albacore to the extent that juveniles contribute to the majority of albacore catches. This, however, does not discount the possibility that the juvenile albacore from the Indian Ocean are not being subjected to significant levels of fishing pressure as the small fish targeted off the west coast of South Africa may have migrated to the Atlantic Ocean from the Indian Ocean (Figure 1).

AVAILABILITY OF INFORMATION FOR STOCK ASSESSMENT

Nominal Catch (NC) Data

The catches of albacore recorded in the IOTC databases are thought to be complete, at least until the mid-1980s. The fleets for which the majority of the catches of albacore are recorded have always reported good catch statistics to the IOTC. The catches of albacore recorded for Illegal and/or Unregulated and/or Unreported (IUU) fleets (recorded mostly as NEI- in the IOTC Database), which have been operating in the Indian Ocean since the early 1980s, have always been estimated by the Secretariat. In recent years the quantities of the NEI catches have decreased markedly.

Catch-and-Effort (CE) Data

Catch and effort data are fully or almost fully available up to the early 1990s but only partially available since then, due to the almost complete lack of catch and effort records from IUU and the Indonesian longline fleet.

The effort statistics are thought good quality for most of the fleets for which long catches series are available, with the exception of the Republic of Korea and Philippines. The use of data for these countries is, therefore, not recommended.

Size Frequency Data

The size frequency data for the Taiwanese longline fishery for the period 1980-2004 is now available. In general, the amount of catch for which size data for the species are available before 1980 is still very low. The data for the Japanese longline fleets is available; however, the number of specimens measured per stratum has been decreasing in recent years. Few data are available for the other fleets.

STOCK ASSESSMENT

The WPTMT conducted a series of analyses based on fitting a production model to various combinations of catch-and-effort data (from Japanese and Taiwanese longline fisheries, and the Taiwanese gillnet fishery). The results of one of the analyses suggested that the stock could be below the level that would produce MSY and that the current fishing mortality is above that required to achieve the MSY, while the remainder failed to produce plausible parameter estimates. In all analyses, there was a discrepancy between the observed and predicted CPUE trends for the most recent years (Figure 5) and the model could not explain appropriately the apparent lack of response in the CPUE to the increase in the catch. Several explanations have been proposed, including a possible increase in productivity of the albacore stock due to a change in environmental conditions, or the inability of the CPUE series to adequately reflect changes in the population abundance. Regarding the first hypothesis, the size frequency data does not offer any evidence supporting the hypothesis of recent increased recruitments.

MANAGEMENT ADVICE

A stock assessment for Indian Ocean albacore (*Thunnus alalunga*) was attempted in 2004 by the Working Party on Temperate Tunas. Results of the analyses conducted were considered unreliable, although one of the results suggested that current catch levels might not be sustainable. Other indicators, such as the average size in the catch and catch rates, have not shown declines in recent years.

Taking into account the absence of a reliable assessment of the status of albacore tuna and the need for a precautionary approach, the SC recommended that the Commission be very cautious in allowing increases in catch or fishing effort from the 2002 levels until the problems with the assessments have been resolved.

ALBACORE TUNA SUMMARY

Maximum Sustainable Yield:	unknown
Preliminary catch in ~~2005~~2006 *(data as of October ~~2006~~2007)*	~~19,300~~23,500 t
Mean catch over the last 5 years (~~2001~~2002-~~05~~06)	~~28,200~~24,900 t
Catch in ~~2004~~2005	~~22,800~~20,700 t
Catch in 2002	33,100 t
Current Replacement Yield	-
Relative Biomass ($B_{current}/B_{MSY}$)	unknown
Relative Fishing Mortality ($F_{current}/F_{MSY}$)	unknown

Note: This Executive Summary has been updated to take account of recent catch data. The management advice, and stock assessment results are based on data up to 2002.

Table 1. *Best scientific estimates of the catches of albacore tuna (as adopted by the IOTC Scientific Committee) by gear and main fleets for the period ~~1956~~1957-~~2005~~ 2006 (in thousands of tonnes). Data as of October ~~2006~~2007*

Gear	Fleet	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
Purse seine	Other Fleets																								0.0	0.0	0.0	0.0
Purse seine	Total																								0.0	0.0	0.0	0.0
Longline	Taiwan,China	0.7	1.0	1.2	1.1	1.4	1.3	1.6	1.5	1.1	1.7	1.6	7.6	7.7	7.2	7.0	7.0	12.0	17.4	6.4	9.7	9.8	12.8	15.0	11.0	12.3	21.9	17.0
Longline	Japan	4.7	6.3	10.4	11.1	15.2	17.6	12.6	17.8	11.4	13.1	14.1	10.1	8.6	4.9	3.3	1.4	2.0	2.8	1.3	1.2	0.4	0.4	0.4	0.6	1.2	1.3	1.7
Longline	Indonesia																		0.0	0.1	0.1	0.1	0.2	0.3	0.2	0.2	0.2	0.2
Longline	Korea, Republic of									0.5	0.6	6.2	0.9	4.4	1.7	2.4	3.8	9.1	9.8	3.9	4.2	2.1	4.6	2.0	1.8	0.9	0.6	0.6
Longline	Other Fleets								0.1	0.2	0.2	0.0	0.8	0.2	0.7	0.6	0.5	0.4	0.2	0.1	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.2
Longline	Total	5.3	7.3	11.6	12.1	16.6	19.0	14.1	19.4	13.2	15.6	22.0	19.3	20.9	14.4	13.3	12.7	23.5	30.2	11.6	15.3	12.5	18.1	17.7	13.7	14.7	24.2	19.6
Gillnet	Taiwan,China																										0.1	0.1
Gillnet	Total																										0.1	0.1
Other gears	Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
All	Total	5.3	7.3	11.6	12.1	16.6	19.0	14.2	19.4	13.2	15.6	22.0	19.3	20.9	14.4	13.4	12.8	23.5	30.3	11.7	15.3	12.5	18.2	17.7	13.7	14.8	24.7	19.8

Gear	Fleet	Av02/06	Av57/06	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06
Purse seine	France	0.4	0.2	0.3	0.5	0.2	0.2	0.2	0.0	0.0	0.9	1.4	0.3	0.3	0.4	0.4	0.5	0.5	0.2	0.4	0.7	0.3	0.6	0.1	0.1	0.9
Purse seine	Spain	0.3	0.2	0.2	0.1		0.0	0.1		0.1	1.1	1.5	0.9	1.8	0.6	0.8	1.0	0.3	0.2	0.4	0.3	0.2	0.5	0.1	0.0	0.4
Purse seine	Other Fleets	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.2	0.3	0.4	0.1	0.5	0.4	0.4	0.5	0.8	0.2	0.4	0.3	0.3	0.4	0.1	0.1	0.1
Purse seine	Total	0.8	0.5	0.6	0.7	0.2	0.2	0.3	0.0	0.3	2.2	3.3	1.3	2.6	1.3	1.6	2.0	1.6	0.6	1.2	1.3	0.8	1.5	0.3	0.2	1.4
Longline	Taiwan,China	13.4	10.4	13.9	6.2	11.1	13.1	11.0	7.1	5.8	13.1	11.1	12.0	14.4	14.2	16.9	15.2	21.6	22.5	21.7	26.9	21.5	13.1	12.5	10.4	9.5
Longline	Japan	3.9	4.6	1.8	2.3	2.5	2.3	1.3	0.9	1.0	1.0	1.8	1.3	1.8	2.0	2.4	3.2	3.2	2.3	2.6	3.0	3.2	2.3	3.6	4.1	6.5
Longline	Indonesia	3.3	0.7	0.3	0.3	0.1	0.3	0.3	0.4	0.4	0.3	0.5	0.4	0.6	0.7	1.3	1.6	1.5	1.7	2.7	2.9	2.6	4.8	4.2	2.6	2.2
Longline	NEI-Deep-freezing	1.1	1.4		0.0	0.7	0.7	1.7	1.0	1.2	2.5	1.8	3.2	4.2	4.2	7.3	4.8	9.0	9.5	8.2	3.1	2.3	1.1	0.5	0.8	0.9
Longline	Seychelles	0.5	0.1																0.0	0.4	0.8	1.1	1.2	0.1	0.1	0.1
Longline	Belize	0.4	0.1																		1.4	0.6	0.2	0.1	0.7	0.7
Longline	France-Reunion	0.4	0.1								0.0	0.0	0.1	0.1	0.1	0.3	0.2	0.3	0.3	0.5	0.6	0.3	0.3	0.4	0.7	0.5
Longline	Korea, Republic of	0.2	1.3	0.4	0.5	0.4	0.4	0.4	0.3	0.2	0.3	0.1	0.1	0.1	0.1	0.2	0.3	0.2	0.1	0.2	0.1	0.0	0.1	0.4	0.2	0.2
Longline	Other Fleets	0.6	0.3	0.2	0.0	0.1	0.1	0.2	0.5	0.6	0.6	0.7	0.6	0.8	0.4	0.2	0.3	0.8	0.6	0.4	0.5	0.5	0.4	0.4	0.6	1.4
Longline	Total	24.0	19.0	16.7	9.3	14.8	17.0	14.9	10.2	9.0	17.8	16.0	17.7	22.1	21.8	28.7	25.6	36.5	37.0	36.6	39.2	32.2	23.4	22.1	20.4	22.0
Gillnet	Taiwan,China		1.9		0.7	18.2	14.0	14.4	10.6	25.7	9.0	2.6														
Gillnet	Total		1.9		0.7	18.2	14.0	14.4	10.6	25.7	9.0	2.6														
Other gears	Total	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
All	Total	24.9	21.5	17.4	10.8	33.2	31.3	29.6	20.8	35.1	29.1	22.0	19.1	24.8	23.2	30.4	27.7	38.1	37.7	37.8	40.6	33.1	25.0	22.4	20.7	23.5

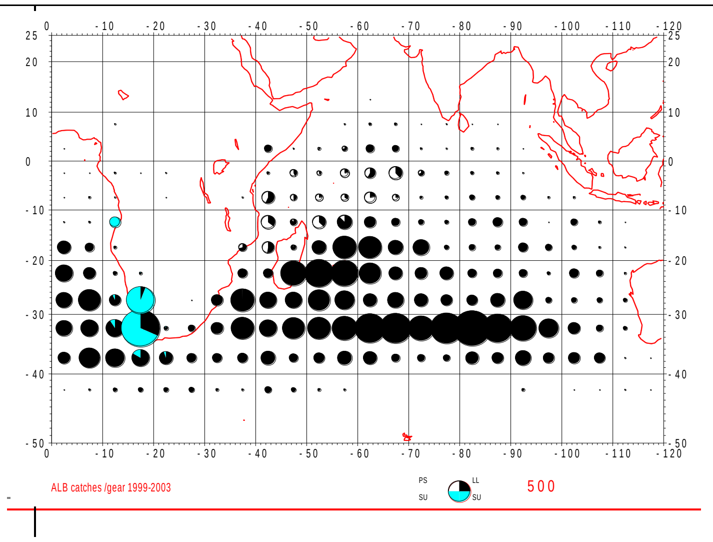


Figure 1. Average albacore catches by gear during the period 1999-2003. Map shows the distribution of albacore extending from the Indian Ocean to the Atlantic Ocean. LL = longline, PS = purse seine, SU = pole and line. Data as of October ~~2006~~2007

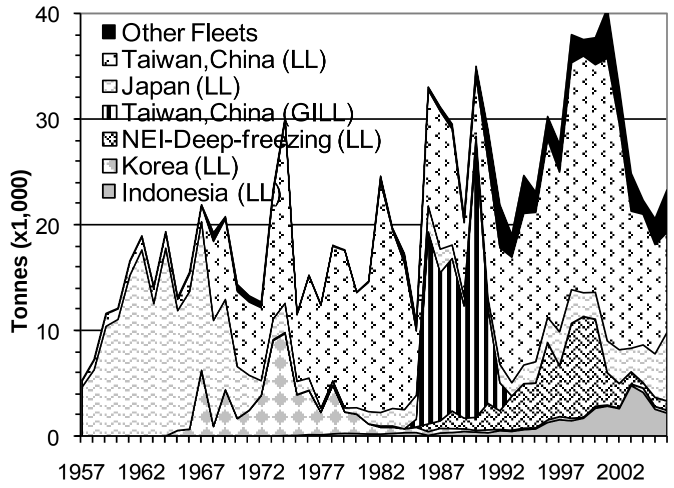


Figure 2. Catches of albacore per fleet and year recorded in the IOTC Database (1957-2006~~1956~~~~2005~~). Data as of October ~~2006~~2007

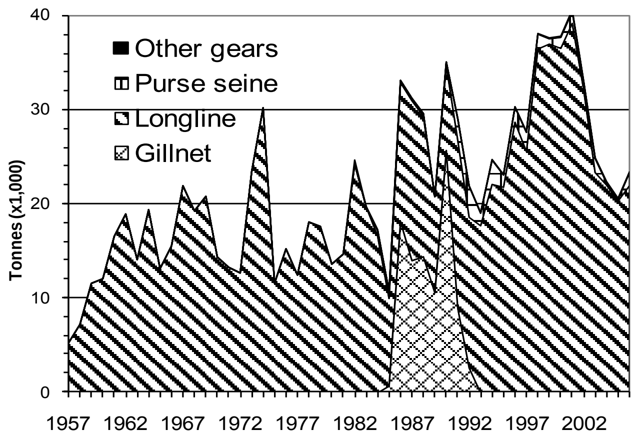


Figure 3. Annual of catches albacore (thousand of metric tonnes) by gear from ~~1956~~ 1957 to ~~2005~~2006. Data as of October ~~2006~~2007

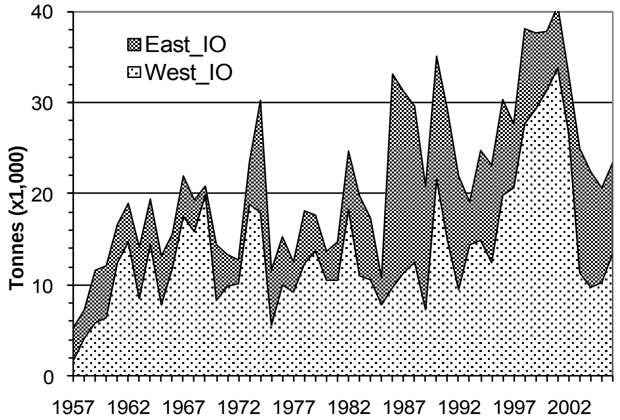


Figure 4. Catches of albacore in relation to the eastern and western areas of the Indian Ocean (~~1956~~1957-~~2005~~2006).Data as of October ~~2006~~2007

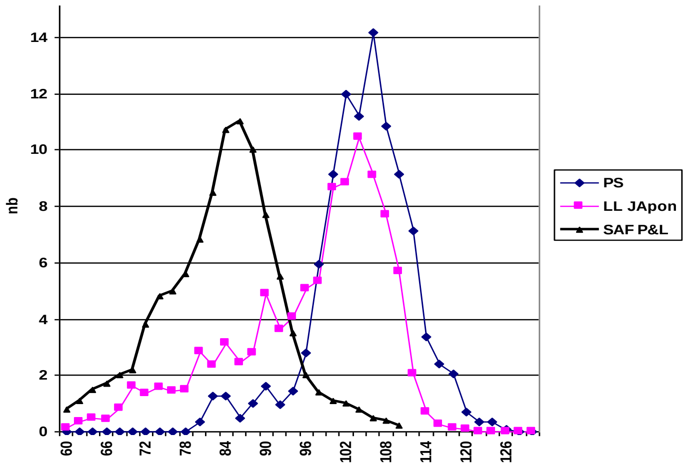


Figure 5. Average sizes of albacore taken by various fisheries in the Indian Ocean, longliners and purse seiners, and by the pole-and-line fishery in the west coast of South Africa (Atlantic Ocean).

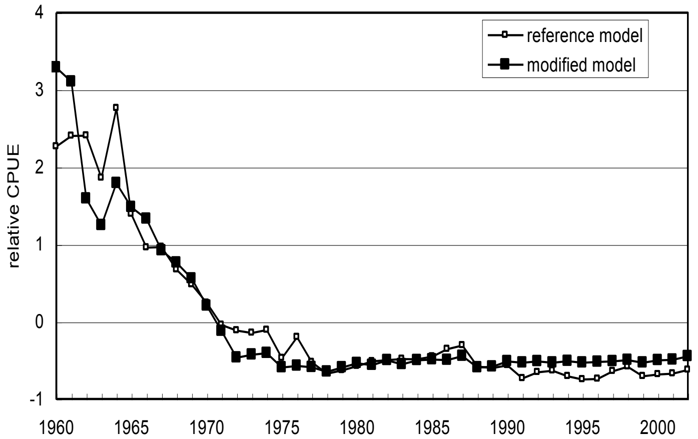


Figure 6. Standardized CPUEs for the reference and modified models. The CPUE for the modified model was calculated using data from Area 2 and Area 4 where albacore is generally abundant.

Executive summary of the status of the bigeye tuna resource

(As adopted by the IOTC Scientific Committee 10 November 2006)

Marked changes are factual changes related mainly to the inclusion of the latest fisheries statistics. All changes are suggestions only for the consideration of the SC in Nov07

BIOLOGY

Bigeye tuna *(Thunnus obesus)* inhabit the tropical and subtropical waters of the Pacific, Atlantic and Indian Oceans in waters down to around 300 m. Juveniles frequently school at the surface underneath floating objects with yellowfin and skipjack tunas. Association with floating objects appears less common as bigeye grow older.

Currently a single bigeye stock is assumed for the Indian Ocean, based on circumstantial evidence. The range of the stock (as indicated by the distribution of catches) includes tropical areas, where reproductively active individuals are found, and temperate waters, usually considered to be feeding grounds.

Of the three tropical tuna species, bigeye tuna lives the longest (more than 15 years) and that makes it the species most vulnerable, in relative terms, to over-exploitation. Bigeye have been reported to grow to 200 cm (fork length) long and over 200 kg and start reproducing when they are approximately three years old, at a length of about 100 cm.

THE FISHERIES

Bigeye tuna is mainly caught by industrial fisheries and appears only occasionally in the catches of artisanal fisheries. Total annual catches have increased steadily since the start of the fishery, reaching the 100,000 t level in 1993 and peaking at 150,000 t in 1999. Total annual catches averaged 123,000 t over the period 2001 to 2005. Bigeye tunas have been caught by industrial longline fleets since the early 1950's, but before 1970 they only represented an incidental catch. After 1970, the introduction of fishing practices that improved the access to the bigeye resource and the emergence of a sashimi market made bigeye tuna a target species for the main industrial longline fleets. Total catch of bigeye by longliners in the Indian Ocean increased steadily from the 1950's to reaching 100,000 t in 1993 and around 140,000–150,000 t for a short period from 1997-1999. (Figure 1). The average annual catch by longliners for the period from 2002 to 2006 was 94,500t. Taiwan,China is the major longline fleet fishing for bigeye and it currently takes just under 50% of the total catch (Table 1). Large bigeye tuna (averaging just above 40 kg) are primarily caught by longlines, and in particular deep longliners (Figure 3). Since the early 1990s bigeye tunas have been caught by purse seine vessels fishing on tunas aggregated on floating objects. Total catch of bigeye by purse seiners in the Indian Ocean reached 40,700 t in 1999, but the average annual catch for the period from 2002 to 2006 was 26,000 t~~has averaged around 25,000 t in recent years (2001-2005)~~ (Table 1). Forty to sixty boats have operated in this fishery since 1984. Purse seiners mainly take small juvenile bigeye (averaging around 5 kg) whereas longliners much larger and heavier fish (Figures 3, 4 and 5); and while purse seiners take much lower tonnages of bigeye compared to longliners (Figure 1), they take larger numbers of individual fish (Figure 6).

By contrast with yellowfin and skipjack tunas, for which the major catches take place in the western Indian Ocean, bigeye tuna is also exploited in the eastern Indian Ocean (Figures 1 and 2). The relative increase in catches in the eastern Indian Ocean in the late 1990's was mostly due to increased activity of small longliners fishing for fresh tuna. This fleet started operating around 1985. In the western Indian Ocean, the catches of bigeye are mostly the result of the activity of large longliners and purse seiners.

AVAILABILITY OF INFORMATION FOR ASSESSMENT PURPOSES

The reliability of the total catches has continued to improve over the past years, although still up to 25% of the catch has to be estimated. The fact that most of the catch of bigeye tuna comes from industrial fisheries has facilitated the estimation of total catches. Catch and effort data, potentially useful to construct indices of abundance, is also considered to be of good overall quality. Size-frequency information is considered to be relatively good for most of the purse-seine fisheries, but insufficient for the longline fisheries. This is due primarily to a lack of reporting from the Korean fleets in the 1970's, lack of reporting from Taiwanese fleets since 1989 and insufficient sample sizes in recent years in the Japanese fishery.

Information on biological parameters is scarce and improvements are needed in particular concerning natural mortality. The ongoing large-scale tagging programme is expected to improve knowledge on a range of biological characteristics. A new growth curve was presented in 2003 which was considered to be an important improvement over previously existing information.

In the case of the purse-seine fishery, it was not possible to derive indices of abundance from catch-and-effort information, because the interpretation of nominal fishing effort was complicated by the use of FADs and increases in fishing efficiency that were difficult to quantify. In the case of the longline fisheries, indices of abundance were derived, although there still remain uncertainties whether they fully take into account targeting practices on different species (Figure 7).

The Japanese longline standardised CPUE (1960 to 2004) for the Indian Ocean tropical waters is currently used to derive the index of bigeye abundance. In 2006, sea surface temperature and gear characteristics were included in the GLM standardisation procedure. This index generally declined from 1960 until 2002, with the exception of higher values in 1977 and 1978. Abundance values in 2003 and 2004 were higher than the lowest historical value in 2002 (Figure 7). A similar analysis of the Taiwanese CPUE series was also presented in 2006. After standardisation, this index shows a variable but generally decreasing trend, similar to that of the Japanese fleet (Figure 7). This is in contrast with previous years, when significant differences could be observed between both indices; and appears to be the result of an increase in the information input into the analysis by Taiwanese researchers. Given that the standardisation procedure of the Taiwanese index is still work in progress, the WPTT decided to apply the Japanese index in the recent stock assessment runs, while recognizing and encouraging the significant improvements achieved in the generation of an index of abundance for the Taiwanese fleet.

Catch at size and catch at age data were updated in 2006. Given that a catch-at-size matrix is an integral part of both length and age based assessment methods, the WPTT expressed their ongoing concerns about the low levels of size sampling being collected in the Indian Ocean. Notwithstanding these concerns the WPTT was encouraged by the potential of the information being obtained from the RTTP-IO in the belief that this programme is going to be important alternative source of size data in the very near future.

STOCK ASSESSMENT

In 2006, five stock assessment models were applied to the Indian Ocean bigeye tuna stock using an agreed list of input parameters. Ten year projections were also carried out for a range of scenarios.

Results

From the range of MSY estimates, the SC chose the value of 111,200 t. This was the MSY estimated by the ASPM and it was reported ahead of the estimates from the other methods because ASPM results have been reported in previous executive summaries; and the WPTT noted that several of the other assessment approaches used in 2006 needed further exploration and development. Given that the mean annual catch for the period 2001-2005 was 123,000 t and the preliminary catch estimate for 2005 is 112,400 t, it appears that the stock is being exploited at around its maximum level. Results from the ASPIC analysis plotting the annual catches as a function of fishing mortality illustrate the MSY and its uncertainty (Figure 8).

Despite the broad agreement of the models in estimating MSY, they produced quite different estimates of absolute levels of virgin and current biomass, and thus in the ratios of current levels of F and SSB to MSY. This was probably due to how the variations in CPUE were interpreted by each model. While acknowledging the value of assessing the status of bigeye from a wide range of modelling perspectives, the WPTT recommended that the results of the ASPM (Table 2) would be used in the Bigeye Executive Summary in 2006.

The ASPM results indicate that the 2005 catch is close to the MSY. Furthermore, spawning stock biomass appears to be above the level that would produce MSY, and the fishing mortality in 2004 appears to below the MSY level.

