Report of the Fourteenth Session of the IOTC Scientific Committee

Mahé, Seychelles, 12–17 December 2011

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ACRONYMS

ACAP	Agreement on the Conservation of Albatrosses and Petrels
B_{MSY}	Biomass at MSY
CBD	Convention on Biological Diversity
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CMM	Conservation and Management Measure (of the IOTC; Resolutions and Recommendations)
CPCs	Contracting parties and cooperating non-contracting parties
CPUE	Catch per unit of effort
EBSA	Ecologically or Biologically Significant marine Areas
EU	European Union
EEZ	Exclusive Economic Zone
ERA	Ecological Risk Assessment
F	Fishing mortality; F_{2009} is the fishing mortality estimated in the year 2009
FAD	Fish-aggregating device
FAO	Food and Agriculture Organization of the United Nations
F_{MSY}	Fishing mortality at MSY
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of AtlanticTunas
IOTC	Indian Ocean Tuna Commission
IOSSS	Indian Ocean Swordfish Stock Structure
IUCN	International Union for Conservation of Nature
LL	Longline
LSTLV	Large-scale tuna longline fishing vessel
MFCL	Multifan-CL
MPA	Marine Protected Area
MPF	Meeting Participation Fund
MSE	Management Strategy Evaluation
MSY	Maximum sustainable yield
NGO	Non-governmental organization
NPOA	National plan of action
OFCF	Overseas Fishery Cooperation Foundation of Japan
OT	Oversears Territory
PS	Purse-seine
ROP	Regional Observer Programme
ROS	Regional Observer Scheme
tRFMO	tuna Regional Fishery Management Organization
RTTP-IO	Regional Tuna Tagging Project of the Indian Ocean
SC	Scientific Committee of the IOTC
SSB	Spawning stock biomass
SSB_{MSY}	Spawning stock biomass at MSY
SWIOFC	South West Indian Ocean Fisheries Commission
SWIOFP	South West Indian Ocean Fisheries Project
UNCLOS	United Nations Convention on the Law of the Sea
VME	Vulnerable marine ecosystems
VMS	Vessel Monitoring System
WP	Working Party of the IOTC
WPB	Working Party on Billfish of the IOTC
WPEB	Working Party on Ecosystems and Bycatch of the IOTC
WPM	Working Party on Methods of the IOTC
WPNT	Working Party on Neritic Tunas of the IOTC
WPDCS	Working Party on Data Collection and Statistics of the IOTC
WPTmT	Working Party on Temperate Tunas of the IOTC
WPTT	Working Party on Tropical Tunas of the IOTC

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EXECUTIVE SUMMARY

The Fourteenth Session of the Indian Ocean Tuna Commission's (IOTC) Scientific Committee (SC) was held on Mahé, Seychelles, from 12 to 17 December 2011. A total of 50 individuals attended the Session, comprised of 39 delegates from 14 Member countries and 0 delegates from Cooperating Non-Contracting Parties, as well as 11 observers and invited experts.

Noting that Table 1 in this report provides an overview of the stock status and management advice for each species under the IOTC mandate as well as species directly impacted by fisheries for tuna and tuna-like species, the SC **AGREED** to an Executive Summary for each species or species group as detailed below.

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The following are a subset of the complete recommendations from the SC14 to the Commission, which are provided at Appendix XXXVIII.

Report of the Third Session of the Working Party on Temperate Tunas

(para. 32) Noting the request by the Commission at its 15th Session for a new assessment of albacore to be undertaken in 2011 (para. 37 of the S15 report), the SC **RECOMMENDED** that the Commission note that although a new assessment was undertaken in 2011, there remains considerable uncertainty about the relationship between abundance and the standardized CPUE series, and about the total catches over the past decade and that the WPTmT has limited confidence in the assessment undertaken. Thus, there is an urgent need to carry out a revised stock assessment for the albacore resource in the Indian Ocean in 2012, and the Commission should consider allocating funds for this purpose, noting that individual CPCs are finding it difficult to justify expending the necessary resources to undertake stock assessments.

Sharks – Wire leaders/traces

(para. 68) On the basis of information presented to the SC in 2011 and in previous years, the SC **RECOGNISED** that the use of wire leaders/traces in longline fisheries may imply targeting of sharks. The SC therefore **RECOMMENDED** to the Commission that if it wishes to reduce catch rates of sharks by longliners it should prohibit the use of wire leaders/traces.

Sharks – Resolution 05/05 *concerning the conservation of sharks caught in association with fisheries managed by IOTC*

Fin to body weight ratio

(para. 69) The SC **ADVISED** the Commission to consider, that the best way to encourage full utilisation of sharks, to ensure accurate catch statistics, and to facilitate the collection of biological information, is to revise the IOTC Resolution 05/05 *concerning the conservation of sharks caught in association with fisheries managed by IOTC* such that all sharks must be landed with fins attached (naturally or by other means) to their respective carcass. However, the SC **NOTED** that such an action would have practical implementation and safety issues for some fleets and may degrade the quality of the product in some cases. The SC **RECOMMENDED** all CPCs to obtain and maintain the best possible data for IOTC fisheries impacting upon sharks, including improved species identification.

Seabirds

(para. 83) The SC **RECOMMENDED** that the Commission consider revising Resolution 10/06 *On Reducing the Incidental Bycatch of Seabirds in Longline Fisheries*, noting the technical specifications and other considerations outlined and agreed to by the SC in paragraphs 73 to 82 of the report of the SC14.

Report of the First Session of the Working Party on Neritic Tunas

(para. 97) The SC **AGREED** that there was an urgent need to carry out stock assessments for neritic tunas in the Indian Ocean, however at present the data held at the IOTC Secretariat would be insufficient to undertake this task. As such, the SC **RECOMMENDED** that the Commission consider allocating appropriate funds to further increase the capacity of coastal states to collect, report and analyse catch data on neritic tuna and tuna-like species in the Indian Ocean.

Increased workload and staffing at the IOTC Secretariat

(para. 114) The SC **RECOMMENDED** that an additional Fishery Officer (P3 or P4) be hired, or consultants contracted, to handle a range of issues related to bycatch, including those from the Commission relating to ecosystems and bycatch issues (see para. 113).

Implementation of the Precautionary approach and Management strategy Evaluation

(para. 146) Noting that the development of an MSE process will require management objectives to be specified, the SC **RECOMMENDED** that the Commission provide clear guidance in this regard, noting that the adoption of the Precautionary Approach, as defined in the Fish Stocks Agreement, may be the first step.

(para. 149) The SC **RECOMMENDED** that interim target and limit reference points be adopted and a list of possible provisional values for the major species is listed in Table 5. These values should be replaced as soon as the MSE process is completed. Provisional target reference points would be based on the MSY level of the indicators, and on different multipliers for the limit reference points.

(para. 157) The SC **ENDORSED** the roadmap presented for the implementation of MSE in the Indian Ocean in IOTC–2011–SC14–36 and **RECOMMENDED** the Commission agree to initiate a consultative process among managers, stakeholders and scientists to begin discussions about the implementation of MSE in IOTC.

Data Provision Needs – by gear

(para. 170) The SC **RECOMMENDED** that IOTC Recommendation 11/06 be modified to include the elements as provided in Appendix XXXV, noting that the lists of species to be recorded, as detailed in section 2.3 of Annex II, and makes collection of these data mandatory.

Outlook on Time-Area Closures

(para. 173) Noting that the request contained in Resolution 10/01 does not specify the expected objective to be achieved with the current or alternative time area closures, and that the SC and WPTT were not clear about the intended objectives of the time-area closure taking into account recent reduction of effort as well as recent likely recovery of the yellowfin tuna population, the SC **RECOMMENDED** that the Commission specify clear objectives as to what are the management objectives to be achieved with this and/or alternative measures. This will, in turn, guide and facilitate the analysis of the SC, via the WPTT in 2012 and future years.

Evaluation of the IOTC time-area closure

(para. 178) The SC **RECOMMENDED** that the Commission note that the current closure is likely to be ineffective, as fishing effort will be redirected to other fishing grounds in the Indian Ocean. The positive impacts of the moratorium within the closed area would likely be offset by effort reallocation. For example, the WPTmT noted that longline fishing effort has been redistributed to traditional albacore fishing grounds in recent years, thereby further increasing fishing pressure on this stock.

(para. 179) Noting that the objective of Resolution 10/01 is to decrease the overall pressure on the main targeted stocks in the Indian Ocean, in particular yellowfin tuna and bigeye tuna, and also to evaluate the impact of the current time/area closure and any alternative scenarios on tropical tuna population, the SC **RECOMMENDED** that the Commission specify the level of reduction or the long term management objectives to be achieved with the current or alternative time area closures, as these are not contained within the Resolution 10/01.

Alternative Management Measures; Impacts of the Purse-Seine Fishery; Juvenile Tuna Catches

(para. 186) The SC **RECOMMENDED** that the Commission note that:

- most of the evidence provided to date has indicated that the resource in the southwest Indian Ocean has been overfished in the past decade and biomass remains below the level that would produce MSY (B_{MSY}), however recent declines in catch and effort have brought fishing mortality rates to levels below F_{MSY}. There is a risk of reversing the rebuilding trend if there is any increase in catch in this region. Thus, catches in the southwest Indian Ocean should be maintained at levels at or below those observed in 2009 (6,600 t), until there is clear evidence of recovery and biomass exceeds B_{MSY}.
- the southwest region should continue to be analysed as a special resource, as it appears to be highly depleted compared to the Indian Ocean as a whole. However the difference in depletion does not appear to be as extreme as analyses in previous years have suggested. A review of the spatial assumptions should be conducted following the final results of the Indian Ocean Swordfish Stock Structure (IOSSS) project and the analysis of tagging experiments undertaken by SWIOFP.
- that there is no current need to apply additional management measures to the southwest Indian Ocean, although the resource in the area should be carefully monitored.
- that the Working Party on Methods will be progressing Management Strategy Evaluation over the coming year that will aid in addressing the Commission's request, which was considered as the appropriate mechanism for this work.

(para. 190) The SC **NOTED** however, that the fishery statistics available for many fleets, in particular for coastal fisheries, are not accurate enough for a comprehensive analysis as has been repeatedly noted in previous WPTT and SC reports. In particular, the SC **RECOMMENDED** that all CPCs catching yellowfin tuna should undertake scientific sampling of their yellowfin tuna catches to better identify the proportion of bigeye tuna catches. Therefore, the SC **RECOMMENDED** the countries engaged in those fisheries to take immediate actions to reverse the situation of fishery statistics reporting to the IOTC Secretariat.

(para. 192) The SC **ADVISED** the Commission that the Western and Central Pacific Fisheries Commission has implemented since 2009 a FAD closure for the conservation of yellowfin tuna and bigeye tuna juveniles which has been very effective. The SC **RECOMMENDED** further investigation of the feasibility and impacts of such a measure, as well as other measures, in the context of Indian Ocean fisheries and stocks.

Requests from the Commission

(para. 222) Noting that each year the Commission makes a number of requests to the SC without clearly identifying the task to be undertaken, its priority against other tasks previously or simultaneously assigned to the SC and without assigning a budget to fund the request made, the SC **RECOMMENDED** that these matters be addressed by the Commission at its next session.

Election of a Chairperson and Vice-Chairperson for the Next Biennium

(para. 232) The SC **RECOMMENDED** that the Commission note the new Chair, Dr. Tom Nishida (Japan) and Vice-Chair, Mr. Jan Robinson (Seychelles), of the SC for the next biennium, as well as the Chairs and Vice-Chairs of each of the Working Parties as provided in Appendix VII.

Table 1. Status summary for species of tuna and tuna-like species under the IOTC mandate, as well as other species impacted by IOTC fisheries.

Stock	Indicators	Prev[1]	2010	2011	Advice to Commission
Major stocks: These are the main stocks being exploitation by industrial and artisanal fisheries throughout the Indian Ocean, both on the high seas and in the EEZ of coastal countries. These stocks are those that have received, in general, the highest fishing pressure in the region.					
Albacore *Thunnus alalunga*	Catch 2010: 43,711 t Average catch 2006–2010: 41,074 t MSY: 29,900 t (21,500–33,100 t) F_{2010}/F_{MSY}: 1.61* (1.19–2.22) B_{2010}/B_{MSY}: 0.89* (0.65–1.12) B_{2010}/B_{1980}: 0.39 (n.a.)	2007			The available evidence indicates considerable risk to the stock status at current effort levels. The two primary sources of data that drive the assessment, total catches and CPUE are highly uncertain and should be investigated further as a priority. Current catches likely exceed MSY. Maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE. <Click here for full stock status summary>
Bigeye tuna *Thunnus obesus*	SS3[3] / ASPM[4] Catch: 102,000 t / 71,500 t Average catch last 5 years: 104,700 t / 104,700 t MSY: 114,000 (95,000–183,000) / 102,900 t (86,600–119,300) F_{curr}/F_{MSY}:[2] 0.79 (0.50–1.22) / 0.67 (0.48–0.86) SB_{curr}/SB_{MSY}:[2] 1.20 (0.88–1.68) / 1.00 (0.77–1.24) SB_{curr}/SB_0:[2] 0.34 (0.26–0.40) / 0.39	2008			At this time, annual catches of bigeye tuna should not exceed 102,000 t. If the recent declines in effort continue, and catch remains substantially below the estimated MSY, then immediate management measures are not required. However, continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in assessments. <Click here for full stock status summary>
Skipjack tuna *Katsuwonus pelamis*	Catch 2010: 428,719 t Average catch 2006–2010: 489,385 t MSY: 564,000 t (395,000–843,000 t) C_{2009}/MSY:[5] 0.81 (0.54–1.16) SB_{2009}/SB_{MSY}: 2.56 (1.09–5.83) SB_{2009}/SB_0: 0.53 (0.29–0.70)				At this time, annual catches of skipjack tuna should not exceed 512,305 t. If the recent declines in effort continue, and catch remains substantially below the estimated MSY, then immediate management measures are not required. However, recent trends in some fisheries, such as Maldivian pole-and-line, as well as the decrease of catches of large skipjack tuna, suggest that the situation of the stock should be closely monitored. <Click here for full stock status summary>
Yellowfin tuna *Thunnus albacares*	Catch 2010: 299,074 t Average catch 2006–2010: 326,556 t MSY: 357 (290–435) F_{2009}/F_{MSY}: 0.84 (0.63–1.10) SB_{2009}/SB_{MSY}: 1.61 (1.47–1.78) SB_{2009}/SB_0: 0.35 (0.31–0.38)	2008			At this time, annual catches of yellowfin tuna should not exceed 300,000 t, in order to ensure that stock biomass levels could sustain catches at the MSY level in the long term. Recent recruitment is estimated to be considerably lower than the whole time series average. If recruitment continues to be lower than average, catches below MSY would be needed to maintain stock levels. <Click here for full stock status summary>
Swordfish (whole IO) *Xiphias gladius*	Catch 2010: 18,956 t Average catch 2006-2010: 23,799 t MSY: 29,900 t–34,200 t F_{2009}/F_{MSY}: 0.50–0.63 SB_{2009}/SB_{MSY}: 1.07–1.59 SB_{2009}/SB_0: 0.30–0.53	2007			At this time, annual catches of swordfish should not exceed 30,000 t. If the recent declines in effort continue, and catch remains substantially below the estimated MSY, then management measures are not required which would pre-empt current resolutions and planned management strategy evaluation. However, continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in assessments. <Click here for full stock status summary>
Swordfish (southwest IO) *Xiphias gladius*	Catch 2009: 6,513 t Average catch 2006-2010: 7,112 t MSY: 7,100 t–9,400 t				At this time, annual catches in the southwest Indian Ocean should be maintained at levels at or below those observed in 2009 (6,678), until there is clear evidence of recovery and biomass exceeds B_{MSY}. <Click here for full stock status

Stock	Indicators	Prev[1]	2010	2011	Advice to Commission
	F_{2009}/F_{MSY}: 0.64–1.19 SB_{2009}/SB_{MSY}: 0.73–1.44 SB_{2009}/SB_0: 0.16–0.58				summary>
Billfish (other than swordfish) : This category includes species that are not usually targeted by most fleets, but are caught as bycatch of the main industrial fisheries. They are important for localised small-scale and artisanal fisheries (e.g. sailfish in the northern Arabian Sea and the Persian Gulf) or as targets in recreational fisheries (e.g. marlins)					
Black marlin *Makaira indica*	Catch 2010: 5,018 t Average catch 2006–2010: 4,689 t MSY: Unknown				No quantitative stock assessment are currently available for these species in the Indian Ocean. The Maximum Sustainable Yield estimates for the whole Indian Ocean is unknown and annual catches urgently need to be reviewed. Improvement in data collection and reporting is required to assess these stocks. However, aspects of species biology, productivity and fisheries combined with a lack of fisheries data on which to base quantitative assessments is a cause for concern. <Click here for full stock status summary>
Indo-Pacific blue marlin *Makaira mazara*	Catch 2010: 11,261 t Average catch 2006–2010: 9,508 t MSY: Unknown				
Striped marlin *Tetrapturus audax*	Catch 2010: 1,921 t Average catch 2006–2010: 2,542 t MSY: Unknown				
Indo-Pacific Sailfish *Istiophorus platypterus*	Catch 2010: 25,498 t Average catch 2006–2010: 22,151 t MSY: Unknown				
Neritic tunas: These are important species for small-scale and artisanal fisheries, almost always caught within the EEZs of IO coastal states. They are caught only occasionally by industrial fisheries. Catches are often reported as aggregates of various species, making it difficult to obtain appropriate data for stock assessment analyses.					
Bullet tuna *Auxis rochei*	Catch 2010: 4,188 t Average catch 2006–2010: 2,884 t MSY: Unknown				No quantitative stock assessment is currently available for these species in the Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock indicators can be used. However, aspects of the biology, productivity and fisheries for these species combined with the lack of data on which to base a more formal assessment are a cause for considerable concern. The continued increase of annual catches for most of these species in recent years has further increased the pressure on the Indian Ocean stocks as a whole, however there is not sufficient information to evaluate the effect this will have on the resource. The apparent fidelity of these species to particular areas/regions is a matter for concern as overfishing in these areas can lead to localised depletion. <Click here for full stock status summary>
Frigate tuna *Auxis thazard*	Catch 2010: 71,023 t Average catch 2006–2010: 64,245 t MSY: Unknown				
Narrow-barred Spanish mackerel *Scomberomorus commerson*	Catch 2010: 124,107 t Average catch 2006–2010: 116,444 t MSY: Unknown				
Kawakawa *Euthynnus affinis*	Catch 2010: 128,871 t Average catch 2006–2010: 122,895 t MSY: Unknown				
Longtail tuna *Thunnus tonggol*	Catch 2010: 141,937 t Average catch 2006–2010: 115,973 t MSY: Unknown				
Indo-Pacific king mackerel *Scomberomorus guttatus*	Catch 2010: 37,257 t Average catch 2006–2010: 37,980 t MSY: Unknown				

Stock	Indicators	Prev[1]	2010	2011	Advice to Commission
Sharks: Although they are not part of the 16 species directly under the IOTC mandate, sharks are frequently caught in association with other species as bycatch, and for some fleets are often as much a target as tuna. As such, IOTC Members and Cooperating non-Contracting Parties are required to report information at the same level of detail as for the 16 IOTC species. The following are the main species caught in tuna fisheries, but the list is not exhaustive.					
Blue shark *Prionace glauca*	Unknown Unknown				There is a paucity of information available for these species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment and limited basic fishery indicators currently available. Therefore the stock status is highly uncertain. The available evidence indicates considerable risk to the stock status at current effort levels. The primary source of data that drive the assessment (total catches) is highly uncertain and should be investigated further as a priority. <Click here for full stock status summary>
Silky shark *Carcharhinus falciformis*	Unknown Unknown				
Oceanic whitetip shark *Carcharhinus longimanus*	Unknown Unknown				
Scalloped hammerhead shark *Sphyrna lewini*	Unknown Unknown				
Shortfin mako *Isurus oxyrinchus*	Unknown Unknown				
Bigeye thresher shark *Alopias superciliosus*	Unknown Unknown				
Pelagic thresher shark *Alopias pelagicus*	Unknown Unknown				

[1] This indicates the last year taken into account for assessments carried out before 2010

[2]Current period ($_{curr}$) = 2009 for SS3 and 2010 for ASPM.

[3]Central point estimate is adopted from the 2010 SS3 model, percentiles are drawn from a cumulative frequency distribution of MPD values with models weighted as in Table 12 of 2010 WPTT report (IOTC–2010–WPTT12–R); the range represents the 5^{th} and 95^{th} percentiles.

[4]Median point estimate is adopted from the 2011 ASPM model using steepness value of 0.5 which is the most conservative scenario (values of 0.6, 0.7 and 0.8, which are more optimistic, are considered to be as plausible as these values but are not presented for simplification); the range represents the 90 percentile Confidence Interval.

[5]Due to numerical problems in the F_{MSY} calculations for this population, the proxy reference point C/MSY is reported instead of F/FMSY, which should be interpreted with caution for the following reasons: it may incorrectly suggest $F>F_{MSY}$ when there is a large biomass (early development of the fishery or large recruitment event); it may incorrectly suggest that $F<F_{MSY}$ when the stock is highly depleted; due to a flat yield curve, C could be near MSY even if $F << F_{MSY.}$

*(Note: at this time the WPTmT had limited confidence in the assessment results (refer to paragraphs 71–77 in the report of the WPTmT03 (IOTC–2011–WPTmT03–R) for further clarification).

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		
Not assessed/Uncertain		

1. OPENING OF THE MEETING

1. The Fourteenth Session of the Indian Ocean Tuna Commission's (IOTC) Scientific Committee (SC) was held on Mahé, Seychelles, from 12 to 17 December 2011. A total of 50 individuals attended the Session, comprised of 39 delegates from 14 Member countries and 0 delegates from Cooperating Non-Contracting Parties, as well as 11 observers and invited experts. The list of participants is provided at Appendix I.

2. The meeting was opened on 12 December, 2011 by the Chair Dr. Francis Marsac (European Union), who subsequently welcomed participants to the Seychelles. The Chair informed participants that his term as Chair and that of the Vice-Chair had expired at the 2010 SC meeting, however, under exceptional circumstances, both positions had been extended for 2011. However, a new Chair and a new Vice-Chair will need to be elected at the end of the current meeting.

2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION

3. The SC **ADOPTED** the Agenda provided at Appendix II. The documents presented to the SC are listed in Appendix III.

3. ADMISSION OF OBSERVERS

4. The SC **NOTED** that at the Third Session of the Commission, Members decided that its subsidiary bodies would be open to the participation of observers from Member parties of the Food and Agriculture Organisation (FAO), from international organisations and from non-governmental organisations, which had attended previous meetings or were admitted to attend Commission Sessions (Rule XIII.9 of the Rules of Procedure).

5. The SC **ADMITTED** the following observers to the Fourteenth Session of the SC: Birdlife International, South West Indian Ocean Fisheries Project, World Wildlife Fund (World Wide Fund for Nature), Food and Agriculture Organisation of the United Nations, Russian Federation, the International Seafood Sustainability Foundation and the Marine Stewardship Council.

6. The SC also **ADMITTED** the invited experts from Taiwan,China, under Rule X of the Rules of Procedure, which states that the Commission may invite experts, in their individual capacity, to enhance and broaden the expertise of the Scientific Committee and of its Working Parties.

4. ACTIVITIES OF THE COMMISSION

7. The SC **NOTED** paper IOTC–2011–SC14–03 which outlined the decisions and requests made by the Commission at its Fifteenth Session, held from 18–22 March 2011, specifically relating to the work of the SC, including the six Conservation and Management Measures (five Resolutions and one Recommendation) adopted during the Session. The SC **AGREED** to develop advice in response to each of the requests made by the Commission during the current session.

8. The SC **NOTED** paper IOTC–2011–SC14–04 which outlined a number of Commission decisions, in the form of previous Resolutions that require a response from the Scientific Committee in 2011, and **AGREED** to develop advice to the Commission in response to each request during the current session.

5. ACTIVITIES OF THE IOTC SECRETARIAT IN 2011

9. The SC **NOTED** paper IOTC–2011–SC14–05 which provided an overview of the work undertaken by the IOTC Secretariat in 2011, including the following key activities: 1) First Working Party on Neritic Tunas; 2) First Capacity Building Workshop aimed at bridging the gap between IOTC science and management; 3) First stock assessment for skipjack tuna; and 4) the continued increase in participation at IOTC scientific meetings by developing coastal states, including via the submission of working papers.

10. The SC **NOTED** with thanks, the outstanding contributions of the staff of the IOTC Secretariat to the science process in 2011, in particular through the contributions of the stock assessment expert, the facilitation of invited experts and in support of the working party and SC meetings.

11. The SC **RECOMMENDED** that while the recruitment process for a new stock assessment expert at the IOTC Secretariat is being finalised, the Secretariat hire an individual/s to fill the staffing gap. This was considered to be particularly important given the upcoming tagging symposium in late 2012.