Biomass trajectories indicate that the spawning stock biomass is currently just above the MSY level, but it has been declining since the late 1970’s (Figure 9). Similarly, the current fishing mortality is estimated be to just above the MSY level, but fishing mortality has been increasing steadily since the 1980’s (Figure 10).

Ten year projections were carried out using the following scenarios:

- constant catch at 2004 levels
- with a 10% reduction in 2004 catch levels
- constant F at 2004 levels, at 2000-02 levels and at 1998-01 levels

If 2004 catch levels were to continue, SSB is predicted to decline gradually over the next 10 years (Figure 11). At a constant catch equivalent to 10 % below the 2004 catch level, the rate of decline in SSB is less severe.

Three different fishing mortality at age scenarios were selected as they reflected different patterns of exploitation for juvenile and adult bigeye. In the period 1998-2000, the fishing pressure on juveniles was higher than it was during the period 2000-2002. The 2004 scenario reflects a fishery in which there was relatively lower pressure on juveniles compared to the other time periods. Scenarios based on F levels were presented, and the results indicate that the three levels considered (2004, 2000-02 and 1998-2001) would not have a strong effect in the trajectories of future SSB, as the differences are relatively minor given the current level of uncertainty (Figure 12).

The effects of the three scenarios of fishing mortality were also considered in terms of yield per recruit. A multi-fleet YPR analysis indicated that an exploitation pattern such as the one observed in 2004 would have a positive impact on the yield per recruit obtained, when compared to the 2000-02 and 1998-01 fishing mortalities by fleet. A slightly higher yield per recruit resulted from a pattern of exploitation in which there was lower pressure on juveniles. Yield per recruit increased from 1.98 kg for the 1998-2001 pattern of exploitation, to 2.06 kg for the 2000-02 pattern, up to 2.22 kg if the 2004 pattern of exploitation were to be retained.

Despite the progress made in the 2006 assessments, uncertainties in the results and projections still exist. These uncertainties relate to:

- Uncertainties concerning the available indices of abundance.
- How well the model structures used in the assessments approximate the true dynamics of the population, and about the quality of the estimation of some of the model key parameters.
- Insufficient size information for the catches of longline fisheries, especially in recent years.
- Uncertainties associated with estimating catch-at-size and catch-at-age.
- Uncertainty about the natural mortality at various life stages, including uncertainty about the functional form of its dependency with age.
- Uncertainty about the changes in catchability of the different fisheries involved, especially in the purse-seine fishery. Future consideration of an increase in efficiency could result in a more pessimistic appraisal of the stock status. For example, it is possible that the fishing mortality that would result in the MSY has already been exceeded.

Notes about exploitation patterns

The exploitation patterns observed in 2003 and 2004 could be considered anomalous, and heavily influenced by the high abundances of yellowfin tuna, which concentrated the activity of the surface fleets. The decrease in the fishing pressure on bigeye currently observed is likely to be temporal, as the fleets appear to have come back in the second half of 2005 to their previous pattern of activity.

Two other factors could also influence the short term evolution of the fishery. Rising fuel costs appear to be having an effect on the operating procedures of the surface fleets. Distances travelled at night, and consequently the number of FADs visited, are being reduced to save on fuel costs. The effect of this change could be however reduced by the increasing use of supply vessels, tasked with visiting FADs and informing purse seiners of the abundance of fish around them. The second factor is the limitation on the activity of all fishing fleets on the coast and EEZ of Somalia, due to the increase in the activity of pirates in the area. Some purse seine fleets have receive indications from their governments not to venture into those waters. An important fishery on FADs has traditionally taken place in this area on the last quarter of the year, with significant catches of juvenile bigeye.

Another factor to consider when analysing the possible futures trends in SSB is the increasing trend in effective fishing power observed in the fleets involved in this fishery.

MANAGEMENT ADVICE

The results of the stock assessments conducted in 2006 were broadly similar and, in general, were more optimistic than previous ones. The ASPM results indicate that the 2005 catch is close to the MSY. Furthermore, spawning stock biomass seems to be above the level that would produce MSY, and the fishing mortality in 2004 seems to below the MSY level. Current (2004) catches of juveniles bigeye by the surface fleets are also less detrimental in terms of yield-per-recruit that previous patterns.

However, the current outlook could revert to a more pessimistic one, if the exploitation pattern is to return to the pre-2003 levels, as expected. Changes in the fishery occurred in 2003 and 2004, but these were due to the exceptional catches of yellowfin, which seem to be the result of anomalous conditions. In 2005, the fishery is already showing a return to the previous pattern of exploitation, which is likely to increase the catches of bigeye tuna associated with floating objects.

If the level in catch in numbers of juvenile bigeye tuna by purse seiners fishing on floating objects returns to pre-2003 levels, this is likely to be detrimental to the stock, as fish of these sizes are below the optimum size for maximum yield-per-recruit.

The Scientific Committee also noted that juvenile bigeye tuna are caught in the FAD purse-seine fishery that targets primarily skipjack tuna. Some measures to reduce the catches of bigeye tuna in this fishery could be expected to result in a decrease in the catches of skipjack tuna.

In view of the most current assessment, the SC recommended that catches should not exceed the MSY and fishing effort should not increase further from the 2004 levels.

BIGEYE TUNA SUMMARY

Maximum Sustainable Yield:	111,200 t (95,000 – 128,000)
Preliminary catch in ~~2005~~2006 *(data as of October ~~2006~~2007)*	~~112~~105,700~~,400~~ t
Catch in ~~2004~~2005	114,600~~126,400~~ t
Mean catch over the last 5 years (~~2001~~2002-~~2005~~2006)	~~122~~121,800 t
Current Replacement Yield	-
Relative Biomass (SSB_{2004}/SSB_{MSY})	1.34 (1.04 – 1.64)
Relative Fishing Mortality (F_{2004}/F_{MSY})	0.81 (0.54 – 1.08)
90% Confidence intervals provided in brackets	

Note: This Executive Summary has been updated to take account of recent catch data. The management advice, and stock assessment results are based on data up to 2004.

***Table 1**. Best scientific estimates of the catches of bigeye tuna (as adopted by the IOTC Scientific Committee) by gear and main fleets for the period ~~1956~~1957-~~2005~~ 2006 (in thousands of tonnes).*

Data as of October ~~2006~~2007

Gear	Fleet	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
Purse seine	France																									0.0	0.0	0.2
Purse seine	NEI-Other																											0.0
Purse seine	Other Fleets																						0.0	0.0	0.0	0.0	0.1	0.3
Purse seine	Total																						0.0	0.0	0.0	0.0	0.1	0.6
Longline	Taiwan,China	0.9	1.5	1.5	1.3	1.9	1.2	1.7	1.8	1.4	2.2	2.3	7.2	8.0	10.0	5.6	5.5	4.0	6.0	5.3	4.2	6.2	4.9	7.4	8.9	6.8	11.3	11.3
Longline	Indonesia																	0.0	0.2	0.4	0.3	0.3	0.4	0.4	0.5	0.5	0.8	1.9
Longline	Japan	11.1	10.2	8.4	14.8	13.0	17.3	11.6	16.0	17.6	21.4	21.8	23.6	14.4	12.7	11.2	8.3	5.2	6.9	5.5	2.1	3.1	10.9	4.2	5.9	7.8	11.4	18.3
Longline	Seychelles																											0.0
Longline	Korea, Republic of									0.2	0.2	0.6	6.8	7.6	3.5	4.9	4.9	7.3	14.7	26.2	21.8	26.1	34.1	21.5	19.3	19.4	19.5	17.4
Longline	Other Fleets								0.2	0.4	0.4	0.1	1.9	0.5	1.6	1.3	1.2	0.9	0.5	0.2	0.1	0.2	0.2	0.0	0.2	0.3	0.3	0.5
Longline	Total	12.0	11.7	9.9	16.1	15.0	18.5	13.3	18.0	19.5	24.1	24.8	39.5	30.4	27.8	23.0	20.0	17.4	28.4	37.7	28.5	35.9	50.5	33.5	34.9	34.8	43.4	49.5
Other gears	Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.2
All	Total	12.0	11.7	9.9	16.1	15.0	18.5	13.3	18.0	19.5	24.1	24.8	39.5	30.4	27.8	23.0	20.1	17.6	28.5	37.8	28.7	36.1	50.7	33.6	35.0	35.1	43.6	50.3

Gear	Fleet	Av02/06	Av57/06	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06
Purse seine	Spain	9.7	3.6	0.8	1.3	1.8	5.0	6.8	5.9	4.9	6.0	3.6	5.4	5.9	12.2	11.4	15.9	11.2	16.0	11.3	7.8	10.9	8.5	8.6	10.3	10.0
Purse seine	France	6.1	2.7	2.3	4.3	7.1	7.0	6.2	3.6	4.6	5.4	3.8	5.0	5.4	7.3	6.9	7.8	6.4	8.5	6.7	5.5	7.3	5.3	5.8	6.5	5.3
Purse seine	Seychelles	3.9	0.6								0.0	0.0					0.9	2.0	3.0	1.8	2.8	3.7	3.4	4.4	4.8	3.5
Purse seine	NEI-Other	2.8	1.2	0.5	0.6	1.0	0.8	0.8	0.5	1.0	1.5	0.9	1.9	2.5	3.4	3.4	6.2	5.2	7.5	6.0	3.1	4.1	2.5	2.3	2.5	2.5
Purse seine	NEI-Ex-Soviet Union	1.4	0.5							0.0		0.4	1.0	0.3	1.3	1.1	1.2	1.9	3.9	2.9	2.6	0.7	2.4	2.2	1.4	0.4
Purse seine	Other Fleets	2.2	0.9	0.5	0.9	0.7	0.7	1.3	2.0	2.2	2.6	2.5	2.6	4.8	4.2	1.7	2.0	1.6	1.7	1.3	1.9	2.4	0.8	0.5	2.5	4.6
Purse seine	Total	26.0	9.5	4.0	7.2	10.6	13.4	15.1	12.0	12.7	15.6	11.3	16.0	18.9	28.4	24.5	34.0	28.3	40.7	29.9	23.7	29.0	22.9	23.8	28.0	26.3
Longline	Taiwan,China	48.6	17.3	10.9	12.2	16.8	17.6	19.4	19.9	20.8	29.0	24.0	39.7	27.8	32.7	29.8	34.1	39.7	37.1	36.4	42.1	50.2	60.0	56.9	40.2	35.8
Longline	Indonesia	12.9	5.7	2.4	2.4	0.7	2.4	3.2	4.5	4.5	4.5	7.6	7.9	10.8	12.2	23.2	27.9	26.1	30.5	20.9	21.1	26.3	11.8	10.3	8.8	7.2
Longline	Japan	11.7	12.3	14.0	17.2	15.8	15.5	12.3	7.7	8.2	7.8	5.6	8.3	17.5	17.2	16.5	18.8	17.1	14.0	13.6	13.0	13.9	10.0	10.6	12.5	11.7
Longline	China	6.7	0.9												0.2	0.6	1.8	2.3	2.4	2.9	3.1	2.8	4.6	8.3	8.9	8.7
Longline	Seychelles	4.4	0.5	0.1	0.1									0.0	0.0	0.1	0.0	0.1	0.1	0.5	1.0	2.2	3.7	7.0	5.4	3.9
Longline	NEI-Deep-freezing	4.1	2.9		0.1	1.1	0.9	2.9	2.8	4.4	5.5	3.8	10.7	8.1	9.7	13.0	10.8	16.7	16.7	14.0	4.4	5.2	4.7	5.3	2.6	2.9
Longline	Korea, Republic of	1.8	8.3	11.7	12.8	11.9	14.4	17.1	12.2	10.7	2.3	4.8	5.3	8.6	6.4	11.3	10.6	3.4	1.4	3.4	1.5	0.2	1.2	2.5	2.6	2.6
Longline	Philippines	1.3	0.2															1.4	0.7	1.3	0.9	0.8	1.4	0.9	1.5	1.8
Longline	NEI-Fresh Tuna	0.8	1.0						1.9	2.6	2.3	2.6	2.9	4.6	3.8	4.3	5.3	4.7	4.8	4.6	0.3	0.4	0.5	1.0	0.7	1.3
Longline	NEI-Indonesia Fresh Tuna		1.5			0.1		2.0	7.5	9.2	9.4	11.4	9.2	11.9	6.5	2.7	2.9	0.2	0.0							
Longline	Other Fleets	2.1	0.6	0.6	0.0	0.3	0.3	0.2	0.0	0.0	0.0	0.3	1.4	0.2	1.2	0.2	0.2	0.4	0.9	0.9	2.7	2.5	2.2	1.7	2.1	2.0
Longline	Total	94.5	51.1	39.7	44.9	46.6	51.2	57.0	56.6	60.4	60.8	60.1	85.4	89.5	89.8	101.5	112.4	112.1	108.7	98.4	90.2	104.5	100.0	104.6	85.4	77.9
Other gears	Total	1.3	0.4	0.4	0.3	0.2	0.4	2.2	0.7	0.7	0.7	0.5	0.6	0.7	1.2	0.9	0.9	0.9	1.2	0.6	1.0	1.2	1.3	1.3	1.2	1.4
All	Total	121.8	61.1	44.1	52.4	57.5	65.0	74.3	69.3	73.8	77.1	71.9	101.9	109.1	119.4	126.9	147.3	141.4	150.5	128.9	114.9	134.8	124.3	129.7	114.6	105.7

Table 2. *2006 bigeye tuna stock assessment. Summary of results obtained by the ASPM stock assessment methods. B = Total biomass, SSB = spawning stock biomass. Brackets contain 90 % CI's.*

	ASPM Results
$\mathbf{B_0}$	1,380,000 t
$\mathbf{B_{2004}}$	720,000 t
$\mathbf{B_{MSY}}$	
Ratio $\mathbf{B_{2004} / B_0}$	0.52 (0.43-0.61)
Ratio $\mathbf{B_{2004} / B_{MSY}}$	
$\mathbf{SSB_0}$	1,150,000 t
$\mathbf{SSB_{2004}}$	430,000 t
$\mathbf{SSB_{MSY}}$	350,000 t
Ratio $\mathbf{SSB_{2004} / SSB_{MSY}}$	1.34 (1.04-1.64)
Ratio $\mathbf{SSB_{2004} / SSB_0}$	0.39 (0.31-0.47)
MSY	111,195 t (94,738-127,652)
$\mathbf{C_{2004}}$	126,518 t
$\mathbf{F_{2004}}$	0.29
$\mathbf{F_{MSY}}$	0.30
Ratio $\mathbf{F_{2004} / F_{MSY}}$	0.81 (0.54-1.08)

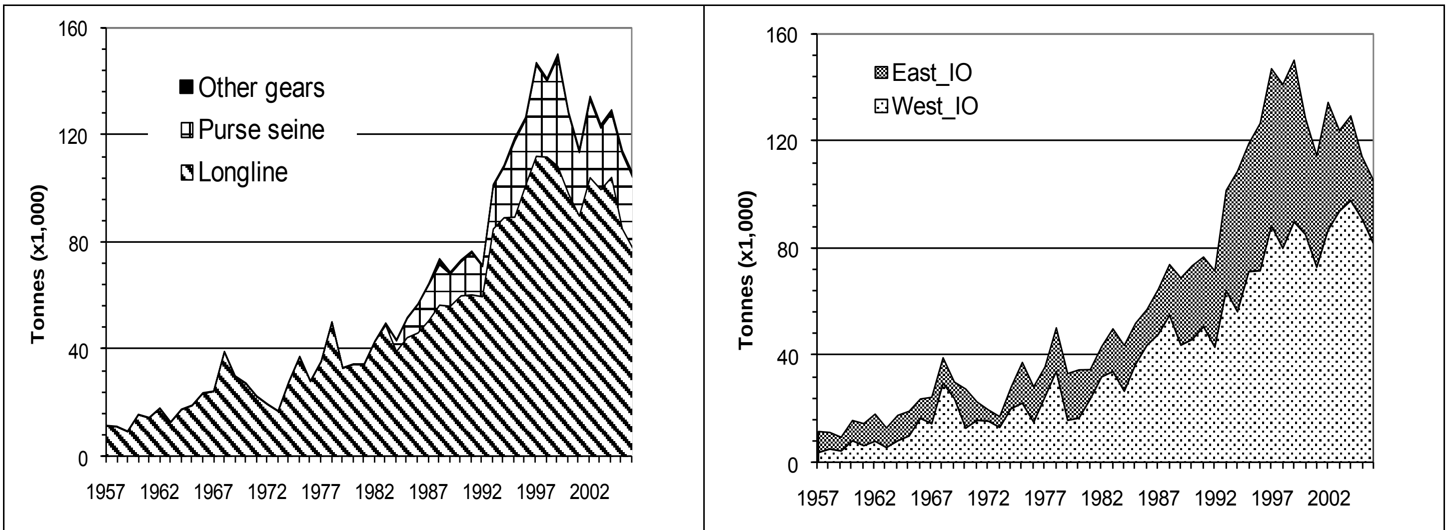


Figure 1. Yearly catches (thousand of metric tonnes) of bigeye tuna by gear from ~~1956~~ 1957 to ~~2005~~ 2006 (left) and by area (Eastern and Western Indian Ocean, right). Data as of October ~~2006~~2007

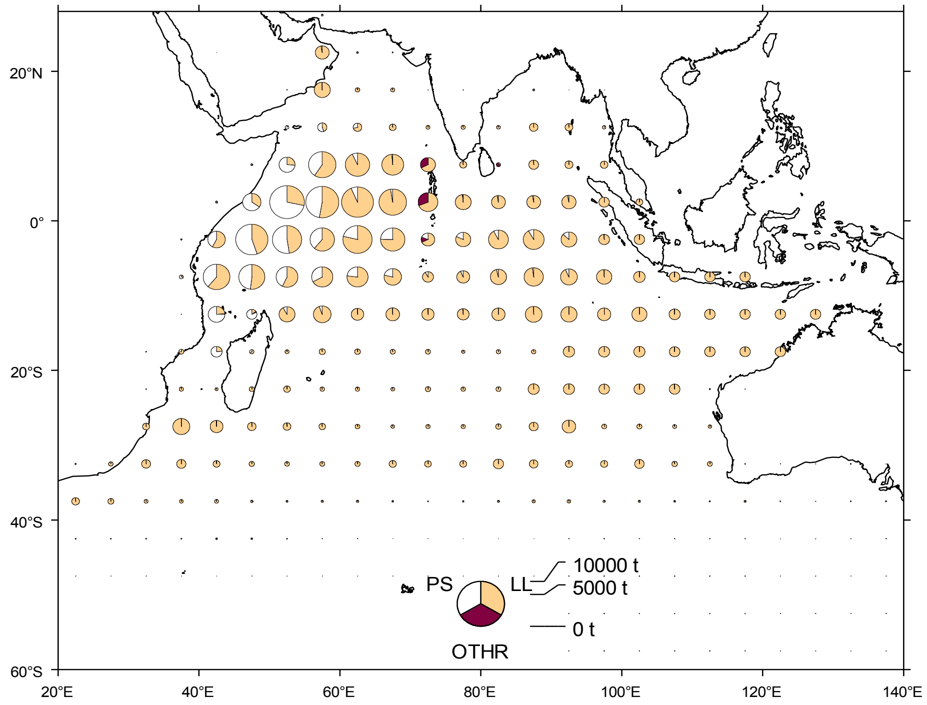


Figure 2. Mean of annual total catches of bigeye tuna (t) by longline and purse seine vessels operating in the Indian Ocean over the period 2000 to ~~2005~~2006. Data as of October ~~2006~~2007

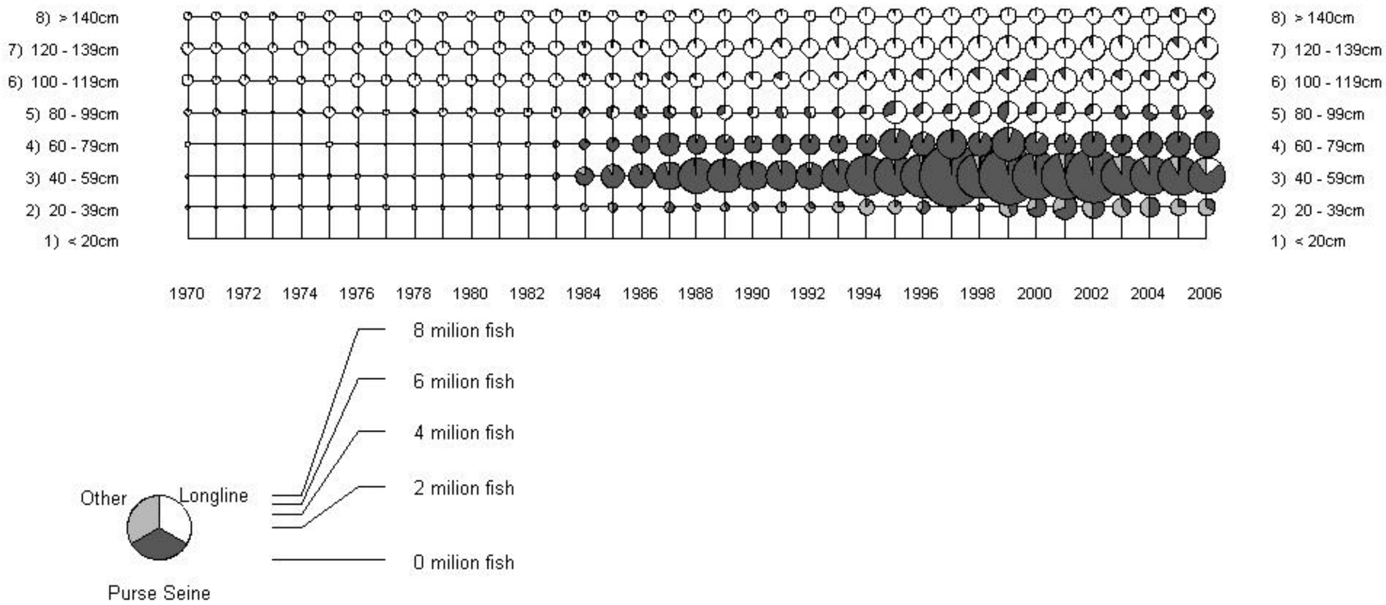


Figure 3. Mean catch at size of bigeye in purse seine (PS) and longline (LL) catches over the period ~~1996~~1970-~~2005~~2006

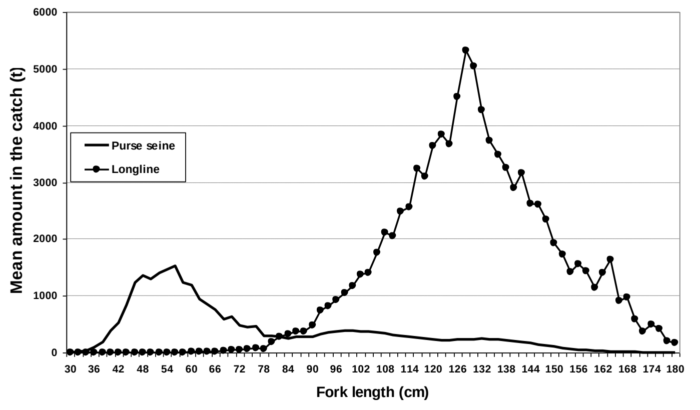


Figure 4. Mean catch at size (weight) of bigeye measured from purse seine and longline catches from 1996-2005.