6. NATIONAL REPORTS FROM CPCS

12. The SC **NOTED** the 25 National Reports presented by CPCs (Contracting parties and cooperating non-contracting parties) for the meeting, the abstracts of which are provided at Appendix IV. The following matters were raised in regard to the content of specific reports:
    - **Australia**: Nil comments.
    - **Belize**: Not presented orally.
    - **China**: Not presented orally.
    - **Comoros**: Nil comments.
    - **Eritrea**: The SC **EXPRESSED** its disappointment that Eritrea did not provide a National Report and urged Eritrea to fulfil its reporting obligations to the IOTC.
    - **European Union** (EU): The SC **NOTED** that species composition sampling of the EU purse seine fleets is being adapted to better reflect the changes in fishing strategies. The EU indicated that the sampling scheme has not undergone major structural changes. The SC was informed that the EU observer program resumed in 2011 with a coverage rate of 11%, in collaboration with TAAF (Terres Australes et Antarctiques Françaises). Finally, the SC recognised that marlins are not well sampled by the EU purse seine fleets and therefore, the SC requested that improvements be made in this regard. In response to a question regarding the catch composition of EU,Portugal longline vessels, which includes almost 50% blue sharks, the EU confirmed that these vessels are using wire leaders to catch more sharks in some areas and periods.
    - **France (territories)**: Not presented orally.
    - **Guinea**: The SC **EXPRESSED** its disappointment that Guinea did not provide a National Report and urged Guinea to fulfil its reporting obligations to the IOTC.
    - **India**: The SC **NOTED** the slightly improved situation by India in regard to the mandatory data reporting requirements, as well as the consultations underway with various stakeholders to further improve data collection and reporting. However, it was noted that there remains substantial improvements to be made and higher quality data needs to be provided by India in 2012.
    - **Indonesia**: The SC **NOTED** that the current level of observer coverage is less than 1% for Indonesian vessels and is based on port samplers in the port of Benoa. Currently, the program consists of five port samplers, however it was indicated that Indonesia plans to double the level of covered in 2012, compared to 2010. Indonesia acknowledged that it has had problems implementing the sampling scheme designed by the IOTC-OFCF, CSIRO (Commonwealth Scientific and Industrial Research Organisation) and ACIAR (Australian Centre for International Agricultural Research) to comply with the IOTC mandatory requirements for data provision. Key actions under the Indonesian NPOA-sharks have begun to be implemented in East Lombok, since this location is considered one of the main places where sharks are landed.
    - **Iran, Islamic Republic of**: Not presented orally.
    - **Japan**: The SC **NOTED** the comment from Japan that its longline fleet operating in the Indian Ocean does use wire leaders although not to target sharks. Japan acknowledged the conflicting estimates of average weight derived from operational catch and size frequency datasets for its longline fisheries, and the concerning effect that the problems identified may have on the assessments of tuna and billfish species. Japan indicated that in order to clarify these issues, it will endeavour to identify deficiencies in the size sampling program and to report progress at the next SC meeting.
    - **Kenya**: The SC **NOTED** that additional information on the composition of recreational fisheries catches from Kenya are available, although the size composition is not yet available for all IOTC species, namely billfishes, as many are released alive and are not measured.

- **Korea, Republic of**: The SC **NOTED** the improved seabird identification reports, from 2009 to 2010, was most likely due to improved observer training as well as improved identification skills by the vessel captains.
- **Madagascar**: Not presented orally.
- **Malaysia**: Not presented orally.
- **Maldives, Republic of**: The SC **NOTED** the substantial declines in the catches of skipjack tuna by the Maldives in recent years (>50% decline from 2006 to 2010), and acknowledged that this trend was of great concern given that the Maldives, even in recent years accounts for approximately 20% of the skipjack tuna catch in the Indian Ocean. There might be multiple causes for such a decline (environmental changes, high fuel price, lower tuna biomass etc.) but there are not well understood and further investigation is needed.
- **Mauritius**: The SC **NOTED** the sharp increase in albacore catches reported from 2008 (2,024 t) to 2009 (4,293 t) due to a shift of effort by longline vessels from the northern Indian Ocean to the southern Indian Ocean.
- **Oman, Sultanate of**: The SC **EXPRESSED** its disappointment that Oman did not provide a National Report and urged Oman to fulfil its reporting obligations to the IOTC.
- **Pakistan**: The SC **EXPRESSED** its disappointment that Pakistan did not provide a National Report and urged Pakistan to fulfil its reporting obligations to the IOTC.
- **Philippines**: The SC **EXPRESSED** its disappointment that the Philippines did not provide a National Report and urged the Philippines to fulfil its reporting obligations to the IOTC.
- **Seychelles, Republic of**: The SC **NOTED** that the Seychelles report did not follow the new reporting format and requested that Seychelles follow the new template in 2012.
- **Sierra Leone**: The SC **EXPRESSED** its disappointment that Sierra Leone did not provide a National Report and urged Sierra Leone to fulfil its reporting obligations to the IOTC.
- **Sri Lanka**: The SC **NOTED** that none of the >3,000 Sri Lankan fishing vessels authorised and capable of fishing on the high seas have any form of VMS, and logbooks are only being used by a very small proportion of vessels. As a result, almost none of the total catch taken by Sri Lankan vessels can be accurately assigned to either the EEZ of Sri Lanka or the high seas, or at any other spatial scale. The lack of spatial data has a negative impact on stock assessments for IOTC species. The SC **NOTED** that Sri Lanka agreed to provide an explanation of the large increase in shark catches reported from 2009 to 2010, and reporting catches by species rather than as an aggregated shark catch, in 2012. The SC **NOTED** that improvements have been made regarding data collection, monitoring and reporting, and encouraged Sri Lanka to continue to improve these systems as quickly as possible.
- **Sudan**: The SC **EXPRESSED** its disappointment that Sudan did not provide a National Report and urged Sudan to fulfil its reporting obligations to the IOTC.
- **Tanzania, United Republic of**: Not presented orally.
- **Thailand**: Nil comments.
- **United Kingdom (BIOT)**: The SC **NOTED** that the potential impacts of Marine Protected Areas (MPAs) in the Indian Ocean will be discussed under Agenda item 16 later in the meeting. A Science Advisory Group will develop a research plan associated with the no-take area, to include engagement with existing research projects within the region. The SC recalled the exceptional location of the BIOT to study movements of tuna between the east and west Indian Ocean using tagging techniques.

    i. The SC **NOTED** the following statement made by the Republic of Mauritius: “The Government of the Republic of Mauritius does not recognize the so-called “British Indian Ocean Territory” (“BIOT”) which the United Kingdom purported to create by illegally excising the Chagos Archipelago from the territory of Mauritius prior to its independence. This excision was carried out in violation of United Nations General Assembly Resolutions 1514 (XV) of 14 December 1960, 2066 (XX) of 16 December 1965, 2232 (XXI) of 20 December 1966 and 2357 (XXII) of 19 December 1967.

       The Government of the Republic of Mauritius reiterates that the Chagos Archipelago, including Diego Garcia, forms an integral part of the territory of Mauritius under both Mauritian law and international law.

       The Government of the Republic of Mauritius does not also recognize the existence of the ‘marine protected area’ which the United Kingdom has purported to establish around the Chagos Archipelago. On 20 December 2010, Mauritius initiated proceedings against the

United Kingdom under Article 287 and Annex VII to the United Nations Convention on the Law of the Sea to challenge the legality of the 'marine protected area."

ii. The SC **NOTED** the following statement made by the United Kingdom: "The UK has no doubt about its sovereignty over the British Indian Ocean Territory which was ceded to Britain in 1814 and has been a British dependency ever since. As the UK Government has reiterated on many occasions, we have undertaken to cede the Territory to Mauritius when it is no longer needed for defence purposes."

- **Vanuatu**: Not presented orally.
- **Mozambique**: Not presented orally.
- **Senegal**: Not presented orally.
- **South Africa, Republic of**: Not presented orally.

Recommendation/s

13. Noting that the Commission, at its 15th Session, expressed concern regarding the limited submission of National Reports to the SC, and stressed the importance of proving the reports by all CPCs, the SC **RECOMMENDED** that the Commission note that in 2011, 25 reports were provided by CPCs, up from 15 in 2010 and 14 in 2009 (Table 2). The SC stressed the importance of the submission of National Reports by all CPCs and urged those CPCs who did not met their reporting obligations in this regard (7), to provide a National Report to the SC in 2012.

Table 2. CPC submission of National Reports to the Scientific Committee in 2010 and 2011.

CPC	2010	2011
Australia	Green	Green
Belize	Red	Green
China	Green	Green
Comoros	Green	Green
Eritrea	Red	Red
European Union	Green	Green
France (territories)	Green hash	Green
Guinea	Red	Red
India	Green	Green
Indonesia	Red	Green
Iran, Islamic Republic of	Red	Green
Japan	Green	Green
Kenya	Green	Green
Korea, Republic of	Green	Green
Madagascar	Green	Green
Malaysia	Red	Green
Maldives, Republic of	Green	Green
Mauritius	Green	Green
Oman, Sultanate of	Red	Red
Pakistan	Red	Red
Philippines	Red	Red
Seychelles, Republic of	Green	Green
Sierra Leone	Red	Red
Sri Lanka	Red	Green
Sudan	Red	Red
Tanzania, United Republic of	Red	Green
Thailand	Green	Green
United Kingdom (BIOT)	Green	Green
Vanuatu	Red	Green
Mozambique*	n.a.	Green
Senegal*	Red	Green
South Africa, Republic of*	Red	Green

*Cooperating non-contracting party in 2011. Green = submitted. Red = not submitted. Green hash = submitted as part of EU report, although needs to be separate. n.a. = not applicable.

Discussions on improving/modifying the National Reporting Template

14. The SC **AGREED** that the National Reporting template should be maintained in its current format for 2012 and be reviewed annually for potential improvements.

Status of development and implementation of Nation Plans of Action for seabirds and sharks

15. The SC **NOTED** paper IOTC–2011–SC14–33 which provided the SC with the opportunity to update and comment on the current status of development and implementation of National Plans of Action for seabirds and sharks by each CPC.

16. The SC **NOTED** that the original purpose of the FAO National Plans of Action for Seabirds (NPOA-Seabirds) in 1998 was to address concerns about longline fishing. However, recent information has shown significant concerns about seabird bycatch in several other capture fisheries, especially gillnet fishing. The 2009 FAO Best Practice Technical Guidelines, developed to assist in the preparation of NPOA-Seabirds, explicitly includes advice on longline, trawl and gillnet fisheries.

17. The SC **NOTED** that species such as cormorants and migratory shearwaters (which are common in coastal waters of many IOTC coastal states), are known to be especially vulnerable to bycatch in gillnet fisheries. CPCs operating gillnet fisheries were strongly **ENCOURAGED** to go through an NPOA-Seabirds assessment exercise. BirdLife International offered assistance to CPCs wishing to assess the impacts of gillnet fishing in their national fisheries.

18. The SC **NOTED** the current status of development and implementation of Nation Plans of Action for sharks and **RECOMMENDED** that all CPCs without an NPOA-Sharks expedite the development and implementation of their NPOA-Sharks, and to report progress to the WPEB in 2012, recalling that NPOA-Sharks are a framework that should facilitate estimation of shark catches, and development and implementation of appropriate management measures, which should also enhance the collection of bycatch data and compliance with IOTC Resolutions.

19. The SC **NOTED** the updated status of development and implementation of National Plans of Action for sharks and seabirds, by each CPC as provided at Appendix V.

7. REPORT OF THE 2011 IOTC WORKING PARTY MEETINGS

7.1 Report of the Ninth Session of the Working Party on Billfish

20. The SC **NOTED** the report of the Ninth Session of the Working Party on Billfish (IOTC–2011–WPB09–R), including the consolidated list of recommendations provided as an appendix to the report. The SC expressed its satisfaction on improved attendance and participation by national scientists working on billfish fisheries (27 participants in 2011 compared to 12 in 2010), particularly from the main fleets targeting swordfish (EU,Spain, EU,Portugal and Indonesia).

21. The SC **NOTED** that a range of quantitative modelling methods were applied to the swordfish assessment in 2011, ranging from the highly aggregated ASPIC surplus production model to the age-, sex- and spatially-structured SS3 analysis (Models used: SS3, ASPIC, BMAP, ASIA; see report of the WPB09 for descriptions).

22. The SC **NOTED** that the stock structure of the Indian Ocean swordfish resource is under investigation, but currently uncertain. The southwest region was identified as a management unit of particular concern, because it seems to be more depleted than other regions in the Indian Ocean, and may have limited mixing with other regions. However the magnitude of depletion does not appear to be as extreme as analyses in previous years have suggested. The limited movements and subsequent viscosity of the swordfish resource in a localized area is not an exceptional situation as it has been observed in most swordfish fisheries globally, leading to sharp CPUE declines and apparent localized depletion.

23. Noting the Commission's request to provide clear advice outlining alternative management approaches which would provide effective protection of a possible southwest Indian Ocean swordfish stock (IOTC–2011–S15–R, para. 46), the SC **AGREED** that a separate Executive Summary for swordfish in the southwest Indian Ocean be provided to the Commission, noting the work currently in progress to determine the level of connectivity between swordfish in the southwest with the wider Indian Ocean.

24. The SC **NOTED** that SWIOFP is currently undertaking a research project on swordfish using pop-up archival tags that may shed additional light on the degree of connectivity between swordfish in the

southwest and the broader Indian Ocean. The SWIOFP representative agreed to present a progress report at the next WPB meeting. The SC also **NOTED** that EU,France, in cooperation with Australia, Seychelles, South Africa, Sri Lanka and Thailand, is conducting the Indian Ocean Swordfish Stock Structure (IOSSS) which aims at understanding the stock structure of swordfish in the Indian Ocean using genetic markers. Progress updates were provided at the WPB sessions in 2010 and 2011.

25. The SC **ACKNOWLEDGED** the outstanding contributions of the outgoing Chair of the Working Party on Billfish, Mr. Jan Robinson, and thanked him for his leadership over the past four years.

7.2 Report of the Third Session of the Working Party on Temperate Tunas

26. The SC **NOTED** the report of the Third Session of the Working Party on Temperate Tunas (IOTC–2011–WPTmT03–R), including the consolidated list of recommendations provided as an appendix to the report.

27. The SC **NOTED** that the assessment of the albacore stock was conducted with a single model in 2011(ASPIC, a surplus production model). While most of the catches of albacore have traditionally come from the western Indian Ocean (on average 64% from 1970–2002), since 2003 a larger proportion of the catch has come from the eastern Indian Ocean (on average 63%). The catches of albacore in recent years have come almost exclusively from vessels flagged in Indonesia and Taiwan,China, although the catches of albacore reported for the fresh tuna longline fishery of Indonesia have increased considerably since 2003 to around 17,000 t, which represents approximately 40% of the total catches of albacore in the Indian Ocean.

28. The SC **NOTED** that the catches of albacore estimated for the fresh tuna longline fishery of Indonesia in recent years are thought to be uncertain, as they cannot be verified using data collected through port sampling, and that to date, the IOTC Secretariat has not received catch-and-effort data for this fishery. The SC was also informed that misidentification between yellowfin tuna and albacore might occur in the Indonesian catches which may contribute to the rise of declared albacore catches in recent years. However, the catch levels estimated by the IOTC Secretariat also account for other sources such as the export declarations from Bali and canning factories receiving the products abroad. Finally, the SC urged Indonesia to undertake a thorough examination of the sampling procedure at landing sites as soon as possible. Indonesia requested that the IOTC Secretariat to bridge the gap of catch data of albacore recorded by Indonesian authorities by providing a list of vessels directly exporting albacore to the canning factories abroad.

29. The SC **NOTED** the difficulties faced by Indonesian scientists and managers in terms of commercial catches being transhipped at sea , as well as catches directly exported abroad contributing to IUU fishing. The SC **HIGHLIGHTED** the need for logbooks to be utilised on all commercial fishing vessels, noting that this is already a mandatory requirement for IOTC CPCs. Indonesia encouraged collaboration among CPCs to exchange necessary information related to vessels landing their catch to their countries.

30. The SC **NOTED** that the impacts of piracy in the western Indian Ocean has resulted in the displacement of a substantial portion of longline fishing effort into the traditional albacore fishing areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on albacore will decline in the near future.

31. Noting that at present very little is known about the population structure and migratory range of albacore in the Indian Ocean, other than the possible connectivity with the southern Atlantic, the SC **AGREED** that the determination of albacore stock structure, migratory range and movement rates in the Indian Ocean should be considered as high priority research projects for 2012, and for these to be included in the IOTC scientific workplan to be discussed under Agenda item 19.

32. Noting the request by the Commission at its 15th Session for a new assessment of albacore to be undertaken in 2011 (para. 37 of the S15 report), the SC **RECOMMENDED** that the Commission note that although a new assessment was undertaken in 2011, there remains considerable uncertainty about the relationship between abundance and the standardized CPUE series, and about the total catches over the past decade and that the WPTmT has limited confidence in the assessment undertaken. Thus, there is an urgent need to carry out a revised stock assessment for the albacore resource in the Indian Ocean in 2012, and the Commission should consider allocating funds for this purpose, noting that individual CPCs are finding it difficult to justify expending the necessary resources to undertake stock assessments.

7.3 Report of the Thirteenth Session of the Working Party on Tropical Tunas

33. The SC **NOTED** the report of the Thirteenth Session of the Working Party on Tropical Tunas (IOTC–2011–WPTT13–R), including the consolidated list of recommendations provided as an appendix to the report. The SC expressed its satisfaction on improved attendance and participation by national scientists working on tropical tuna fisheries (49 participants in 2011 compared to 39 in 2010).

Skipjack tuna

34. The SC **ACKNOWLEDGED** the excellent work undertaken by the IOTC Secretariat's stock assessment expert and other collaborators in undertaking the first fully quantitative assessment of skipjack tuna in the Indian Ocean.

35. The SC **NOTED** that the skipjack tuna stock was assessed using a single model in 2011 (SS3, a statistical integrated model). The model estimates a steep biomass decline between 1980 and 1990 followed by a steep biomass increase. At this stage, there are no CPUE series during this period to inform the model. The catch increased in this period due to the onset of industrial purse seine fishing and motorisation of the Maldivian pole and line fishing vessels and thus, trends in recruitment are required to explain the biomass patterns. The biomass/recruitment trends were supported only by the length frequency data, and it is not likely that these data are sufficiently informative to estimate this trend. Furthermore, the trend is not evident in the nominal CPUE series from either the pole and line or purse seine fisheries.

36. The SC **NOTED** that the CPUE series from the EU fleet targeting free schools of skipjack tuna could be extended back to 1983. It was noted, however, that this nominal series would not take into account changes in fishing/gear efficiency and so could still be unsuitable as an index of abundance for the earlier years. These restrictions also apply to the post–1991 series. However, it should be taken into account that the free school catch of purse seiners is relatively small in comparison to Fish-Aggregating Device (FAD)-associated fishing (less than 10%) and the fishery is seasonal, located mainly in the Mozambique Channel in March, April and May.

37. The SC recognised that skipjack tuna assessments are generally difficult to conduct in most fisheries, mainly because the purse seine CPUE does not represent biomass levels accurately. In the particular case of the Indian Ocean, there are additional reasons related to coastal states' fisheries. Those fisheries which contribute greatly to the skipjack tuna catches (~55%) are sampled with a large degree of uncertainty and are characterized by a lack of, or poor reporting in a number of CPCs (notably Comoros, Indonesia, I.R. Iran, Madagascar, Pakistan, Sri Lanka). The lack of quality data usually leads to assessments being limited to rough fisheries indicators instead of formal and quantitative approaches.

38. The SC **AGREED** that further investigation of the existing data irregularities, and expansion of the logbook programme to improve Maldivian CPUE analyses for skipjack tuna in the Indian Ocean be carried out in 2012. The SC also **AGREED** that further analyses of standardization of purse seine CPUE should be carried out in 2012.

Yellowfin tuna

39. The SC **NOTED** that the yellowfin tuna stock was assessed using a single model in 2011 (MULTIFAN-CL (MFCL), a statistical integrated model). While the biomass trends were very similar between the 2010 and 2011 assessments, the estimates of stock productivity and thus, the status, differed. There were several reasons for this: there was poor convergence in the 2010 assessment, thus the fits were suboptimal and alternative solutions were near optimal. Refitting the 2010 assessment is now more optimistic. Also, fitting the 2010 model to 2011 data was more optimistic. Thus, revisiting of key parameters and the inclusion of the latest year of data in the 2011 assessment appeared to be important. These issues are difficult to explore in the MFCL framework.

40. The SC **NOTED** that the WPTT reviewed several alternative model structures and parameter formulations for the model that were presented in the assessment. These included: the new longline model structure for Region 5; alternative Japanese CPUE indices; a single region model where all 5 Regions were collapsed into one; a Region 2 model estimated separately from other Regions; the 5 values of steepness and alternative tag mixing periods (1–4 quarters). Additionally, an attempt was made to estimate age-specific mortality (M). In regards to the latter, this parameter was not well estimated and the WPTT adopted the low M profile as the most appropriate way to proceed.

41. The SC **NOTED** the large uncertainty in the assessment when considering the model outputs (biomass and recruitment trends, movements across areas). The surprisingly low level of natural mortality estimated from tag-recovery data has large impacts on the dynamics of the stock. Similarly, the longevity considered in the analysis (7 yrs) might be too low and should be set at a higher value. Finally, the model does not appear to reflect well enough the fishing mortality expected from the record catches of yellowfin tuna taken between 2003 and 2006, suggesting that some processes might not be well captured by the current model.

42. The SC **NOTED** that some of the key biological parameters used in stock assessment (natural mortality, growth, movements) need further work from the IOTC tag-recovery dataset and **AGREED** that results be presented at the Tagging Symposium which will be held in Mauritius in October or November 2012.

43. The SC **NOTED** that Yield-per-recruit analyses are absent among the various methods used to assess the yellowfin tuna stock, whereas they are useful when there are several fleet components exploiting different age groups, and when gear regulations affecting age/size at first capture may be an important management tool. Therefore, the SC **AGREED** that the WPTT should be presented with such analytical approaches as part of the next assessment process.

44. The SC **NOTED** the problems identified in the catch data from some fisheries, and especially on the length frequencies in the catches of various fleets, a very important source of information for stock assessments. Length frequency data is almost unavailable for some fleets, while in other cases sample sizes are too low to reliably document changes in abundance and selectivity by age.

Bigeye tuna

45. The SC **NOTED** the bigeye tuna stock was assessed using a single model in 2011 (ASPM). With respect to the modelling approach used in 2011, the steepness value (h=0.5) was selected on the basis of the likelihood and was near the lower boundary of what would be considered plausible for bigeye tuna. Selection of steepness on the basis of the likelihood was not considered reliable because i) steepness is difficult to estimate in general, and ii) substantial autocorrelation in the recruitment deviates was ignored in the likelihood term.

46. The SC **NOTED** that uncertainty in natural mortality was not considered, and **AGREED** that it was essential to include uncertainty in the steepness parameter as a minimum requirement for the provision of management advice.

47. The SC **NOTED** that the general population trends and MSY parameters estimated by the ASPM model appeared to be plausibly consistent with the general perception of the fishery and the data. However, these results are considered to be uncertain because of i) uncertainty in the catch rate standardization, and ii) uncertainty in recent catches due to the expansion of artisanal fleets offshore in areas where bigeye tuna is recognised to be abundant.

48. The SC **NOTED** that the management advice for bigeye tuna was based on the 2010 SS3 stock assessment and various steepness scenarios of the current 2011 ASPM stock assessment results.

49. The SC **NOTED** that the recent drop in catches of bigeye tuna could be related to the expansion of piracy in the western tropical Indian Ocean, which has led to a marked drop in the levels of longline effort in the core fishing area of the species. The purse seine effort also declined substantially (30% in number of EU purse seiners) and this, combined with the drop of longline effort, had a positive effect on status of the stock. In addition, it was considered that during the period of record catches of yellowfin tuna (2003–2006), fishing effort on bigeye tuna was also reduced to a level which allowed rebuilding of the stock over several years.

50. The SC **SUGGESTED** that at future WPTT meetings, the WPTT consider developing a figure that shows the likely status of the stock under different fishing scenarios, i.e. with and without particular fleets and gears, providing that sufficient data is available, noting that size sampling for some fleets is considered unreliable. The WPTT should also consider developing yield per recruit plots.

Other relevant papers

51. The SC **NOTED** paper IOTC–2011–SC14–46 which provided a comparison between yellowfin tuna stocks and 2011 stock assessment results for the Indian and Eastern Pacific oceans. Although many similarities exist in the biological characteristics of both stocks and the geographical size of the fisheries, the assessment produced by models of the same nature gives very diverging results. Some

explanation might be related to environmental signals which differ from one ocean to another but some other reasons may also exist.

52. The SC **NOTED** the suggestion by the author that an ad hoc working party between IOTC and IATTC stock assessment experts be held, in order to clarify issues presented above, and **AGREED** that at present, an ad-hoc working group would not be desirable, but rather, for scientists to work collaboratively via other means (electronically) and for this matter to be revisited at the next SC meeting in 2012, following the Tagging Symposium tentatively scheduled for November 2012.

53. The SC **NOTED** paper IOTC–2011–SC14–INF07 which outlined some of the outcomes of the FAD symposium held in Tahiti, from 28 November to 2 December, 2011.

7.4 Report of the Seventh Session of the Working Party on Ecosystems and Bycatch

54. The SC **NOTED** the report of the Seventh Session of the Working Party on Ecosystems and Bycatch (IOTC–2011–WPEB07–R), including the consolidated list of recommendations provided as an appendix to the report. The SC expressed its satisfaction on improved attendance and participation by national scientists working on ecosystem and bycatch topics (49 participants in 2011 compared to 37 in 2010).

Definitions of scientific terms

55. The SC **CONSIDERED** the need to develop and agree to a set of definitions for the most commonly used scientific terms in IOTC Conservation and Management Measures (CMM) and **REQUESTED** the IOTC Secretariat to develop definitions in this regard, and for these to be posted to the IOTC website for reference by those drafting CMM proposals for the consideration of the Commission. The SC indicated that it may wish to modify these incrementally in the future.

56. The SC **AGREED** that the IOTC currently utilises the following definition for bycatch: All species, other than the 16 species listed in Annex B of the IOTC Agreement, caught or interacted with by fisheries for tuna and tuna-like species in the IOTC area of competence.

Status of catch statistics

57. The SC **RECOMMENDED** that the Commission note the status of catch statistics for the main species of sharks, by major fisheries (gears), for the period 1950–2010, as provided in Appendix VI:Tables a–c. Although some CPCs have reported more detailed data on sharks in recent years, including time-area catches and effort, and length frequency data for the main commercial shark species, the SC expressed strong **CONCERN** that the information on retained catches and discards of sharks contained in the IOTC database remains very incomplete.

58. The SC **NOTED** that despite the adoption of IOTC Resolutions 05/05 and 08/01, recently superseded by Resolution 10/02, the levels of reporting of data on sharks and other bycatch species remains very poor and prevents useful analyses of that data.

59. Noting that despite the mandatory reporting requirements detailed in Resolutions 05/05, 08/04, 09/06, 10/02, 10/03, and 10/06, bycatch data remain largely unreported by CPCs and the SC **RECOMMENDED** that the Compliance Committee and the Commission address this non-compliance by taking steps to develop mechanisms which would ensure that CPCs fulfil their bycatch reporting obligations.

60. The SC **RECOMMENDED** that the current IOTC Resolution 08/04 concerning the recording of catch by longline fishing vessels in the IOTC area, Resolution 10/03 concerning the recording of catch by fishing vessels in the IOTC area and Resolution 10/02 mandatory statistical requirements for IOTC members and cooperating non-contracting parties be amended in order to include a clear list of shark and marine turtle species or group of species, that should be recorded and reported to the IOTC Secretariat as per the IOTC requirements for target species.

61. Noting that there is extensive literature available on pelagic shark fisheries and interactions with fisheries targeting tuna and tuna-like species, in countries having fisheries for sharks, and in the databases of governmental or non-governmental organizations, the SC **AGREED** on the need for a major data mining exercise in order to compile data from as many sources as possible and attempt to rebuild historical catch series of the most commonly caught shark species. In this regard, the WPEB **RECOMMENDED** that the Scientific Committee considers presenting a proposal to the Commission for this activity, including a budget.

On Resolution 98/02 Data confidentiality policy and procedures

62. Noting that CPCs have begun to submit observer trip reports and observer data to the IOTC Secretariat, and that confidentially rules contained apply to these data (Cf. Resolution 11/04, para. 12), the SC **RECOMMENDED** that Resolution 98/02 be amended in order to clearly incorporate observer data in the data confidentiality policy of the IOTC.

63. The SC **NOTED** the following statement from Japan: "*Japan showed its view that the SC is a subsidiary body to propose scientific recommendations for action to the Commission and proposing recommendation for amendment of existing resolutions of IOTC is beyond its authority*".

64. The SC **RECOGNIZED** that it is a subsidiary body of the Commission, and that its primary role is to provide scientific advice of relevance to the Commission. With the exception of Japan, the SC **RECOGNIZED** that, where appropriate, its advice may include the provision of recommendations for amendment of existing Resolutions.

Species identification cards – Sharks, seabirds and marine turtles

65. The SC **NOTED** that the IOTC Secretariat has finalised the IOTC identification cards for sharks, seabirds and marine turtles and **COMMENDED** the Secretariat for its work.

66. The SC **RECOMMENDED** that the Commission agree to allocate additional funds from the IOTC accumulated funds, or other sources, be allocated to print and distribute the identification cards for sharks, seabirds and marine turtles to developing coastal states.

Sharks – ERA

67. Noting the general lack of catch data on sharks, the SC strongly **RECOMMENDED** that an (Ecological Risk Assessment) ERA is conducted for sharks caught in fisheries targeting tuna and tuna-like species in the Indian Ocean before the next session of the WPEB. In order to do so, the SC **RECOMMENDED** that the Commission allocate specific funds for such an analysis. Should a Fishery Officer be recruited at the IOTC Secretariat, he/she may be in a position to coordinate this task.

Sharks – Wire leaders/traces

68. On the basis of information presented to the SC in 2011 and in previous years, the SC **RECOGNISED** that the use of wire leaders/traces in longline fisheries may imply targeting of sharks. The SC therefore **RECOMMENDED** to the Commission that if it wishes to reduce catch rates of sharks by longliners it should prohibit the use of wire leaders/traces.

Sharks – Resolution 05/05 concerning the conservation of sharks caught in association with fisheries managed by IOTC

Fin to body weight ratio

69. The SC **ADVISED** the Commission to consider, that the best way to encourage full utilisation of sharks, to ensure accurate catch statistics, and to facilitate the collection of biological information, is to revise the IOTC Resolution 05/05 *concerning the conservation of sharks caught in association with fisheries managed by IOTC* such that all sharks must be landed with fins attached (naturally or by other means) to their respective carcass. However, the SC **NOTED** that such an action would have practical implementation and safety issues for some fleets and may degrade the quality of the product in some cases. The SC **RECOMMENDED** all CPCs to obtain and maintain the best possible data for IOTC fisheries impacting upon sharks, including improved species identification.

Sharks – Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC'S)*:

70. Noting that the collection and reporting of data on sharks as per the IOTC Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPCs)* is very poor at the moment, the SC **RECOMMENDED** that Resolution 10/02 is reinforced by including specific requirements in the provision of nominal catch data for a list of most commonly caught shark species (Table 3). The SC **NOTED** that nominal catch data can be derived from logbook data, observer data or port sampling scheme. Furthermore, the Resolution should be strengthened by amending the provision of catch-and-effort and size data to be applicable to sharks species as well as other bycatch, noting that these data can be derived from logbook or observer data.

Table 3. List of the most commonly caught elasmobranch species.

Common name	**Species**	Code
Manta and devil rays	Mobulidae	MAN
Whale shark	*Rhincodon typus*	RHN
Thresher sharks	*Alopias spp.*	THR
Mako sharks	*Isurus spp.*	MAK
Silky shark	*Carcharhinus falciformis*	FAL
Oceanic whitetip shark	*Carcharhinus longimanus*	OCS
Blue shark	*Prionace glauca*	BSH
Hammerhead shark	Sphyrnidae	SPY
Other Sharks and rays	–	SKH

Sharks – On Resolution 10/12 on the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence

71. Noting that Resolution 10/12 *on the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence* prohibits the retention of any part or whole carcass of thresher sharks and that the collection of biological samples on dead individuals would increase the scientific knowledge of these species, the SC **RECOMMENDED** that Resolution 10/12 be amended in order to allow observers to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs) from thresher sharks that are dead at haulback.

Seabirds

72. The SC **AGREED** that the current area of application for seabird bycatch mitigation measures contained in Resolution 10/06, i.e. south of 25°C, was supported by the available evidence and should not be revised at this point.

73. The SC **NOTED** that three measures ─ weighting of branchlines, night setting of longlines and use of bird scaring lines (tori lines) ─ are proven and recommended measures for use in pelagic longline gear, and that other measures, including the three which are currently included in Resolution 10/06 ─ blue-dyed squid bait, offal discharge control and use of a line shooting device ─ are not considered to be effective mitigation measures following ACAPs (Agreement on the Conservation of Albatrosses and Petrels) review of available mitigation measures for the following reasons:
    - <u>Blue dyed squid bait</u> has been insufficiently researched and cannot be recommended.
    - <u>Line shooting device</u>. There is no experimental evidence that line shooters reduce seabird bycatch in pelagic longline fisheries; therefore, they should not be considered a seabird bycatch mitigation option, although they will continue to be used on many vessels because they are considered to improve fishing efficiency and they avoid bycatch of epipelagic species
    - <u>Offal discharge control</u>. Appropriate management of offal is encouraged as good operating practice but is not considered a primary mitigation measure in pelagic fisheries as there are much smaller quantities of fish waste derived from fishing operations, in direct contrast to the situation in demersal fisheries. The inclusion of offal management as a mitigation measure in Resolution 10/06 most likely has been taken from use of this measure in CCAMLR and other demersal longline fisheries, where it is much more important.

74. The SC **AGREED** that:
    - A combination of weighted branchlines, bird scaring lines and night setting are best practice mitigation in reducing bycatch of seabirds to the lowest possible level in pelagic longline fisheries. These measures should be applied in high risk areas, i.e. South of 25°S, within the IOTC area of competence.
    - Currently, no single mitigation measure can reliably prevent the incidental mortality of seabirds in most pelagic longline fisheries. The most effective approach is to use the measures described in combination. Other factors such as safety, practicality and the characteristics of the fishery should also be recognised when framing conservation measures.
    - The current recommended minimum standards for branchline weighting configurations are:
        i. Greater than a total of 45 g weight attached within 1 m of the hook; or
        ii. Greater than a total of 60 g weight attached within 3.5 m of the hook; or
        iii. Greater than a total of 98 g weight attached within 4m of the hook.
    - Positioning weight farther than 4 m from the hook is not recommended.

75. The SC **NOTED** that for bird scaring lines (BSL), ACAP best practice advice recognises that vessel size is an important determinant in their practical use, with respect to the aerial extent that can be achieved, and the ability to deploy single or twin BSLs. For vessels that exceed 35 m in length, an aerial extent of 100 m and use of two BSLs is recommended; for smaller vessels an aerial extent of 75 m and use of a single BSL is recommended.

76. Taking into account the information presented at the WPEB (WPEB working papers IOTC–2011–WPEB07–43, IOTC–2011–WPEB07–44 and IOTC–2011–WPEB07–54) and to the SC, the SC **AGREED** that a combination of weighted branchlines, bird scaring lines and night setting is best practice mitigation in reducing bycatch of seabirds to the lowest possible level in pelagic longline fisheries.

77. The SC further **NOTED**, in agreement with the WPEB, that if this proposal was accepted, together with the proposal to remove blue-dyed squid bait, line shooters and offal discharge control from the existing measure, the 'two column' approach used in Resolution 10/06 would be abandoned in favour of an approach that specifies the three measures to be applied in areas of seabird interaction risk (Table 4), of which two shall be implemented by the vessels operating south of 25°S.

Table 4. Seabird bycatch mitigation measures.

Mitigation measure	**Description**
Night setting with minimum deck lighting	No setting between nautical dawn and before nautical dusk. Deck lighting to be kept to a minimum
Bird scaring lines (Tori lines)	Bird scaring lines shall be deployed before longline setting starts and for the entire setting operation to deter birds from approaching the branch line
Line weighting	Line weights to be deployed on the branch line prior to setting

78. The SC **AGREED** that at this stage, line weighting should be seen as an adaptive management response to the seabird bycatch problem. Continued refinement of line weighting configurations (mass, number and position of weights and materials) through controlled research and application in fisheries, is highly desirable to find configurations that are most safe, practical and effective. The regimes recommended above should be implemented in working fisheries, monitored through observer programmes, and reviewed and modified if found to be inadequate in reducing bycatch to acceptable levels.

Recommendations

79. The SC **RECOMMENDED** that the specifications for the design and deployment of bird scaring lines be amended in order to take into account different specifications depending on the size of the longline fishing vessel, as follows:

Bird-scaring line design

1. The bird-scaring line shall be a minimum aerial extent of 100 m in length for vessels that exceed 35 m in length and of 75 m in length for vessel less or equal to 35 m in length. If the bird-scaring line is less than 150 m in length, it will include an object towed at the seaward end to create tension to maximise aerial coverage. The section above water shall be a strong fine line of a conspicuous colour such as red or orange.

Deployment of bird scaring lines

1. The bird scaring line shall be deployed before longlines enter into the water.
2. The vessels exceeding 35 m in length should deploy two lines with an aerial extent of 100 m minimum. The vessels that are less or equal to 35 m in length could deploy a single line with an aerial extent of 75 m minimum. To achieve this coverage the line shall be suspended from a point a minimum of 5 metres above the water at the stern on the windward side of the point where the branch line enters the water.

80. The SC further **NOTED** the benefits for the IOTC to harmonize its Conservation and Management Measure for seabirds with that from ICCAT (Supplementary recommendation by ICCAT on reducing incidental bycatch of seabirds in ICCAT longline fisheries, PA4-813A/2011), as there are a number of longline fishing vessels operating in both the Atlantic and Indian Ocean south of 25°S.

81. The SC **RECOMMENDED** that Resolution 10/06 be strengthened in order to make the reporting of seabird interactions mandatory for vessels fishing for species under the IOTC mandate.

82. The SC **RECOMMENDED** that any amendment to Resolution 10/06 should allow sufficient time for orderly implementation, to allow training and redevelopment of gears and operations.

83. The SC **RECOMMENDED** that the Commission consider revising Resolution 10/06 *On Reducing the Incidental Bycatch of Seabirds in Longline Fisheries*, noting the technical specifications and other considerations outlined and agreed to by the SC in paragraphs 73 to 82 of the report of the SC14.

84. The SC **AGREED** that seabird identification can be very difficult, even for trained scientific observers, and **RECOMMENDED** that observers take photographs of seabirds caught by fishing vessels and submit them to seabird experts, or to the IOTC Secretariat, for confirmation of identification.

85. As a matter of consistency and to increase the reporting of seabird interactions, the SC **RECOMMENDED** that the recording of interactions with seabirds (as a group) be included in the minimum requirements for logbooks or through observer programmes for all fleets.

86. The SC further **RECOMMENDED** the Commission consider that more research is conducted on the identification of hot spots of interactions of seabirds with fishing vessels.

Marine turtles

87. The SC **NOTED** that the lack of data from CPCs on interactions and mortalities of marine turtles in the Indian Ocean is a significant concern, resulting in an inability of the WPEB to estimate levels of marine turtle bycatch.

88. Noting the general lack of data on incidental catch of marine turtles, the SC **RECOMMENDED** that an ERA be conducted for marine turtles caught in fisheries targeting tuna and tuna-like species in the Indian Ocean before the session of the WPEB where marine turtles will be a priority. In order to do so, the SC **RECOMMENDED** that the Commission allocate specific funds for such an analysis.

89. Noting that reporting of interactions with marine turtles is already mandatory through Resolution 09/06 which states "*CPCs shall collect (including through logbooks and observer programs) and provide to the Scientific Committee all data on their vessels' interactions with marine turtles in fisheries targeting the species covered by the IOTC Agreement"* (Res.09/06, para.2), and in order to increase the reporting of interactions, the SC **RECOMMENDED** that the recording of marine turtles caught as bycatch is included in the minimum requirements of logbooks or through observer programmes for all fleets fishing in the IOTC area.

90. The SC **NOTED** that there is an urgent need to quantify the effects of fisheries for tuna and tuna-like species in the Indian Ocean on non-target species, and it is clear that little progress on obtaining and reporting data on interactions with marine turtles has been made. This data is imperative to allow the IOTC to respond and manage the adverse effects on marine turtles, and other bycatch species.

91. The SC **RECOMMENDED** that current IOTC Resolution 09/06 *on Marine Turtles* be strengthened to ensure that CPCs report annually on the level of incidental catches of marine turtles by species.

92. Noting that paragraph 4 of Resolution 09/06 *on Marine Turtles* currently refers to "hard shelled turtles", which could be read to exclude leatherback turtles, and noting the Scientific Committee's previous recommendation to the Commission that the resolution should apply to leatherback turtles, the SC **RECOMMENDED** that the Commission revise Resolution 09/06 *on marine turtles* so that the term "hard-shelled" be deleted and replaced by "marine" to ensure application to all marine turtle species.

Redundant/obsolete Conservation and Management Measures (Resolutions and Recommendations)

93. The SC **RECOMMENDED** that the Commission revoke the following Conservation and Management Measures, noting that they have either been superseded by a new Resolution adopted by the Commission, but were not specifically revoked (Recommendation 05/09 and 05/08), or the CMM was to carry out a specific scientific task which is now complete (Resolution 00/02):
    - Recommendation 05/09 *On incidental mortality of seabirds*
    - Recommendation 05/08 *On sea turtles and Resolution 09/06 On marine turtles*
    - Resolution 00/02 *On a survey of predation of longline caught fish*.

Other relevant papers

94. The SC **NOTED** paper IOTC–2011–SC15–45 which provided a review of IOTC discussions and recommendation for shark conservation in the Indian Ocean. In particular, the SC **NOTED** Australia's

intention to present a proposal at the 16th Session of the Commission that would amend both Resolution 05/05 and Resolution 10/12. The proposal will seek to strengthen conservation and management arrangements for sharks caught in association with fisheries managed by the IOTC, in line with the discussion and recommendations of the WPEB and SC.

7.5 Report of the First Session of the Working Party on Neritic Tunas

95. The SC **NOTED** the report of the First Session of the Working Party on Neritic Tunas (IOTC–2011–WPNT01–R), including the consolidated list of recommendations provided as an appendix to the report. The meeting was attended by 28 participants, including 9 recipients of the Meeting Participation Fund. The SC **AGREED** that the outcomes of the meeting will form the basis of a productive and dynamic group of national scientists focused on neritic tuna and tuna-like stocks which are known to be critically important to many of the Indian Ocean coastal states. The SC expressed its satisfaction that the first meeting of this working party had finally been held after several failed attempts, and thanked all of those responsible for the organisation and successful delivery of the meeting outcomes.

96. The SC **NOTED** that at present very little is known about the population structure and migratory range of most neritic tunas in the Indian Ocean, and **AGREED** that research needs to be undertaken along two separate lines; i) genetic research to determine the connectivity of neritic tunas throughout their distributions, and ii) tagging research to better understand the movement dynamics, possible spawning locations, and post-release mortality of neritic tunas from various fisheries in the Indian Ocean.

97. The SC **AGREED** that there was an urgent need to carry out stock assessments for neritic tunas in the Indian Ocean, however at present the data held at the IOTC Secretariat would be insufficient to undertake this task. As such, the SC **RECOMMENDED** that the Commission consider allocating appropriate funds to further increase the capacity of coastal states to collect, report and analyse catch data on neritic tuna and tuna-like species in the Indian Ocean.

7.6 Report of the Eighth Session of the Working Party on Data Collection and Statistics

98. The SC **NOTED** the report of the Eighth Session of the Working Party on Data Collection and Statistics (IOTC–2011–WPDCS08–R), including the consolidated list of recommendations provided as an appendix to the report.

IOTC Observer Trip Report Template

99. Noting that in 2010, the SC requested that the WPDCS discuss collection and reporting by observers of the data items below:
    - Information on the type and numbers of branch lines and wire leaders used (longline)
    - Information on the number and type of electronic equipment used on board
    - Area resolution (1 degree square at present)
    - Information on the state of the sea and weather conditions
    - Information on depredation
    - Information on lost fishing gear
    - Information on the number of hooks used by type and size.

    and noting the difficulties that some observers may have in collecting and reporting of the data items that are requested in the observer trip report template (seven items listed above), and further noting that collecting this information may compromise access to other basic data on board longline vessels, the SC **RECOMMENDED** that the Commission allow for some flexibility in the collection and reporting of these data, until such a time where the CPCs concerned are in a position to collect and provide this information.

100. Noting that the use of monofilament leaders may allow sharks to escape by biting through the line (removing the hook), in contrast to wire leaders which are not prone to 'bite-off', the SC **RECOMMENDED** that, where possible for fleets that have not already prohibited the use of wire leaders, the number of 'bite-off' per leader type is added to the longline hauling information recorded by the observer (currently in the IOTC observer form FORM 4-LL – Fishing Event Longline).

101. Noting that the current observer trip reporting template includes summaries of catch and bycatch by 1° square as required in Resolution 11/04, and that there is no summary of the effort exerted during the trip at the same scale, the SC **RECOMMENDED** that a new table is added to the observer trip reporting template that would ensure effort during the trip is recorded, as follows:

Year	Month	Square (1°x1°)	Effort deployed
			Longline: number of hooks deployed *Purse seine on free-schools: number of fishing sets* *Purse seine on associated schools: number of fishing sets, and number of new FADs deployed* *Gillnet: number of panels deployed* *Pole-and-line: number of fishing days* *Handline: number of fishing days* *Troll-line: number of fishing days*

102. The SC **RECOMMENDED** that the observer trip report is submitted in an electronic format, where possible, noting that the forms/tables in the observer trip report template are for illustrative purposes and that the complete information required could be reported in a different format.

103. Noting that at present, the observer reporting template includes obligatory reporting of information concerning waste management on board the fishing vessel (International Convention for the Prevention of Pollution from Ships – MARPOL), the SC **RECOMMENDED** that the reporting of this information be made optional, as most fishing vessels are already bound by this international regulation.

104. Noting that the reporting of transhipment events have to be reported through the IOTC Transhipment Programme, and that the IOTC Transhipment Programme applies only where transhipments involve a fishing vessel with LOA 24 m or greater and carrier vessels, pointing out that transhipments between fishing vessels, in particular, fresh-tuna longliners, are very common, the SC **AGREED** that in order to avoid duplication, observers under the IOTC Regional Observer Scheme can refrain from reporting Transhipments when those events are recorded by observers under the IOTC Transhipment Programme, **RECOMMENDING** that this is incorporated into the observer report.

105. The SC **AGREED** that from a technical point of view the existing standards for the collection and reporting of data by observers are appropriate, and **ENDORSED** the data requirements of the observer trip report template with the amendments recommended in paragraphs 99 to 104.

Review of IOTC Minimum Requirements for Operational Catch and Effort Data (Logbook Templates)

106. The SC **NOTED** the agreement reached by the WPDCS on revised logbook templates, which is discussed in detail under section 15 below.

Activities under the IOTC-OFCF Project

107. Acknowledging the value of projects such as the IOTC-OFCF in the region, the SC **NOTED** with thanks the support offered by the IOTC-OFCF project since 2002, and strongly **RECOMMENDED** that the activities carried out under the IOTC-OFCF project, including the IOTC-OFCF project itself, continue after the project ends in March 2013.

Common topics among IOTC Working Party's

Meeting participation fund

108. The SC **NOTED** that the increased attendance by national scientists from developing CPCs to IOTC Working Parties in 2011 was partly due to the IOTC Meeting Participation Fund (MPF), adopted by the Commission in 2010 (Resolution 10/05 *on the establishment of a Meeting Participation Fund for developing IOTC Members and non-Contracting Cooperating Parties*), and **RECOMMENDED** that the Commission maintain this fund into the future.

109. The SC **RECOMMENDED** that the Commission consider the problems encountered by potential MPF recipients in 2011. Specifically, there were a number of officially funded recipients who could not attend the various IOTC meetings at the last moment due to internal/domestic administrative processes (including but not limited to South Africa, I.R. Iran). In some cases this resulted in loss of the Commission's MPF funds due to late cancellations.

Dedicated workshop on CPUE standardisation

110. Noting the combined recommendations from the WPB, WPTmT and WPTT to hold a dedicated workshop on CPUE standardization in 2012, the SC **RECOMMENDED** that a dedicated, informal workshop on CPUE standardization, including issues of interest for other IOTC species, should be carried out before the next round of stock assessments in 2013, and that where possible it should include a range of invited experts, including those working on CPUE standardisation in other

ocean/RFMOs, in conjunction with scientists from Japan, Republic of Korea and Taiwan,China, and supported by the IOTC Secretariat. The SC **NOTED** the CPUE workshop organised by ISSF and scheduled to be held late March 2012 in Hawai'i, USA, and urged national scientists working on purse seine CPUE standardisations to attend where possible.