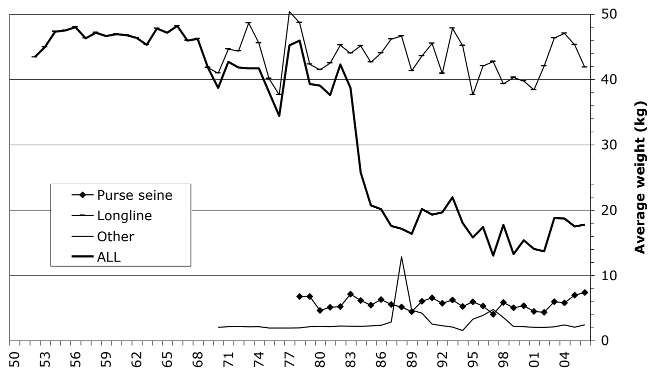


Figure 5. Mean weight of bigeye measured from purse seine (PS) and longline (LL) catches over time. *Data as of July ~~2006~~2007*

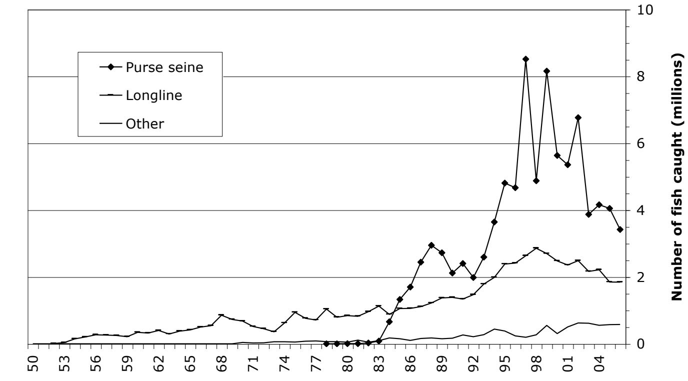


Figure 6. Catch in numbers of bigeye tuna by gear (PS: purse seine; LL: longline). *Data as of July ~~2006~~2007*

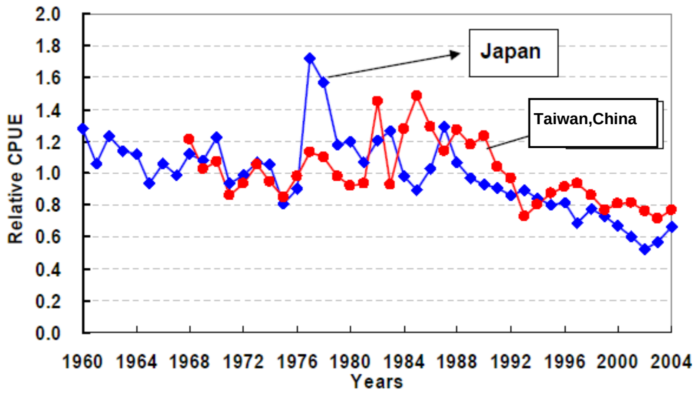


Figure 7. Standardised CPUE indices for the Japanese and Taiwanese longline fleets in the Indian Ocean tropical waters

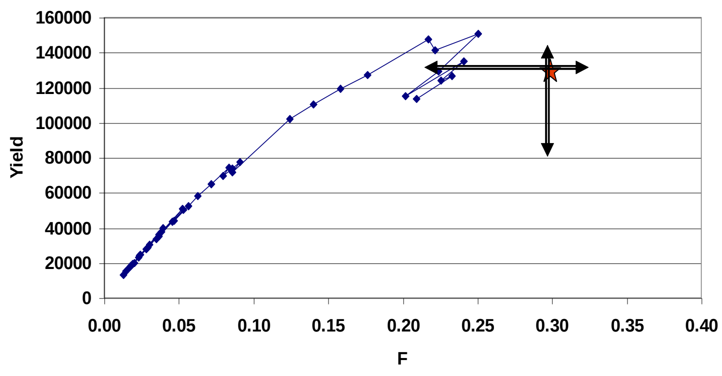


Figure 8. 2006 bigeye tuna stock assessment: Plot of annual bigeye tuna catches as a function of mean fishing mortality derived from the ASPIC model. The star represents MSY and the arrowed lines represent the associated uncertainty (source A. Fonteneau).

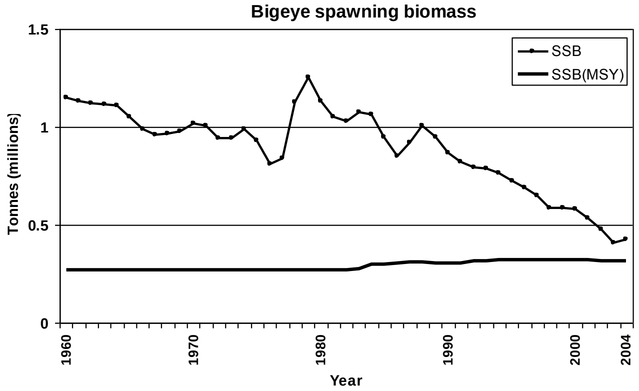


Figure 9. 2006 bigeye tuna stock assessment (ASPM): Spawning stock trajectories relating estimates of annual spawning stock size and the estimated maximum sustainable yield of the spawning stock biomass.

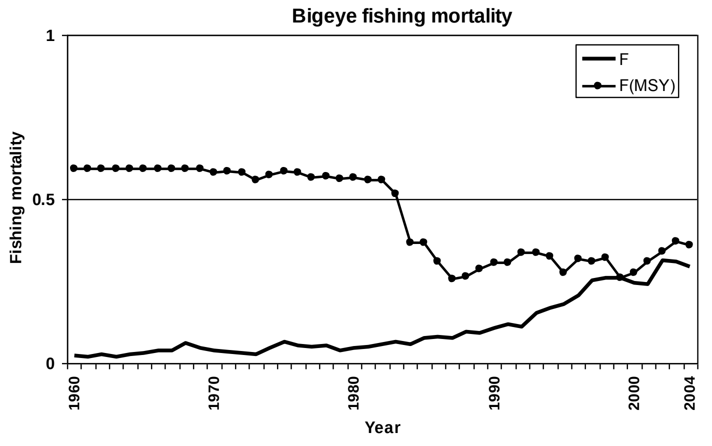


Figure 10. 2006 bigeye tuna stock assessment (ASPM): Fishing mortality trajectories relating estimates of annual fishing mortality and the estimated maximum sustainable level of fishing mortality.

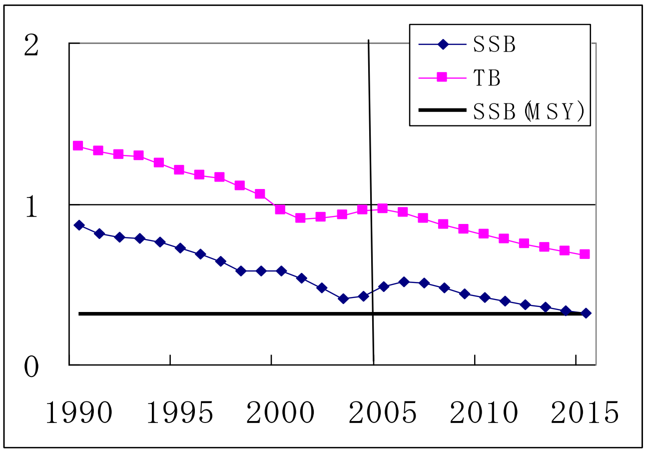
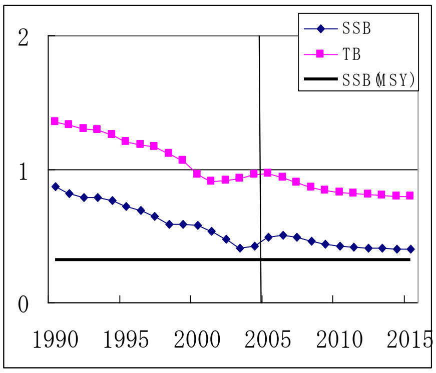
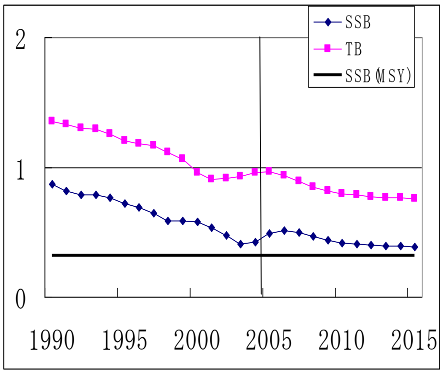


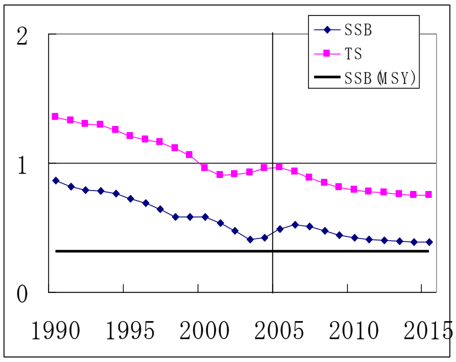
Figure 11. 2006 bigeye tuna stock assessment: Forward projections from the ASPM model illustrating trends in total biomass and spawning biomass for bigeye tuna in the Indian Ocean if catches were maintained at the 2004 level.



(a) F (2004) = 0.293



(b) F (2000-2002) = 0.265



(c) F (1998-2001) = 0.251

Figure 12. 2006 bigeye tuna stock assessment: Forward projections from the ASPM model illustrating trends in total biomass and spawning biomass for bigeye tuna in the Indian Ocean at various levels of fishing mortality (a) F in 2004 (b) F between 2000-02 (c) F between 1998 and 2001.

Executive summary of the status of the skipjack tuna resource

(As adopted by the IOTC Scientific Committee 10 November 2006)

Marked changes are factual changes related mainly to the inclusion of the latest fisheries statistics. All changes are suggestions only for the consideration of the SC in Nov07

BIOLOGY

Skipjack tuna (*Katsuwonus pelamis*) is a cosmopolitan species found in the tropical and subtropical waters of the three oceans. It generally forms large schools, often in association with other tunas of similar size such as juveniles of yellowfin and bigeye.

Skipjack exhibits characteristics that result in a higher productivity when compared to other tuna species. This species has a short lifespan (probably up to 5 years) and is exploited during a short period (probably less than three years), a high fecundity, and spawns opportunistically throughout the year in the whole interquatorial Indian Ocean (north of 20°S, with surface temperature greater than 24°C) when conditions are favorable. The size at first maturity is about 41-43 cm for both males and females (and as such most of the skipjack taken by the fisheries are fish that have already reproduced).

Little is known about the growth of skipjack, and no new information or document on biology were presented at the working party. It is still a priority to gain more knowledge on the skipjack time-and-space variability in growth patterns.

In the absence of any stock structure information, a single Indian Ocean stock is assumed. However, skipjack appears to be less migratory than the other tunas. Given these biological characteristics and the relatively localised areas where fishing takes place (Figure 1), smaller management units for skipjack could be considered by managers.

Because of the above characteristics, skipjack tuna stocks are considered to be resilient and not prone to overfishing.

FISHERIES

Catches of skipjack increased slowly from the 1950s, reaching around 50,000 t at the end of the 1970s, mainly due to the activities of baitboats (or pole and line) and gillnets. The catches increased rapidly with the arrival of the purse seiners in the early 1980s, and skipjack became one of the most important tuna species in the Indian Ocean. Annual total catches ~~reached~~ exceeded ~~around~~ 400,000 t in the late ~~mid~~ 1990's and the average annual catch for the period from 2002 to 2006 was 514,100 t~~have fluctuated between 500,000 – 580,000 t since 1999~~ (Figure 2 and Table 1). Preliminary data indicate that catches in ~~2005~~ 2006 may have been the highest reported in the history of the fishery ~~(581,700~~596,200 t).

It should be noted that an important amount of the skipjack catch (an average of 75,000 t since 2000) is estimated from data (mainly from some artisanal fisheries) which do not identify the species in the catch. Figure 3 illustrates the evolution of the importance of the catch which has to be dis-aggregated.

In recent years, the proportions of the catch taken by the industrial purse seine fishery and the various artisanal fisheries (baitboat, gillnets and others) have been fairly consistent, the majority of the catch originating from the western Indian Ocean (Figure 2). In general, there is low inter-annual variability in the catches taken in the Indian Ocean compared to those taken in other oceans.

The increase of skipjack catches by purse seiners is due to the development of a fishery in association with Fish Aggregating Devices (FADs). Currently, 80 % of the skipjack tuna caught by purse-seine is taken under FADs. Catch rates by purse seiners show an increasing trend in two of the three main fishing areas (Figure 4) possibly due to an increase in fishing power and to an increase in the number of FADs (and the technology associated with them) in the fishery.

The Maldivian fishery has effectively increased its fishing effort with the mechanisation of its pole and line fishery since 1974, and the use of anchored FADs since 1981. Skipjack represents some 75 % of its total catch, and catch rates have regularly increased since the beginning of the 1980s (Figure 5).

Little information is available on the gillnet fisheries (mainly from Sri Lanka, Iran, Pakistan, India and Indonesia). However, it is estimated that the gillnet fisheries take around 30 to 40 % of the total catch of skipjack.

The average weight of skipjack caught in the Indian Ocean is 2.8 kg for purse-seine (2000-2005 average), 3.0 kg for the Maldivian baitboats and 4-5 kg for the gillnet (Figure 6). For all fisheries combined, it fluctuates between 3.0-3.5 kg; this is larger than in the Atlantic, but smaller than in the Pacific.

AVAILABILITY OF INFORMATION FOR STOCK ASSESSMENT

During its last assessment in 2003, the WPTT analyzed the information available and considered that the uncertainties in the information were too large to conduct a complete assessment of the Indian Ocean skipjack tuna.

Fishery indicators

As an alternative, the WPTT decided to analyse various fishery indicators to gain a general understanding of the state of the stock. Several of these indicators were updated in 2006.

1. **Trends in catches**: The trend in catches indicate a large and continuous increase in the catches of skipjack tuna since the mid-1980's (Figure 2). This is mainly due to the expansion of the FAD-associated fishery in the western Indian Ocean. There is no sign that the rate of increase in the catches of skipjack is diminishing.
2. **Nominal CPUE Trends:** Figure 4 shows the catch and nominal CPUE trends of the purse seine fishery for three major skipjack fishing areas: East-Somalia, North-West Seychelles and Mozambique Channel. In the Somalia and North-West Seychelles areas, catches have been variable but generally increasing. In each of these areas, despite some inter annual variation, the current nominal CPUE's are around the same as those of the early 1990's. Since this is a period during which it is believed that effective purse-seine effort has increased substantially (increase of efficiency), it is likely that the true abundance in these areas has decreased. In itself, this is not unexpected given the large increase in catches over that period. However, as these areas may be source of skipjack recruitment to the Maldives artisanal fishery, there is a potential for interactions to occur between these fisheries.
3. **Average weight in the catch by fisheries:** The Working Party noted that the average weights of the skipjack taken from various areas and gears have remained relatively stable since 1991 (Figure 7). Figure 6 shows catches at size expressed as average weight from the major gears, purse seine, baitboat and gillnet and others, as well as the mean weight for the total catch. The purse seine and the baitboat fisheries take the greatest catch around 40-65 cm while catches taken from gillnet fisheries ranges from 70-80 cm.
4. **Number of 1 CWP squares visited or fished:** This indicator (Figure 8) reflects the spatial extension of a fishery. Trends observed in the number of CWP with effort or catch since 1991 suggest that the area exploited by the purse-seine fishery has changed little since 1991, apart in 1998 when a particularly strong El Niño episode resulted in a much wider spatial distribution of the fishery.

Length-based analyses

The WPTT did not develop a formal stock assessment for skipjack tuna. However, a length-based cohort analysis was carried during the meeting to analyze skipjack catches and length frequencies (Figure 9). In the 1980's, there was a marked increase of catches of smaller size fish (40-60 cm) due to the development of the purse seine fishery. The largest mode (60 cm+) reflects the artisanal fisheries (mainly the Maldives's pole-and-line one). The marked increase in the catch of large skipjack (60-70 cm) since 2000 is reflected for most gears by marked increase of the mean weight of their catches (Figure 6).

The patterns of mean fishing mortality by fish for four 5 years periods (Figure 10) illustrate the evolution of the fishery and highlight the increased mortality due to the purse seine and the artisanal fisheries in the recent period.

Interaction between skipjack fisheries and other species

Purse seiners catch 40-60 cm skipjack whereas artisanal fisheries catch 60-70 cm fish, thus the fishing pressure applied by purse seiners on smaller size skipjack is likely to affect the catches of larger sized skipjack by the artisanal fisheries. Furthermore, large numbers of juvenile bigeye and yellowfin tuna are caught in the course of purse-seine sets on FADs that target skipjack tuna. However, the fact that skipjack appears to be less migratory than the other tunas should also be considered.

Managers need to be aware that such interactions between fleets, gears and species have the potential to cause competition and conflict (e.g. the western Indian Ocean purse-seine fishery for small skipjack versus the Maldivian baitboat fishery for larger skipjack; the purse seine fishery for skipjack which catches juvenile bigeye versus the bigeye longline fishery; the purse seine catch of juvenile yellowfin on FADs versus their catch of large free school yellowfin) and affect the efficacy of management measures aimed at particular fleets or gears in isolation. These interactions have to be taken in account when management decisions are considered.

STOCK ASSESSMENT

No quantitative stock assessment is currently available for skipjack tuna in the Indian Ocean. The range of stock indicators available to the Scientific Committee do not signal that there are any problems in the fishery currently.

The SC also note that in most fisheries, declining catches combined with increasing effort are usually indicators that a stock is being exploited close or above its MSY. In the case of skipjack tuna, catches have continued to increase as effort increased. This is illustrated in the trend of yearly skipjack catches of the Indian Ocean using Relative Rate of Catch Increase (RRCI), a modified version of the Grainger and Garcia index (Figure 11). Furthermore, the majority of the catch comes from fish that are sexually mature (greater than 40 cm) and therefore likely to have already reproduced.

The SC noted that, although there might be no reason for immediate concern, it is clear that the catches cannot be increased at the current rate indefinitely. Therefore, it recommends that skipjack be monitored regularly.

MANAGEMENT ADVICE

The high productivity life history characteristics of skipjack tuna suggest this species is resilient and not prone to overfishing, and the stock status indicators indicate that there is no need for immediate concern about the status of skipjack tuna.

SKIPJACK TUNA SUMMARY

Maximum Sustainable Yield:	unknown
Preliminary catch in ~~2005~~2006 *(data as of October ~~2006~~2007)*	~~582~~596,000 t
Catch in ~~2004~~2005	~~530~~529,600~~,000~~ t
Mean catch over the last 5 years (~~2001~~2002-~~05~~06)	~~544~~514,100~~,000~~ t
Current Replacement Yield:	-
Relative Biomass (B_{cur}/B_{MSY}):	unknown
Relative Fishing Mortality (F_{cur}/F_{MSY}):	unknown

Note: This Executive Summary has been updated to take account of recent catch data. The management advice, and stock assessment results are based on data up to 2002.

***Table 1.** Best scientific estimates of the catches of skipjack tuna (as adopted by the IOTC Scientific Committee) by gear and main fleets for the period ~~1956~~1957-~~2005~~ 2006 (in thousands of tonnes).* Data as of October ~~2006~~2007

Gear	Fleet	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
Purse seine	France																									0.2	1.0	9.4
Purse seine	NEI-Other																											0.4
Purse seine	Japan																					0.1	0.9	0.6	0.4	0.1	0.5	0.6
Purse seine	Other Fleets	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.8	2.7	1.5
Purse seine	Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.9	0.6	1.4	2.0	4.2	11.9
Baitboat	Maldives	10.0	10.0	10.0	9.0	8.0	8.0	8.0	8.0	14.1	16.9	18.9	17.5	19.6	27.6	28.0	17.5	19.5	22.5	14.9	18.6	13.7	13.2	17.3	22.2	19.6	15.3	19.3
Baitboat	India	0.2	0.3	0.2	0.4	0.6	0.2	0.4	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.6	0.6	2.6	0.8	1.0	1.9	1.3	1.7	2.3	2.7	1.7	2.2	2.5
Baitboat	Other Fleets														0.2	0.0	0.4	5.0	10.8	2.1	0.1	0.6	0.8	0.4	0.0	0.2	1.4	1.3
Baitboat	Total	10.2	10.3	10.2	9.4	8.6	8.2	8.4	8.3	14.4	17.1	19.2	17.8	19.9	28.1	28.7	18.4	27.2	34.1	18.0	20.5	15.5	15.7	20.0	24.9	21.5	18.9	23.0
Gillnet	Sri Lanka	1.6	1.7	1.9	2.4	3.0	4.5	6.0	5.8	5.6	6.3	7.1	8.0	8.8	6.9	5.0	8.8	10.5	9.3	7.2	12.7	12.6	14.8	12.3	16.2	18.3	17.9	16.3
Gillnet	Indonesia	1.3	1.4	1.3	1.3	1.7	1.7	1.8	1.9	2.1	2.3	2.2	2.4	2.6	1.9	2.0	3.2	3.5	3.8	5.8	7.6	5.7	5.6	8.4	9.2	9.4	14.1	16.8
Gillnet	Pakistan	1.9	0.9	0.9	1.1	1.0	1.6	2.4	3.4	3.6	4.8	4.7	4.7	4.3	3.9	3.2	3.8	3.0	4.1	4.5	4.2	3.8	2.2	3.8	1.8	2.7	3.4	1.1
Gillnet	Other Fleets	0.3	0.3	0.3	0.6	0.8	0.2	0.5	0.4	0.3	0.3	0.4	0.4	0.4	0.4	0.8	0.8	3.2	1.1	1.3	2.6	1.6	2.1	2.8	0.3	0.3	0.5	0.3
Gillnet	Total	5.1	4.4	4.5	5.5	6.5	8.1	10.7	11.4	11.7	13.8	14.5	15.5	16.0	13.1	10.9	16.6	20.2	18.2	18.8	27.1	23.6	24.7	27.4	27.5	30.7	35.9	34.5
Line	Total	0.7	0.8	0.8	0.9	1.1	1.3	1.7	1.7	1.7	1.9	2.0	2.3	2.5	3.5	3.2	3.7	4.3	4.1	4.6	6.2	5.3	5.1	5.3	6.4	6.8	4.9	5.1
Other gears	Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All	Total	16.1	15.4	15.5	15.8	16.2	17.6	20.9	21.7	27.8	32.8	35.7	35.7	38.4	44.9	42.9	38.9	51.7	56.5	41.5	53.9	44.6	46.5	53.3	60.3	61.0	63.9	74.5