Definition of overfishing

111. The SC **NOTED** the recommendations from the WPB, WPTmT and WPTT to:
   - **NOTE** the current definition of overfishing used by the IOTC, where fishing mortality is in excess of F_{MSY} ($F_{curr}/F_{MSY} > 1$) is considered overfishing;
   - **NOTE** that fishing mortality in excess of F_{MSY} is not always defined as overfishing (within tRFMOs) if the stock is well above the B_{MSY} level, although no specific threshold has been defined;
   - **CONSIDER** the current definition of overfishing ($F_{curr}/F_{MSY} >1$), and determine that if in situations where the biomass of a given stock is well above B_{MSY}, but $F_{curr}/F_{MSY} >1$, under what circumstances should a stock be classified as subject to overfishing;

112. The SC **AGREED** that the current definition of overfishing ($F_{curr}/F_{MSY} >1$) should be maintained, irrespective of the level of biomass of a particular stock. Any future modification to the definitions, including the possible introduction of alternative reference points and harvest controls rules, should be addressed through the IOTC Management Strategy Evaluation process, as agreed by the Commission in 2011.

Increased workload and staffing at the IOTC Secretariat

113. The SC, **NOTED:**
   - the recommendation of the first Bycatch Joint Technical Working Group (BJTWG) meeting and the KOBE II and III meetings, that an additional staff member be hired at each tuna RFMO to deal with bycatch issues;
   - the increasing workload of the IOTC Secretariat regarding bycatch issues, including through the direct requests of the Commission;
   - that the workload of the WPEB has increased exponentially in recent years and yet there appears to be limited resources being given to issues of bycatch, despite the range of IOTC Conservation and Management Measures and other international agreements addressing bycatch in fisheries for tuna and tuna-like species;

114. The SC **RECOMMENDED** that an additional Fishery Officer (P3 or P4) be hired, or consultants contracted, to handle a range of issues related to bycatch, including those from the Commission relating to ecosystems and bycatch issues (see para. 113).

115. Noting the need to provide advice to the Commission concerning the status of the most commonly caught species of sharks in the Indian Ocean, the SC **AGREED** on the need to explore the shark data presently available at the IOTC Secretariat, and to determine if that data can be used to derive total estimates of shark catches for each species.

Chairs and Vice-Chairs of the Working Parties

116. The SC **NOTED** and welcomed the re-elected and new Chairs and Vice-Chairs for each of the IOTC Working Parties, as listed in Appendix VII.

Recommendations from the Working Parties on data collection and reporting deficiencies

117. Noting the wide range of recommendations from the IOTC Working Parties in 2011, which included requests to address the deficiencies in data collection, monitoring and reporting by CPCs, as well as recommendations to improve research, the SC **ENDORSED** the consolidated list of recommendations of the WP's on these matters as those of the SC (provided at Appendix VIII). The SC requested that the IOTC Secretariat communicate these recommendations to relevant parties so that they may address these matters in 2012 and provide progress updates to the IOTC Working Parties at their next meetings.

Recommendations from the Working Parties to the IOTC Secretariat, Chairs and NGOs

118. The SC **ADOPTED** the recommendations from the WPs to the IOTC Secretariat, Chairs and other groups (Appendix IX).

8. UPDATE ON THE KOBE PROCESS

119. The SC **NOTED** paper IOTC–2011–SC14–06 which provided a report on the first meeting of the bycatch joint technical working group (BJTWG). The BJTWG developed recommendations on data collection and harmonization, sharks, collaboration and research, and a provisional list of research priorities was proposed covering bycatch mitigation measures, their impacts in a multi-taxa context, depredation, life history parameters, electronic monitoring systems and the development of Ecological Risk Assessments. The SC **NOTED** that the current activities undertaken by the WPEB cover most of the priority topics, and thus, **ENCOURAGED** that WPEB scientists get involved in the BJTWG workplan.

120. The SC **NOTED** paper IOTC–2011–SC14–07 which provided the recommendations arising from the KOBE III meeting. The SC expressed its disappointment at the very limited scope of the three scientific recommendations arising from the meeting, in comparison to the list of research priorities agreed by the Chairs of the tRFMO's scientific committees and presented at the meeting. The SC **NOTED** that the Kobe process continues, but allow some time for implementation of agreed recommendations before convening another joint meeting.

9. EXAMINATION OF THE EFFECT OF PIRACY ON FLEET OPERATIONS AND SUBSEQUENT CATCH AND EFFORT TRENDS

121. The SC **NOTED** that the Commission, at its 15th Session *recognized that piracy activities in the western Indian Ocean, have had substantial negative consequences on the activities of some fleets, as well as the level of observer coverage in these areas. The Commission requests that the Scientific Committee assess the effect of piracy on fleet operations and subsequent catch and effort trends (para. 40 of the S15 report).*

122. The SC **NOTED** that many papers presented at the WPTT meeting in 2011 demonstrated clear impacts of piracy on fishing operations in the western Indian Ocean (Somali Basin). In particular, the impacts appear to have been greatest on the longline fleets with effort having declined to negligible levels in recent years by most fleets. Of the vessels from Taiwan,China, 10 have moved to the Atlantic Ocean. These originally targeted bigeye tuna, however according to information from observers, some of the remaining vessels have now moved south to target albacore. Japan reported a reduction of ~90 vessels since 2006, with 85 remaining in 2010 (preliminary numbers), which corresponds to a decrease of total catch of about 75–80%. Rep. of Korea reported that one longline vessel was hijacked in 2006 and this had resulted in a large reduction (50%) of the number of Korean active vessels, from 26 in 2006 to 13 in 2010, while the remaining vessels moved to the Southern Indian Ocean.

123. The SC **NOTED** the number of purse seiners has decreased from 51 in 2006 to 35 in 2010 (30% reduction). There was also a large increase in the proportion of sets made on drifting FADs by the EU fleet (from 53 to 77%) and a parallel decline of sets made on free schools. For security reasons, the number of supply vessels has also decreased in comparison with previous years. Fishing effort of the EU purse seine fleet initially shifted east by at least 100 miles compared to the historic distribution of effort in the Somali basin, but the fleets progressively returned in the traditional area whilst military forces were set on board the vessels. However this situation halted the EU observer programme in 2008, but which resumed on EU,France and France(OT) vessels in 2011. Overall, the piracy situation did not significantly decrease the catch and the catch rates of the EU purse seine fleet.

124. The SC **NOTED** that piracy was also reported to be playing a role in the behaviour of some small-scale fishing vessels for which the number have declined in the region.

125. The SC **NOTED** that for skipjack tuna, the large declines of catches observed in the Maldives are unlikely to be linked to the impacts of piracy, but rather by other factors which require further investigation to be elucidated.

126. The SC **NOTED** that a workshop will be held in the Seychelles in early 2012 that will explore the impacts of piracy on fisheries at national, regional and international levels. The workshop is being convened by the governments of Seychelles and Norway and the South West Indian Ocean Fisheries Project, with support from the European Bureau for Conservation and Development. The SC **AGREED** that it is preferable for consolidated information from the various working parties to be presented at the workshop, focusing on current knowledge of pirate impacts on fisheries managed by the IOTC.

127. In response to the request of the Commission (para. 40 of the S15 report), the SC **RECOMMENDED** that given the lack of quantitative analysis of the effects of piracy on fleet operations and subsequent catch and effort trends, and the potential impacts of piracy on fisheries in other areas of the Indian Ocean through the relocation of longliners to other fishing grounds, specific analysis should be carried out and presented at the next WPTT meeting by the CPCs most affected by these activities, including Japan, Republic of Korea and Taiwan,China.

10. STATUS OF TUNA AND TUNA-LIKE RESOURCES IN THE INDIAN OCEAN

128. Noting that Table 1 in this report provides an overview of the stock status and management advice for each species under the IOTC mandate as well as species directly impacted by fisheries for tuna and tuna-like species, the SC **AGREED** to an Executive Summary for each species or species group as detailed below.

10.1 Tuna – Highly migratory species

129. The SC **RECOMMENDED** that the Commission note the management advice developed for each tropical and temperate tuna species as provided in the Executive Summary for each species.
    - Albacore (*Thunnus alalunga*) – Appendix X
    - Bigeye tuna (*Thunnus obesus*) – Appendix XI
    - Skipjack tuna (*Katsuwonus pelamis*) – Appendix XII
    - Yellowfin tuna (*Thunnus albacares*) – Appendix XIII

130. The SC **AGREED** that the Chairs of the IOTC Working Parties should ensure that where possible, all KOBE plots should be presented in a standardized format for the consideration of the SC.

131. The SC **NOTED** paper IOTC–2011–SC14–12 which provided an overview of the biology, stock status and management of southern bluefin tuna (*Thunnus maccoyii*), and thanked CCSBT for providing it.

10.2 Tuna and mackerel – Neritic species

132. The SC **RECOMMENDED** that the Commission note the management advice developed for each neritic tuna species as provided in the Executive Summary for each species:
    - Longtail tuna (*Thunnus tonggol*) – Appendix XIV
    - Narrow-barred Spanish mackerel (*Scomberomorus commerson*) – Appendix XV
    - Bullet tuna (*Auxis rochei*) – Appendix XVI
    - Frigate tuna (*Auxis thazard*) – Appendix XVII
    - Kawakawa (*Euthynnus affinis*) – Appendix XVIII
    - Indo-Pacific king mackerel (*Scomberomorus guttatus*) – Appendix XIX

10.3 Billfish

133. The SC **RECOMMENDED** that the Commission note the management advice developed for each billfish species as provided in the Executive Summary for each species:
    - Swordfish (*Xiphias gladius*) – Appendix XX
    - Black marlin (*Makaira indica*) – Appendix XXI
    - Indo-Pacific blue marlin (*Makaira mazara*) – Appendix XXII
    - Striped marlin (*Tetrapturus audax*) – Appendix XXIII
    - Indo-Pacific sailfish (*Istiophorus platypterus*) – Appendix XXIV

11. STATUS OF MARINE TURTLES, SEABIRDS AND SHARKS IN THE INDIAN OCEAN

11.1 Marine turtles

134. The SC **RECOMMENDED** that the Commission note the management advice developed for marine turtles, as provided in the Executive Summary encompassing all six species found in the Indian Ocean:
    - Marine turtles – Appendix XXV

11.2 Seabirds

135. The SC **RECOMMENDED** that the Commission note the management advice developed for seabirds, as provided in the Executive Summary encompassing all species commonly interacting with IOTC fisheries for tuna and tuna-like species:
    - Seabirds – Appendix XXVI

11.3 Sharks

136. The SC **RECOMMENDED** that the Commission note the management advice developed for a subset of shark species commonly caught in IOTC fisheries for tuna and tuna-like species:
   - Blue sharks (*Prionace glauca*) – Appendix XXVII
   - Oceanic whitetip sharks (*Carcharhinus longimanus*) – Appendix XXVIII
   - Scalloped hammerhead sharks (*Sphyrna lewini*) – Appendix XXIX
   - Shortfin mako sharks (*Isurus oxyrinchus*) – Appendix XXX
   - Silky sharks (*Carcharhinus falciformis*) – Appendix XXXI
   - Bigeye thresher sharks (*Alopias superciliosus*) – Appendix XXXII
   - Pelagic thresher sharks (*Alopias pelagicus*) – Appendix XXXIII

12. Implementation of the Regional Observer Scheme

137. The SC **NOTED** paper IOTC–2011–SC14–34 which provided an update on the national implementation of the regional observer scheme by CPCs, noting that the IOTC Regional Observer Scheme (ROS) started on July 1st, 2010 (Resolution 10/04 – superseded by Resolution 11/04).

138. The SC **NOTED** the update on the implementation of the Regional Observer Scheme set out in Resolution 11/06 *on a Regional Observer Scheme* and **EXPRESSED** its concerns regarding the low level of implementation and reporting to the IOTC Secretariat of both the observer trip reports and the list of accredited observers since the start of the ROS in July 2010 (8 CPCs provided a list of accredited observers and 11 reports were submitted from 4 CPCs).

139. The SC **RECOMMENDED** that all IOTC CPCs urgently implement the requirements of Resolution 11/04 on a Regional Observer Scheme, which states that: "The observer shall, within 30 days of completion of each trip, provide a report to the CPCs of the vessel. The CPCs shall send within 150 days at the latest each report, as far as continuous flow of report from observer placed on the longline fleet is ensured, which is recommended to be provided with 1°x1° format to the Executive Secretary, who shall make the report available to the Scientific Committee upon request. In a case where the vessel is fishing in the EEZ of a coastal state, the report shall equally be submitted to that Coastal State." (para. 11), **NOTING** that the timely submission of observer trip reports to the Secretariat is necessary to ensure that the Scientific Committee is able to carry out the tasks assigned to it by the Commission, including the analysis of accurate and high resolution data, in particular for bycatch, which would allow the scientists to better assess the impacts of fisheries for tuna and tuna-like species on bycatch species.

140. The SC **NOTED** that the implementation of the ROS is not a simple task and CPCs should continue to work towards full implementation of the scheme as prescribed in Resolution 11/04. Solving the difficulties experienced in the training of observers and deployment, would benefit from collaborative arrangements among CPCs.

141. The SC **NOTED** the work being undertaken by the SWIOFP to accredit observers in the region (40 observers trained so far) and the development of a database for observer data. SWIOFP indicated that it has also been proving field sampling equipment for CPCs in the region to carry out the necessary observer tasks onboard vessels.

142. The SC **NOTED** the indication by some CPCs present at the SC14 meeting (Rep. of Korea, Thailand, Mauritius), that they do have the necessary information available but due to domestic administrative difficulties, the information has not yet been provided to the IOTC Secretariat. The SC **NOTED** the commitment by these CPCs to provide the information early in 2012.

143. The SC **AGREED** that such a low level of implementation and reporting is detrimental to its work, in particular regarding the estimation of incidental catches of non-targeted species, as requested by the Commission and **RECOMMENDED** the Commission to consider how to address the lack of implementation of observer programmes by CPCs for their fleets and reporting to the IOTC Secretariat as per the provision of Resolution 11/04 *on a Regional Observer Scheme*, noting the update provided in Appendix XXXIV.

144. The SC **RECOGNISED** the difficulties that some CPCs have in developing and implementing a national observer programme, in particular due to the piracy activities in the western Indian Ocean, the lack of trained observers and the lack of resources and expertise in observer training and management of such programmes.

13. IMPLEMENTATION OF THE PRECAUTIONARY APPROACH AND MANAGEMENT STRATEGY EVALUATION

145. The SC **NOTED** that the Commission, at its 15th Session *endorsed the development of a Management Strategy Evaluation (MSE) in the framework of IOTC and* ***requests*** *that this process be continued in 2011 (para. 43 of the S15 report).*

146. Noting that the development of an MSE process will require management objectives to be specified, the SC **RECOMMENDED** that the Commission provide clear guidance in this regard, noting that the adoption of the Precautionary Approach, as defined in the Fish Stocks Agreement, may be the first step.

147. The SC **NOTED** paper IOTC–2011–SC14–35 which provided a proposal for the implementation of the precautionary approach by the IOTC, responding to the recommendations from the Performance Review Panel, and in line with recommended best practices from international legal instruments and eco-certification guidelines.

148. The SC **NOTED** that the proposed implementation includes the formulation of interim or provisional target and reference points for the major tuna stocks. These provisional reference points will be replaced by updated reference points and harvest control rules, that will be recommended based on their performance in the management strategy evaluation process.

149. The SC **RECOMMENDED** that interim target and limit reference points be adopted and a list of possible provisional values for the major species is listed in Table 5. These values should be replaced as soon as the MSE process is completed. Provisional target reference points would be based on the MSY level of the indicators, and on different multipliers for the limit reference points.

Table 5. Interim target and limit reference points.

Stock	Target Reference Point	Limit Reference Point
Albacore	B_{MSY}; F_{MSY}	$0.4*B_{MSY}$; $1.4*F_{MSY}$
Bigeye tuna	B_{MSY}; F_{MSY}	$0.5*B_{MSY}$; $1.3*F_{MSY}$
Skipjack tuna	B_{MSY}; F_{MSY}	$0.4*B_{MSY}$; $1.5*F_{MSY}$
Yellowfin tuna	B_{MSY}; F_{MSY}	$0.4*B_{MSY}$; $1.4*F_{MSY}$
Swordfish	B_{MSY}; F_{MSY}	$0.4*B_{MSY}$; $1.4*F_{MSY}$

150. The SC **NOTED** that the proposal further includes provisions for the SC to be mandated to conduct a full management strategy evaluation and report on its results by the year 2014. The SC considered a workplan to advance this process through the Working Party on Methods, focusing its efforts exclusively on the development of MSE simulations, and taking advantage of existing national initiatives to develop the analytical tools needed.

151. The SC, with reservations from India, **ENDORSED** the initiative to implement the precautionary approach as described.

152. The SC **NOTED** paper IOTC–2011–SC14–36 which provided a proposal for a Management Strategy Evaluation process for the IOTC.

153. The SC **NOTED** that the adoption of management plans requires careful and detailed work that attempts, to the best capacity of the IOTC scientific community, to acknowledge all sources of error and variability, explore possible measures robust to those uncertainties, and present this in a clear and direct manner to managers and stakeholders.

154. The SC **NOTED** that the use of Management Strategy Evaluation (MSE), also termed Management Procedure approach, was first proposed as a way of developing management plans for IOTC stocks in 2002.

155. The SC **NOTED** that:
- the impact on management of a MSE procedure is likely to depend on several factors. The political will to better manage the fisheries, and even the support of fishery stakeholders for doing so, is a necessary although not sufficient condition for achieving success. The first element in which stakeholder and manager input is required relates to the objectives for the fishery, both in terms of stock status and economic or yield expectations.
- deciding on precise objectives for management is an essential component for the development of HCRs. Discussion on this issue could be best carried out in some multi-lateral meeting,

where scientists, managers, industry and other stakeholders, can be introduced into the precise ways in which IOTC finally decides to conduct the development of management plans, feedback can be obtained on the issues of interest to various parties, and agreement could be attempted on the exact objectives that the plans should attempt to provide for.

- given the likely diversity of the audience, an extra effort needs to be made to make the presentation of model and results as clear and attractive as possible. The issue of communication of scientific results, always difficult, is likely to be of major impact for the acceptance of modelling exercise on great complexity. The development of user friendly software tools, for example TUMAS (Tuna Management Simulator), which has been developed for MSE in the WCPFC is strongly encouraged so as to broaden participation in the MSE process.
- some kind of external review process is probably appropriate, both in terms of internal quality assurance, and for external accreditation of results and methods.
- Fisheries management objectives evaluated by MSE are often stock specific but there is also a need to consider food security, economics, multispecies interactions and environmental impacts. These objectives may not be well prioritized in an international context as they are not technical issues but political issues, so scientific exploration of potential objectives should be carried out with open minds as to the objectives of the Commission.

156. The SC **RECALLED** the necessity that all CPCs be fully participative in this process, but that capacity building activities would be necessary especially on the quantitative aspect of the approach. Opportunities for funding such capacity building activities should be sought and ISSF announced they could contribute to this kind of financial support.

157. The SC **ENDORSED** the roadmap presented for the implementation of MSE in the Indian Ocean in IOTC–2011–SC14–36 and **RECOMMENDED** the Commission agree to initiate a consultative process among managers, stakeholders and scientists to begin discussions about the implementation of MSE in IOTC.

158. The SC **AGREED** that Dr. Iago Mosqueira (European Union) and Dr. Toshihide Kitakado (Japan) would act in the roles of co-ordinators for the MSE process until the Working Party on Methods can consider candidates for Chair and Vice-Chair at its meeting in 2012.

14. EVALUATION OF DATA COLLECTION AND REPORTING SYSTEMS

159. The SC **NOTED** paper IOTC–2011–SC14–38 which provided an evaluation of data collection and reporting systems for artisanal fisheries in the Indian Ocean.

160. The SC **NOTED** the actions undertaken by the IOTC Secretariat to address the request from the Commission on the ability of coastal countries in the IOTC region to report catch data for their artisanal fisheries in close-to-real time, in particular catch data for of yellowfin tuna and bigeye tuna. Two timeframes for the reporting of close-to-real-time catches are defined, depending on the type of fishery. For industrial fisheries, close-to-real-time reporting of catches occurs when catches are reported within 30 days of the day of capture. For artisanal fisheries, close-to-real-time reporting of catches occurs when catches are reported within 60 days of the day of capture. Artisanal fisheries are defined as those undertaken by vessels (or any other types of fishing crafts) with LOA less than 24m and operated full time within the EEZ of their flag states.

161. The SC **NOTED** that the report identifies deficiencies in data collection and reporting in the majority of the countries assessed noting that the reporting of catches as per the timeframes specified will not be possible in eleven out of the eighteen countries evaluated. Those countries will require significant amounts of time and resources to streamline their statistical systems if data by the proposed timeframe is to be reported in the future. Overall an estimated 35% of the combined catches of yellowfin tuna and bigeye tuna will not be reported in time unless the countries address the issues identified as a matter of priority. In the event of catches not being reported, the catches will need to be estimated. The use of such an approach will require the adoption of more conservative measures, to account for the uncertainty of the estimates, and mitigate the risk of exceeding any future catch limits set by the Commission.

162. The SC **ACKNOWLEDGED** the excellent work undertaken by the consultant in collaboration with the IOTC Secretariat in undertaking this thorough, difficult and highly valuable work.

163. Noting that in the case of purse seine fleets the catches recorded in the logbooks are corrected for species composition after a delay of approximately three months, the SC **NOTED** that CPCs having purse seine vessels could provide preliminary estimates in a shorter timeframe based on the best information available. However, the SC acknowledged that the catches estimated close-to-real time may slightly differ from the final catches estimated for these fleets, requesting that the CPCs concerned conduct research to assess the difference between both estimates and report back to the SC in 2012.

164. The SC **NOTED** the comments from various participants who indicated that their reporting abilities are highly variable, from near real time to many months. It was agreed that data collection and reporting systems need to be continuously updated and improved.

15. DATA PROVISION NEEDS – BY GEAR

165. The SC **NOTED** that the Commission, at its 15th Session *requested that the Scientific Committee in its 2011 Session, to evaluate the data provision needs for longline, purse seine, gillnet and pole-and-line gear types, notably regarding information relating to the vessel characteristics and the definition of the pole-and-line 'fishing event'. The evaluation is requested in order to ensure that consistent and uniform information is collected to assist the IOTC to fulfil its mandate. The Scientific Committee should make appropriate recommendations to the 2012 Commission meeting* (para. 45 of the S15 report).

166. Noting the Commission's request to evaluate the data provision needs for longline, purse seine, gillnet and pole and line gear types, notably regarding information relating to the vessel characteristics and the definition of the pole and line 'fishing event', which was requested in order to ensure that consistent and uniform information is collected to assist the IOTC to fulfil its mandate, the SC **CONSIDERED** the recommendations issued by the WPDCS and WPEB in 2011, including a revised draft of minimum data requirements for trip and operational data, and bycatch species to be recorded, by gear, respectively. In addition, the SC considered a proposal from the WPDCS to incorporate requirements for two more gear types (trolling and handline) into the text of a revised proposal for a Resolution.

167. The SC **NOTED** the extended list of shark species (including rays) proposed by the WPEB for each gear, provided at Table 6 below for information, agreeing on the need to collect catch data for all the species proposed by the WPEB. However, the SC acknowledged the difficulties that some CPCs may have to add more shark species into their existing logbooks, as identification of some species may be difficult by the crew. In this regard, the SC **NOTED** that the IOTC Secretariat has put together identification cards for shark species, which will be available early in 2012 and will be forwarded to interested parties.

Table 6. Proposed list of shark species to be recorded in logbooks for all gears.

For longline:	**For gillnet:**
Blue Shark (*Prionace glauca*)	Blue Shark (*Prionace glauca*)
Mako Sharks (*Isurus* spp.)	Mako Sharks (*Isurus* spp.)
Porbeagle Shark (*Lamna nasus*)	Other requiem sharks (*Carcharhinus spp.*)
Other requiem sharks (*Carcharhinus spp.*)	Oceanic Whitetip Shark (*Carcharhinus longimanus*)
Oceanic Whitetip Shark (*Carcharhinus longimanus*)	Hammerhead Sharks (Sphyrnidae)
Hammerhead Sharks (Sphyrnidae)	Thresher Sharks (*Alopias* spp.)
Thresher Sharks (*Alopias* spp.)	Tiger shark (*Galeocerdo cuvier)*
Other sharks	Mantas and devils rays (Mobulidae)
	Other sharks
	Other rays
For purse seine:	
Oceanic Whitetip Shark (*Carcharhinus longimanus*)	
Silky sharks (*Carcharhinus falciformis*)	
Mantas and devils rays (Mobulidae)	
Other sharks	
Other rays	

168. Noting the concerns expressed by some CPCs, the SC **AGREED** that the logbook recording requirements for shark species are not extended at this time. The SC further **AGREED** that recording

of shark species other than those in recommendation 11/06, as proposed by the WPEB, be made optional, but to be collected through observer programmes.

169. The SC **RECOMMENDED** that the minimum recording requirements for handline and trolling provided in Appendix XXXV be incorporated into the revised proposal for minimum recording requirements as detailed in para. 170.

170. The SC **RECOMMENDED** that IOTC Recommendation 11/06 be modified to include the elements as provided in Appendix XXXV, noting that the lists of species to be recorded, as detailed in section 2.3 of Annex II, and makes collection of these data mandatory.

171. The SC **RECOGNISED** that not all CPCs attended the SC meeting and that some of these CPCs, especially coastal states, may have difficulties implementing new minimum data requirements immediately. The SC therefore **RECOMMENDED** that the Commission adopt a flexible approach to any further resolutions on minimum data requirements, e.g. through staged implementation over a period of two years.

16. OUTLOOK ON TIME-AREA CLOSURES

172. The SC **NOTED** that the Commission, at its 15th Session *reiterated the request that the Scientific Committee should evaluate the time-area closure established in Resolution 10/01 for the conservation and management of tropical tunas stocks in the IOTC area of competence, in terms of its impacts on the stocks of tuna and tuna-like species* (para. 47 of the S15 report).

173. Noting that the request contained in Resolution 10/01 does not specify the expected objective to be achieved with the current or alternative time area closures, and that the SC and WPTT were not clear about the intended objectives of the time-area closure taking into account recent reduction of effort as well as recent likely recovery of the yellowfin tuna population, the SC **RECOMMENDED** that the Commission specify clear objectives as to what are the management objectives to be achieved with this and/or alternative measures. This will, in turn, guide and facilitate the analysis of the SC, via the WPTT in 2012 and future years.

174. Noting the lack of research examining time-area closures in the Indian Ocean by the WPTT in 2011, as well as the slow progress made in addressing the Commission request, the SC **RECOMMENDED** that the SC Chair begins a consultative process with the Commission in order to obtain clear guidance from the Commission about the management objectives intended with the current or any alternative closure. This will allow the SC to address the Commission request more thoroughly.

175. Seychelles presented information to the SC on the planned activities in the Indian Ocean by the Convention on Biological Diversity (CBD) with respect to Ecologically or Biologically Significant marine Areas (EBSAs), noting that this CBD process links to the FAO recommendations for incorporating vulnerable marine ecosystems (VMEs) in fisheries management. The SC recognised the importance of active contribution by IOTC and its member scientists to this process.

Evaluation of the IOTC time-area closure

176. The SC **NOTED** paper IOTC–2011–SC14–39 which provided an evaluation of the IOTC time-area closure by estimating what the maximum potential loss of catches would be under different scenarios of time-area closure, as estimated from the catch statistics of the IOTC. The estimation was based on the historical IOTC database as no information was available for the specific closed periods of 2011 (February for longline, November for purse seine) when the measure took effect. The longline effort had already been entirely redistributed to other areas and the purse seine data for November were not yet available when the paper was prepared, nor at the date of the SC.

177. The SC **NOTED** that the results obtained from the study are similar to the analysis carried out for the SC in 2010, which emphasized that catch reduction expected from the current time-area closure were negligible.

178. The SC **RECOMMENDED** that the Commission note that the current closure is likely to be ineffective, as fishing effort will be redirected to other fishing grounds in the Indian Ocean. The positive impacts of the moratorium within the closed area would likely be offset by effort reallocation. For example, the WPTmT noted that longline fishing effort has been redistributed to traditional albacore fishing grounds in recent years, thereby further increasing fishing pressure on this stock.

179. Noting that the objective of Resolution 10/01 is to decrease the overall pressure on the main targeted stocks in the Indian Ocean, in particular yellowfin tuna and bigeye tuna, and also to evaluate the impact of the current time/area closure and any alternative scenarios on tropical tuna population, the SC **RECOMMENDED** that the Commission specify the level of reduction or the long term management objectives to be achieved with the current or alternative time area closures, as these are not contained within the Resolution 10/01.

MPA effects on yellowfin tuna

180. The SC **NOTED** paper IOTC–2011–SC14–40 which provided a preliminary investigation into the effects of the network of Indian Ocean MPAs on yellowfin tuna, *Thunnus albacares*, with particular emphasis on the IOTC closed area.

181. The SC **NOTED** the results of the study which indicated that the current IOTC closure network with only two, one month closures (one month for purse seine and one month for longline), is likely to have little impact on stock status, whether effort is eliminated or redistributed

182. The SC **NOTED** that if there were to be a year-round closure of the IOTC area, in addition to the BIOT and Maldivian closures, and under the assumption that fishing effort was removed entirely, would result in the most beneficial conservation outcomes. However, if effort was reallocated under these scenarios, there would be little benefits to the stocks and possibly more fishing pressure in other areas of the distribution range of the stocks. Thus, taking into consideration the precautionary approach, the issues of potential effort reallocation will need to be considered.

183. The SC **AGREED** that the current network of closures is unlikely to be sufficient to protect yellowfin tuna stocks without additional management measures (e.g. a quota allocation system).

17. ALTERNATIVE MANAGEMENT MEASURES; IMPACTS OF THE PURSE-SEINE FISHERY; JUVENILE TUNA CATCHES

184. The SC **NOTED** that the Commission, at its 15th Session *requested that the Scientific Committee provide clear advice outlining alternative management approaches which would provide effective protection of a possible southwest Indian Ocean swordfish stock* (para. 46 of the S15 report).

185. The SC **NOTED** that advice provided by the WPB that the stock structure of the Indian Ocean swordfish resource is under investigation, but currently uncertain. The southwest region was identified as a management unit of particular concern, because it seems to be more depleted than other regions in the Indian Ocean, and may have limited mixing with other regions.

186. The SC **RECOMMENDED** that the Commission note that:

- most of the evidence provided to date has indicated that the resource in the southwest Indian Ocean has been overfished in the past decade and biomass remains below the level that would produce MSY (B_{MSY}), however recent declines in catch and effort have brought fishing mortality rates to levels below F_{MSY}. There is a risk of reversing the rebuilding trend if there is any increase in catch in this region. Thus, catches in the southwest Indian Ocean should be maintained at levels at or below those observed in 2009 (6,600 t), until there is clear evidence of recovery and biomass exceeds B_{MSY}.
- the southwest region should continue to be analysed as a special resource, as it appears to be highly depleted compared to the Indian Ocean as a whole. However the difference in depletion does not appear to be as extreme as analyses in previous years have suggested. A review of the spatial assumptions should be conducted following the final results of the Indian Ocean Swordfish Stock Structure (IOSSS) project and the analysis of tagging experiments undertaken by SWIOFP.
- that there is no current need to apply additional management measures to the southwest Indian Ocean, although the resource in the area should be carefully monitored.
- that the Working Party on Methods will be progressing Management Strategy Evaluation over the coming year that will aid in addressing the Commission's request, which was considered as the appropriate mechanism for this work.

187. The SC **NOTED** that the Commission, at its 15th Session *requested that the Scientific Committee provide advice to the Commission that adds to the information currently available or already requested of the Scientific Committee regarding the take of juvenile yellowfin tuna, bigeye tuna and other species, and on alternative management measures, including an assessment of the impact of current purse seine*

activities, including the size/fishing capacity (and gear types i.e. mesh size etc.) of vessels, and the potential implications that may arise for tuna and tuna-like species. Such advice should include options for capping purse seine effort and use in conjunction with drifting FADs in the Indian Ocean (para. 105 of the S15 report).

188. The SC **NOTED** that the most direct measure of impact of fishing fleets on juveniles could be obtained by looking at the catches of juvenile yellowfin tuna and bigeye tuna by gear, as presented in Table 7 below. It should be noted that the estimates of catches of juvenile fish are doubtful for some gears, for which catch-at-length information is severely limited or almost non-existent. The SC **AGREED** that the WPTT should provide the SC with multi-gear yield-per-recruit estimates for all stocks assessed in 2012, as this is another useful indicator of the impact of each gear on potential yields.

Table 7. Catches of juvenile yellowfin tuna and bigeye tuna by gear.

Yellowfin tuna Gear type*	Total catch (mt)	% Juveniles of catch within gear	% Juveniles total juvenile catch
BB	18438	85	13.97
GN	84305	40	30.06
HD	32728	25	7.29
LL	94610	2	1.69
TL	21297	37	7.02
FS	92957	3	2.49
LS	69128	60	36.98
OT	1516	37	0.50
TOTAL	414979	27	100
Bigeye tuna Gear type	**Total catch (mt)**	**% Juveniles of catch within gear**	**% Juveniles total juvenile catch**
BB	1070	70	3.44
GN	445	15	0.31
HD	27	1	0.00
LL	99535	1	4.57
TL	1079	41	2.03
FS	6425	13	3.83
LS	21990	84	84.80
OT	241	92	1.02
TOTAL	130813	17	100

(*) BB : baitboat / GN : Gillnet / HD : Handline / LL : Longline / TL : Troll / FS : Purse seine free schools / LS : Purse seine FAD schools / OT : Others

189. The SC **NOTED** that the existing statistics on catches of juvenile fish by species obtained by the various purse seine fleets fishing on FADs, in both numbers and weight, provide a measure of their impact on the stocks, and the corresponding effort statistics (number of boats, GRT and fishing days), give an indication of the capacity of this fleet, which engages, although not exclusively, on the FAD fishery.

190. The SC **NOTED** however, that the fishery statistics available for many fleets, in particular for coastal fisheries, are not accurate enough for a comprehensive analysis as has been repeatedly noted in previous WPTT and SC reports. In particular, the SC **RECOMMENDED** that all CPCs catching yellowfin tuna should undertake scientific sampling of their yellowfin tuna catches to better identify the proportion of bigeye tuna catches. Therefore, the SC **RECOMMENDED** the countries engaged in those fisheries to take immediate actions to reverse the situation of fishery statistics reporting to the IOTC Secretariat.

191. The SC **NOTED** that a complete analysis of the likely impact of the juveniles caught by any fishery in the Indian Ocean and of any management plan should be carried out within the context of the work on Management Strategy Evaluation that the SC has agreed to carry out in the future. This could, if necessary, also quantify the impact of such measures not only on the stocks, but also on the fleets, including likely economic impact on activities dependent on the fleets affected.

192. The SC **ADVISED** the Commission that the Western and Central Pacific Fisheries Commission has implemented since 2009 a FAD closure for the conservation of yellowfin tuna and bigeye tuna juveniles which has been very effective. The SC **RECOMMENDED** further investigation of the

feasibility and impacts of such a measure, as well as other measures, in the context of Indian Ocean fisheries and stocks.

193. The SC **AGREED** that the SC Chair present the response to the Commission on this request, at the Technical Committee on Allocation Criteria, to be held in the Maldives from 4–6 March, 2012.

18. PROGRESS IN IMPLEMENTATION OF THE RECOMMENDATIONS OF THE PERFORMANCE REVIEW PANEL

194. The SC **NOTED** paper IOTC–2011–SC14–37 which provided an update on progress regarding resolution 09/01 – on the performance review follow–up. The SC **NOTED** that the Commission, at its 15th Session *agreed that the Secretariat and Chair of each of the three Committee's should further develop the status table by including a work plan with proposed timelines and priorities. The Secretariat was tasked with ensuring the revised table is provided to the respective Committee's in advance of their next Sessions, in accordance with the rules of procedure* (para. 125 of the S15 report).

195. The SC **RECOMMENDED** that the Commission note the updates on progress regarding Resolution 09/01 – on the performance review follow–up, as provided at Appendix XXXVI.

19. SCHEDULE AND PRIORITIES OF WORKING PARTY AND SCIENTIFIC COMMITTEE MEETINGS FOR 2012 AND TENTATIVELY FOR 2013

196. The SC **NOTED** paper IOTC–2011–SC14–42 which outlined the proposed schedule and list of priorities for IOTC Working Party and Scientific Committee meetings in 2012 and tentatively for 2013.

197. The SC **RECOMMENDED** that the Commission endorse the schedule of Working Party and Scientific Committee meetings for 2012, and tentatively for 2013 (Table 8).

Table 8. Schedule of Working Party and Scientific Committee meetings for 2012, and tentatively for 2013.

Meeting	2012		2013 (tentative)	
	Date	Location	Date	Location
Working Party on Temperate Tunas	3–5 July (3d)	TBD (China?)	Early Aug (3d)	TBD (ICCAT SAA)
Working Party on Billfish	11–15 Sept (5d)	Cape town, South Africa – TBD	10–14 Sept (5d)	Bali, Indonesia
Working Party on Ecosystems and Bycatch	17–19 Sept (3d)	Cape town, South Africa – TBD	16–18 Sept (5d)	Bali, Indonesia
Working Party on Methods	22–23 Oct (2d)	Port Louis, Mauritius	18–19 Oct (2d)	TBD
Working Party on Tropical Tunas	24–29 Oct (6d)	Port Louis, Mauritius	21–26 Oct (6d)	TBD
Working Party on Neritic Tunas	Pending (3d)	Penang, Malaysia	Pending (3d)	TBD
Working Party on Data Collection and Statistics	nil	nil	5–6 Dec	TBD
Scientific Committee	10–15 Dec (6d)	Victoria, Seychelles	9–14 Dec (6d)	TBD

198. The SC **NOTED** the proposed workplans and priorities of each of the Working Parties and **AGREED** to the following:

199. The SC **AGREED** that the SC Chair should develop a draft workplan for the IOTC Scientific Process prior to the SC each year, taking into account the research priorities identified by the Commission and the Working Parties, for the consideration and potential endorsement of the SC.

200. The SC **NOTED** a draft paper developed by Australia presenting various options for improving the efficiency and accountability of the SC and Working Parties. The SC **AGREED** that delegations will consider the issues raised and will discuss with their respective Commissioners.

Working Party on Billfish (WPB) – Research Recommendations and Priorities

201. The SC **RECOMMENDED** that marlins and sailfish undergo CPUE analysis in 2012, with striped marlin taking priority over other species.

202. The SC **RECOMMENDED** that as a matter of priority, striped marlin be the subject of CPUE analysis in 2011, and that CPUE series be compared among fleets where possible.

203. The SC **AGREED** that there was no urgent need to carry out stock assessments for the swordfish resources in the Indian Ocean in 2012, and **RECOMMENDED** that efforts over the coming year be focused on the other billfish species, in particular on striped marlin.

204. The SC **RECOMMENDED** the following core areas as priorities for research over the coming year;

- Swordfish stock structure and migratory range – using genetics
- Swordfish stock structure and movement rates – using tagging techniques
- Billfish species growth rates
- Size data analyses
- Stock status indicators – exploration of indicators from available data
- CPUE standardization – swordfish, marlins and sailfish
- Stock assessment – Istiophorids
- Depredation – focus on the southwest

Working Party on Temperate Tunas (WPTmT) – Research Recommendations and Priorities

CPUE standardisation

205. The SC **AGREED** that there was an urgent need to investigate the CPUE issues as outlined in paragraph 61 and for this to be a high priority research activity for the albacore resource in the Indian Ocean in 2012.

Stock assessment

206. The SC **AGREED** that there was an urgent need to carry out revised stock assessments for the albacore resource in the Indian Ocean in 2012, and **RECOMMENDED** that the Commission consider approving funds for this purpose.

Stock structure

207. Noting that at present very little is known about the population structure and migratory range of albacore in the Indian Ocean, other than the possible connectivity with the southern Atlantic, the SC **RECOMMENDED** that a research project addressing the albacore stock structure, migratory range and movement rates in the Indian Ocean be considered at its 2012 annual meeting as this project is assigned a high priority.

Additional core topics for research

208. The SC **RECOMMENDED** that the following core topic areas as priorities for research over the coming year:

- Size data analyses
- Growth rates and ageing studies
- Stock status indicators – exploration of indicators from available data
- Collaborate with SPC-OFP to examine their current simulation approach to determine priority research areas.

Working Party on Tropical Tunas (WPTT) – Research Recommendations and Priorities

CPUE standardisation

209. Noting the importance of the various CPUE indices for stock assessment of the tuna tropical species, the SC **AGREED** that there was an urgent need to investigate the CPUE issues as outlined in sections 8–10, for bigeye tuna, skipjack tuna and yellowfin tuna, and for these to be a high priority research activity for the tropical tuna resources in the Indian Ocean in 2012.

210. The SC **NOTED** that there are various levels of needs for each fleet. For example, while for pole-and-line and purse seine fleets, the data and methodological approach are considered key issues to be resolved before any attempt of CPUE standardization; longline CPUE standardization constraints (differences between fleets, spatial structure, materials, etc.) can be resolved and reviewed in a dedicated workshop with the presence of other tRFMO CPUE experts.

211. The SC **RECOMMENDED** that if possible, the IOTC Secretariat and Maldivian scientists continue the joint effort to standardize the Maldivian pole-and-line CPUE in preparation for assessment in 2012.

212. The SC **RECOMMENDED** that standardization of purse seine CPUE be made where possible using the operational data on the fishery, and that participants working on CPUE for the main fleets, attend the CPUE standardization workshop being organized by ISSF in Honolulu, Hawaii in 2012.

Stock assessment

213. Noting the difficulty of carrying out stock assessments for three tropical tuna species in a single year, the SC **RECOMMENDED** to a revised assessment schedule on a two- or three-year cycle for the three tropical tuna species as outlined in Table 9. Following the uncertainty remaining in the yellowfin tuna assessment the SC **AGREED** that priories for stock assessments in 2012 would be yellowfin tuna (Multifan-CL and SS3, Yield per recruit and possibly others) with an update of fishery indicators for the other two species.

Table 9. New schedule proposed for tropical tuna species stock assessment.

Species/Assessment year	2012	2013	2014	2015	2016	2017
Yellowfin tuna	Full	Update	Update	Full	Update	Update
Skipjack tuna	Update	Full	Update	Update	Full	Update
Bigeye tuna	Update	Update	Full	Update	Update	Full

Note: the schedule may be change depending on the situation of the stock from various sources such as fishery indicators, Commission requests, etc.

Additional topics for research

214. The SC **RECOMMENDED** the following core topic areas as priorities for research over the coming year in order of priority:
- An update of the Brownie-Peterson method for the 3 tropical tuna species (possible issue for the 2012 IO Tuna Tagging Symposium).
- An updated yellowfin tuna growth curve (work in progress to be presented to 2012 Tuna Tagging Symposium).
- Multi-gear yield per recruit.

Working Party on Ecosystems and Bycatch (WPEB) – Research Recommendations and Priorities

215. The SC **AGREED** that sharks should be the priority for the next meeting of the WPEB in 2012, and seabirds, marine turtle, marine mammals and other bycatch should be reassessed as priorities at the next session of the SC. Thus, the SC **RECOMMENDED** the following core topic areas as priorities for research over the coming year.
- ***Ecological Risk Assessment***
    i. All sharks
- ***CPUE analyses***
    i. Oceanic whitetip shark
    ii. Other sharks
- ***Stock status analyses***
    i. Oceanic whitetip shark
    ii. Other sharks
- ***Capacity building***
    i. Scientific assistance to CPCs and specific fleets considered to have the highest risk to bycatch species (e.g. gillnet fleets and longline fleets).

Working Party on Neritic Tunas (WPNT) – Research Recommendations and Priorities

Stock structure

216. Noting that at present very little is known about the population structure and migratory range of most neritic tunas in the Indian Ocean, the SC **RECOMMENDED** a research plan that includes two separate research lines; i) genetic research to determine the connectivity of neritic tunas throughout their distributions, and ii) tagging research to better understand the movement dynamics, possible spawning locations, and post-release mortality of neritic tunas from various fisheries in the Indian Ocean. These should be considered high priority research projects for 2012 and 2013.

Biological information

217. The SC **RECOMMENDED** that quantitative biological studies are required to determine maturity-at-age and fecundity-at-age relationships, and age and growth for all neritic tunas throughout their range.

CPUE standardisation

218. The SC **AGREED** that there was an urgent need to develop standardised CPUE series for each neritic tuna species for the Indian Ocean as a whole or by sub-region as appropriate, once stock structure and management units have been determined.

219. The SC **RECOMMENDED** that where feasible, support should be provided by the IOTC Secretariat and other CPCs, to aid in the development of standardised CPUE series for each neritic tuna species.

220. The SC **ENCOURAGED** CPCs catching neritic tunas to participate in the CPUE standardisation workshop that will be organized by the IOTC Secretariat in 2013.

Stock assessment

221. The SC **AGREED** that there was an urgent need to carry out stock assessments for neritic tunas in the Indian Ocean, however at present the data held at the IOTC Secretariat would be insufficient to undertake this task. As such, the SC **RECOMMENDED** that the Commission consider allocating appropriate funds to further increase the capacity of coastal states to collect, report and analyse catch data on neritic tunas.

Requests from the Commission

222. Noting that each year the Commission makes a number of requests to the SC without clearly identifying the task to be undertaken, its priority against other tasks previously or simultaneously assigned to the SC and without assigning a budget to fund the request made, the SC **RECOMMENDED** that these matters be addressed by the Commission at its next session.

20. OTHER BUSINESS

20.1 Rules for the appointment of an invited expert

223. The SC **NOTED** paper IOTC–2011–SC14–43 which provided a proposed set of rules for the appointment of invited experts to attend IOTC Working Party meetings. The SC **AGREED** to a revised set of "*Rules for the appointment of an Invited Expert*" as provided at Appendix XXVII.

20.2 Guidelines for the appointment of a consultant

224. The SC did not add to the previously agreed positions at SC13 and WPTT13.

20.3 Peer review process for IOTC stock assessments

225. The SC **NOTED** paper IOTC–2011–SC14–44 which provided an overview of how peer review of how other tRFMO's undertake peer review of their stock assessments. The SC **AGREED** that at this time it did not feel that there was a need to undertake a peer review of IOTC stock assessments and deferred this discussion to its next meeting in 2013.

20.4 IOTC Regional Tuna Tagging Programme – Tagging Symposium

226. The SC **NOTED** the development on the International Tagging Symposium, funded by the EU (300,000€), the IOTC (50,000€) and the IRD (25,000€), that will be organized in Mauritius in early November 2012 (31 October to 2 November, 2012). Part of the funds will be used to undertake analyses of the large datasets from the Indian Ocean Tuna Tagging Programme (IOTTP), in particular from the Regional Tuna Tagging Programme in the Indian Ocean (RTTP-IO), during which more than 200,000 tropical tunas were tagged and released, and more than 31,000 were recaptured and reported. These studies will include analyses of the growth of the three tropical tuna species (based on the tagging data and otolith readings), updates of the estimation of the reporting and shedding rates, estimation of exploitation rates and natural mortalities and the improved use of tagging data in the Indian Ocean stock assessments for tuna and tuna-like species.

227. The SC **RECALLED** that the IOTTP and its main phase, the RTTP-IO, were a great success, tagging large numbers of yellowfin tuna, bigeye tuna and skipjack tuna. However, much of the data collected remains largely under-analysed and that this symposium will be the perfect opportunity i) to undertake

these essentials analyses and ii) to present the results of the IOTTP to all interested stakeholders in the region.

20.5 Translation of SC documents into English and French

228. The EU **SUGGESTED** that the limited production and submission of scientific documents to the SC meetings could be due to the translation requirements, i.e. each document should be presented in both French and English. However, it was clarified that translation is ensured by the IOTC Secretariat, if the document is not provided in both languages to the extent possible considering the limited translation resources available at the Secretariat.

229. The SC **AGREED** that documents should continue to be provided in both English and French for SC meetings.

21. ELECTION OF A CHAIRPERSON AND VICE-CHAIRPERSON FOR THE NEXT BIENNIUM

230. The SC participants were unanimous in **THANKING** the outgoing Chair Dr. Francis Marsac for his outstanding Chairpersonship over the past six years, including his dedication to the IOTC scientific process. It was noted that he has tirelessly attended most of the working party meetings over the six year period and has contributed greatly to almost the full range of activities undertaken by the IOTC.

231. Noting the rules of procedure of the IOTC: Rule X.6: The Scientific Committee shall elect, preferably by consensus, a Chairperson and a Vice-Chairperson from among its members for two years, the SC **CALLED** for nominations for the newly vacated positions of Chair and Vice-Chair for the next biennium. Dr. Tom Nishida (Japan) was nominated and elected as Chair, and Mr. Jan Robinson (Seychelles) was nominated and elected as Vice-Chair of the SC for the next biennium, following a vote by the 13 CPCs present.

232. The SC **RECOMMENDED** that the Commission note the new Chair, Dr. Tom Nishida (Japan) and Vice-Chair, Mr. Jan Robinson (Seychelles), of the SC for the next biennium, as well as the Chairs and Vice-Chairs of each of the Working Parties as provided in Appendix VII

22. REVIEW OF THE DRAFT, AND ADOPTION OF THE REPORT OF THE FOURTEENTH SESSION OF THE SCIENTIFIC COMMITTEE

233. The SC **RECOMMENDED** that the Commission consider the consolidated set of recommendations arising from SC14, provided at Appendix XXXVIII.

234. The report of the Fourteenth Session of the Scientific Committee (IOTC–2011–SC14–R) was **ADOPTED** on 17 December 2011.