Gear	Fleet	Av 02/06	Av 57/06	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06
Purse seine	Spain	91.4	27.2	6.4	18.6	19.1	27.9	39.7	63.9	47.9	41.8	46.7	51.3	61.6	69.6	66.3	62.9	58.6	74.3	79.4	68.5	91.3	88.0	64.4	94.3	118.9
Purse seine	France	44.5	18.6	27.3	29.8	36.1	35.6	36.1	43.1	29.0	39.4	45.0	48.2	58.4	48.7	40.1	31.3	30.3	42.7	39.9	36.3	54.4	38.9	38.0	43.2	48.1
Purse seine	Seychelles	38.0	5.2								1.8	0.6					4.9	10.7	15.8	11.6	26.2	29.9	36.8	30.0	46.0	47.5
Purse seine	NEI-Other	21.1	8.4	8.2	8.4	6.4	4.8	7.0	7.9	11.0	10.8	10.8	17.4	24.5	22.3	18.4	24.3	31.2	33.4	40.8	26.4	31.9	27.4	14.0	15.7	16.2
Purse seine	NEI-Ex-Soviet Union	12.7	4.0							0.7		10.1	8.7	8.2	18.4	14.7	11.2	10.2	17.3	19.8	19.2	6.8	24.7	17.8	11.3	2.7
Purse seine	Japan	2.2	3.5	0.7	0.3	0.6	0.9	2.3	3.4	10.9	15.9	31.6	31.3	20.1	16.1	7.0	6.7	5.7	4.6	2.3	1.8	1.9	2.4	1.5	3.1	2.0
Purse seine	Other Fleets	10.9	3.7	3.1	3.2	4.5	10.1	7.9	8.4	8.8	13.1	6.4	7.1	6.3	3.9	2.9	4.9	5.1	10.1	6.0	10.2	22.4		0.1	9.2	22.9
Purse seine	Total	220.7	70.7	45.7	60.4	66.7	79.2	92.9	126.8	108.3	122.8	151.3	163.9	179.2	178.9	149.4	146.3	152.0	198.2	199.9	188.6	238.6	218.3	165.7	222.8	258.3
Baitboat	Maldives	118.6	42.8	32.3	42.2	45.1	42.6	58.2	57.8	60.7	58.3	57.6	58.0	69.0	69.9	66.2	68.1	77.8	92.3	78.8	86.8	113.9	107.5	104.5	130.4	136.7
Baitboat	India	2.9	2.7	3.2	3.1	4.0	5.4	4.7	5.9	5.4	5.6	5.9	12.7	6.8	6.9	7.2	7.8	2.0	2.3	4.6	2.7	3.2	3.1	4.0	0.4	4.0
Baitboat	Other Fleets		0.7	1.0	1.0	1.1	1.3	1.2	1.3	1.2	1.3	1.3	1.4	0.1	0.5											
Baitboat	Total	121.6	46.3	36.5	46.3	50.1	49.4	64.2	65.0	67.3	65.2	64.8	72.1	75.8	77.3	73.4	75.9	79.8	94.5	83.4	89.5	117.0	110.6	108.5	130.9	140.7
Gillnet	Iran, Islamic Republic	58.2	7.6						0.3	0.8	1.1	4.3	4.4	7.4	1.1	2.5	8.3	4.7	13.9	18.5	23.2	23.1	36.0	53.6	79.4	98.8
Gillnet	Sri Lanka	56.4	23.2	13.3	14.8	14.5	15.3	15.8	17.3	20.4	23.1	27.0	31.5	38.8	40.5	47.2	56.0	56.8	72.4	73.1	68.3	74.1	70.0	70.0	34.0	33.8
Gillnet	Indonesia	45.8	18.0	14.5	16.0	15.2	18.9	19.7	23.4	20.6	22.1	23.5	28.4	30.7	29.5	40.9	48.8	45.2	47.1	46.8	56.3	36.7	38.1	52.4	50.9	50.9
Gillnet	Pakistan	3.5	3.8	1.2	2.0	1.5	3.7	5.6	7.5	7.6	7.5	6.1	6.9	8.1	7.1	4.4	4.6	4.5	4.8	4.6	3.6	3.3	3.2	3.5	3.8	3.8
Gillnet	Other Fleets	0.9	0.9	0.5	0.5	0.5	0.6	0.6	0.9	0.9	0.6	0.7	1.2	1.3	1.6	1.2	1.9	0.6	0.7	0.9	0.4	0.5	0.6	0.8	1.1	1.4
Gillnet	Total	164.7	53.4	29.6	33.4	31.9	38.5	41.7	49.5	50.4	54.4	61.6	72.3	86.3	79.8	96.1	119.6	111.9	139.0	143.9	151.7	137.6	147.9	180.2	169.2	188.7
Line	Total	6.5	4.6	4.7	4.6	4.7	5.0	5.2	8.1	7.9	7.9	12.2	9.2	5.7	5.9	5.6	5.6	5.0	3.5	3.9	4.0	4.8	4.0	9.5	6.2	8.0
Other gears	Total	0.6	0.1	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.2	1.2	0.5	0.6	0.5
All	Total	514.1	175.1	116.5	144.6	153.4	172.1	204.0	249.5	234.0	250.3	290.0	317.8	347.1	342.1	324.5	347.4	348.8	435.4	431.2	433.8	498.2	482.0	464.5	529.6	596.2

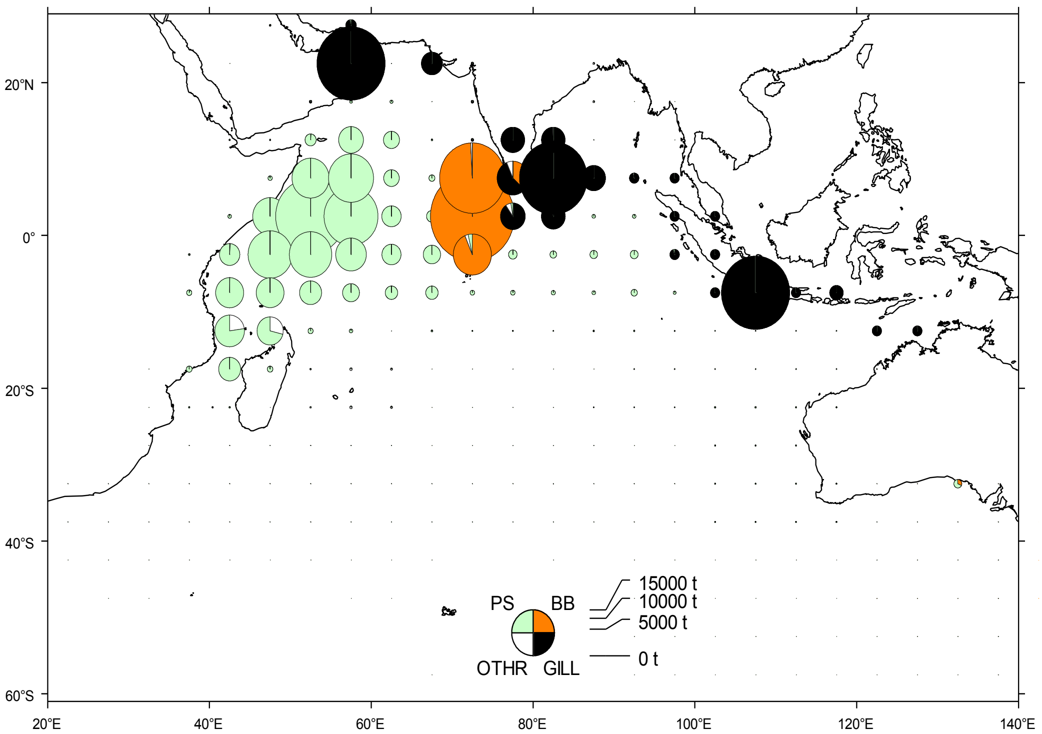


Figure 1.: Mean spatial distribution of skipjack tuna catches in the Indian Ocean by gear type, 2000-~~2005~~2006. BB = bait boat (pole and line); GILL = gillnet; LL = longline; PS = purse seine. Data as of October ~~2006~~2007

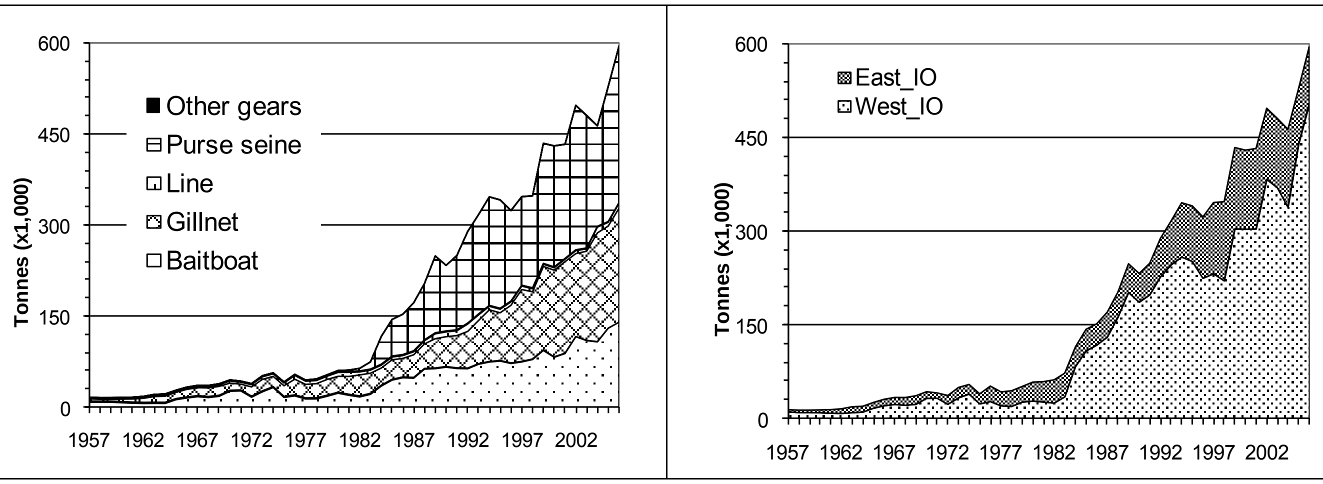


Figure 2. Yearly catches (thousand of metric tonnes) of skipjack tuna by gear (left) and by area (Eastern and Western Indian Ocean, top right) from ~~1956~~ 1957 to ~~2005~~2006. Data as of October ~~2006~~2007

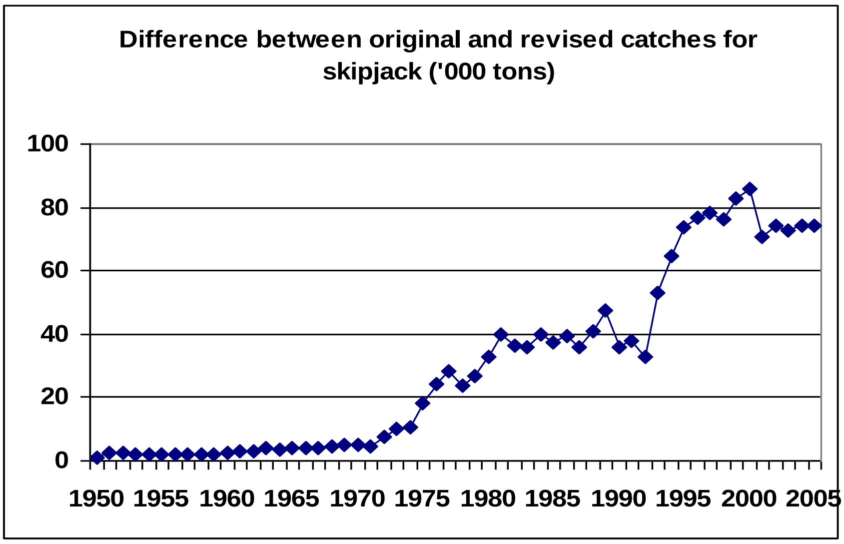


Figure 3. Total amount of the skipjack catches estimated from aggregated data

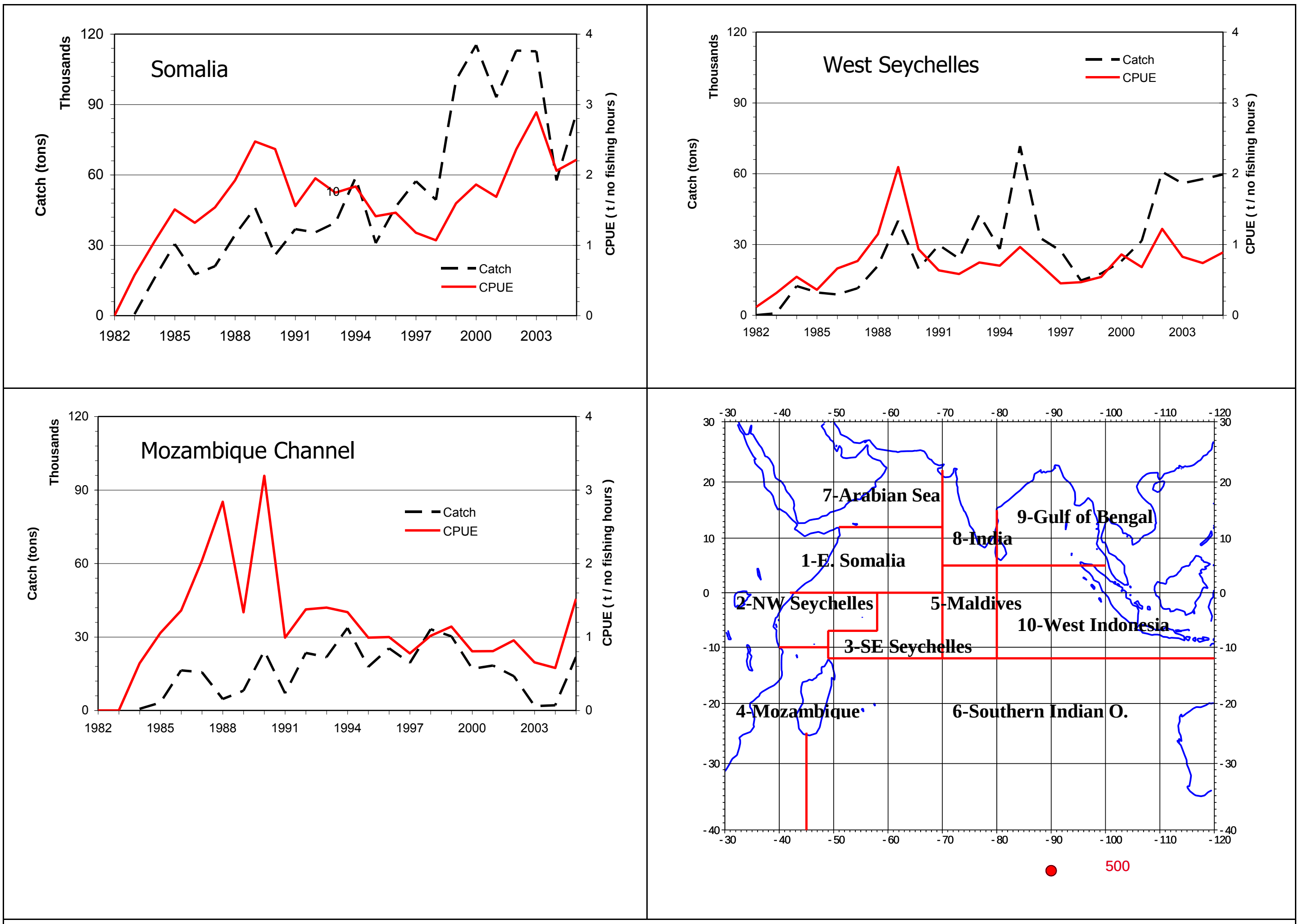


Figure 4.: Nominal CPUEs for three important purse seine fishing ground areas: East Somalia (top left); Mozambique Channel (top right) and North-West Seychelles (bottom left).
Areas used for the calculation of the CPUE trends are represented (bottom right). Data as of July 2006

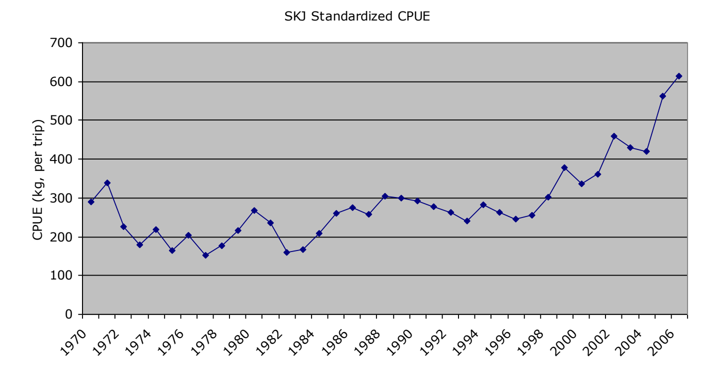


Figure 5. Time series of CPUE, nominal and adjusted effort of the Maldivian baitboats fishery, 1970-2002 (from IOTC-2007-WPTT-R~~WPTT-03-23~~).

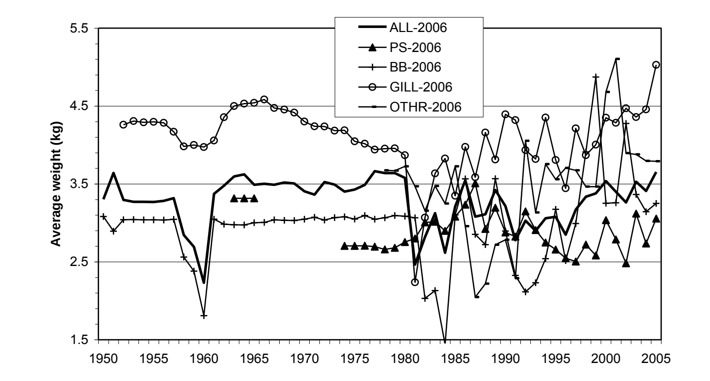


Figure 6. Skipjack tuna average weight by main gear (from size-frequency data) and for the whole fishery (estimated from the total catch at size), 1950-~~2005~~2006. Data as of June ~~2006~~2007

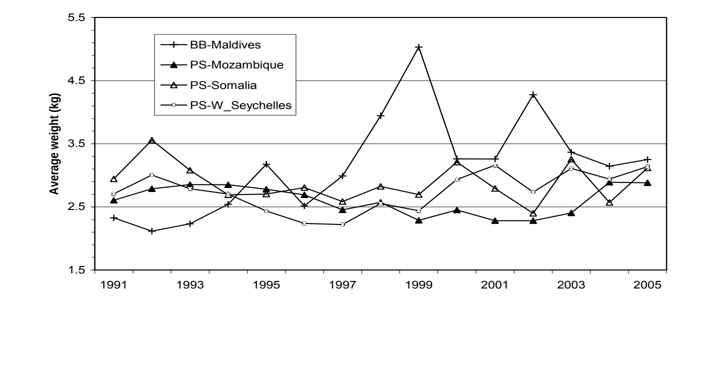


Figure 7. Time series of average weight of skipjack caught by the purse seine and baitboat fisheries by major areas. (1991-2005). Data as of June 2006

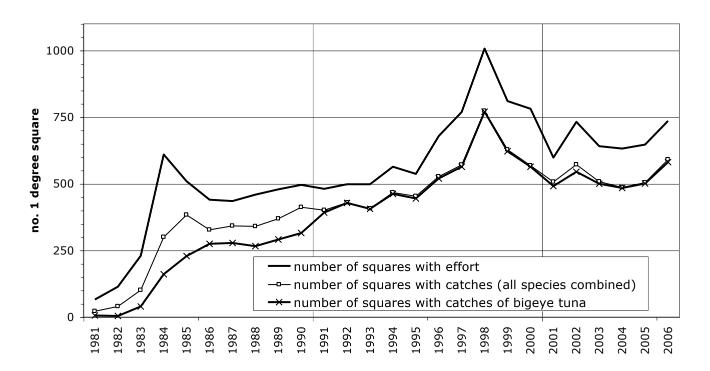


Figure 8. Number of one degree CWP squares explored by the purse seine fishery (IOTC-2007-WPTT-R)~~, 1980-2005~~

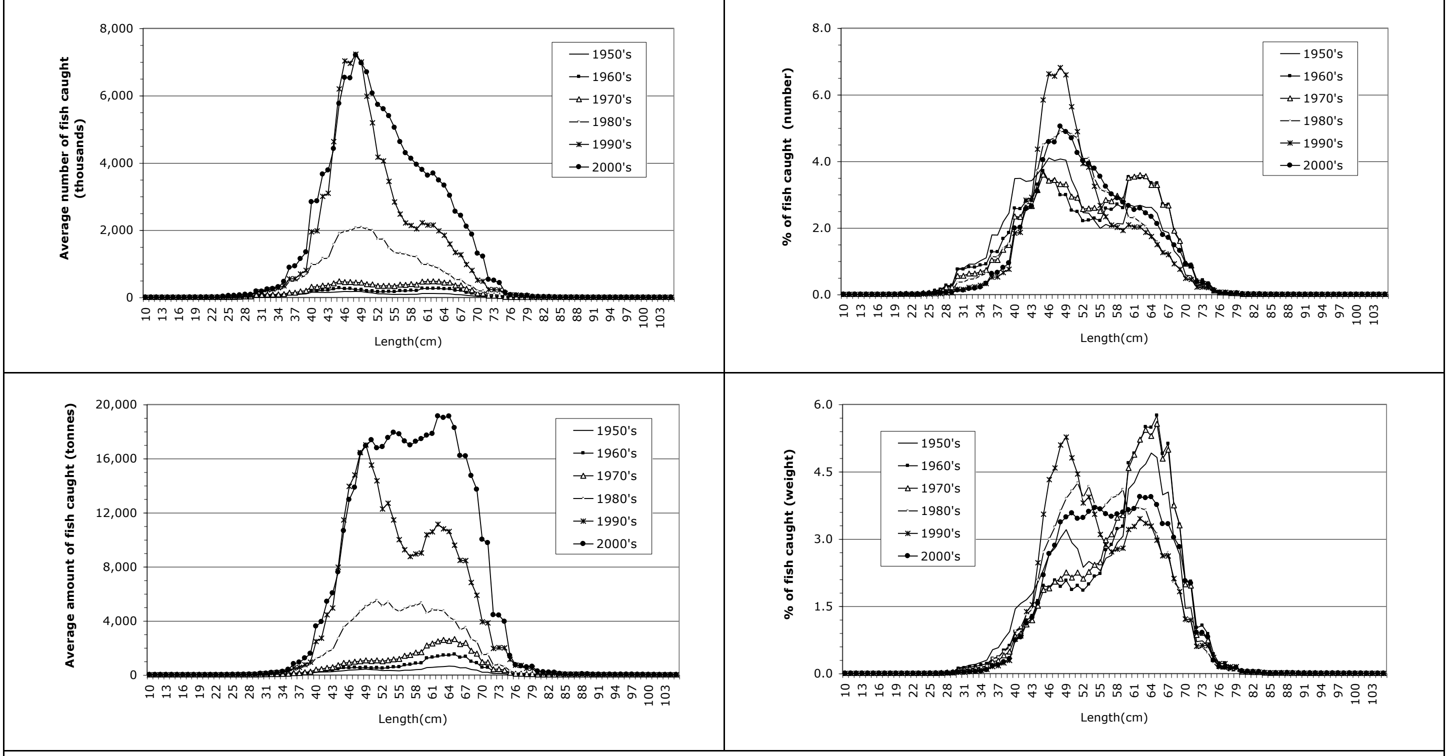
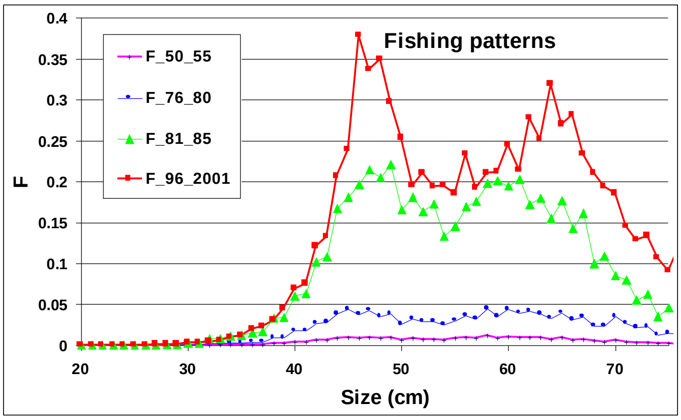


Figure 9. Catch by size in numbers (top panels) and weight (bottom panels) for six ten-year mean periods: 1950-59, 1960-69, 1970-79, 1980-89, 1990-99 and 2000-2005. Left panels are actual numbers and right panels are in proportions.
Note the two modes (40-50 and 55-65 cm) that appear in the yield frequencies but which are less visible in the number frequencies.
Data as of June ~~2006~~2007



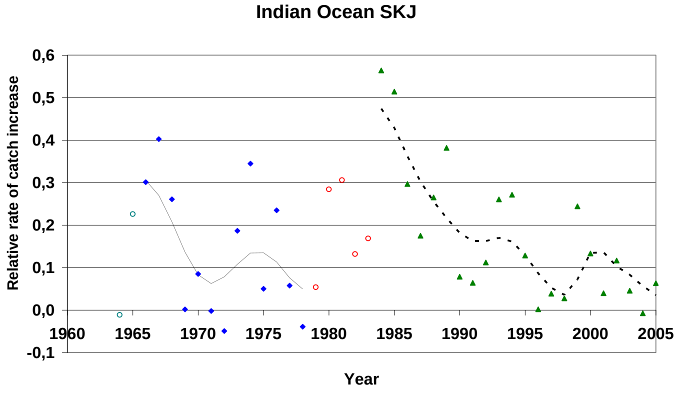


Figure 10. Estimated mean fishing mortality by size for four periods: 1950-55, 1976-80, 1981-85, and 1996-2001.	*Figure 11. Relative Rate of Catch Increase (RRCI) for skipjack, 1960-2005)*

Executive summary of the status of the yellowfin tuna resource

(As adopted by the IOTC Scientific Committee 10 November 2006)

Marked changes are factual changes related mainly to the inclusion of the latest fisheries statistics. A stock assessment was undertaken in 2007 and relevant sections have been updated using the text from the 2007 WPTT report and other related sources. All changes are suggestions only for the consideration of the SC in Nov07

BIOLOGY

Yellowfin tuna *(Thunnus albacares)* is a cosmopolitan species distributed mainly in the tropical and subtropical oceanic waters of the three major oceans, where it forms large schools. The sizes exploited in the Indian Ocean range from 30 cm to 180 cm fork length. Smaller fish (juveniles) form mixed schools with skipjack and juvenile bigeye tuna and are mainly limited to surface tropical waters, while larger fish are found in surface and sub-surface waters. Intermediate age yellowfin are seldom taken in the industrial fisheries, but are abundant in some artisanal fisheries, mainly in the Arabian Sea.