APPENDIX I
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Thanks to the support team from the Seychelles Fishing Authority
Slim Dogley

APPENDIX II
AGENDA FOR THE FOURTEENTH SESSION OF THE SCIENTIFIC COMMITTEE

Date: 12–17 December, 2011
Location: International Conference Centre, Victoria
Mahé, Seychelles
Time: 09:00 – 17:00 daily
Chair: Dr. Francis Marsac

1. **OPENING OF THE SESSION** (Chair)
2. **ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION** (Chair)
3. **ADMISSION OF OBSERVERS** (Chair)
4. **ACTIVITIES OF THE COMMISSION** (Secretariat)
5. **ACTIVITES OF THE IOTC SECRETARIAT IN 2011** (Secretariat)
6. **NATIONAL REPORTS FROM CPCs** (CPCs)
7. **REPORTS OF THE 2011 IOTC WORKING PARTY MEETINGS**
   - 7.1. IOTC–2011–WPB09–R: Report of the Ninth Session of the Working Party on Billfish
   - 7.2. IOTC–2011–WPTmT03–R: Report of the Third Session of the Working Party on Temperate Tunas
   - 7.3. IOTC–2011–WPTT13–R: Report of the Thirteenth Session of the Working Party on Tropical Tunas
   - 7.4. IOTC–2011–WPEB07–R: Report of the Seventh Session of the Working Party on Ecosystems and Bycatch
   - 7.5. IOTC–2011–WPNT01–R: Report of the First Session of the Working Party on Neritic Tunas
   - 7.6. IOTC–2011–WPDCS08–R: Report of the Eighth Session of the Working Party on Data Collection and Statistics
8. **UPDATE ON THE KOBE PROCESS** (Chair)
9. **EXAMINATION OF THE EFFECTS OF PIRACY ON FLEET OPERATIONS AND SUBSEQUENT CATCH AND EFFORT TRENDS** (Chair)
10. **STATUS OF TUNA AND TUNA-LIKE RESOURCES IN THE INDIAN OCEAN** (Chair)
    - 10.1 Tuna – Highly migratory species
    - 10.2 Tuna and mackerel – Neritic species
    - 10.3 Billfish
11. **STATUS OF MARINE TURTLES, SEABIRDS AND SHARKS IN THE INDIAN OCEAN** (Chair)
    - 11.1 Marine turtles
    - 11.2 Seabirds
    - 11.3 Sharks
12. **IMPLEMENTATION OF THE REGIONAL OBSERVER SCHEME** (Secretariat)
13. **IMPLEMENTATION OF THE PRECAUTIONARY APPROACH AND MANAGEMENT STRATEGY EVALUATION** (Chair & Secretariat)
14. **EVALUATION OF DATA COLLECTION AND REPORTING SYSTEMS** (Secretariat)
15. **DATA PROVISION NEEDS – BY GEAR** (Chair WPDCS)
16. **OUTLOOK ON TIME-AREA CLOSURES** (Chair)
17. **ALTERNATIVE MANAGEMENT MEASURES; IMPACTS OF THE PURSE SEINE FISHERY; JUVENILE TUNA CATCHES** (Chair)
18. **PROGRESS IN IMPLEMENTATION OF THE RECOMMENDATIONS OF THE PERFORMANCE REVIEW PANEL** (Secretariat)

19. SCHEDULE AND PRIORITIES OF WORKING PARTY AND SCIENTIFIC COMMITTEE MEETINGS FOR 2012 AND TENTATIVELY FOR 2013 (Secretariat)

20. OTHER BUSINESS (Chair)

- 20.1 Rules for the appointment of an invited expert
- 20.2 Guidelines for the appointment of a consultant
- 20.3 Peer review process for IOTC stock assessments
- 20.4 IOTC Regional Tuna Tagging Programme – Tagging Symposium
- 20.5 Translation of SC documents into English and French

21. ELECTION OF A CHAIRPERSON AND VICE-CHAIRPERSON FOR THE NEXT BIENNIUM (Chair & Secretariat)

22. REVIEW OF THE DRAFT, AND ADOPTION OF THE REPORT OF THE FOURTEENTH SESSION OF THE SCIENTIFIC COMMITTEE (Chair)

APPENDIX III
LIST OF DOCUMENTS

Document	Title	Availability
IOTC–2011–SC14–01a	Draft agenda of the Fourteenth Session of the Scientific Committee	✓ (19 August)
IOTC–2011–SC14–01b	Draft annotated agenda of the Fourteenth Session of the Scientific Committee	✓ (12 November)
IOTC–2011–SC14–02	Draft list of documents	✓ (12 November)
IOTC–2011–SC14–03	Outcomes of the Fifteenth Session of the Commission	✓ (11 August)
IOTC–2011–SC14–04	Previous decisions of the Commission	✓ (7 November)
IOTC–2011–SC14–05	Report of the secretariat – Activities in support of the IOTC science process in 2011	✓ (24 November)
IOTC–2011–SC14–06	Report of the First Meeting of the Bycatch Joint Technical Working Group	✓ (22 August)
IOTC–2011–SC14–07	Recommendations arising from the KOBE III meeting	✓ (12 August)
IOTC–2011–SC14–08	Status of the albacore resource	✓ (8 November)
IOTC–2011–SC14–09	Status of the bigeye tuna resource	✓ (23 November)
IOTC–2011–SC14–10	Status of the skipjack tuna resource	✓ (22 November)
IOTC–2011–SC14–11	Status of the yellowfin tuna resource	✓ (23 November)
IOTC–2011–SC14–12	Status and management of southern bluefin tuna (from CCSBT)	✓ (21 November)
IOTC–2011–SC14–13	Status of the bullet tuna resource	✓ (23 November)
IOTC–2011–SC14–14	Status of the frigate tuna resource	✓ (23 November)
IOTC–2011–SC14–15	Status of the longtail tuna resource	✓ (23 November)
IOTC–2011–SC14–16	Status of the Indo-Pacific king mackerel resource	✓ (23 November)
IOTC–2011–SC14–17	Status of the kawakawa resource	✓ (23 November)
IOTC–2011–SC14–18	Status of the narrow-barred Spanish mackerel resource	✓ (23 November)
IOTC–2011–SC14–19	Status of the swordfish resource	✓ (17 November)
IOTC–2011–SC14–20	Status of the black marlin resource	✓ (17 November)
IOTC–2011–SC14–21	Status of the Indo-Pacific blue marlin resource	✓ (17 November)
IOTC–2011–SC14–22	Status of the striped marlin resource	✓ (17 November)
IOTC–2011–SC14–23	Status of the Indo-Pacific sailfish resource	✓ (17 November)
IOTC–2011–SC14–24	Status of marine turtles	✓ (24 November)
IOTC–2011–SC14–25	Status of seabirds	✓ (25 November)
IOTC–2011–SC14–26	Status of blue sharks	✓ (25 November)
IOTC–2011–SC14–27	Status of silky sharks	✓ (25 November)
IOTC–2011–SC14–28	Status of oceanic whitetip sharks	✓ (25 November)
IOTC–2011–SC14–29	Status of scalloped hammerhead sharks	✓ (25 November)
IOTC–2011–SC14–30	Status of shortfin mako sharks	✓ (25 November)
IOTC–2011–SC14–31	Status of bigeye thresher sharks	✓ (25 November)
IOTC–2011–SC14–32	Status of pelagic thresher sharks	✓ (25 November)
IOTC–2011–SC14–33	Status of development and implementation of National Plans Of Action for seabirds and sharks (Secretariat)	✓ (7 November)
IOTC–2011–SC14–34 Rev_3	National Implementation of the regional observer scheme by CPCs (Secretariat)	✓ (23 November)
IOTC–2011–SC14–35	On the implementation of the precautionary approach (Secretariat)	✓ (25 November)
IOTC–2011–SC14–36	Development of a Management Strategy Evaluation process for the IOTC (SC Chair, in the absence of a Chair WPM)	✓ (30 November)
IOTC–2011–SC14–37 Rev_3	Update on progress regarding Resolution 09/01 – on the performance review follow–up (Secretariat and Chair)	✓ (12 August)
IOTC–2011–SC14–38	Evaluating the ability of IOTC CPCs and other fishing parties in the Indian Ocean to produce close-to-real time estimates of catches of yellowfin tuna and bigeye tuna (Secretariat)	✓ (28 November)

Document	Title	Availability
IOTC–2011–SC14–39 Add_1 & Add_2	Evaluation of current and alternative time/area closures by catch reductions scenarios (H. Murua, M. Herrera, A. Fonteneau and F. Marsac)	✓ (2 December)
IOTC–2011–SC14–40	A preliminary investigation into the effects of Indian Ocean MPAs on yellowfin tuna, *Thunnus albacares*, with particular emphasis on the IOTC closed area (S. Martin, C. Mees, C. Edwards, and L. Nelson)	✓ (25 November)
IOTC–2011–SC14–41	A preliminary investigation into the potential effects of limiting size at first capture of yellowfin tuna, *Thunnus albacares*, in the Indian Ocean (S. Martin , C. Edwards and C. Mees)	WITHDRAWN
IOTC–2011–SC14–42	Proposed schedule and priorities of Working Party and Scientific Committee meetings for 2012 and 2013 (Secretariat)	✓ (25 November)
IOTC–2011–SC14–43	Rules for the appointment of an invited expert (Chair SC and Secretariat)	✓ (25 November)
IOTC–2011–SC14–44	Peer review of IOTC stock assessments (Secretariat)	✓ (25 November)
IOTC–2011–SC14–45	Review of IOTC discussions and recommendations for shark conservation in the Indian Ocean (Australia)	✓ (17 November)
IOTC–2011–SC14–46	A comparison between stocks and between 2011 stock assessment results of yellowfin in the Indian and Eastern Pacific oceans (European Union)	✓ (19 November)
Working Party Reports		
IOTC–2011–WPB09–R	Report of the Ninth Session of the Working Party on Billfish	✓ (2 August)
IOTC–2011–WPTmT03–R	Report of the Third Session of the Working Party on Temperate Tunas	✓ (29 September)
IOTC–2011–WPTT13–R	Report of the Thirteenth Session of the Working Party on Tropical Tunas	✓ (9 November)
IOTC–2011–WPEB07–R	Report of the Seventh Session of the Working Party on Ecosystems and Bycatch	✓ (7 November)
IOTC–2011–WPNT01–R	Report of the First Session of the Working Party on Neritic Tunas	✓ (18 November)
IOTC–2011–WPDCS08–R	Report of the Eighth Session of the Working Party on Data Collection and Statistics	✓ (10December)
National Reports – Members		
IOTC–2011–SC14–NR01	Australia	✓ (10 November)
IOTC–2011–SC14–NR02	Belize	✓ (26 October)
IOTC–2011–SC14–NR03 Rev_1	China	✓ (25 November) ✓ (16 December)
IOTC–2011–SC14–NR04 Rev_1	Comoros	✓ (25 November) ✓ (4 December)
IOTC–2011–SC14–NR05	Eritrea	Not provided
IOTC–2011–SC14–NR06	European Union	✓ (2 December)
IOTC–2011–SC14–NR07	France	✓ (9 December)
IOTC–2011–SC14–NR08	Guinea	Not provided
IOTC–2011–SC14–NR09	India	✓ (25 November)
IOTC–2011–SC14–NR10 Rev_2	Indonesia	✓ (10, 12 & 17 December)
IOTC–2011–SC14–NR11	Iran, Islamic Republic of	✓ (26 November)
IOTC–2011–SC14–NR12 Rev_1	Japan	✓ (30 November) ✓ (4 December)
IOTC–2011–SC14–NR13	Kenya	✓ (25 November)
IOTC–2011–SC14–NR14	Korea, Republic of	✓ (26 November)
IOTC–2011–SC14–NR15	Madagascar	✓ (26 November)
IOTC–2011–SC14–NR16	Malaysia	✓ (28 November)
IOTC–2011–SC14–NR17	Maldives, Republic of	✓ (9 December)
IOTC–2011–SC14–NR18	Mauritius	✓ (3 December)
IOTC–2011–SC14–NR19	Oman, Sultanate of	Not provided
IOTC–2011–SC14–NR20	Pakistan	Not provided

Document	Title	Availability
IOTC–2011–SC14–NR21	Philippines	Not provided
IOTC–2011–SC14–NR22	Seychelles, Republic of	✓ (30 November)
IOTC–2011–SC14–NR23	Sierra Leone	Not provided
IOTC–2011–SC14–NR24	Sri Lanka	✓ (23 November)
IOTC–2011–SC14–NR25	Sudan	Not provided
IOTC–2011–SC14–NR26 Rev_1	Tanzania	✓ (29 November) ✓ (3 December)
IOTC–2011–SC14–NR27 Rev_1	Thailand	✓ (10 December) ✓ (12 December)
IOTC–2011–SC14–NR28	United Kingdom	✓ (25 November)
IOTC–2011–SC14–NR29	Vanuatu	✓ (8 December)
National Reports – Cooperating non-Contracting Parties		
IOTC–2011–SC14–NR30	Mozambique	✓ (2 December)
IOTC–2011–SC14–NR31	Senegal	✓ (25 November)
IOTC–2011–SC14–NR32	South Africa, Republic of	✓ (29 November)
Information Papers		
IOTC–2011–SC14–INF01	Guidelines for the Presentation of Stock Assessment Models	✓ (3 Aug 2011)
IOTC–2011–SC14–INF02	Kobe Strategy Matrix (Secretariat)	✓ (25 November)
IOTC–2011–SC14–INF03	Protection of leatherback turtles (*Dermochelys coriacea*) from fishing impacts in the Indian Ocean (Australia)	✓ (17 November)
IOTC–2011–SC14–INF04 Rev_1	Report of the 10th OFCF tuna statistics and management training course (Japan)	✓ (4 December) ✓ (9 December)
IOTC–2011–SC14–INF05	Recording and reporting of catch and effort by fishing vessels in the IOTC area of competence (Australia)	✓(30 November)
IOTC–2011–SC14–INF06	Toward improvement of IUCN Red List (Japan)	✓ (4 December)
IOTC–2011–SC14–INF07	Summary of the 2nd symposium on "Tuna Fisheries and FAD" Tahiti, November 28th-December 2nd, 2011 (European Union)	✓ (10 December)
IOTC–2011–SC14–INF08	Effects of wire leader use and species-specific distributions on shark catch rates off the southeastern United States (W.B. Driggers, J.K. Carlson, E. Cortés & G.W Ingram)	✓ (10 December)

APPENDIX IV
NATIONAL REPORT ABSTRACTS

Australia

Pelagic longline and purse seine are the two main fishing methods used by Australian vessels to target tuna and billfish in the Indian Ocean Tuna Commission (IOTC) Convention Area. In 2010, four Australian longliners (three from the Western Tuna and Billfish Fishery and one from the Eastern Tuna and Billfish Fishery) operated in the IOTC Convention Area. Together they caught 18.7 t of albacore tuna (*Thunnus alalunga*), 65.3 t of bigeye tuna (*Thunnus obesus*), 21.9 t of yellowfin tuna (*Thunnus albacares*), 349.4 t of swordfish (*Xiphius gladius*) and 0.5 t of striped marlin (*Tetrapturus audax*). These catches represent less than 15 per cent of the peak catches taken by Australian vessels fishing in the IOTC Convention Area in 2001, for these five species combined. The number of active longliners and levels of fishing effort have declined substantially in recent years due to reduced profitability, primarily as a result of lower fish prices and higher operating costs. The catch of southern bluefin tuna (*Thunnus maccoyii*) in the purse seine fishery was 4039 t in 2010. There was no purse seine catch of skipjack tuna (*Katsuwonus pelamis*) in 2010. The peak skipjack catch taken by Australian vessels fishing in the IOTC Convention Area was 1039 t in 2001. In 2010, approximately 5 t of shark was landed by the Australian longline fleet operating in the IOTC Convention Area and approximately 14 000 sharks were discarded/released.

Belize

Long line is the main fishing method used by Belize flagged vessels to target tuna and tuna like species in the Indian Ocean Tuna Commission (IOTC) Convention area. In 2010 our fleet consisted of 7 long line vessels. Together they caught 141.125 m/t of Albacore tuna (*Thunnus alalunga*), 14.362 m/t of yellowfin tuna (*Thunnus albacares*), 31.456 m/t of bigeye tuna (*Thunnus obesus*), 6.689 m/t of swordfish (*Xiphius gladius*), 1.663 m/t of black marlin (*Makaria indica*) and 6.317 of Wahoo (*Acanthocybium solandri*). There has been an 88% reductions in our overall catches from 1257 m/t in 2007 to 201 m/t in 2010. Albacore has always been the main target species for our vessels from 2007 to 2010 followed by bigeye tuna, yellowfin and swordfish. The number of active long liners and levels of fishing effort have declined significantly in recent years due to reduced profitability, principally resulting from reduced fish prices and increased operating cost. The average size of our vessels from 2007 to 2010 have fluctuated over the years from 162 gt in 2007 to 241 gt in 2008, 88 gt in 2009 and 179 gt in 2010. There has also been a reduction in the number of vessels operating in this area from 10 vessels in 2007, 9 in 2008, 6 in 2009 and 7 in 2010.

China

Longline is the only fishing method used by Chinese vessels to catch tuna and tuna-like species in the IOTC waters. The number of longliners operating in the Indian Ocean reduced from 32 in 2009 to 20 in 2010 due to piracy, with the main fishing area shifting to the central and eastern Indian Ocean (60 ºE ~ 85ºE , 5ºN ~20ºS). Chinese fishing fleet caught 1894 MT of main tunas (BET, YFT) in 2010 (39 % lower than the catch of 3114 MT in 2009). The bigeye tuna and yellowfin tuna catches both from deep freezing longliners and ice fresh longliners have been declined dramatically since 2006. There was a remarkable increase in albacore catch for deep freezing longliner since 2009 and for ice fresh longliners since 2008. The logbook and observer programs are going on for the Chinese longline fleets in the Indian Ocean, for which catch and effort data collection of bycatch species are being improved. The observer trip report for 2010 has been submitted to the secretariat.

Comoros

Fishing in Comoros is exclusively artisanal, and operated on 3-9 m motorized or non-motorized wooden or fibreglass non-decked vessels. Comorian fishing exploits mainly pelagic species (*Thunnus albacares, Katsuwonus pelamis, Thunnus alalunga, Istiophorus platypterus, Thunnus obesus, Euthynnus affinis*) and contributes entirely to the population's diet, while providing 55% of total jobs in the agricultural sector, *i.e.* about 8,000 fishermen. According to the latest statistics in 1994, the production was estimated at about 9,822 tonnes. Troll line, drop line and few nets for small pelagic species are the main fishing techniques used. A trip lasts between one to seven days. For technical and financial reasons, since 1995 we haven't been able to continue data collection and processing. Since February 2011, Comoros have implemented a data collection system at unloading sites, thanks to technical and financial support from the IOTC and the OFCF.

Eritrea
National Report not provided.

European Union
Tuna fisheries and research activities of the EU countries through 2010 are outlined in the EU report, doc NR06. Four EU countries operate tuna activities in the Indian Ocean: two countries, Spain and France, have had large fleets of purse seiners and longliners for several decades, and catch significant amounts of tuna annually (average annual catches over the last decade: 150,000 t for Spain and 95,000t for France). Two other EU countries, Portugal and the United Kingdom have also operated tuna fishing activities in the area in recent years, but with longliners exclusively et at a small scale (average annual catches over the last decade: 1,160 t for Portugal and 630 t for the United Kingdom, mainly swordfish). All these fisheries have had good statistical monitoring, most of their catch, fishing effort and size frequency data have been submitted according to IOTC standards, and multi-species sampling has been supported and continuously carried out by scientists. Occasional statistical problems remain for some years and fleets, such as French Reunion longliners in 2009 and 2010, but they should be resolved shortly. Il has been observed in recent years that piracy, which has developed in the western Indian Ocean, has had a significant impact on the EU fleets, by reducing very significantly the number of purse seiners, longliners and supply vessels and their fishing effort, shifting effort and fishing areas since mid-2009 with armed forces on board all purse seiners, and prohibiting the boarding of observers since then. Despite this strong impact on fisheries, it is found that total catches and catches by species made by European purse seine fleets have been very stable for 4 years: a minimum of 192,000 t.in 2009 and 205,000t. in 2010 (despite the departure in 2010 of 7 of the 33 European purse seiners that were active in 2009). Research conducted by European researchers on tuna resources and harvest, on the different components of high-sea pelagic ecosystems and on bycatch, continued to be active and varied. This research is carried out by the different research bodies in EU countries (IEO, AZTI, IFREMER, IRD, CNRS, IPIMAR) in close cooperation with regional laboratories, in particular the SFA in Seychelles. The majority of research funded by the European Union, through its basic program of biological data collection, or through ad hoc research programmes, such as the MADE programme aiming at reducing tuna fishery discharge. Many scientific papers outlining the results obtained were submitted in 2011 by EU experts to the different IOTC working parties. Finally, note that the EU has just confirmed it will co-fund a symposium to be organized by the IOTC in November 2012, in order to carry out a thorough review of the numerous and very interesting results of the large tuna tagging programme conducted by the IOTC from 2005 to 2007, also financed by the EU. Scientists from the EU play an active part in the preparation of this important symposium, which results should improve significantly the reliability of stock assessments of skipjack, yellowfin and bigeye in the Indian Ocean.

France (territories)
Indian Ocean French territories include Mayotte, overseas community, and the Scattered Islands, which are administratively incorporated into the French Southern and Antarctic Lands (TAAF). The Mayotte Exclusive Economic Zone (EEZ) is a Marine Park (NMP) since January 2010, with a Management Board. The Glorioso EEZ, which is part of the Scattered Islands and adjoins the Mayotte EEZ, will likely become a Marine Park in December 2012. Total catches in the Indian Ocean of purse seiners registered in Mayotte amounted to 18,350 tonnes in 2010, corresponding to a significantly higher level than in 2009 (13,700 t), due to an increased fishing effort. The observer programme implemented in 2005, and then suspended in 2009 for safety reasons given the development of Somali piracy, resumed in 2011, in particular on the biggest purse seiners of the fleet, through collaboration with the TAAF. The artisanal coastal fishing fleet of Mayotte is composed of a great number of canoes and boats mainly engaged in drop line, troll line and net fishing, and of four small longliners (drifting pelagic longline) targeting tuna and swordfish, primarily. Catches by this fleet in the waters of Mayotte have increased in comparison with 2009. The current French tuna research system (IRD & Ifremer essentially) includes observatory-type activities, a study on migratory behaviours of large pelagic fishes, genetic studies for the delineation of stocks, studies on reproductive biology, the implementation of bycatch mitigation measures and a study on tropical ecosystem dynamics. Most of the projects are funded through international, European or national bids. A list of the different projects that continued or started in 2010-2011 can be found in the report.

Guinea
National Report not provided.

India

India's tuna fishing fleet includes coastal multipurpose boats operating a number of traditional gears, oceanic pole and line boats, small longliners and industrial longliners. The total production of tunas and tuna-like fishes, including neritic and oceanic tunas, billfishes and seerfishes during the year 2010 was 127616 tonnes, against a total production of 135262 tonnes during the year 2009. There was a reduction in production by the coastal fishery and increase in the tuna landings by oceanic sector during the year under report. There was considerable reduction in the quantity of tuna exports during the financial year 2010-11 compared to the year 2009-10. Survey conducted by the Fishery Survey of India in the EEZ revealed that sharks constitute 19.49% by number and 28.33% by weight to the total catch in the longline fishery. There are no reported instances of sea bird interaction in any of the Indian tuna fishery. Sea turtles, marine mammals and whale sharks are protected in India under various national legislations. Data on tuna production is collected by different agencies in India including Fishery Survey of India (FSI), Central Marine Fisheries Research Institute (CMFRI) and Marine Products Export Development Authority (MPEDA).

Indonesia

Fisheries management Areas (FMA) 572 (Indian Ocean – west Sumatera) and 573 (South of Java – East Nusa Tenggara), are two fisheries management area among eleven FMAs that located within the IOTC area of competence**.** Long line contribute a bigger proportion (44 %) of tuna catch com pare to other gears and the number of active long liners registered and operated on the two FMAs is 1118**.** The national catch of four main tuna species in 2009 is estimated 101,292 while the total catch for all species by all gears type tend to increase to just above 600,000 mt in 2010. Benoa fishing port has demonstrated a long history of both port sampling and scientific observer programs. Although observer data set is currently the most detailed and most reliable data available from the fishery expanding the coverage of scientific observer is substantially required. Indonesia since 10 October 2010 already has a National Plan of Action of the Shark (NPOA-Shark). Template of Indonesia fishing logbook was developed and regulated, however it is required more effort to introduce and implement for both to fishers as well as port officers as required by the commission.

Iran, Islamic Republic of

Tuna and tuna-like species fisheries is one of the most important activities in the Persian Gulf & Oman Sea. In 2010 a total of 5 industrial purse- seiners and 5920 Gillnetters operated in the area. GRT of purse seiners is >1000 t and GRT of Gillnetters ranges from less than 3 t to more than 100 t. Iranian Annual catch Tuna and tuna-like species in 2010 were estimated as follows: Yellowfin tuna: 31485 t; Skipjack tuna: 22285 t; Longtail tuna: 64450 t; Kawakawa: 16336 t; Frigate tuna: 6172 t; Billfish*: 9209 t; Indo-pacific king mackerel: 3170 t; Narrow- barred Spanish mackerel: 10884 t; Total catch: 163991 tons. *contain Sailfish and Marlin. The amount of catch for purse-seiners showed an ascending trend in 2010 comparing to 2009. The amount of catch for different fishing methods of purse seine, Gillnet and trolling was estimated 3377 t, 159320 t and 1294, respectively.

Japan

This Japanese national report describes following 8 issues in recent five years (2007-2011), i.e., (1) tuna fisheries (longline fishery and purse seine fishery) (2) fleet information, (3) catch and effort by species and gear, (4) ecosystem and bycatch, (5) national data collection and processing systems including "logbook data collection and verification", "vessel monitoring system", "scientific observer programme", "port sampling programme" and "unloading/transhipment", (6) national research programs and (7) Implementation of Scientific Committee recommendations & resolutions of the IOTC relevant to the Scientific Committee and (8) literature cited and working documents.

Kenya

Tuna fisheries in Kenya continue to play an important role in the socio-economic development of the country. Artisanal landings of 180 tons of tuna were realised in 2010 while a local longliner landed 137 tons. Recreational big- game fishing for tuna and billfishes landed 60 tons. The artisanal fleet structure remains multi-gear fleet of locally made crafts of varied capacities. Regarding tuna fisheries governance, Kenya is implementing port sampling, improving artisanal fisheries data collection system and playing an active part in implementing the national sea turtle conservation strategy.

Korea, Republic of

Longline is the only type of fishing gear for Korea fishing for tuna species in the Indian Ocean. Korean longline fishery in the Indian Ocean commenced in 1957. 13 longliners were operated in 2010, which were the lowest in number of vessels as it ranged from 31 to 21 during previous 5 years. With this fishing capacity, Korean longloners caught 2,723 mt in 2010, which was 8.6% decreasing of the catch in 2009. In 2010, fishing efforts were 5,079 thousand hooks and distributed higher in the western and eastern areas around 20-40 °S, while the fishing efforts averaged for 2005-2009 were 9,214 thousand hooks and distributed higher in the western areas around 20 °N -20 °S, as well as in the western and eastern areas around 20-40 °S. It was noted that fishing efforts had not been deployed in the western Indian Ocean around 20 °N -20 °S in recent years. As results, the catch of bigeye tuna and yellowfin tuna significantly decreased and albacore became important in catch. In 2010, 2 scientific observers were dispatched for monitoring compliance and scientific data collection and, as results, carried out 7.5 % of observer coverage in terms of the number of hooks.

Madagascar

The year 2010 saw a reconversion attempt of several artisanal prawn trawlers into targeting fish. Those were vessels of less than 12 m LOA. In addition, new handline vessels have started to operate along the eastern coast of Madagascar. Overall, fishing licences were granted to 41 vessels this year, developing a power of 3 398 KW for 1012 GRT. In general, those vessels operate several gears and target several species. Regarding research activities and data collection and processing, Madagascar, through the *Unité Statistique Thonière* in Antsiranana, is planning to implement projects aiming at assessing scrap fishes which are unloaded in Antsiranana and implementing a national database on sport fisheries.

Malaysia

Malaysia is considered as a new country in tuna fisheries in the Indian Ocean. And has experienced a drastic growth in tuna longline fleet from 15 vessels in 2003, the year when it started fishing to 58 in 2010. The highest catch was recorded in 2005 at 2885 tonnes. However, the tuna catch (*Thunnus albacares* and *Thunnus obesus*) from the past two years showed a significant dropped from 2,532 tonnes in 2008 to 1,138 tonnes in 2010. Similar pattern were observed in total effort (number of berthing) which decreased from 79 to 30 during the same period. The highest number of berthing was recorded in 2005 with 110 berthings. The catch of neritic tuna from the Malacca Straits (under IOTC areas of Competence) showed a steady increased in catch from 8,978 tonnes in 2001 to the record highest at 20,147 tonnes in 2010. The fishing areas only confined within the EEZ of Malaysian continental shelf with *Thunnus tonggol*, *Euthynnus affinis* and *Auxis thazard* formed the only known neritic tuna species found from these areas. Purse seine nets contributed over 90% of the neritic tuna landings from the Malacca Straits followed by trawl nets, gill/drift nets and hook & lines.

Maldives, Republic of

Maldives has a tuna fishery dating back hundreds of years. Fishing is conducted from pole-and-line vessels using livebait. Tuna catches increased to an all time record of 167,000 t in 2006 but have been steadily declining since then. The catch of 2010 was about 60,000 t, more than 50% lower than catches reported in 2006. The pole-and-line method contributes 75-80% of all tuna landings. A handline fishery targeting surface dwelling large yellowfin fishery started in later 1990s. Current catches from landline fishery are estimated to be 10,000 - 12,000 t exported fresh to lucrative markets of EU. Longline fishing is restricted to a licensed foreign fleet of round 25-30 vessels operating in outer EEZ of 75 miles and beyond. Licensing was suspended in 2010. A domestic fleet is now being developed with 4 vessels licensed to fish outside 100 miles range. Maldives used to have an important troll fishery targeting kawakawa and frigate tuna in the coastal areas and atoll basins. The fishery no longer exists and so trolling is now a very minor component of the tuna fishery. The national data collection is based on an enumeration system and requires use of conversion factors to estimate total catch. The conversion factors in use are inadequate both in magnitude and its coverage leading to potential bias in the estimate of total catches. Use of conversion factors however, is now getting less important as catches are also been recorded in weights and being reported through logbook system introduced in January 2010. Reporting from both methods will continue until fishermen have accustomed to reporting through logbooks. Maldives has limited amount of recreational fishing targeting large-bodied reef fish varieties in the so called 'night fishing'. More recently recreational fishing for pelagics is getting popular in the tourism sector. At present there is no formal method of the recording catches. The two main component of the tuna fishery (PL and HL) are extremely selective in their targets and therefore have almost zero bycatch and nothing is discarded. Sharks and other non-target species do occur in the longline fishery and their reporting is mandatory under the new rules on longline fishing.

Mauritius

Though Mauritius is not presently classified as a fishing nation for tuna species, however the tuna fishery forms the basis for the local fish processing industries. Tuna transhipment at Port Louis is another fish related activity. In 2010, a total of 592 calls of fishing vessels was registered and transhipped 43 723 tonnes of fish. The local longliner unloaded 306 tonnes of tuna and related species. Mauritius issued 225 licenses to foreign vessels to operate in its waters during 2010. Licences are issued to foreign longliners (mostly Asian) and purse seiners to operate in the Mauritian waters under a set of conditions which include the compliance of the vessels to international conservation and management measures, listing of the vessel in the Positive or Active lists of IOTC and mandatory VMS reporting. The sport fishery also lands about 330 tonnes of pelagic fishes mostly for the local market. An artisanal tuna fishery has also been developed around fish aggregating devices. Mauritius is implementing all the recommendations of the Scientific Committee. All tuna statistics collected are processed and are transmitted to the IOTC regularly. It has also developed its NPOA-IUU. A Standard Operating Procedure (SOP) is under preparation for the implementation of the NPOA-IUU as well as the IOTC Regulation 10/11on Port State Measures (PSM) to prevent, deter and eliminate IUU fishing. The implementation of an effective PSM would help control the harvest of fish caught in the IOTC Area and thereby would ensure the long-term conservation and sustainable use of these resources and the marine ecosystems.

Oman, Sultanate of

National Report not provided.

Pakistan

National Report not provided.

Philippines

National Report not provided.

Seychelles, Republic of

The Seychelles national report summarizes activities of the purse seine, longline and semi-industrial fishery for the past 5 years. The total catch for the whole Purse Seine fleet in 2010 is estimated at 279,244 MT, representing increase of 6% over the catches reported for 2009. The mean catch rate stands at 28.243 MT/ fishing day for 2010. CPUE has been on an increasing trend from 15.69 MT /fishing day in 2007. For the Seychelles fleet the total catch for 2010 is estimated at 75,787 MT, representing an increase of 11% and the mean catch rate stand at 29.26 MT/ fishing days. Skipjack remained the dominant species accounting for 55% of the total catch and 58% for the Seychelles catch. Similar to 2009, the year 2010 saw increasing effort on FADs associated schools whereas effort on free swimming schools dropped. For the longline fishery, a decrease of 39% was recorded in licensed issued and a remarkable increase to 83% in logbook return to SFA. The total catch for the Seychelles fleet in 2010 is estimated at 6,659 MT obtained from a fishing effort of 18 million hooks, representing a 16% drop in catch and 12% drop in fishing effort when compared to 2009. The total catch for the local semi industrial vessel targeting tuna and swordfish stands at 295MT representing a decrease of 10%. The fishing effort increase slightly by 4% from 484,597 hooks to 506,334 hooks. This fishery has been experiencing declining CPUE trends since 2007. The decline has been more significant over the past 2 years. Reported shark catches in the semi-industrial fishery has also decreased significantly since 2008. Seychelles has taken various actions to implement the Scientific Committee recommendations and IOTC Resolutions. Some of the actions include; modification of logbook format to meet mandatory minimum statistic requirement, particularly with regards to data recording of sharks in longline fishery, steps to implement a National Scientific Observer Programme, collaboration with other institutions on research projects focusing on bycatch mitigation, and swordfish (stock structure/ movement).

Sierra Leone

National Report not provided.

Sri Lanka

Sri Lanka is one of the oldest and most important tuna producing island in the Indian Ocean. Longline and the Gillnet are the main fishing gears used for harvesting of tuna and tuna like species. operation of the longlines has become more popular among fishermen, due to the provision of better quality fish than the gillnets. A recent survey indicated that around 20% of the local fishing fleet, used only longline with greater number of hooks per set, as the principal fishing gear, by mechanizing the gear operation, with line-haulers.Two boat types, OFRP and IMUL, which catogorised based on the size/length and the duration of the fishing trip are being operated in Neritic and Oceanic provinces around Sri Lanaka. According to this categorization, six boat types are being operated with the length of 6-7M, OFRPs (one day operating) and 9-10M, 10-12M, 12-15M, 15-18M length IMUL (operating oneday and >1day). Around 3700 boats are actively operated during the period of 2009 – 2010, for large pelagic fishery. About 1% of them are <15M in length.

The catches of tuna fishery resources are mainly, Yellowfin tuna (*Thunnus albacares),* Bigeye tuna (*Thunnus obsesus*), Skipjack tuna (*Katsuwonus pelamis*), Kawakawa (*Enthynnus affinis*), Frigate tuna (*Auxis thazard*) and Bullet tuna (*Auxis rochei*). The estimated total production of large pelagic species in 2010 was 136,626Mt. which is an increment of 28% to the production in 2009. Major portion of the catches of large pelagic varities, in 2010, consisted of tunas; 91,903mt. (66% of the total). Among tunas, skipjack tuna dominated the production, with 55,438Mt., followed by yellow fin tuna with 26,959Mt. Yellowfin tuna production has shown and increase of about 10%. Export of Chilled- yellowfin tuna has become a lucrative venture in recent times. Hence attention is being paid to the production maintanance of the quality of the tuna catch in terms of handling, storage and transport. Shashimi tuna and tuna-loins, etc. Of the yellowfin tuna are exported mainly to Japan and EU markets.

Sudan

National Report not provided.

Tanzania, United Republic of

Presently the national fleet of Tanzania is all artisanal that is involved in multi-species, multi-gear and multi-cultural fisheries. Most of the fishing takes place within 6nm from shore predominantly on reef areas. However a small number of boats are involved in the fisheries of tuna, bill fish and sharks, using manually handled drift gill nets and long lines. The catch data is collected in terms of weight of fish group and is not based on gear type, vessel size and duration of fishing operations. Statistics from the Fisheries Departments (of Zanzibar and the United Republic of Tanzania) show 1643 tonnes of Tuna species were fished in 2010 and information from Zanzibar alone shows catches of 1334 tonnes and 1418 tonnes of bill fish and shark-and-rays species respectively. There is no available data from the recreational fisheries, and because the artisanal fleet does not operate with any kind of a geographic positioning system there is no data on the distribution of fishing effort and fishing catch. Initial discussions on NPOAs for sharks, seabirds and marine turtles have commenced while terms and conditions related to the protection of these species are contained within the EEZ fishing licenses. Logsheet data started to be collected in 2002 from all licensed EEZ fishing vessels and a Vessel Monitoring System has been monitoring the Tanzania EEZ since 2009. There have been no Observer and Port sampling programmes as well as unloading and transhipment because Tanzanian Ports have no facilities for handling commercial deep sea fishing vessels. Current research programmes are focusing on the potential of establishing a national fleet for small pelagics and tuna and tuna like species in the Exclusive Economic Zone with the aim of reducing the rapidly increasing fishing pressure within the inshore waters.

Thailand

Neritic tuna and king mackerel species in the Andaman Sea Coast, Thailand comprise 6 species (*Thunnus tonggol*, *Euthynnus affinis*, *Auxis thazard*, *Katsuwonus pelamis* and *Sarda orientalis*, *Scomberomorus* spp.). These species were caught from purse seine, king mackerel gill net and trawl, while purse seine was the main fishing gear. The trend of neritic tuna catches have been decreasing from 45,083 tons in 1997 to 13,093 metric tons in 1999. The production was quite stable around 17,000 tons during 1999 to 2008. These neritic tuna species are more or less have its production trend similarity. Three Thai tuna longliners were operated in the Indian Ocean in 2007 and in 2008-2009 only two Thai tuna longliners kept on fishing there. Fishing grounds were mainly in the western coast of Indian Ocean. The total catches were 1,026.15 tons with 1,429 days of fishing effort. The average catch rate of total catch was the highest at 27.24 number/1,000 hooks in

2007 followed by 16.46 and 14.46 number/ 1,000 hooks in 2008 and 2009. Albacore was the dominant species in 2007 followed by yellowfin tuna and bigeye tuna in 2008 and 2009. While, tuna purse seine fishery operated by four Thai purse seiners, 227-670 fishing operations was conducted in the Indian Ocean during 2007-2010. Fishing ground was mainly in the western Indian Ocean. Tuna purse seine fishery can be operated throughout the year in both the eastern and western parts of the Indian Ocean with the peak from February - May and September - October. Total catch was 28,688.50 tonnes. It was found that skipjack tuna comprised the highest proportion (64.94%) followed by bigeye tuna (18.83%), yellowfin tuna (13.78%) and bonito (2.44%). The average size of skipjack, yellowfin and bigeye tuna were 50.34±9.87, 63.32±23.09 and 63.24±16.94 cm., respectively.

United Kingdom (BIOT)
On 1 April 2010 the BIOT Commissioner proclaimed a Marine Protected Area (MPA) in the British Indian Ocean Territory [UK (BIOT)]. No fishing licences have been issued since that date and the last foreign fishing licences expired on 31 October 2010. Diego Garcia and its territorial waters are excluded from the MPA and include a recreational fishery. The United Kingdom National Report summarises fishing in its recreational fishery in 2010 and provides details of research activities undertaken. BIOT does not operate a flag registry and has no commercial tuna fleet or fishing port. 28.4t of tuna and tuna like species were landed by recreational fishers on Diego Garcia in 2010. Length frequency data were recorded for a sample of 738 yellowfin tuna from this fishery. The mean length was 74cm. Sharks caught in the recreational fishery are released alive. There was no BIOT observer programme during 2010 on the licensed foreign fishery. IUU fishing remains the greatest threat to the BIOT ecosystem. Research was undertaken into the impact of the network of Indian Ocean MPAs. A Science Advisory Group has been formed to define a science strategy for BIOT and future research priorities, including those relevant to the pelagic ecosystem and IOTC fisheries. Recommendations of the Scientific Committee and those translated into Resolutions of the Commission have been implemented as appropriate by the BIOT Authorities and are reported.

Vanuatu
There was only longline fishery operated by Vanuatu in 2010 in the Indian Ocean. Four longliners targeted oilfishes with bycatch of yellowfin, bigeye and albacore tunas in the southwestern region of the Ocean. Total catch of 2010 was estimated to be 622.2 mt, with 383.0 mt for oilfishes, 93.9 mt for yellowfin tuna, 87.4 mt for bigeye tuna, 53.5 mt for albacore and 4.4 mt for swordfish (data is still preliminary). These data were compiled from the logsheets that submitted by the vessels. All the four vessels have now removed registration from Vanuatu.

Mozambique
Purse seine and long line are the two main fishing techniques used in Mozambique in the tuna fishery. Those activities are undertaken by distant water fishing fleets, which operate in the EEZ as from 12 nautical miles off shore from January to December. Purse seine fishing occurs mainly between the parallels 10º 32’ and 20º south. The purse seine fleet is composed of vessels from France, Spain and Seychelles. Long line fishing occurs between 20º and 26º 52’ south, with particular intensity below parallel 25º south. For the purse seine fleet, the peak period of fishing activities occurs between March and June. The longline fleet operates from January to December in Mozambique waters and the peak period is from December to February. During the last 5 years, the longline fleet was composed of vessels from Belize, Panama, Cambodia, Honduras, Japan, China, Korea, Spain and Taiwan. The fishery employs only foreign labour. The catches are conserved on board and transferred to cargo reefer ships or unloaded at foreign ports, mainly Seychelles, Madagascar, Mauritius and South Africa. The tuna fleet never calls to a Mozambican port for landing catches in Mozambique but call for pre-fishing briefing and inspection (Japan fleet). Over the last 10 years, the total catch in Mozambique waters ranges from 948 to 17.470 tonnes per year. For the period 2005 / 2010, 264 licenses and 486 licenses were issued respectively to purse seine vessels and longline vessels, giving an average of 125 tuna licenses issued per year. The number of longline vessels operating in Mozambique EEZ has declined substantially since 2007. In 2010, a total of 31 fishing companies were authorized to fish large pelagic species.

Senegal
In 2010, the Senegalese industrial tuna fleet consisted of 6 baitboats targeting mainly yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus*) and skipjack (*Katsuwonus pelamis*) and 1 longliner targeting swordfish. In addition, some artisanal fisheries (handline, troll line and purse seine) and the sport fishery catch billfishes

(marlins, swordfish and sailfish) and small tunas (kawakawa, king mackerel, frigate etc.). In 2010, total catches from Senegalese baitboats were estimated at 4,606 tonnes (1,168 tonnes of yellowfin, 2,412 tonnes of skipjack, 844 tonnes of bigeye). Catches have decreased in comparison with 2009 (6,720 tonnes). This decrease comes from the decline in fishing effort, from 1,574 fishing days in 2009 to 1,220 in 2010. Longline catches in 2010 are estimated at 312 tonnes (590 tonnes in 2009). Catches mainly consist of swordfish, sharks and marlins. Regarding artisanal fisheries, small tuna and tuna-like catches amounted to 8,719 tonnes. Catches have increased in comparison with 2009 (5,315 tonnes). Regarding the sport fishery, catches were estimated at 288 tonnes in 2010 for a fishing effort of 682 trips. Regular monitoring of tuna vessel fishing activities is still undertaken by the team set up by the CRODT at the port of Dakar. The work undertaken consists in collecting catch and fishing effort statistics. This work is complemented by information from various sources (plants, fitting-out, Department of Marine Fisheries etc.). Multi-species sampling are also undertaken in industrial and artisanal fisheries. Thanks to funds from the Enhanced Program for Billfish Research (EPBR), Istiophorid catch, effort and size sampling is improved at the main artisanal fishing unloading sites.

South Africa, Republic of

South Africa has three commercial fishing sectors which either target or catch tuna and tuna-like species as by-catch in the Indian Ocean. These sectors are swordfish/tuna longline, pole and line/ rod and reel, and shark longline. In addition, there is a boat-based recreational/sport fishery.

APPENDIX V
PROGRESS ON THE DEVELOPMENT AND IMPLEMENTATION OF NPOAS FOR SHARKS AND SEABIRDS

CPC	Sharks	Date of Implementation	Seabirds	Date of implementation	Comments
MEMBERS					
Australia		14-Apr-2004		2006	Sharks: 2nd NPOA-Sharks due to be released by end of 2011. Seabirds: Threat Abatement Plan (longline fishery only) in review. No Plan for purse seine or other gears.
Belize					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
China		–		–	Sharks: Development has not begun. Seabirds: Development has not begun.
–Taiwan,China		May 2006		May 2006	Sharks: No revision currently planned. Seabirds: No revision currently planned.
Comoros		–		–	Sharks: Development has not begun. Seabirds: Development has not begun.
Eritrea					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
European Union		5 Feb 2009		–	Sharks: Approved on 05-Feb-2009 and it is currently being implemented. Seabirds: Currently being finalised for adoption in the last quarter of 2011.
France (territories)					Sharks: Approved on 05-Feb-2009 but not yet implemented. Seabirds: No information received by the Secretariat.
Guinea					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
India					Sharks: Currently being drafted with the assistance of BOBP-IGO Seabirds: India has determined that seabird interactions are not a problem for their fleets.
Indonesia		–		–	Sharks: NPOA guidelines developed and released for public comment among stakeholders in 2010 (funded by ACIAR Australia—DGCF). Training to occur in 2011, including data collection for sharks based on forms of statistical data to national standards (by DGCF (supported by ACIAR Australia). Implementation expected late 2011/early 2012. Seabirds: Development has not begun.
Iran, Islamic Republic of		–		–	Sharks: Have communicated to all fishing cooperatives the IOTC resolutions on sharks. Have in place a ban on the retention of live sharks. Seabirds: I.R. Iran determined that seabird interactions are not a problem for their fleet as they consist of gillnet vessels only.
Japan		03-Dec-2009		03-Dec-2009	Sharks: NPOA–Shark assessment report submitted to COFI in Jan. 2011 Seabirds: NPOA–Seabird implementation report submitted to COFI in Jan. 2011.
Kenya					Sharks: Development has not begun. Scheduled for development in 2012. Sharks are

					considered a target species by Kenya. Seabirds: Development has not begun. Scheduled for development in 2012. Kenya has a single longliner targeting swordfish and no seabird interactions have been reported to date.
Korea, Republic of		–		–	Sharks: Approved on 18/08/2011 but not yet implemented. Seabirds: Early stages of development.
Madagascar		–		–	Sharks: Development has not begun. Seabirds: Development has not begun. Note: A fisheries monitoring system is in place in order to ensure compliance by vessels with the IOTC's shark and seabird conservation and management measures.
Malaysia		2006			Sharks: No update received by the Secretariat. Seabirds: No information received by the Secretariat.
Maldives, Republic of					Sharks: NPOA has been formulated and will be discussed with stakeholders in November 2011. Shark fishing was banned on 15th March 2010 based on scientific advice. The Government has spent ~US$5 million on a gear buyback scheme from Maldivian fishers. Seabirds: Development has not begun.
Mauritius					Sharks: Currently being drafted. Seabirds: Drafting will commence upon completion of NPOA–Sharks. In the meantime fishing companies have been requested to implement all mitigation measures as provided in the IOTC Resolutions.
Oman, Sultinate of					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
Pakistan					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
Philippines		Sept. 2009		–	Sharks: Under periodic review. Shark catches for 2010 provided to the Secretariat. Seabirds: Development has not begun. No seabird interactions recorded.
Seychelles, Republic of		Apr-2007		–	Sharks: NPOA-sharks to be reviewed in 2012. Seabirds: Development has not begun.
Sierra Leone					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
Sri Lanka					Sharks: An NPOA-sharks is planned for development in 2012 and an update will be provided at the next SC meeting. Seabirds: Sri Lanka has determined that seabird interactions are not a problem for their fleets.
Sudan					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
Tanzania, United Republic of		–		–	Sharks: Initial discussions have commenced. Seabirds: Initial discussions have commenced. Note: Terms and conditions related to protected sharks and seabirds contained within fishing licenses.
Thailand		23-Nov-2005		–	Sharks: No revision currently planned. Seabirds: Development has not begun.
United Kingdom		–		–	Chagos waters are a MPA closed to fishing except recreational fishing around Diego Garcia. Section 7 (10) (e) of the Fisheries (Conservation and Management) Ordinance

					refers to recreational fishing and requires sharks to be released alive.
Vanuatu					Sharks: No information received by the Secretariat. Seabirds: No information received by the Secretariat.
COOPERATING NON-CONTRACTING PARTIES					
Mozambique		–		–	Sharks: Development has not begun. Seabirds: Development has not begun.
Senegal		25-Sept-2006		–	Sharks: The Sub-Regional Fisheries Commission supported the development of a NPOA-sharks for Senegal in 2005. Other activities conducted include the organization of consultations with industry, the investigation of shark biology and social -economics of shark fisheries). The NPOA is currently being revised. Consideration is being made to the inclusion of minimum mesh size, minimum shark size, and a ban on shark finning. Seabirds: The need for a NPOA-seabirds has not yet been assessed.
South Africa, Republic of		–		2008	Sharks: Currently being drafted. Seabirds: Not currently under review.