Stock structure is unclear, and a single stock with complete mixing is usually assumed for stock assessment purposes. Longline catch data indicates that yellowfin are distributed continuously throughout the entire tropical Indian Ocean, but some more detailed analysis of fisheries data suggests that the stock structure may be more complex and that mixing may be incomplete. A study of stock structure using DNA was unable to detect whether there were subpopulations of yellowfin tuna in the Indian Ocean.

Spawning occurs mainly from December to March in the equatorial area (0-10°S), with the main spawning grounds west of 75°E. Secondary spawning grounds exist off Sri Lanka and the Mozambique Channel and in the eastern Indian Ocean off Australia. Yellowfin size at first maturity has been estimated at around 100 cm, and recruitment occurs predominantly in July. Newly recruited fish are primarily caught by the purse seine fishery on floating objects. Males are predominant in the catches of larger fish at sizes than 150 cm (this is also the case in other oceans).

There are no direct estimates of natural mortality (M) for yellowfin in the Indian Ocean. In stock assessments, new estimates of M at length based on those from other oceans have been used. These were then converted to estimates of M at age using the two growth curves. This indicated a higher M on juvenile fish than for older fish.

There is little information on yellowfin movement patterns in the Indian Ocean, and what information there is comes from analysis of fishery data, which can produce biased results because of their uneven coverage. However, there is good evidence that medium sized yellowfin concentrate for feeding in the Arabian Sea. Feeding behaviour is largely opportunistic, with a variety of prey species being consumed, including large concentrations of crustacea that have occurred recently in the tropical areas and small mesopelagic fishes which are abundant in the Arabian Sea.

FISHERY

Catches by area, gear, country and year from 1957~~6~~ to 2006~~5~~ are shown in Table 1 and illustrated in Figure 1. Contrary to the situation in other oceans, the artisanal fishery component in the Indian Ocean is substantial, taking approximately 20-25 % of the total catch.

The geographical distribution of yellowfin tuna catches in the Indian Ocean in recent years by the main gear types is shown in Figure 2. Most yellowfin tuna are caught in Indian Ocean north of 12°S and in the Mozambique Channel (north of 25°S).

Although some Japanese purse seiners have fished in the Indian Ocean since 1977, the purse seine fishery developed rapidly with the arrival of European vessels between 1982 and 1984. Since then, there has been an increasing number of yellowfin tuna caught although a larger proportion of the catches is made of adult fish, when compared to the case of the bigeye tuna purse-seine catch. Purse seiners typically take fish ranging from 40 to 140 cm fork length (Figure 3) and smaller fish are more common in the catches taken north of the equator (Figure 4). Catches of yellowfin increased rapidly to around ~~131~~128,000 t in 1993. Subsequently, they fluctuated around that level, until 2003 and 2004 when they were substantially higher (~~227~~224,1~~0~~00 t and 233,800 t, respectively). In recent years, catches appear to be higher in the first quarter of the year (Figure 5). The amount of effort exerted by the EU purse seine vessels (fishing for yellowfin and other tunas) varies seasonally and from year to year. Since 2000 between 800 and 1200 boat days per month were fished annually (Figure 6).

The purse seine fishery is characterized by the use of two different fishing modes: the fishery on floating objects (FADs), which catches large numbers of small yellowfin in association with skipjack and juvenile bigeye, and a fishery on free swimming schools, which catches larger yellowfin on mixed or pure sets. Between 1995 and 2003, the FAD component of the purse seine fishery represented 48-66 % of the sets undertaken (60-80 % of the positive sets) and took 36-63 % of the yellowfin catch by weight (59-76 % of the total catch). Since 1997, the proportion of log sets has steadily decreased from 66 % to 48 %.

The longline fishery started in the beginning of the 1950's and expanded rapidly over the whole Indian Ocean. It catches mainly large fish, from 80 to 160 cm fork length (Figure 1c), although smaller fish in the size range 60 cm – 100 cm have been taken by longliners from Taiwan,China since 1989 in the Arabian Sea. The longline fishery targets several tuna species in different parts of the Indian Ocean, with yellowfin and bigeye being the main target species in tropical waters. The longline fishery can be subdivided into an industrial component (deep-freezing longliners operating on the high seas from Japan, Korea and Taiwan,China) and an artisanal component (fresh tuna longliners). The total longline catch of yellowfin reached a maximum in 1993 (196,000 t). Since then, catches have typically fluctuated between 80,000 t and 123,000 t.

Artisanal catches, taken by bait boat, gillnet, troll, hand line and other gears have increased steadily since the 1980s. In recent years the total artisanal yellowfin catch has been around 130,000-140,000 t, with the catch by gillnets (the dominant artisanal gear) at around 80,000 t to 90,000 t.

Yellowfin catches in the Indian Ocean during 2003, 2004, and 2005 and 2006 were much higher than in previous years, while bigeye catches remained at their average levels. Purse seiners currently take the bulk of the yellowfin catch — mostly from the western Indian Ocean. In 2003, 2004, and 2005 and 2006, purse seine total catches were around 224,100 t, 233,000 t, 203,700 t and [170,100 t]227,000 t and 234,000 t and 202,000 t, respectively — about 50% more than the previous largest purse seine catch, which was recorded in 1995. Similarly, artisanal yellowfin catches have been near their highest levels and longliners have reported higher than normal catches in the tropical western Indian Ocean during this period.

Yellowfin catches in number by gear (purse seine, longline and bait boat) are reported in Figure 7. Current estimates of annual mean weights of yellowfin caught by different gears and by the whole fishery are shown in Figure 8. After an initial decline, mean weights in the whole fishery remained quite stable from the 1970s to the early 1990s. Since 1993, mean weights in the catches in the industrial fisheries have declined. Prior to 2003, although total catch in biomass has been stable for several years, catches in numbers have continued to increase, as there has been more fishing effort directed towards smaller fish. As described above, this situation changed during 2003 and 2004; where most of the very large catches were obtained from fish of larger sizes.

AVAILABILITY OF INFORMATION FOR ASSESSMENT PURPOSES

The reliability of the estimates of the total catch has continued to improve over the past few years, and the Secretariat has conducted several reviews of the nominal catch databases during in recent years2004. This has led to marked increases in estimated catches of yellowfin tuna since the early 1970s. In particular, the estimated catches for the Yemen artisanal fishery have been revised upwards sharply, based on new information, but they still remain highly uncertain. In 2005, Taiwan,China provided size data for yellowfin tuna by IOTC area for 1980 – 2003, thereby substantially improving the information available to estimate catches by size.

Estimates of annual catches at size for yellowfin were calculated using the best available information prior to the 2005 2007 WPTT meeting. A number of papers dealing with fisheries data, biology, CPUE trends and assessments were discussed by the WPTT in 20052007, and additional data analyses were performed during that meeting. Estimated catches at age were calculated using the catch-at-size data and two three alternative growth curves. The two growth curves were used to develop two sets of natural mortality at age, maturity at age and average weight at age schedules. M was assumed to be higher on juvenile than adult fish.

Standardized CPUE series for both Japanese and Taiwanese longline data were presented and used during the assessments. Standardised purse seine CPUE analyses were also presented and discussed, but these were not used during the assessments because it was believed that they still did not fully account for the increases in purse seine catching efficiency over time.

The two standardized longline CPUE series showed similar trends, with an initial steep decline, over a period when catches were relatively low and stable, followed by stable standardized CPUEs since the late 1970s, a period during which catches have increased strongly following the development of the purse seine fishery (Figure 9). The observed pattern of standardised longline CPUEs does not correspond well with the expected response of CPUE to changes in catch and biomass, if standardized CPUE is directly proportional to the abundance of the part of the stock exploited by the gear concerned. There are several possible explanations for this, such as changes in catchability or behaviour, or the population existing in two fractions with differential availability to purse seine and longline gears, or a substantial decrease in the accumulated biomass in the oldest age groups in the early years. However, current analyses are unable to distinguish which, if any, of these explanations is correct.

In 2007 a new standardised Japanese longline CPUE for yellowfin tuna (1968 to 2005) was derived for an area combining, area 3 north of 30°S, area 2 and area 5, using . The CPUE indices are variable from year to year but generally decline steeply from 1960 until the late 1970's. From the late 1970's to the early 1990's the index is relatively stable. From the mid 1990's to 2005 the index is at lower levels than previously, but again relatively stable (Figure 9).

A new standardised CPUE for yellowfin tuna caught in the Taiwanese longline fishery (1968 to 2005) was also developed in 2007. Overall, the indices have been variable from year to year, but relatively stable since the late 1970s. The catch rate has shown a slowly increasing trend since 1997 (Figure 9).

Since the early 1990's the Taiwanese fleet has concentrated its operation in the Arabian Sea area whereas the Japanese fleet has operated more in the central and western Indian Ocean. It appears that the the Japanese and Taiwanese longline fisheries are now spatially distinct and both indices of abundance need to be viewed and modelled separately.

STOCK ASSESSMENT

Four stock assessment models were applied to the Indian Ocean yellowfin tuna stock in July 2007; however, there remained strong uncertainties in each of the assessments conducted. In particular, none of the assessments were able to consistently explain the trends in standardized CPUEs in the early years of the fishery without using trends in catchabilities or recruitment for which there is no evidence. Also, the trends observed in recent years were not fully consistent with those of total catches and the models had great difficulty at combining these contradictory sources of information. Several scientists and the Secretariat were assigned to attempt a number of extended analyses to assist the deliberations of the Scientific Committee on the management advice for this stock.

The ASPM and SS2 assessment models were re-run using new catch at size and catch at age data based on the new growth equation generated by tag data from the RTTP-IO; revised Taiwanese CPUE in the whole sub-areas; and the newly-defined tropical CPUE series for the Japanese longline fleet. The two assessments also used the previous catch at size (CAS) and catch at age (CAA) inputs to compare the results with those based of the new CAS and CAA matrices. Both models showed that using the new CAS/CAA set produced more optimistic results (larger population sizes) due to the faster growing curve leading to relatively large discrepancies in weights in older ages between the new and the previous growth equations

Both the ASPM and SS2 models produced similar estimates for MSY-related parameters. Other parameters such as the F ratio showed large differences and this may be due to the differences in model structures. The estimates of MSY, SSB (MSY) and F (MSY) were similar in both in ASPM and SS2 and this indicates that fishing levels have exceeded the MSY in recent years probably due to high catches over the period from 2003 to 2005.

A full assessment was attempted for yellowfin tuna in 2005 by the WPTT. Two papers presenting assessment results were presented, one using the age structured production model (ASPM) method and one using a new Bayesian two-age-class production model. Additional assessments were carried out during the WPTT meeting using agreed data sets and the following methods: the PROCEAN method, the CATAGE trend (statistical catch at age analysis) method, ASPM, and the Bayesian two-age-class production model.

Although there were differences in the details of results from the different assessments, the overall picture they presented was consistent, particularly in terms of estimated trends in stock biomass and fishing mortality rates. Estimated trends in the fishing mortality rates are shown in Figure 10. Estimates of catchability using the PROCEAN and CATAGE methods show a strong increasing trend since the mid-1980s for both the longline fleets and the purse-seine fleets (Figure 11). The assessment runs considered at this meeting consistently indicated that fishing mortality rates between 1992 and 2002 have been close to or at levels of F corresponding to the Fmsy estimated by the most plausible ASPM assessment. Catches during this period were in the vicinity of, or possibly above, the MSY levels estimated by PROCEAN and the most plausible ASPM assessment. Estimated catches in

~~2003 and 2004 were well above those MSY levels, and projections carried out indicate that these are not sustainable unless supported by very high recruitments.~~

~~The Scientific Committee emphasized, however, that there remain strong uncertainties in each of the assessments conducted. In particular, none are yet able to consistently explain the trends in standardized CPUEs in the early years of the fishery without using trends in catchabilities or recruitment for which there is no evidence. Consequently, the implications drawn from them regarding current stock status are also uncertain.~~

~~Since the early 1980s there has also been an increase in both purse seine fishing on floating objects and artisanal fisheries which has led to a rapid increase in the catch of juvenile yellowfin. The rapid expansion, particularly on juvenile fish, is cause for concern, since it displays all the symptoms of a potentially risky situation. The increases in catches in general has not been as a result of geographic expansion to previously unfished areas, but rather as a result of increased fishing pressure on existing fishing grounds.~~

EXCEPTIONAL CATCHES DURING 2003, 2004, ~~AND~~ 2005 AND 2006

Yellowfin catches in the Indian Ocean ~~have~~ were~~been~~ very high in over the period 2003 to 2006 (Figure 1)..~~recent years. The total catch in 2003 was 455,000 t, 507,000 t in 2004 and~~ P~~p~~reliminary figures indicate that the total catch of yellowfin in ~~2005~~ 2007 is going to be ~~was~~ lower than in the last four years~~over 484,000 t~~. The catches in each of the years over the period 2003-2006 ~~se catches~~ ~~represented~~ were ~~more than a~~over 30 % ~~increase~~ higher than~~above~~ the average annual catch taken in the previous five years (343,400 t), and were, except for 2006, substantially greater than the previous high in 1993 (407,000 t). These anomalous catches occurred all over the western Indian Ocean, in particular in a small area off eastern Africa, although the anomaly extended over a much wider area, from the Arabian Sea to South Africa, in both industrial (purse seine on free-swimming schools and longline) and artisanal fisheries. The fish caught were of large sizes (100-150 cm FL).The Scientific Committee discussed two possible hypotheses explaining the observed high catches, noting that it is possible that a combination of factors was responsible for this event. There are two main categories of factors:

Increase in the biomass of the population:

According to this hypothesis, there may have been several large recruitments to the population in the late 1990's or early 2000's that could have been responsible for the large increase in yellowfin catches. In these years, environmental conditions favourable to good recruitment may have occurred in the Indian Ocean. But recruitment is not the only process by which the biomass could increase. Additional explanations could be reduced natural mortality during some critical life stage and/or increased growth rates related to favourable environmental conditions.

The Scientific Committee noted there is no evidence from existing data of unusually large numbers of small fish being caught in the surface fisheries in the early 2000's. This could indicate that either the juveniles from these large cohorts were present, but outside the normal purse seine fishing grounds (e.g. in the eastern Indian Ocean), or that the recent cohorts were only at average levels.

An increase in catchability due to a concentration of the resource and/or an increase in the fishing efficiency

It is also possible that during 2003, 2004 and 2005, the catchability of large yellowfin tuna had increased. Possible factors that could have caused this include aggregation of large yellowfin tuna over a relatively small area and/or depths that made it easier for purse seiners and longliners to catch them in large quantities and technological improvements on purse-seiners that could have the schools more vulnerable to fishing. No technological improvements have been reported for industrial longliners during this period.

While these factors might explain the high catches of industrial fisheries in a small area off eastern Africa, there are also reports of exceptionally high catches by the commercial and artisanal fisheries from Yemen, Oman, Iran, South Africa and Maldives.

Large concentrations of the shallow water crustacean *Natosquilla investigatoris* and swimming crabs, were reported to have occurred in 2003 and 2004 in the western Indian Ocean, and yellowfin tuna were observed feeding voraciously on them. New information on anomalies in the thermocline depth and primary productivity in 2003 also supported the hypothesis that there may have been an increased catchability due in some part to environmental factors.

By the end of 2002, most purse seine vessels had new sonar equipment installed. These devices potentially enable skippers to locate schools at distances up to 5 km, both night and day. This could make schools more vulnerable to fishing, and catches could be expected to increase. However, there is no indication of similar increases in efficiency in the Atlantic Ocean, where vessels were also fitted with the same equipment. In addition, higher catches also occurred in artisanal and longline fisheries for which there is no indication of recent technological advances.

~~The Scientific Committee agreed that it was most likely that the increased catches were due to a combination of these two sets of factors, increased recruitment in the early 2000s and increased catchability of large yellowfin tuna during 2003, 2004 and 2005. A full assessment of the event will be undertaken once full catch data for 2005 and 2006 are available.~~

MANAGEMENT ADVICE

~~While there was greater consistency in the 2005 assessment results than previously, the Scientific Committee emphasised that there remain considerable uncertainties in the assessments, as none as yet are able to fully explain the observed trends in standardized longline CPUEs over the duration of the fishery.~~

~~In interpreting the high catches of yellowfin 2003, 2004 and 2005, the Scientific Committee noted that if the hypothesis of one or two high recruitments entering the adult stock is correct, the increased catches from these year classes are unlikely to be detrimental to the stock, but these catches would not be sustainable in the longer term unless supported by continued high recruitments. On the other hand, there could be serious consequences if the hypothesis that there was an increased catchability during this time is correct. In this case, the very large catches would represent a much higher fishing mortality and certainly would not be sustainable. Furthermore, they could lead to a sudden decline of the existing adult biomass of yellowfin tuna, potentially reducing the stock to below MSY levels. If such is the case, management action might be needed to reduce catches and fishing mortality to below the levels prevailing in 1999 – 2002 to allow the stock to recover. If, as the Scientific Committee believes, the most likely cause of the exceptional catches is a combination of these factors, then some reduction of stock biomass is to be expected in the future. However, the extent of any such reduction will only become apparent in several years following detailed stock assessments.~~

~~Considering all the stock indicators and assessments, as well as the recent trends in effort and total catches of yellowfin, the Scientific Committee considered that:~~

1) ~~The current fishing pressure on juvenile yellowfin by both purse seiners fishing on floating objects and artisanal fisheries is likely to be detrimental to the stock if it continues, as fish of these sizes are well below the optimum size for maximum yield per recruit estimated in 2002.~~

2) ~~The Scientific Committee also noted that juvenile yellowfin tuna are caught in the purse-seine fishery that targets primarily skipjack tuna. Some measures to reduce the catches of juvenile yellowfin tuna in the FAD fishery will be accompanied by a decrease in the catches of skipjack tuna.~~

3) ~~Fishing mortality rates between 1999 and 2002 were probably slightly below or around FMSY, and total catches during that period, at an average level of 347,000 t, were probably close to, or possibly above MSY. Total catches in 2003, 2004 and 2005 were substantially above MSY; see above for interpretation of the possible reasons for and possible effects of these catches.~~

~~In conclusion, the Scientific Committee recommended that any further increase in both effective fishing effort and catch above average levels in 1999 - 2002 should be avoided.~~

Despite the major differences in outputs between the models presented in 2007, both in July and intersessionally, the estimates of MSY are similar. Acknowledging the uncertainties in the results, the models indicate that fishing levels have exceeded MSY in recent years.

In interpreting the high catches of yellowfin over the period from 2003 to 2006, the 2006 Scientific Committee noted that if the hypothesis of one or two high recruitments entering the adult stock is correct, the increased catches from these year classes are unlikely to be detrimental to the stock, but these catches would not be sustainable in the longer term unless supported by continued high recruitments. On the other hand, there could be serious consequences if the hypothesis that there was an increased catchability during this time is correct. In this case, the very large catches would represent a much higher fishing mortality and certainly would not be sustainable. Furthermore, they could lead to a sudden decline of the existing adult biomass of yellowfin tuna, potentially reducing the stock to below MSY levels.

The WPTT does not have any clear indication whether or not high recruitments did occur in the stock. On the other hand, direct observations confirm that the biological productivity in the Indian Ocean was enhanced in 2003-2004 and that a shallow thermocline prevailed in the West Indian Ocean over the period from 2001-2005. These factors could have led to higher concentration of tuna in the western part of the Indian Ocean. Therefore, the increased catchability hypothesis leading to a high fishing mortality is more likely.

Considering all the stock indicators and assessments presented this year, as well as the recent trends in fishing effort and total catches of yellowfin, the WPTT note that:

1) Recent yellowfin tuna catches are most likely above the MSY level - although there are still uncertainties on the exact level of this difference. Considering the precautionary principle, catch should be decreased to pre-2003 levels and fishing capacity should not exceed the current level.

2) The current fishing pressure on juvenile yellowfin by both purse seiners fishing on floating objects and artisanal fisheries is likely to be detrimental to the stock if it continues, as fish of these sizes are well below the optimum size for maximum yield per recruit estimated in 2002.

3) Juvenile yellowfin tuna are caught in the purse-seine fishery that targets primarily skipjack tuna. Some measures to reduce the catches of juvenile yellowfin tuna in the FAD fishery will be accompanied by a decrease in the catches of skipjack tuna.

YELLOWFIN TUNA SUMMARY

Maximum Sustainable Yield (2007):	The range from 2007 assessment results ranged from (271,000 t – 360,000 t) Approximately 300,000 – 350,000 t
Preliminary catch in 20052006 *(data as of October 20062007)*	493,300484,700 t
Catch in 20042005	478,900506,900 t
Mean catch over five years before 2003 (1998 – 2002)	343,400 t
Current Replacement Yield	-
Relative Biomass $B_{current}/B_{MSY}$	uncertain
Relative Fishing Mortality $F_{current}/F_{MSY}$	uncertain

Note: This Executive Summary has been updated to take account of recent catch data. The management advice, and stock assessment results are based on data up to 20032005.

Table 1. *Best scientific estimates of the catches of yellowfin tuna (as adopted by the IOTC Scientific Committee) by gear and main fleets for the period ~~1956~~ 1957 to ~~2004~~2006.* Data as of October ~~2006~~2007

Gear	Fleet	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
Purse seine	France																									0.2	1.0	10.5
Purse seine	NEI-Other																											0.7
Purse seine	Other Fleets							0.0	0.0	0.0					0.0		0.0		0.0	0.0		0.0	0.2	0.1	0.1	0.1	0.1	1.5
Purse seine	Total							0.0	0.0	0.0					0.0		0.0		0.0	0.0		0.0	0.2	0.1	0.1	0.3	1.2	12.6
Baitboat	Maldives	2.0	2.0	2.0	1.0	1.5	1.5	1.5	1.5	1.0	1.5	1.7	1.7	1.8	2.3	1.4	2.5	6.9	5.0	4.6	5.2	4.9	3.8	4.4	4.4	5.6	4.5	7.7
Baitboat	Other Fleets	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.7	1.3	0.3	0.1	0.1	0.1	0.2	0.3	0.5	0.3	0.1
Baitboat	Total	2.0	2.0	2.0	1.0	1.5	1.5	1.5	1.5	1.0	1.5	1.7	1.7	1.8	2.3	1.4	2.6	7.6	6.3	4.8	5.4	5.0	3.9	4.6	4.7	6.1	4.9	7.8
Longline	Taiwan,China	1.3	1.8	2.4	2.2	2.9	3.5	3.4	2.9	2.2	4.4	3.4	22.7	21.1	14.9	11.9	11.8	5.7	4.4	4.6	3.4	8.1	4.2	3.7	3.8	4.1	4.7	5.6
Longline	Japan	31.9	22.6	22.2	36.1	32.7	44.2	22.0	22.2	24.9	40.8	30.2	48.3	23.1	10.3	13.4	7.9	3.9	4.9	6.4	2.8	2.1	4.6	3.3	3.2	4.9	7.3	7.8
Longline	Indonesia																	0.1	0.3	0.7	1.0	1.3	1.3	1.4	2.1	2.6	2.7	0.8
Longline	Korea, Republic of									0.1	0.1	0.4	5.3	9.2	5.2	7.4	10.3	10.8	13.2	13.4	13.7	33.1	26.6	18.0	13.2	12.4	19.4	16.2
Longline	Other Fleets								0.3	0.5	0.5	0.1	2.4	0.6	1.9	1.6	1.5	1.2	0.7	0.2	1.1	0.9	0.2	0.4	0.5	0.4	0.4	0.7
Longline	Total	33.1	24.5	24.6	38.3	35.6	47.7	25.4	25.3	27.7	45.7	34.0	78.6	54.0	32.4	34.4	31.5	21.7	23.5	25.4	21.9	45.4	37.0	26.9	22.8	24.4	34.5	31.1
Gillnet	Sri Lanka	1.0	1.1	1.2	1.5	1.8	2.7	3.6	3.5	3.3	3.7	4.1	4.6	5.1	4.0	2.9	4.5	5.4	4.8	3.9	7.0	6.4	6.9	7.6	8.4	9.6	9.5	9.1
Gillnet	Oman	0.5	0.5	0.7	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.9	2.9	3.4	3.8	4.0	4.4	4.1	5.0	4.8	3.5	1.6
Gillnet	Pakistan	1.4	0.7	0.7	0.9	0.8	1.2	1.8	2.5	2.7	3.6	3.5	3.5	3.2	2.9	2.4	2.8	2.2	3.0	3.4	3.1	2.8	1.6	2.8	1.3	2.0	2.5	0.8
Gillnet	Other Fleets	0.4	0.4	0.4	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.6	0.6	1.1	1.4	0.9	0.7	1.5	2.0	3.5	4.0	3.1	0.8	2.3	1.6
Gillnet	Total	3.4	2.8	3.0	3.4	3.8	5.1	6.6	7.2	7.3	8.6	9.1	9.6	9.8	8.2	6.6	9.2	10.0	11.6	11.3	15.4	15.2	16.5	18.5	17.8	17.3	17.9	13.1
Line	Yemen	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.7	0.8	0.9	1.0	1.0	1.0	1.1	0.8	0.8	1.5
Line	Comoros														0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Line	Maldives														0.3	0.2	0.2	0.3	0.3	0.3	0.5	0.4	0.5	0.7	0.7	0.7	0.3	0.3
Line	Other Fleets	0.5	0.5	0.5	0.7	0.9	0.9	1.2	1.4	1.1	1.2	1.4	1.5	1.6	1.2	1.3	1.7	2.6	1.8	1.6	2.3	5.0	3.8	3.4	3.7	3.7	4.3	3.2
Line	Total	0.7	0.7	0.8	1.0	1.1	1.1	1.4	1.6	1.3	1.4	1.6	1.7	1.9	1.8	1.8	2.2	3.3	3.0	2.8	3.8	6.6	5.5	5.2	5.6	5.3	5.5	5.3
All	Total	39.3	30.0	30.4	43.7	42.1	55.3	34.9	35.6	37.4	57.3	46.5	91.7	67.4	44.7	44.2	45.6	42.6	44.3	44.3	46.5	72.2	63.1	55.3	51.1	53.4	63.9	69.9

Gear	Fleet	Av02/06	Av57/06	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06
Purse seine	Spain	72.3	22.3	11.5	18.4	20.0	26.3	44.9	41.1	43.7	44.0	37.8	47.8	43.1	65.1	59.4	61.0	38.6	51.9	49.4	47.7	53.4	79.0	80.8	77.5	70.9
Purse seine	France	52.9	19.5	36.7	39.1	43.3	46.8	59.9	38.4	45.3	38.1	45.3	39.5	35.8	39.6	35.6	31.2	22.4	30.8	37.7	34.1	36.4	63.3	63.5	57.2	44.3
Purse seine	Seychelles	32.7	4.2								0.4	0.2					2.8	7.4	9.8	11.6	12.9	16.6	33.3	48.8	36.5	28.1
Purse seine	NEI-Other	17.2	6.9	8.4	9.4	6.3	5.2	7.9	4.5	11.9	11.9	8.1	15.5	19.7	19.3	16.7	21.9	20.3	25.8	27.1	18.9	19.1	24.5	14.8	14.3	13.5
Purse seine	NEI-Ex-Soviet Union	8.1	2.7							0.8		5.2	8.7	5.8	14.6	11.7	9.8	5.3	11.8	10.9	8.9	2.2	15.1	13.8	7.8	1.4
Purse seine	Iran, Islamic Republic	8.0	1.3									2.1	3.4	2.7	4.3	1.6	1.9	3.3	2.5	2.2	2.2	5.0	8.3	11.0	7.3	8.4
Purse seine	Other Fleets	2.8	2.4	1.7	1.8	3.8	5.5	5.9	5.8	6.9	11.0	14.2	13.6	7.2	6.5	4.6	3.5	3.2	2.1	1.3	5.3	6.4	0.7	0.3	3.2	3.4
Purse seine	Total	194.0	59.3	58.2	68.8	73.4	83.8	118.6	89.8	108.7	105.4	112.9	128.4	114.4	149.4	129.7	132.2	100.4	134.8	140.3	130.0	139.0	224.1	233.0	203.7	170.1
Baitboat	Maldives	15.5	6.5	8.2	6.9	6.2	7.4	5.9	5.5	4.9	7.0	8.0	9.3	12.4	11.8	11.5	12.2	13.0	12.6	10.0	11.1	16.3	16.1	14.4	14.9	15.8
Baitboat	Other Fleets	0.8	0.3	0.2	0.4	0.2	0.3	0.2	0.2	0.3	0.4	0.5	0.5	0.4	0.4	0.5	0.5	0.4	0.5	0.6	0.5	0.6	0.6	0.4	2.1	0.4
Baitboat	Total	16.3	6.8	8.4	7.3	6.4	7.7	6.1	5.8	5.2	7.5	8.5	9.8	12.8	12.2	12.0	12.7	13.4	13.1	10.6	11.6	16.9	16.7	14.9	17.0	16.3
Longline	Taiwan,China	43.0	17.4	5.8	7.3	16.2	22.3	22.7	22.4	31.6	30.7	56.0	88.2	34.1	23.1	27.9	18.4	23.4	17.7	17.4	26.9	33.2	29.7	49.8	67.6	34.7
Longline	Japan	18.6	15.1	7.9	9.5	10.7	8.3	9.3	4.6	6.3	4.4	5.7	5.7	9.7	8.0	12.8	15.6	16.8	14.7	15.5	13.9	13.9	17.2	16.0	21.8	24.2
Longline	Indonesia	16.0	7.4	0.8	0.8	0.7	1.3	2.3	3.8	4.6	5.5	9.3	10.8	14.8	16.7	31.8	38.2	35.7	41.7	29.6	28.4	24.2	20.2	15.3	12.0	8.5
Longline	NEI-Deep-freezing	4.0	2.7		0.1	1.1	1.2	3.4	3.2	6.7	5.9	8.9	23.8	9.9	6.9	12.1	5.9	9.8	7.7	6.6	2.2	3.4	2.8	5.7	3.9	4.1
Longline	NEI-Fresh Tuna	3.6	4.4						11.9	16.6	14.4	16.7	16.5	23.7	17.1	17.7	21.2	16.6	14.8	13.3	0.5	0.5	1.0	1.5	5.9	8.8
Longline	Korea, Republic of	2.7	7.1	10.2	12.5	15.5	13.2	14.2	8.7	7.5	3.2	4.4	4.3	4.0	2.7	4.0	4.2	2.6	1.0	2.0	1.5	0.3	2.1	4.1	3.5	3.5
Longline	NEI-Indonesia Fresh Tuna		2.0			0.1		2.7	10.3	12.6	12.9	15.6	12.6	16.3	8.9	3.7	4.0	0.3	0.0							
Longline	Other Fleets	11.0	3.4	0.7	0.3	1.0	0.6	0.4	0.4	0.1	1.9	20.1	33.6	8.0	4.2	3.9	2.0	4.0	6.0	5.6	5.3	4.6	7.6	11.9	19.9	11.0
Longline	Total	98.9	59.6	25.5	30.5	45.2	46.9	54.9	65.2	86.0	78.8	136.7	195.6	120.5	87.6	113.8	109.3	109.3	103.7	90.0	78.8	80.2	80.6	104.4	134.6	94.8
Gillnet	Iran, Islamic Republic	31.2	7.0						1.0	2.3	3.2	12.1	13.3	19.5	22.5	28.5	20.0	18.0	24.3	13.5	18.0	19.0	29.5	39.7	35.8	32.1
Gillnet	Sri Lanka	28.7	11.8	6.4	6.9	7.1	7.4	7.7	8.4	9.6	11.6	13.9	16.6	21.6	19.0	23.8	29.6	29.3	37.1	33.8	28.2	30.3	33.9	33.9	19.6	25.7
Gillnet	Oman	14.8	6.2	4.6	2.3	2.5	5.9	15.6	16.2	14.4	9.0	13.5	11.5	19.2	21.4	11.6	9.9	11.3	7.4	7.1	6.3	5.3	10.3	24.6	15.9	17.9
Gillnet	Pakistan	4.1	3.0	0.9	1.5	2.6	2.4	3.9	8.6	3.3	4.9	3.9	2.6	2.4	2.1	3.3	3.9	3.9	9.4	5.4	4.0	3.3	3.5	3.3	5.3	5.3
Gillnet	Other Fleets	4.0	2.1	1.5	3.5	4.5	3.1	2.7	1.3	1.6	2.2	2.0	2.6	3.0	2.8	3.1	3.4	3.2	3.5	3.7	3.2	3.4	3.5	3.4	4.5	5.3
Gillnet	Total	82.8	30.1	13.4	14.2	16.6	18.9	29.9	35.5	31.2	31.0	45.4	46.7	65.7	67.9	70.3	66.8	65.7	81.8	63.5	59.7	61.3	80.6	104.8	81.1	86.3
Line	Yemen	25.9	6.8	2.3	3.1	3.9	4.6	5.4	6.2	6.9	7.7	8.5	7.6	8.3	13.2	15.0	17.0	19.1	21.1	23.1	25.2	27.2	25.3	31.3	26.4	19.2
Line	Comoros	6.1	2.0	0.2	0.2	0.2	0.2	0.2	3.7	3.7	3.7	5.0	5.0	5.9	5.9	5.8	5.6	5.6	5.4	5.9	5.4	5.8	6.1	6.2	6.2	6.2
Line	Maldives	5.0	0.8	0.3	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.3	0.3	0.2	0.3	0.3	0.3	0.6	0.7	1.6	2.5	4.2	2.5	6.8	5.5	5.8
Line	Other Fleets	3.4	2.5	2.8	3.6	3.4	3.4	3.1	2.8	3.3	3.1	3.2	3.2	3.0	3.1	2.9	2.8	2.2	2.3	2.9	2.9	2.7	2.6	2.7	4.4	4.6
Line	Total	40.3	12.1	5.5	7.1	7.7	8.5	9.0	12.9	14.1	14.7	17.0	16.1	17.4	22.4	24.0	25.7	27.5	29.6	33.5	36.1	40.0	36.5	47.0	42.4	35.8
Other gears	Total	0.1	0.0					0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	0.2	0.2	0.1	0.1
All	Total	432.5	167.9	111.0	127.9	149.3	165.7	218.4	209.1	245.3	237.3	320.5	396.5	330.8	339.5	349.7	346.6	316.2	362.9	337.9	316.1	337.4	438.7	504.2	478.9	403.3

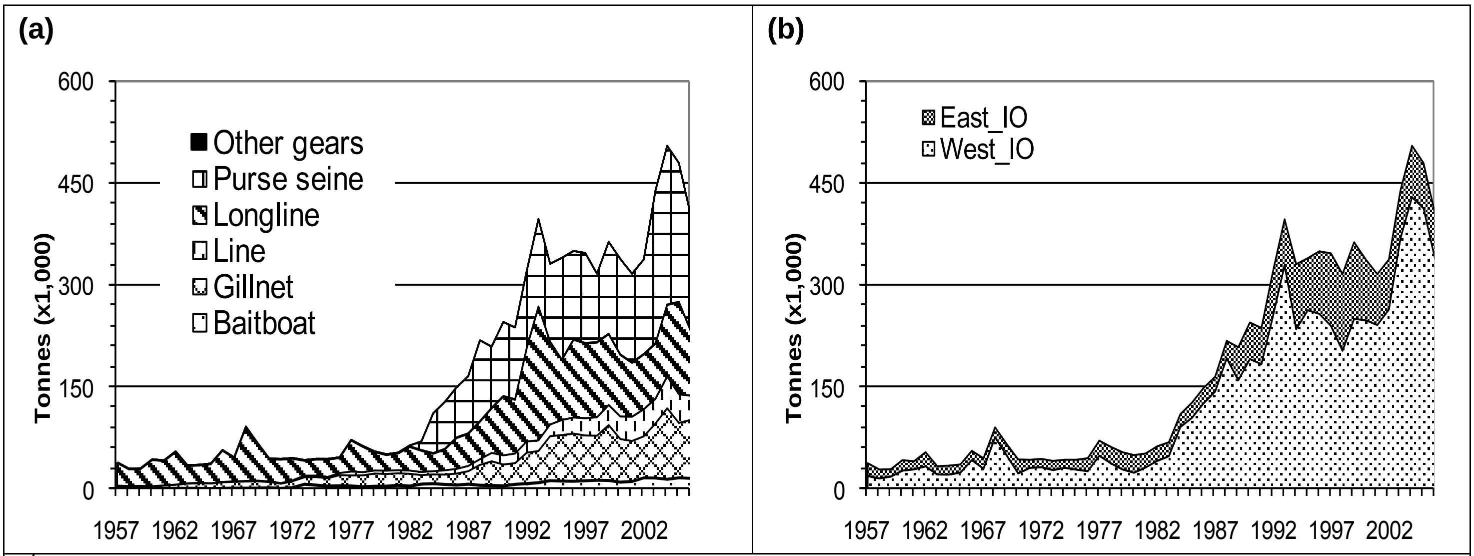


Figure 1. *Yearly catches (tonnes x 1000) of yellowfin by (a) gear and (b) area from ~~1956~~ 1957 to ~~2005~~2006.*

Data as of October ~~2006~~2007

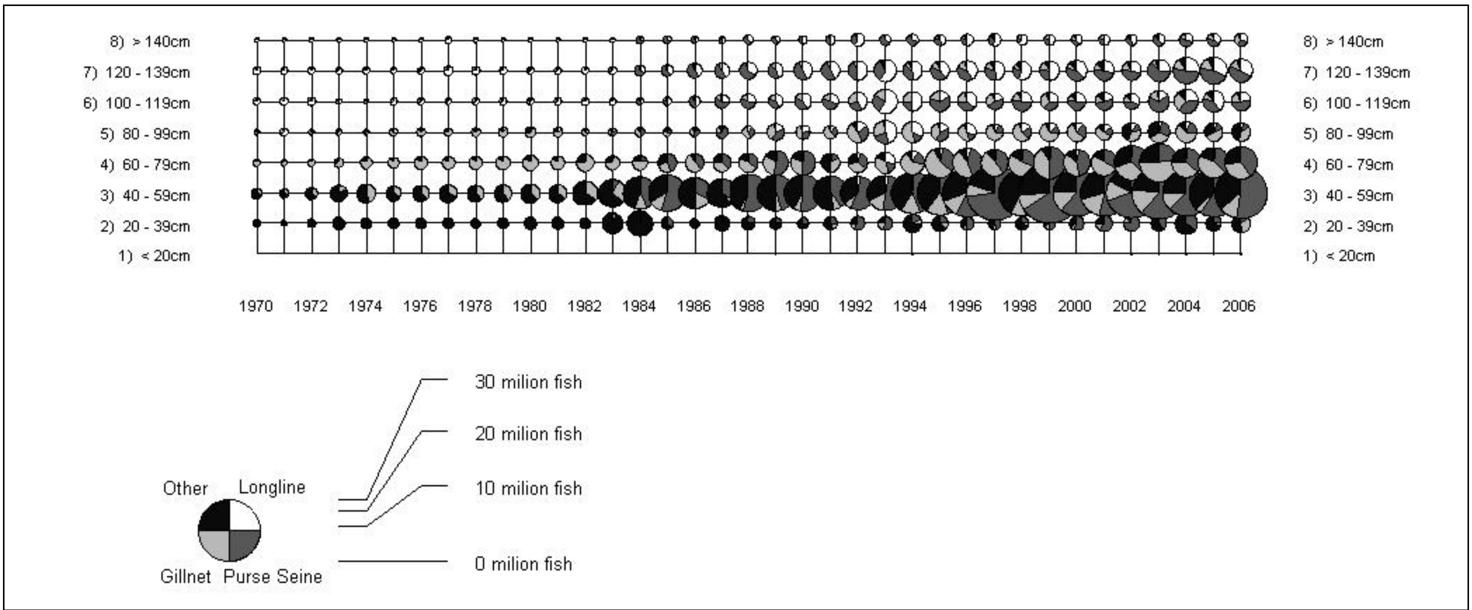


Figure 3. *Yellowfin tuna**:** total catches at size in the Indian Ocean by gear from 1970 to ~~2005~~2006*

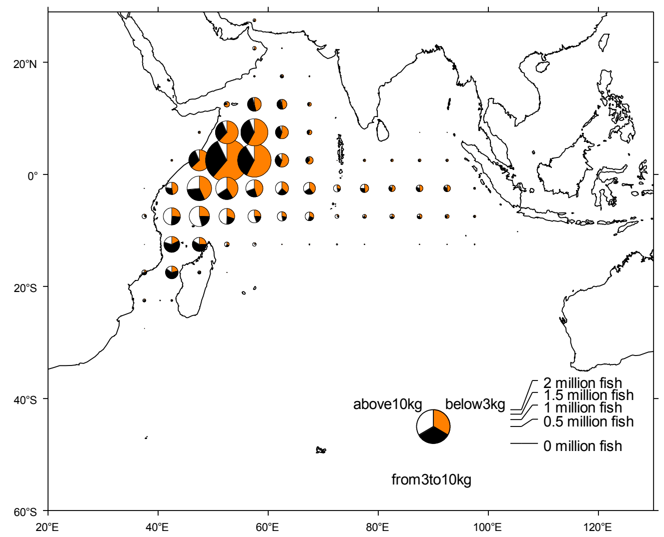


Figure 4. *Yellowfin tuna**:** location of catches of small (<3 kg) medium (3-10 kg) and large (>10 kg) sized fish taken by purse seiners from ~~1995~~ 1997 to ~~2004~~2006..*

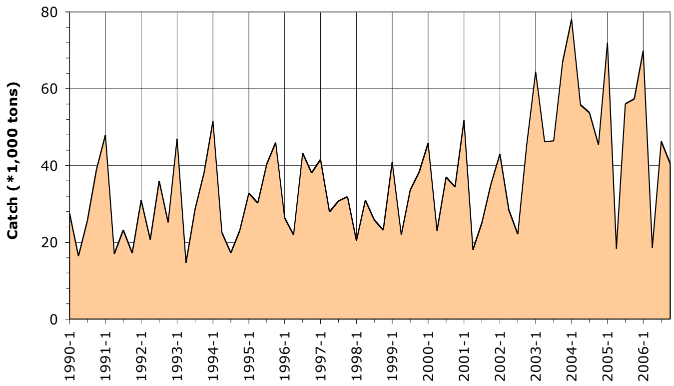
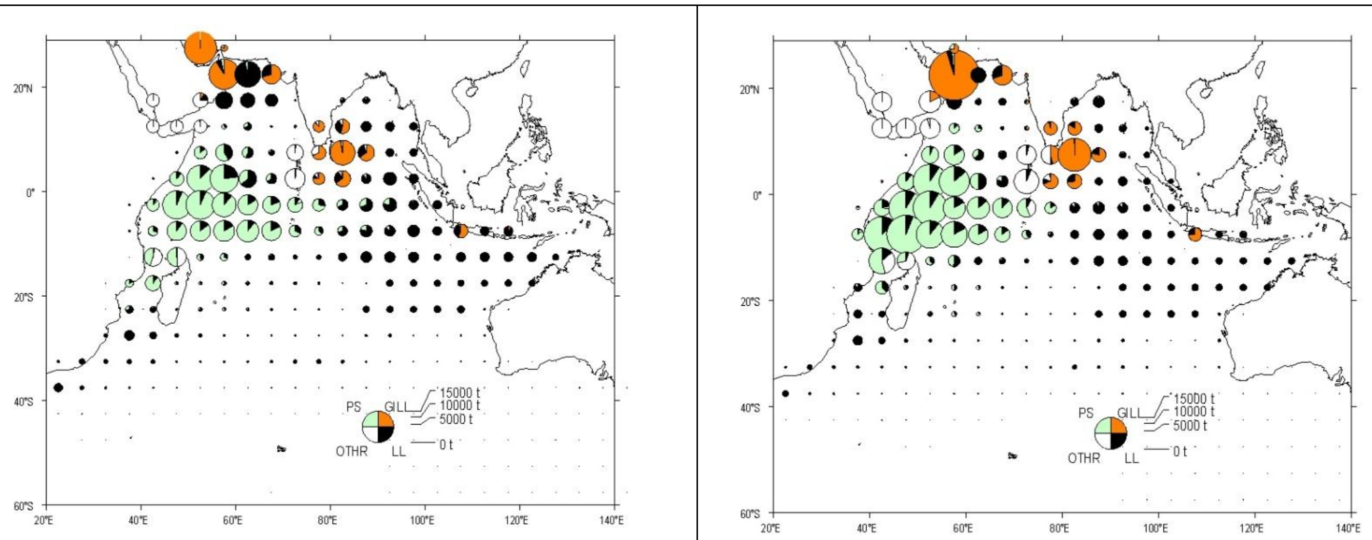
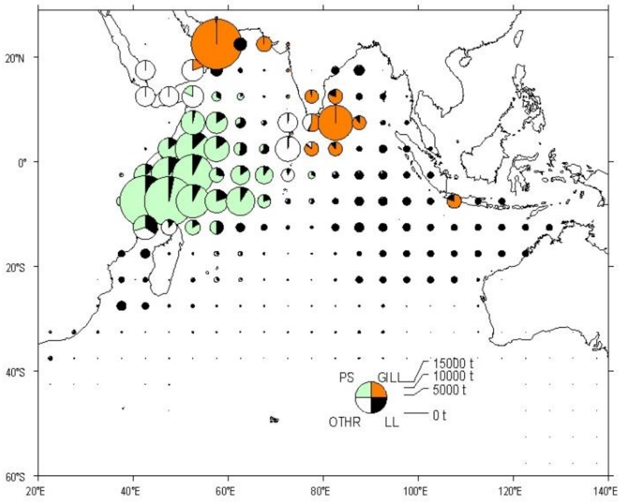


Figure 5. *Yellowfin tuna**:** quarterly catches by purse seiners in the Indian Oceans over the period 1999 to 2005*

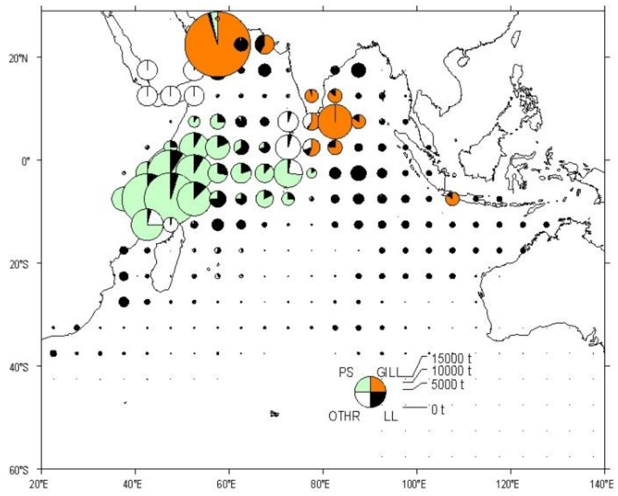


1990-1999	**2000-2006**

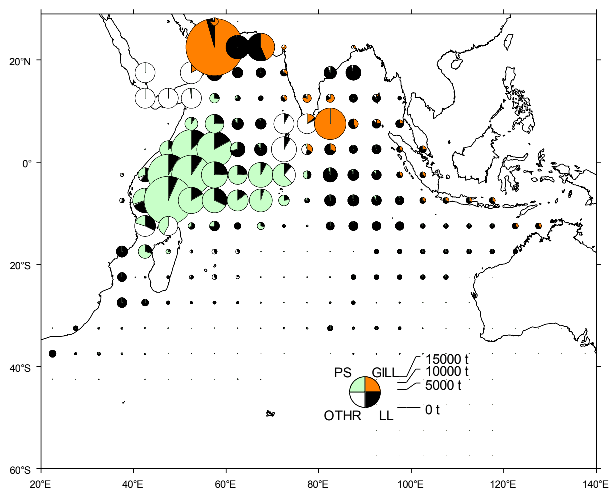
Figure 2a. *Location and size of yellowfin tuna catches in the Indian Ocean by gear type. GILL = gillnet, LL = longline, PS = purse seine. Data as of October ~~2006~~2007*



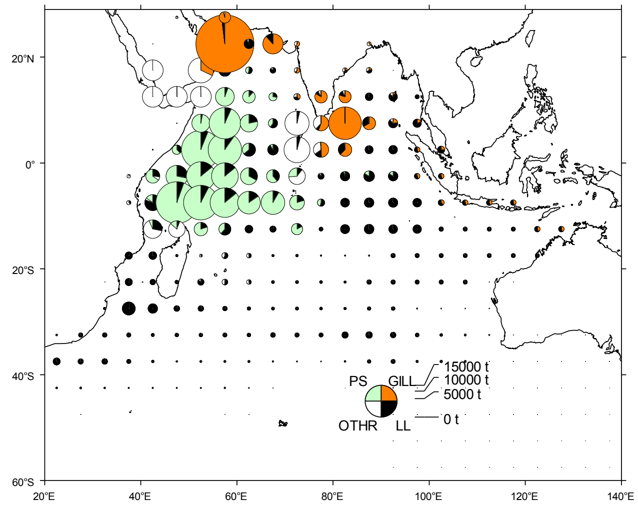
2003



2004



2005



2006

Figure 2b. *Location and size of yellowfin tuna catches in the Indian Ocean by gear type for 2003, 2004, 2005 and ~~2005~~ 2006 when extraordinarily large catches were taken. GILL = gillnet, LL = longline, PS = purse seine.*

Data as of October ~~2006~~2007

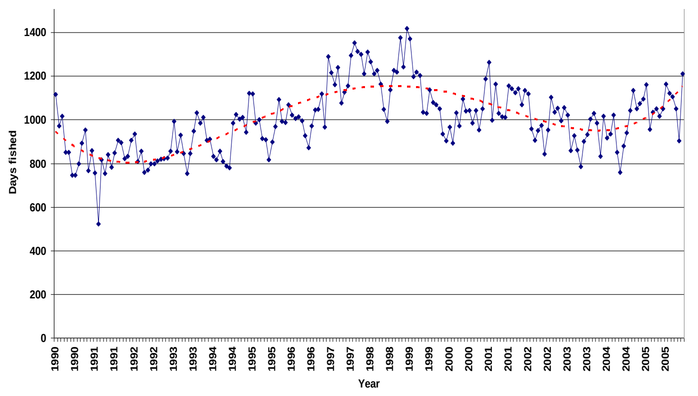


Figure 6. *Amount of effort (boat days per month) exerted by the EU purse seine fleet in the Indian Ocean.*

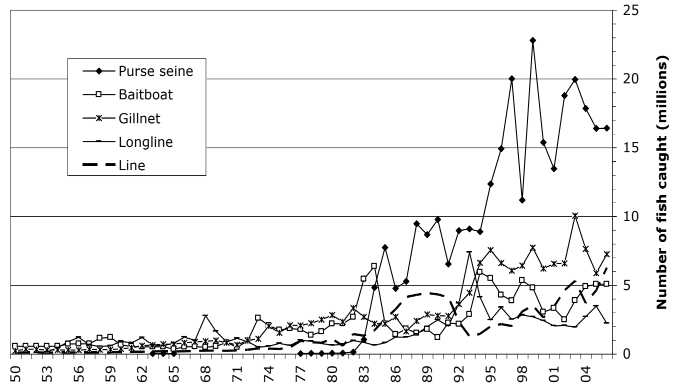


Figure 7. *Numbers of yellowfin caught by gear-type.*
Data as of July ~~2006~~2007

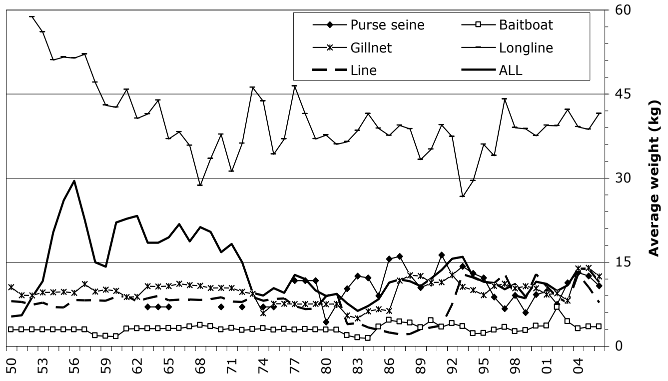


Figure 8. *Mean weight (kg) of yellowfin individuals in the catch by gear and for all gear-types (estimated from the total catch at size). PS: purse seine, BB: bait boat, LL: longline, GIL: gillnet, OTH: other. Data as of July ~~2006~~2007*

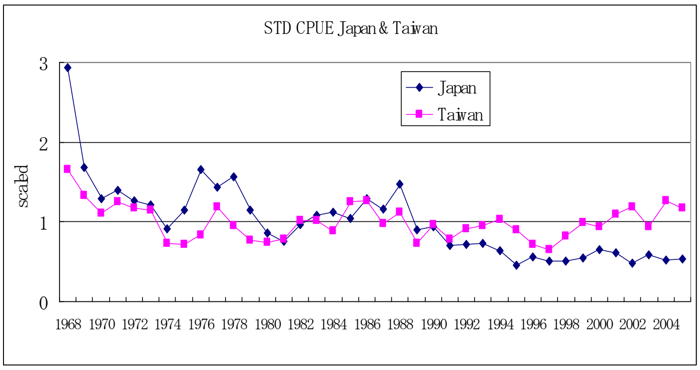
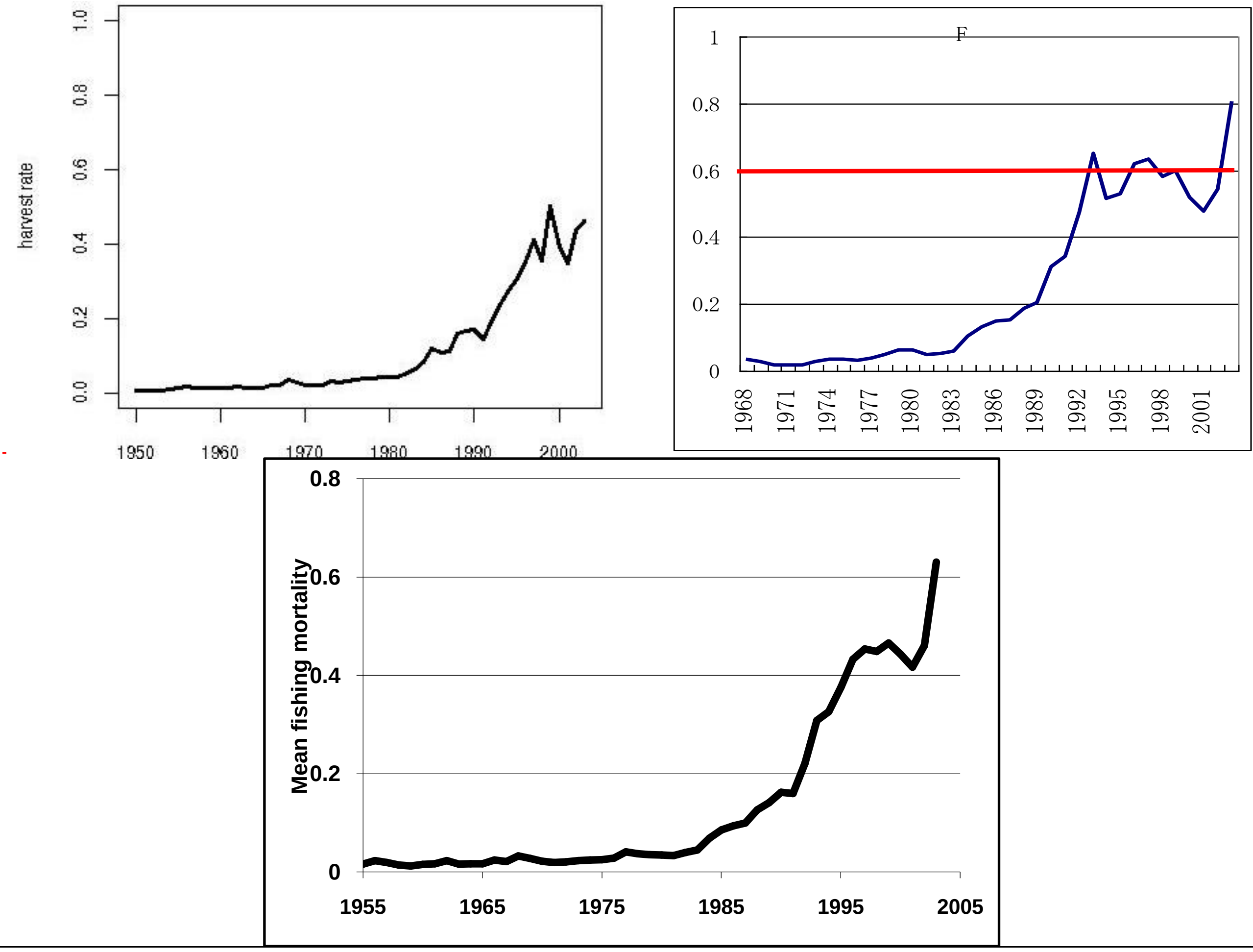
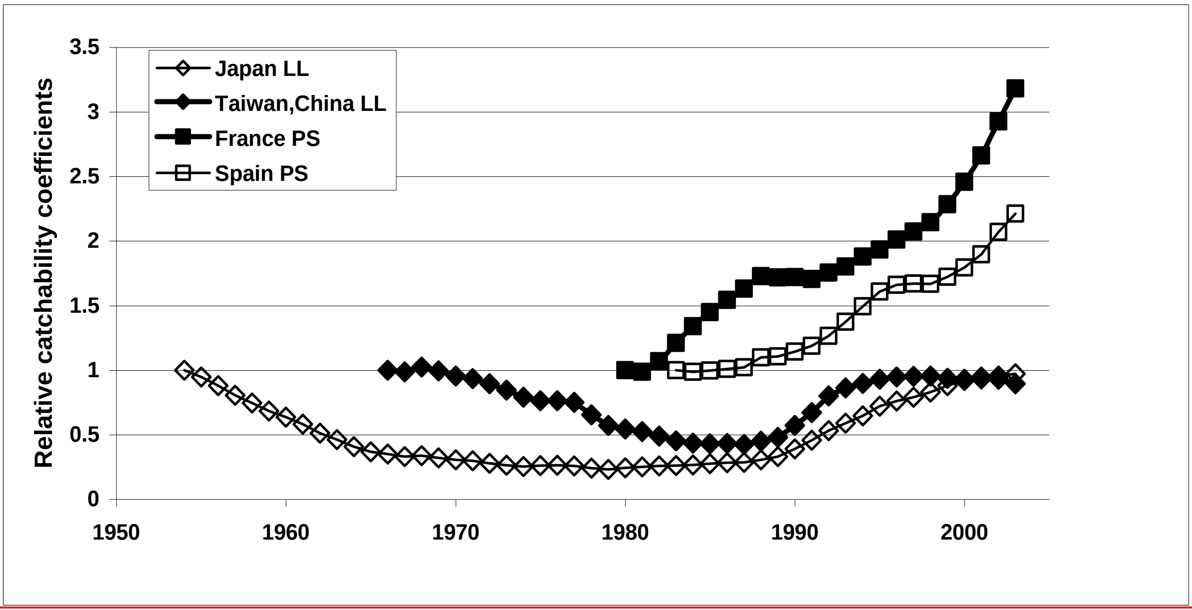


Figure 9. *Yearly standardised CPUE indices for yellowfin tuna based on the Japanese and Taiwan,China longline catch rates in the Indian Ocean.October 2007*



~~***Figure 10.** Yellowfin fishing mortality rate trends from each of the models in 2005. Bayesian (top left), ASPM (top right) and CATAGE (bottom).*~~



~~***Figure 11.** Mean yearly relative catchability coefficients estimated from CATAGE for Japanese longline (LL), Taiwan,China longline, French purse seine (PS) and Spanish purse seine*~~.

Executive summary of the status of the Indian Ocean swordfish resource

(As adopted by the IOTC Scientific Committee 10 November 2006)

Marked changes are factual changes related mainly to the inclusion of the latest fisheries statistics. All changes are suggestions only for the consideration of the SC in Nov07

BIOLOGY

Swordfish (*Xiphius gladius*) is a large oceanic apex predator that inhabits all the world's oceans and in the Indian Ocean ranges from the northern coastal state coastal waters to 50°S. Swordfish is known to undertake extensive diel vertical migrations, from surface waters during the night to depths of 1000m during the day, in association with movements of the deep scattering layer and cephalopods, their preferred prey. By contrast with tunas, swordfish is not a gregarious species, although densities increase in areas of oceanic fronts and seamounts.

Genetic studies of the stock structure of swordfish in the Indian Ocean have failed to reveal spatial heterogeneity, and for the purposes of stock assessments one pan-ocean stock has been assumed. However, spatial heterogeneity in stock indicators (CPUE trends), indicate the potential for localised depletion of swordfish in the Indian Ocean.

As with many species of billfish, swordfish exhibit sexual dimorphism in maximum size, growth rates and size and age at maturity – females reaching larger sizes, growing faster and maturing later than males. Length and age at 50% maturity in SW Indian Ocean swordfish is 170 cm (maxillary-fork length = LJFL) for females and 120 cm for males. These sizes correspond to ages of 6-7 years and 1-3 years for females and males, respectively.

Swordfish are highly fecund, batch spawners with large females producing many millions of eggs per spawning event. One estimate for Indian Ocean populations suggests that a female swordfish in equatorial waters may spawn as frequently as once every three days over a period of seven months.

Swordfish are long lived – having a maximum age of more than 30 years. The species also exhibits rapid growth in the first year of life - by one year of age, a swordfish may reach 90 cm (~15 kg). The average size of swordfish taken in Indian Ocean longline fisheries is between 40 kg and 80 kg (depending on latitude).

The species life history characteristics of relatively late maturity, long life and sexual dimorphism make it vulnerable to over exploitation.

FISHERIES

Swordfish are taken as a target or by-catch of longline fisheries throughout the Indian Ocean (Figure 1) and is likely to be a component of the "unidentified Billfish" catch by Sri Lankan gill net fisheries in the central northern Indian Ocean

Exploitation of swordfish in the Indian Ocean was first recorded by the Japanese in the early 1950's as a by-catch in their tuna longline fisheries. Over the next thirty years, catches in the Indian Ocean increased slowly as the level of coastal state and distant water fishing nation longline effort targeted at tunas increased. In the 1990's, exploitation of swordfish, especially in the western Indian Ocean, increased markedly, peaking in 1998 at around 35,000 t (Figure 2, Table 1). By 2002, twenty countries were reporting catches of swordfish (Figure 3, Table 1). The average annual catch for the period from 2002 to 2006 was 31,100 t ~~The annual total catch has averaged 31,400 t in recent years (2000-2004)~~ and in ~~2004~~ was ~~31~~28,000 t in 2005. The highest catches are taken in the south west Indian Ocean; however, in recent years the fishery has been extending eastward (Figure 4).

Since the early 1990's China,Taiwan has been the dominant swordfish catching fleet in the Indian Ocean (41-60 % of total catch). Taiwanese longliners, particularly in the south western and equatorial western Indian Ocean, target swordfish using shallow longlines at night. The night sets for swordfish contrast with the daytime sets used by the Japanese and Taiwanese longline fleets when targeting tunas.

During the 1990's a number of coastal and island states, notably Australia, La Reunion/France, Seychelles and South Africa have developed longline fisheries targeting swordfish, using monofilament gear and light sticks set at night. This gear achieves significantly higher catch rates than traditional Japanese and Taiwanese longlines. As a result, coastal and island fisheries have rapidly expanded to take over 10,000 t of swordfish per annum in the late 1990's.

STOCK STATUS

While the 2006 stock assessments (IOTC-2006-WPB-R) represent a major advance in the assessment of Indian Ocean swordfish the results should be considered preliminary and as such (and as in previous years) the Scientific Committee has considered a range of information (e.g. indicators of abundance and stock status such as trends in CPUE and size composition) to formulate its technical advice in 2006.

The standardised CPUE of swordfish for the Japanese fleet for all areas of the Indian Ocean combined showed a variable but continuous decline over time (Figure 5). However, this result appears to be driven by the declining trend in the areas north of the equator (areas 3 and 4 combined – see Figure 5) as the CPUE trend from the areas south of the equator (areas 6, 7 and 8 combined – see Figure 5) appears to have stabilised in recent years. Catch rates following 1990 are markedly lower than those prior to this time (particularly in southern areas) and this may be due to an apparent regime shift in fishing practices after 1990 (Figure 6). This marked decrease in CPUE also follows substantial increases in catches throughout the 1990's, particularly in the western Indian Ocean (Figure 2). The apparent fidelity of swordfish to particular areas is a matter for concern as this can lead to localised depletion. In previous years, localised depletion was inferred on the basis of decreasing CPUEs following fine scale analyses of the catch effort data. While no fine scale analyses of CPUE were carried out in 2006, localised depletion may still be occurring in some areas. Localised depletion has occurred in other parts of the world where swordfish have been heavily targeted.

The annual average sizes of swordfish in the respective Indian Ocean fisheries are variable but show no trend Figure 7). While there are no clear signals of declines in the size-based indices, these indices should be carefully monitored. It was noted that since females mature at a relatively large size, a reduction in the biomass of large animals could potentially have a strong effect on the spawning biomass.

Notwithstanding the uncertainties in the 2006 assessments using surplus production models, the overall results were consistent, particularly in terms of the current levels of fishing mortality and stock biomass levels (Figure 8). Stock biomass decreased markedly from the early 1990's corresponding to a sharp increase in fishing mortality. Based on the point estimates and confidence limits, on balance the assessment model results (excluding the high productivity scenario which was considered to be the least plausible) indicate that the fishing mortality has exceed the MSY level in recent years although the stock does not appear to be in an overfished state. The current catch level (around 31,500 t) is above the MSY and probably not sustainable.

MANAGEMENT ADVICE

On the basis of the 2006 assessments and stock indicators the SC concluded that the level of catch in 2004 (about 32,000 t) is above the MSY and unlikely to be sustainable. Furthermore, while the assessments indicated that the stock i.e. for the Indian Ocean overall is probably not currently overfished, catch rate data from the southwest Indian Ocean suggest that overfishing of swordfish may be occurring in localised areas, in particular in the southwest Indian Ocean. Notwithstanding this, the reductions in catch rates have not been accompanied by reductions in average size of the fish in the catch, as has been the case in other oceans. The SC expressed concern regarding the very rapid increase in effort targeting swordfish in other areas of the Indian Ocean and the relatively large incidental catch of swordfish in fisheries targeting bigeye. These increases in effort exploiting swordfish have continued since 2000.

The fact that large, rapid increases in fishing effort followed by a reduction in catch rates have been seen in the southwest Indian Ocean indicates that this might also occur in other areas where fishing effort directed to swordfish is increasing rapidly.

The SC recommends that management measures focussed on controlling and/or reducing effort in the fishery targeting swordfish in the southwest Indian Ocean be implemented. Similar measures may be needed in the future if reductions in catch rates are detected in other areas of the Indian Ocean.

SWORDFISH SUMMARY

Maximum Sustainable Yield:	estimates range between 23,540 t and 27,000 t.
Preliminary catch in ~~2005~~2006 *(data as of October ~~2006~~2007)*	~~26,200~~29,000 t
Catch in ~~2004~~2005	~~31,700~~28,000 t
Mean catch over the last 5 years (~~2001~~2002-06~~5~~)	~~30,200~~31,100 t
Current Replacement Yield	-
Relative Biomass (B_{2004}/B_{MSY})	estimates range between 1.17 – 1.60
Relative Fishing Mortality (F_{2004}/F_{MSY})	estimates range between 0.74 – 1.29

Note: This Executive Summary has been updated to take account of recent catch data. The management advice, and stock assessment results are based on data up to the end of 2004.

***Table 1**. Best scientific estimates of the catches of swordfish (as adopted by the IOTC Scientific Committee) by gear and main fleets for the period ~~1955~~1957-~~2004~~ 2006 (in thousands of tonnes).* *Data as of October ~~2006~~2007*

Gear	Fleet	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
Longline	Taiwan,China	0.1	0.1	0.2	0.2	0.3	0.3	0.5	0.5	0.3	0.3	0.2	0.6	0.8	1.2	0.9	0.9	0.6	1.0	0.9	0.9	0.9	0.6	1.1	1.3	1.1	1.5	1.9
Longline	Indonesia																		0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0
Longline	Japan	0.6	0.7	0.9	1.2	1.3	1.4	1.1	1.3	1.5	1.7	2.2	1.7	1.6	1.2	1.1	0.9	0.8	0.8	0.8	0.4	0.3	0.9	0.6	0.6	0.8	1.0	1.2
Longline	Korea, Republic of									0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.1	0.1	0.3	0.5	0.6	0.7	0.8	0.6	0.3	0.4	0.3	0.3
Longline	Other Fleets								0.1	0.2	0.0	0.0	0.1	0.0	0.1					0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Longline	Total	0.7	0.9	1.2	1.4	1.6	1.7	1.6	1.9	2.0	2.1	2.5	2.6	2.6	2.7	2.1	2.0	1.6	2.0	2.3	1.9	1.9	2.4	2.3	2.3	2.3	2.8	3.4
Other gears	Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
All	Total	0.7	0.9	1.2	1.4	1.6	1.7	1.6	1.9	2.0	2.1	2.5	2.6	2.6	2.7	2.1	2.0	1.6	2.0	2.3	1.9	1.9	2.4	2.3	2.3	2.3	2.8	3.4

Gear	Fleet	Av02/06	Av57/06	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06
Longline	Taiwan,China	10.9	5.0	1.7	2.0	3.2	3.8	5.4	4.1	3.8	4.7	9.0	15.3	12.5	18.3	17.6	17.2	16.8	14.7	15.2	12.9	13.5	14.4	12.3	7.5	6.8
Longline	Spain	4.5	0.6										0.2	0.7	0.0	0.0	0.5	1.4	2.0	1.0	1.9	3.5	4.3	4.7	5.1	5.2
Longline	NEI-Deep-freezing	3.1	1.4		0.0	0.2	0.2	0.8	0.6	0.8	0.9	1.4	4.2	3.6	5.4	7.7	5.5	7.3	6.5	6.0	1.6	1.8	2.3	4.5	3.4	3.5
Longline	Indonesia	1.9	0.4	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5	0.5	1.0	1.2	1.1	1.3	0.7	0.6	1.3	2.6	2.4	1.7	1.3
Longline	Japan	1.4	1.3	1.3	2.2	1.3	1.4	1.5	1.0	1.0	0.9	1.7	1.4	2.6	1.7	2.1	2.8	2.2	1.5	1.6	1.2	1.3	1.1	1.2	1.5	1.8
Longline	Portugal	1.2	0.1															0.1	0.2	0.2	0.6	0.8	0.9	0.9	1.1	2.2
Longline	Seychelles	1.1	0.1												0.0	0.1	0.2	0.2	0.3	0.5	0.7	0.6	1.4	1.4	1.2	0.8
Longline	France-Reunion	0.9	0.3								0.0	0.1	0.3	0.7	0.8	1.3	1.6	2.1	1.9	1.7	1.6	0.8	0.8	0.9	1.2	0.9
Longline	Australia	0.8	0.2						0.0		0.0	0.0	0.2	0.1	0.1	0.0	0.0	0.3	1.4	1.8	2.9	1.3	1.8	0.4	0.3	0.3
Longline	China	0.6	0.1												0.1	0.2	0.3	0.1	0.4	0.4	0.3	0.4	0.8	0.7	0.6	0.8
Longline	Guinea	0.6	0.1																		0.0	0.5	0.5	0.5	0.8	0.8
Longline	Mauritius	0.6	0.1												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.7	0.6	0.7
Longline	South Africa	0.5	0.1														0.0	0.4	0.1	0.0	0.3	0.9	0.8	0.2	0.2	0.2
Longline	Korea, Republic of	0.2	0.2	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.1	0.0	0.0	0.1	0.3	0.3	0.3
Longline	NEI-Fresh Tuna	0.1	0.2						0.5	0.7	0.6	0.7	0.7	1.1	0.9	0.9	1.1	1.0	0.9	0.9	0.0	0.0	0.1	0.1	0.2	0.3
Longline	Other Fleets	1.0	0.2	0.0	0.0	0.0	0.1	0.1	0.3	0.4	0.4	0.5	0.4	0.5	0.3	0.1	0.1	0.7	0.3	0.0	0.8	0.9	0.8	0.8	1.4	1.3
Longline	Total	29.5	10.4	3.2	4.2	4.9	5.6	7.9	6.7	7.0	7.8	13.8	23.1	22.3	28.1	31.3	30.7	33.9	31.6	30.1	25.5	27.9	33.1	32.0	27.2	27.3
Gillnet	Sri Lanka	1.5	0.4			0.0	0.0	0.0	0.0	0.1	0.2	0.3	1.9	0.9	0.9	1.0	1.3	0.9	1.1	2.8	2.4	2.7	1.4	1.4	0.7	1.1
Gillnet	Other Fleets		0.0			0.0	0.1	0.3	0.1	0.1	0.0	0.0														
Gillnet	Total	1.5	0.4			0.1	0.1	0.3	0.2	0.2	0.2	0.3	1.9	0.9	0.9	1.0	1.3	0.9	1.1	2.8	2.4	2.7	1.4	1.4	0.7	1.1
Other gears	Total	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.5
All	Total	31.1	10.9	3.2	4.2	4.9	5.7	8.2	6.9	7.2	8.0	14.1	25.1	23.2	28.9	32.2	32.1	34.8	32.7	32.9	28.0	30.6	34.5	33.4	28.0	29.0

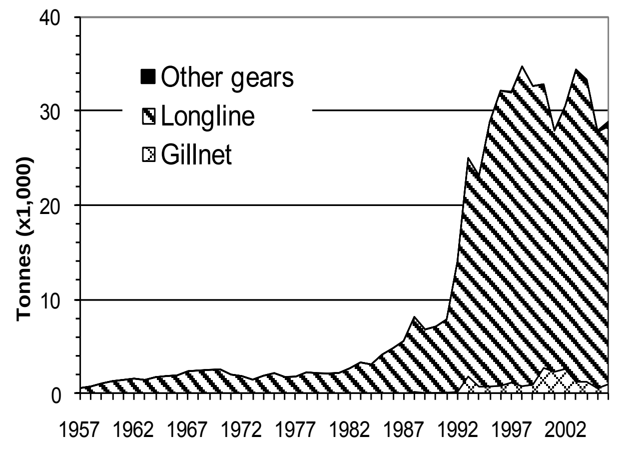


Figure 1. *Catches of Swordfish per gear and year recorded in the IOTC Database (~~1956~~1957-~~2005~~2006).*
Data as of October ~~2006~~2007

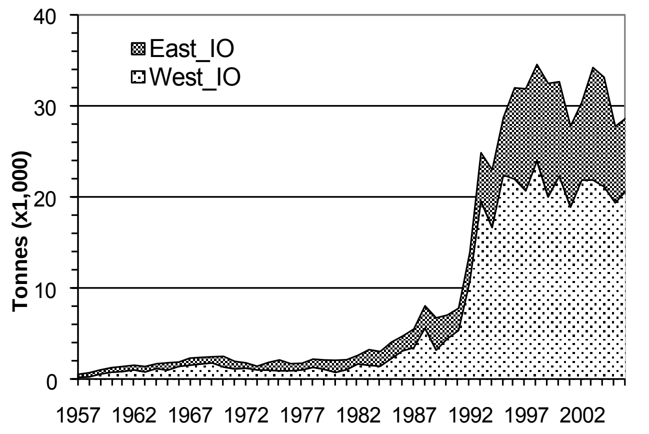
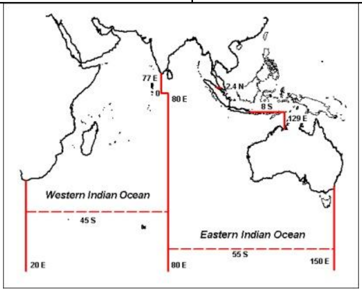


Figure 2. *Trends of the swordfish catches in the western and the eastern area of the Indian Ocean from ~~1956~~ 1956 – ~~2005~~2006.*
Data as of October ~~2006~~2007



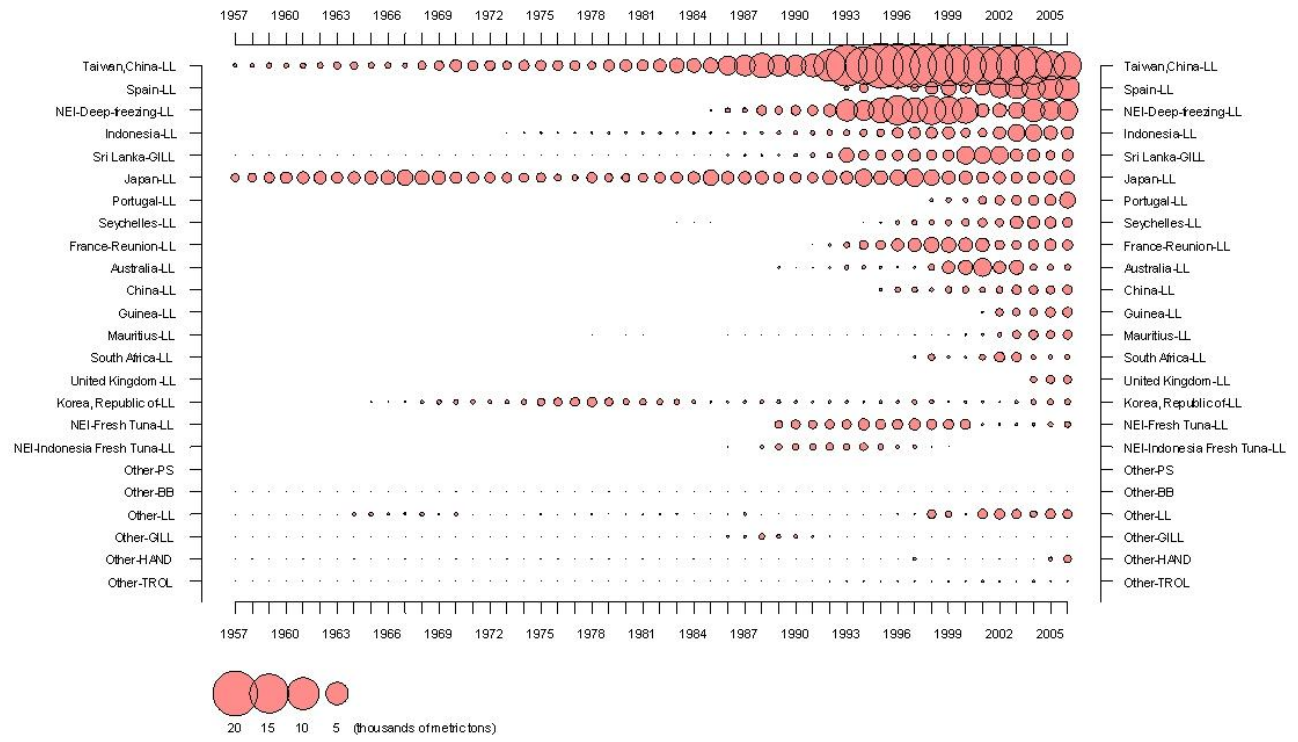
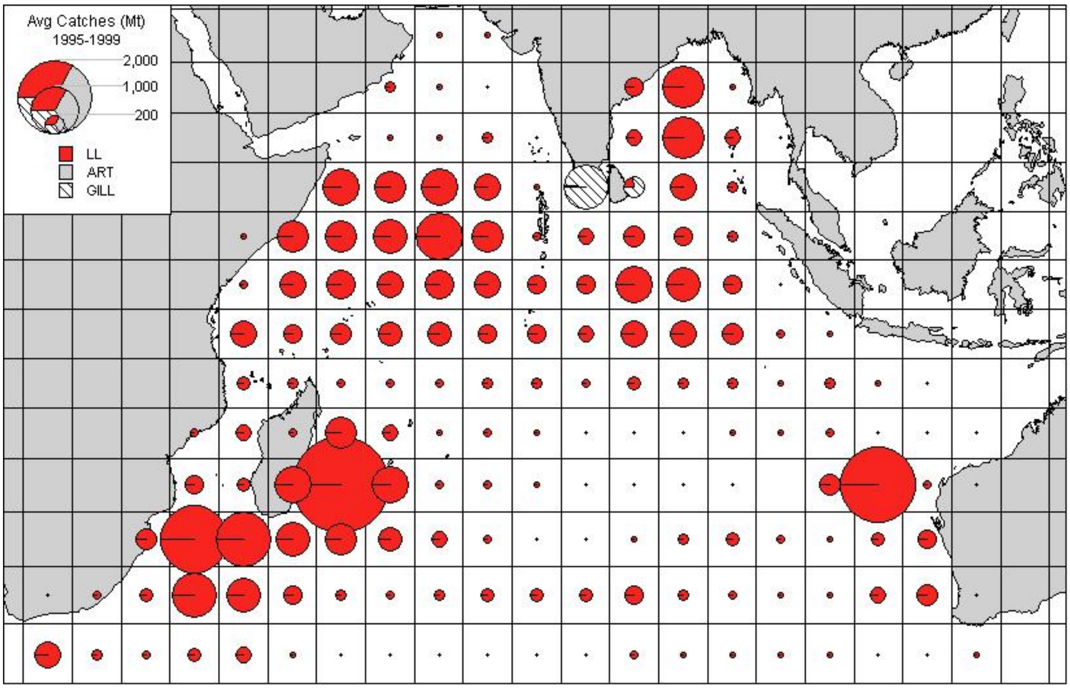


Figure 3. *Catches of swordfish in the Indian Ocean for the period ~~1956~~1957-~~2005~~2006, in thousands of metric tons by gear and country/fleet.* *Data as of October ~~2006~~2007*

1995-1999



2000-2004

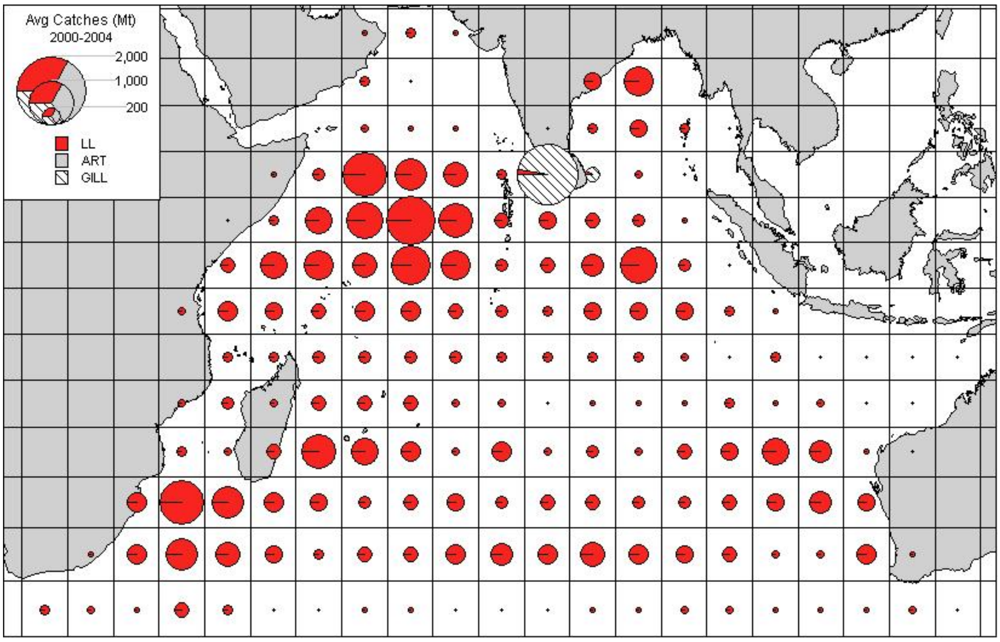


Figure 4. *Mean annual catches of swordfish (t) for the periods 1995 to 1999 and 2000 to 2004 for longline, gillnet and other fisheries in the Indian Ocean – yet to be updated.*

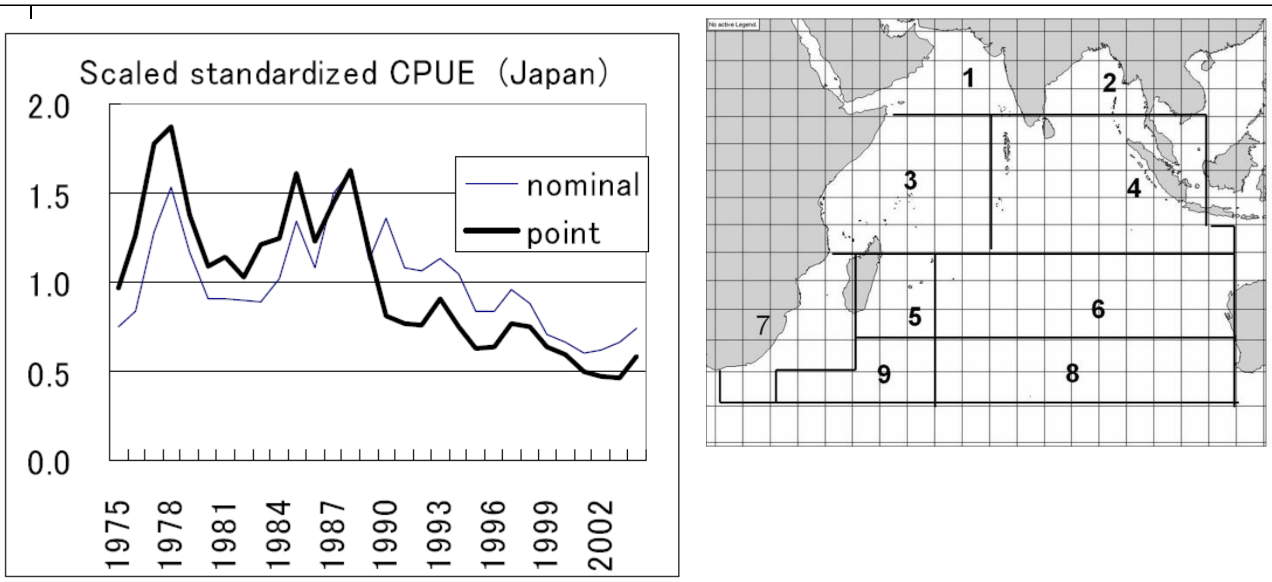
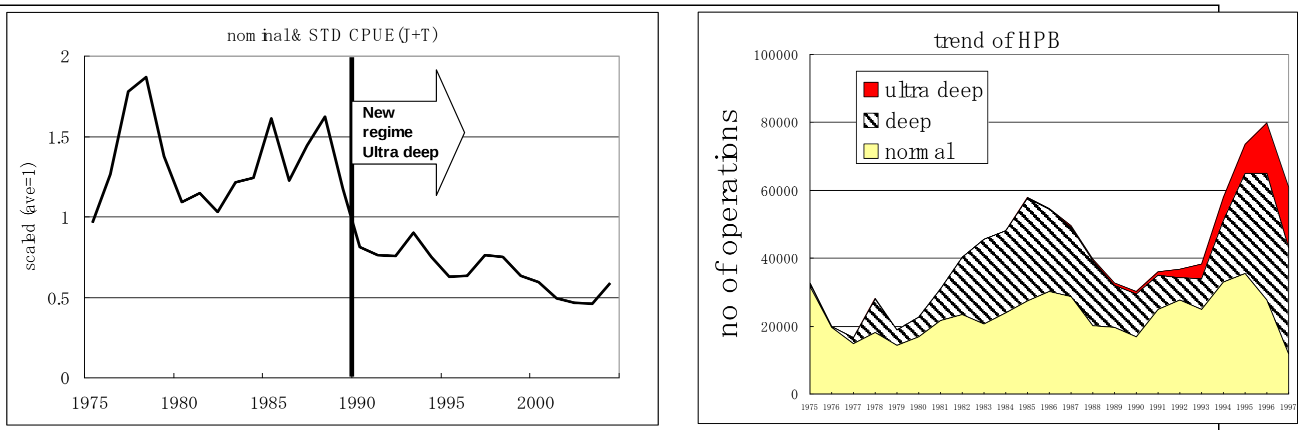


Figure 5. *Catch per unit effort indices (nominal and standardised) for swordfish caught by the Japanese fleet in the Indian Ocean (average set to 1). Insert (top right): Areas used in the standardisation of catch rates.*



~~1.~~ ***Figure 6.*** *Indications of a possible regime shift in catch rates related to changes in the setting practices of Japanese longliners over time. Nominal catch rates (left)umber of operations performed using normal, deep and ultra-deep longline sets (right).*

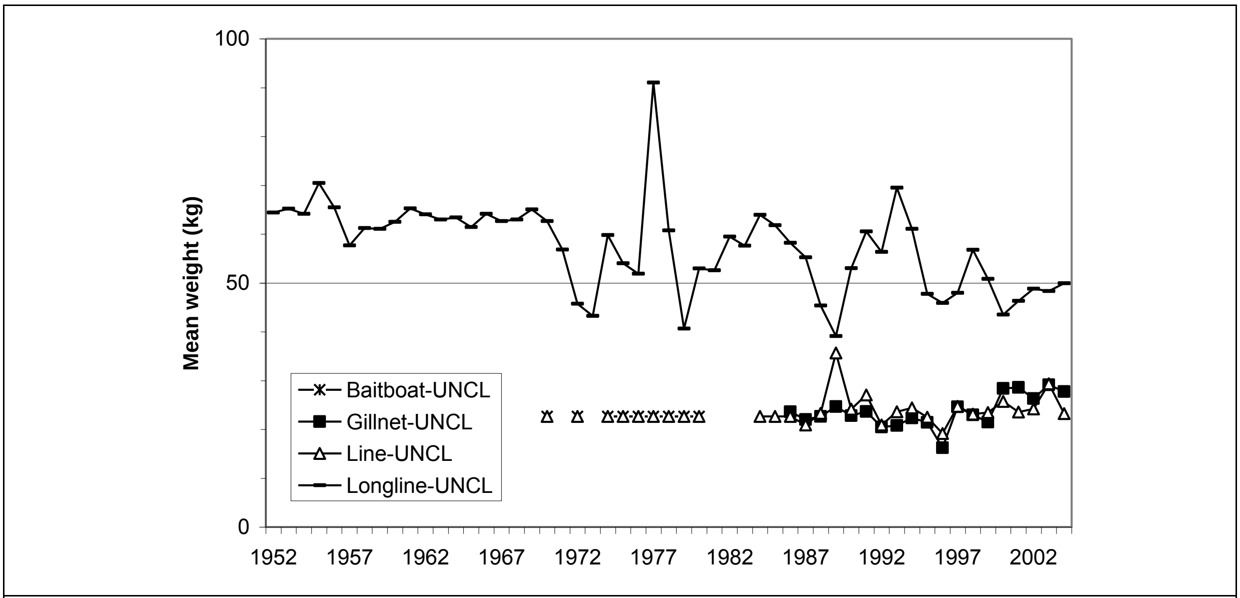
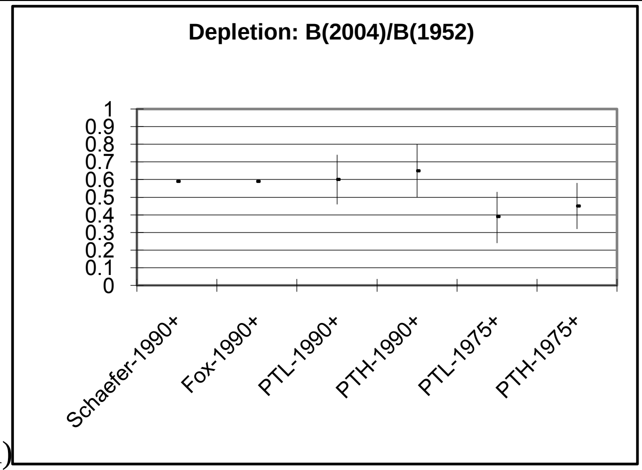
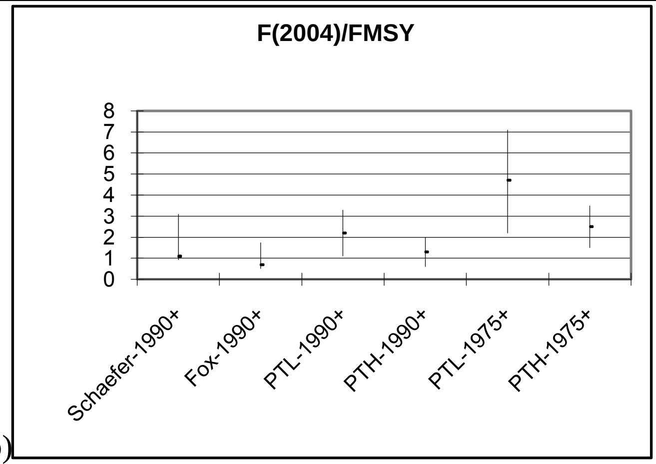


Figure 7. *Trends in average size of swordfish in Indian Ocean fisheries.*

a)


b)


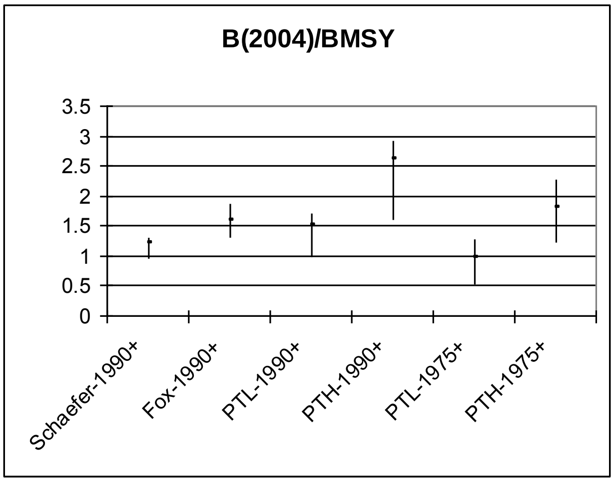
(c)


Figure 8. *2006 Indian Ocean swordfish stock assessment results. Stock status estimates from the six successful production model fits. (a) Current biomass levels as a proportion of the biomass in 1952 (when the stock was considered to be at carrying capacity i.e. at equilibrium in an unfished state (b) Current fishing mortality relative to the level of fishing mortality at MSY (c) current biomass relative to the estimated biomass at MSY. Confidence limits are 80% for the Fox and Schaefer models (Confidence limit estimates are not available for the depletion estimates) and 95% for the Pella-Tomlinson models.*