Colour key	
NPOA Completed	
Drafting being finalised	
Drafting commenced	
Not begun	

APPENDIX VI
AVAILABILITY OF CATCH DATA FOR SHARKS BY GEAR

Availability of catch data for the main shark species expressed as the amount of fleets (%) for which catch data on sharks are available out of the total number of fleets for which data on IOTC species are available, by fishery, species of shark, and year, for the period 1950–2010

a. Longline and gillnet fisheries

Availability of catch data for main shark species expressed as the amount of fleets (%) for which catch data on sharks are available out of the total number of fleets for which data on IOTC species are available, by fishery, species of shark, and year, for the period 1950–2010

b. Purse seine and pole-and-line* fisheries

*** Note that catch rates of sharks on pole-and-line fisheries are thought to be nil or negligible**

Availability of catch data for main shark species expressed as the amount of fleets (%) for which catch data on sharks are available out of the total number of fleets for which data on IOTC species are available, by fishery, species of shark, and year, for the period 1950–2010

c. Handline, trolling (Line) and other fisheries operated in coastal waters (Other)

APPENDIX VII
LIST OF CHAIRS, VICE-CHAIRS AND THEIR RESPECTIVE TERMS FOR ALL IOTC SCIENCE BODIES

Group	Chair/Vice-Chair	Chair	CPC/Affiliation	Term commencement date	Term expiration date (End date is until replacement is elected)	Comments
SC	Chair	Dr. Tsutomu Nishida	Japan	17 December 2011	End of SC in 2013	1st term
	Vice-Chair	Mr. Jan Robinson	Seychelles	17 December 2011	End of SC in 2013	1st term
WPB	Chair	Mr. Jerome Bourjea	La Reunion/France	08 July 2011	End of WPB in 2013	1st term
	Vice-Chair	Mr Miguel Santos	EU,Portugal	08 July 2011	End of WPB in 2013	1st term
WPTmT	Chair	Dr. Zang Geun Kim	Korea, Rep. of	22 September 2011	End of WPTmT in 2013	1st term
	Vice-Chair	Dr. Tsutomu Nishida	Japan	22 September 2011	End of WPTmT in 2013	1st term
WPTT	Chair	Dr. Hilario Murua	EU,Spain	25 October 2010	End of WPTT in 2012	1st term
	Vice-Chair	Dr. Shiham Adam	Maldives, Rep. of	23 October 2011	End of WPTT in 2013	1st term
WPEB	Chair	Dr. Charles Anderson	UK/Independent	14 October 2010	End of WPEB in 2013	2nd term
	Vice-Chair	Dr. Evgeny Romanov	La Reunion/France	27 October 2011	End of WPEB in 2013	1st term
WPNT	Chair	Dr. Prathibha Rohit	India	27 November 2011	End of WPNT in 2013	1st term
	Vice-Chair	Mr. Farhad Kaymaram	I.R. Iran	27 November 2011	End of WPNT in 2013	1st term
WPDCS	Chair	Mr. Miguel Herrera	Secretariat	04 December 2010	End of WPDCS 2012	2nd term
	Vice-Chair	Dr. Pierre Chavance	European Union	10 December 2011	End of WPDCS 2013	1st term
WPM	Chair (Coordinator)	Dr. Iago Mosqueira	European Union	18 December 2011	Start of WPM 2012	Interim
	Vice-Chair (Co-Coordinator)	Dr. Toshihide Kitakado	Japan	18 December 2011	Start of WPM 2012	Interim
WPFC	Chair	Not active	Not active	Not active	Not active	Not active
	Vice-Chair	Not active	Not active	Not active	Not active	Not active

APPENDIX VIII
CONSOLIDATED RECOMMENDATIONS TO CPCS ON IMPROVED DATA COLLECTION, MONITORING, REPORTING AND RESEARCH

Working Party on Billfish

Data collection and reporting systems

The SC **RECOMMENDED** that as a matter of priority, India, Iran and Pakistan provide catch-and-effort data and size data for billfish, in particular gillnet fisheries, as soon as possible, noting that this is already a mandatory reporting requirement.

Species identification

The SC **RECOMMENDED** that marlin and sailfish identification material, currently being used by the La Réunion fleets, be provided to the IOTC Secretariat in the coming months to aid in the development of the identification cards.

Sampling coverage

The SC **RECOMMENDED** that Japan increase sampling coverage to attain the minimum recommended by the Commission (1 fish by metric ton of catch by type of gear and species).

Size data

NOTING that the EU,Portugal had recently reported size data for swordfish from its longline fleets; The SC **RECOMMENDED** that the EU,Portugal report size data for marlin and sailfish species for its longline fleets, noting that this is already a mandatory reporting requirement.

NOTING that eleven longliners from the EU,United Kingdom, Kenya, Guinea, and Tanzania have operated in the Indian Ocean in recent years; The SC **RECOMMENDED** that the EU,United Kingdom, Kenya, Guinea, and Tanzania make every possible effort to collect and report size data for billfish species for their longline fleets, noting that this is already a mandatory reporting requirement.

The SC **RECOMMENDED** that Japan and Taiwan,China analyse the size samples collected from their longline fisheries for swordfish and marlins in order to verify if the length frequencies derived from such samples are representative of their fisheries. In particular Japan to compare length frequency distributions derived from samples collected:

- by fishermen on commercial vessels
- by observers on commercial vessels
- by scientists on research and training vessels.

The SC **RECOMMENDED** that Taiwan,China collect and provide the IOTC Secretariat with size data for billfish caught by its fresh tuna longliners, noting that this is already a mandatory requirement.

The SC **RECOMMENDED** that the EU,Spain longline fleet provide the IOTC Secretariat with catch-and-effort and size data of marlins and sailfish by time and area strata, noting that this is already a mandatory reporting requirement.

Sports fisheries

The SC **RECOMMENDED** that the African Billfish Foundation continue its important work, particularly in the areas of collaborative research aimed at obtaining more information on movements of billfishes, via both conventional and archival tagging programs that will allow the collection of information on both horizontal and vertical movements.

Mozambique billfish landings

The SC **RECOMMENDED** that sports fishery and other recreational fishery catches taken from Mozambique waters should be reported to the WPB in 2012.

India longline fishery: Indo-Pacific sailfish

The SC **RECOMMENDED** that Indian scientists continue to carry out new and innovative research on billfish species, and to report findings to each WPB meeting.

Sri Lankan billfish fisheries

The SC **RECOMMENDED** that as a matter of priority, Sri Lanka increase sampling coverage to attain at least the coverage levels recommended by the Commission, including:

- catches sampled for at least 5% of the vessel activities for coastal fisheries, including collection of catch, effort and size data for IOTC species and main bycatch species;
- implementation of logbook systems for offshore fisheries.

The information collected through the above activities should allow Sri Lanka to estimate catches by gear and species for billfish and other important IOTC or bycatch species.

The SC **RECOMMENDED** that billfish catches by Sri Lankan vessels, by gear and location, as per IOTC requirements, be presented at the next WPB meeting.

Portuguese longline fishery

The SC **RECOMMENDED** that EU,Portugal scientists undertake a CPUE analysis for the EU,Portugal longline fleet, and to consider combining the analysis with catch-and-effort data from the EU,Spain longline fleet for the next WPB meeting.

Logbook coverage

The SC **RECOMMENDED** that Japan and Taiwan,China analyse the size samples collected from their longline fisheries for swordfish and marlins in order to verify if the length frequencies derived from such samples are representative of their fisheries. In particular Japan to compare length frequency distributions derived from samples collected:

- by fishermen on commercial vessels
- by observers on commercial vessels
- by scientists on research and training vessels.

Working Party on Temperate Tunas

Review of the data available for temperate tuna species

The SC **NOTED** the main albacore data issues that are considered to negatively affect the quality of the statistics available at the IOTC, by type of dataset and fishery, which are provided in Appendix V [Report of the WPTmT03], and **RECOMMENDED** that the CPCs listed in the Appendix, make efforts to remedy the data issues identified and to report back to the WPTmT at its next meeting.

Logbook coverage

The SC **RECOMMENDED** that the main fleets catching albacore (Japan, Taiwan,China and Indonesia) collect biological information on albacore caught in their fisheries, preferably through observer programmes, and provide this information (including the raw data) to the Secretariat in 2012.

Catch-and-effort and Size data

The SC **RECOMMENDED** that as a matter of priority, India provide catch-and-effort data and size data for temperate tuna, in particular from its commercial longline fleet, as soon as possible, noting that this is already a mandatory reporting requirement.

The SC **RECOMMENDED** that as a matter of priority, Indonesia and Malaysia provide catch-and-effort data and size data for temperate tuna, in particular for their fresh tuna and/or deep-freezing longline fleets, as soon as possible, noting that this is already a mandatory reporting requirement. Reporting should also include data from their vessels operating from other CPCs.

The SC **RECOMMENDED** that size data for albacore from the Japanese longline fleet are collected and reported to the IOTC Secretariat in 2012, with a summary to be provided to the WPTmT.

The SC **RECOMMENDED** that Japan and Taiwan,China analyse the size samples collected from their longline fisheries for albacore in order to verify if the length frequencies derived from such samples are representative of their fisheries. In particular Japan to compare length frequency distributions derived from samples collected:

- by fishermen on commercial vessels
- by observers on commercial vessels
- by scientists on research and training vessels.

The SC **RECOMMENDED** that as a matter of priority, the Philippines provide size data for temperate tuna, noting that this is already a mandatory reporting requirement.

Observer data from China

Noting that the current information available on albacore biology from the Indian Ocean is limited, the SC **RECOMMENDED** that China provide further updates on research carried out as part of its national observer program, at the next session of the SC and **ENCOURAGED** other CPCs to provide similar research reports on albacore biology, either from data collected through observer programs or other research programs, at the next WPTmT meeting.

Noting that there are difficulties faced by some CPCs in collecting gonad samples from albacore – albacore is generally frozen whole and not gutted, the SC **RECOMMENDED** that CPCs, in particular Japan, collect gonad samples from albacore to confirm the spawning time and location of the spawning area that are presently hypothesized for albacore, over the coming year and to report findings at the next WPTmT.

Korean catch and effort for albacore

Noting that the nominal catch (NC) data provided at the WPTmT03 meeting was found to conflict with the NC data history provided by the Republic of Korea for all years prior to 1994, and for catch-and-effort data for most of the history of the longline fleet, the SC **RECOMMENDED** that the Rep. of Korea liaise with the Secretariat to provide a fully justified revised catch history which will replace the data currently held by the Secretariat before the end of 2011.

Indonesian longline fishery

Noting that Indonesian catches represent more than 40% of the total albacore catches in the Indian Ocean, determined from the revised catch history developed by the Secretariat, the SC **RECOMMENDED** that Indonesia further strengthen sampling efforts on its coastal and off-shore fisheries in early 2012, where required, and liaise with the Secretariat in order to better determine the catches of albacore by the Indonesian longline fleet.

The SC **RECOMMENDED** that as a matter of priority, India, Indonesia and Japan increase sampling coverage to attain at least the coverage levels recommended by the Commission, including:

- catches sampled or observed for at least 5% of the vessel activities, including collection of catch, effort and size data for IOTC species and main bycatch species;

- implementation of logbook systems for offshore fisheries.

The information collected through the above activities should allow India, Indonesia and Japan to estimate catches by gear and species.

Piracy in the Indian Ocean

The SC **RECOMMENDED** that given the potential impacts of piracy on the albacore fishery through the relocation of longliners into traditional albacore fishing grounds, specific analysis should be carried out and presented at the next WPTmT meeting by CPCs most affected by these activities, including Japan, Republic of Korea and Taiwan,China.

CPUE discussion summary

The SC **RECOMMENDED** that the following matters be taken into account when undertaking CPUE standardisation analysis:

- The SC **AGREED** that changes in species targeting is the most important issue to address in CPUE standardisations, and that the following points should be taken into consideration:
  i. While hooks between floats (HBF) provides some indication of setting depth, it is generally considered not to be a sufficient indicator of species targeting. HBF is just one aspect of the setting technique, which can vary by species, area, set-time, and other factors.
  ii. Highly aggregated (e.g. 5x5 degrees) data can make it difficult to observe the factors driving CPUE in a fishery, in particular the targeting effects. Operational data provides additional information that may allow effort to be classified according to fishing strategy (e.g. using cluster analyses or regression trees to estimate species targeting as a function of spatial areas, bait type, catch species composition, set-time, vessel-identity, skipper, etc.). Operational data also permits vessel effects to be included in analyses.
  iii. The inclusion of other species as factors in a Generalized Linear Model (GLM) standardization may be misleading, because the abundance of all species changes over time. Including these factors may also fail to resolve problems due to changes in targeting, particularly when modeling aggregated data. However, comparing models with and without the other species factors can be useful to identify whether there is likely to be a targeting problem.
- The SC **AGREED** that appropriate spatial structure needs to be considered carefully as fish density (and targeting practices) can be highly variable on a fine spatial scale, and it can be misleading to assume that large areas are homogenous when there are large shifts in the spatial distribution of effort. The following points should also be taken into consideration:
  i. Addition of finer scale (e.g. 5x5 degrees) fixed spatial effects in the model can help to account for heterogeneity within sub-regions.
  ii. Efforts should be made to identify spatial units that are relatively homogeneous in terms of the population and fishery to the extent possible (e.g. uniform catch size composition and targeting practices).
  iii. There may be advantages in conducting separate analyses for different sub-regions. The error distribution may differ by sub-region (e.g. proportion of zero sets), and there may be very different interactions among explanatory variables.
  iv. If the selectivity differs among regions (e.g. due to spatial variability in the age composition of the population, it may not be appropriate to pool sub-regional indices into a regional index (e.g. albacore populations seem to be partitioned with spawners caught predominantly in the equatorial/tropical regions and juveniles caught predominantly in the temperate waters and the two age categories could have somewhat different CPUE trends).
  v. The possibility of defining a representative ‘space-time’ window: if this leads to the identification of a fishery with homogeneous targeting practices, it is probably worthwhile. However, it may not be possible to identify an appropriate window, or the window may be so small that it is not representative of the larger population (or has a high variance).
- The SC **AGREED** that if there are many observations with positive effort and zero catch, it is worth considering models which explicitly model the processes that lead to the zero observations (e.g. negative binomial, zero-inflated or delta models). Adding a small constant to the lognormal model may be okay if there are few zeroes, but may not be appropriate for areas with many zero catches (e.g. north of 10^{o}S). Sensitivity to the choice of constant should be tested.
- The SC **NOTED** that the appropriate inclusion of environmental variables in CPUE standardization is an ongoing research topic. The SC **AGREED** that often these variables do not have as much explanatory power as, or may be confounded with, fixed spatial effects. This may indicate that model-derived environmental fields are not accurate enough at this time, or there may need to be careful consideration of the mechanisms of interaction to include the variable in the most informative way.
- The SC **AGREED** that it is difficult to prescribe analyses in advance, and model building should be undertaken as an iterative process to investigate the processes in the fishery that affect the relationship between CPUE and abundance. Specifically:

i. Model building should proceed with a stepwise introduction of explanatory terms, in which the net effect of each level of complexity is presented. Parameter estimates should be presented and examined to see if the mechanism makes sense and the contribution has a practical influence.
ii. Simulations have shown that model selection using Akaike Information Criterion (AIC) tends to recommend over-parameterized models.

The SC also **ENCOURAGED** data to be used in stock assessments, including CPUE standardisations, be made available not less than three months before each meeting by CPCs and where possible, data summaries no later than two months prior to each meeting, from the IOTC Secretariat; and **RECOMMENDED** that data to be used in stock assessments, including CPUE standardisations be made available not less than 30 days before each meeting by CPCs.

Stock assessment

Noting that the only stock assessment for albacore was not made available by the authors until the 19th September, 2011 which did not allow the other participants of the meeting to adequately review the methodology, the SC reminded working party participants of the 2010 Scientific Committee **RECOMMENDATION** that stock assessment papers need to be provided to the Secretariat for posting to the IOTC website no later than 15 days before the commencement of the relevant meeting.

The SC **AGREED** that there is value in undertaking a number of different modelling approaches to facilitate comparison, and **RECOMMENDED** that spatially structured integrated models, which are capable of more detailed representation of complicated population and fishery dynamics, and integrate several sources of data and biological research that cannot be considered in the simpler production models, be carried out for the next WPTmT.

Working Party on Tropical Tunas

Review of the data available for tropical tuna species

The SC **NOTED** the main tropical tuna data issues that are considered to negatively affect the quality of the statistics available at the IOTC, by type of dataset and fishery, which are provided in Appendix V [Report of the WPTT13], and **RECOMMENDED** that the CPCs listed in Appendix V [Report of the WPTT13] make efforts to remedy the data issues identified and to report back to the WPTT at its next meeting.

Review of the data available for tropical tuna species

The SC **RECOMMENDED** that as a matter of priority, Pakistan provide catch-and-effort data and size data for tropical tunas, in particular from their gillnet fisheries, noting that this is already a mandatory reporting requirement.

The SC welcomed the efforts of Sri Lanka to improve data collection and management for its fisheries and **RECOMMENDED** that the IOTC-OFCF project and Sri Lanka continue their cooperation towards improving the collection and reporting of fisheries statistics and to report back to the WPTT at its 2012 Session.

The SC **RECOMMENDED** that Maldives report catch and effort data as per the IOTC standards for 2010 and that for earlier statistics (2002 to 2009), and that they are reported by atoll, month, gear and species, as it was done in the past.

The SC urged Madagascar and Yemen to collect and report statistics on their coastal fisheries and **RECOMMENDED** that these countries request assistance from the IOTC Secretariat where required.

The SC **RECOMMENDED** that Philippines investigate the reasons for the differences between bigeye tuna export data and reported catch data from their longline fishery, and to report findings to the next WPTT meeting.

The SC **RECOMMENDED** that Iran and Pakistan report size data for tropical tuna species, as per the IOTC requirements, for their gillnet fleets, noting that this is already a mandatory reporting requirement, and that the Secretariat assist Iran and Pakistan to facilitate reporting of this information where required.

The SC **RECOMMENDED** that India, Malaysia, Oman and Philippines make every possible effort to collect and report size data for tropical tuna species for their longline fleets, noting that this is already a mandatory reporting requirement.

The SC **RECOMMENDED** that Indonesia report size data for tropical tuna species for its longline vessels as soon as possible as per IOTC standards, noting that this is already a mandatory reporting requirement.

The SC **RECOMMENDED** that Japan increase sampling coverage to attain at least the minimum required by the IOTC Resolution 10/02 *on mandatory statistical requirements* (1 fish by metric ton of catch by type of gear and species), and for the IOTC Secretariat to assess levels of reporting for Japan upon receiving size data for 2010 and to report back to the WPTT at its next meeting

The SC **RECOMMENDED** that biological data is gathered and reported to the IOTC Secretariat in order to develop specific length-age, length-weight and processed weight-live keys for the Indian Ocean tropical tuna species, in particular by the main longline fisheries (Taiwan,China, Indonesia, Japan, EU and China).

Noting the importance of biological information to be considered in the stock assessment models, the SC **RECOMMENDED** that gonad collection and calculation of the gonadosomatic index for yellowfin tuna be carried out prior to the next WPTT meeting.

The SC **RECOMMENDED** that Japan and Taiwan,China review catch, effort and size frequency datasets in order to assess reasons for discrepancies identified by the IOTC Secretariat and to report results at the next meeting of the WPTT, including a comparison of length frequency data samples collected from commercial and research and training vessels.

The SC **RECOMMENDED** that all CPCs catching small yellowfin tuna should undertake scientific sampling of their yellowfin tuna catches in order to identify potential bigeye tuna catches (in particular for those CPCs identified in previous paragraphs) and to report findings at the next WPTT meeting.

Mozambique catch data

Noting the difficulties Mozambique has experienced in receiving the logbooks of fishing vessels licensed to fish in its EEZ, the SC **RECOMMENDED** that the CPCs concerned send the logbook data to Mozambique, noting that this is already a mandatory requirement under IOTC Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area* and Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.

Noting that to date, Mozambique has not reported data for its coastal fisheries to the IOTC Secretariat the SC **RECOMMENDED** that data are collected and reported as soon as possible.

Comoros artisanal fisheries

The SC welcomed the implementation of a frame survey and of a new sampling programme in the Comoros and strongly **RECOMMENDED** that Comoros maintain this activity after the end of the programme to be able to report annual data as per IOTC requirements.

Malaysian fisheries

Noting that to date, vessels flagged to Malaysia are not using logbooks to record their activities, as required by IOTC Resolution 08/04, which includes minimum requirements for collecting and reporting operational data, the SC **RECOMMENDED** that Malaysia implement the requirements under Resolution 08/04 as a matter of priority.

Indian fisheries

Noting that India has a large data set collected on the research longline vessels operated by the Fishery Survey of India during the last 30 years, the SC **RECOMMENDED** that Indian scientists participate in the CPUE standardization workshop in order to assess the value of using this information.

Thailand fisheries

Noting that both the total catches and species composition presented for purse seine vessels flagged to Thailand were substantially different from those reported for other purse seine fleets operating in the Indian Ocean, and that the difference may originate from Thai and EU purse seiners operating in different areas, the SC **RECOMMENED** that the EU and Thailand further investigate the reasons for this difference and to report findings to the next WPTT meeting.

Republic of Korea longline fishery

Noting that the nominal catch (NC) and the catch-and-effort (CE) data provided at the WPTT13 meeting was found to conflict with the historical data for the longline fleet previously provided by the Rep. of Korea to the IOTC Secretariat, and that the differences were due to the ongoing internal data review by the Rep. of Korea, the SC **RECOMMENDED** that the Rep. of Korea liaise with the Secretariat to provide a fully justified revised catch history which will replace the data currently held by the Secretariat before the end of 2011.

I.R. Iran fisheries

The SC **RECOMMENDED** that the I.R. Iran strengthen its port sampling so that bigeye tuna can be properly identified and its catches estimated routinely by field samplers.

Maldives tuna length sampling

Noting that to date no bigeye tuna have been reported as being caught by the Maldives pole-and-line fleet, despite independent verification of substantial numbers of bigeye tuna being caught by these vessels, the SC **RECOMMENDED** that the Maldives rapidly improve species identification in logbooks and in their sampling programme.

Maldives yellowfin tuna fishery

The SC commended the authors for the efforts devoted to reviewing the time-series of catch and length data for the fisheries in the Maldives and the results presented to the meeting. In this regard, the SC **RECOMMENDED** that the revised dataset be reported to the IOTC Secretariat by the end of 2011, so that the IOTC databases can be updated to include the latest estimates produced by the Maldives.

Noting that an ad-hoc procedure had been used to separate length frequency samples of yellowfin tuna not recorded by gear, in particular those combining specimens of yellowfin tuna caught by pole-and-line and handline gears during the same trip, the SC **RECOMMENDED** that the Maldives validate the procedure using samples collected for each individual gear, in port or, where not possible, through observers onboard baitboats, and to report progress to the next WPTT meeting.

Maldives skipjack tuna fishery

Noting that the Maldivian skipjack tuna catch is not separated for FAD and free schools, and therefore the proportion of skipjack tuna caught under the FADs anchored around the Maldives is unknown, the SC **RECOMMENDED** that the Maldivian data collection system is improved in order to account for the association of the reported catch, as this could improve the standardization of the pole-and-line CPUE.

Review of new information on the status of skipjack tuna

Noting that catch rates by free and associated school sets for purse seine have showed analogous absolute levels on yearly fluctuations over the time-series, the SC **RECOMMENDED** that EU scientists explore the reasons for this, and to report findings at the next session of the WPTT.

The SC **RECOMMENDED** further investigation of the existing data irregularities, and expansion of the logbook programme to improve CPUE analyses for skipjack tuna in the Indian Ocean, and for information on these matters to be presented to the next meeting of the WPTT.

Review of new information on the status of yellowfin tuna

The SC **NOTED** that the change in gear appears to have had the effect of increasing the ratio of yellowfin tuna in the Japanese longline catch when compared to bigeye tuna. The SC also **NOTED** that other factors associated with targeting shifts could be explored in more detail (e.g. NHFCL might not always be the best indicator of hook depth or targeting). Understanding the interactions among NHFCL, fine-scale oceanographic condition, and gear shape under the water might bring further improvement of the CPUE standardization and, thus, the SC **RECOMMENDED** to further examine those issues in the future.

Review of new information on the status of bigeye tuna

The SC **RECOMMENDED** that the following matters be taken into account when undertaking CPUE standardisation analysis for bigeye tuna as well as yellowfin tuna in 2012:

- The SC **AGREED** that changes in species targeting is the most important issue to address in CPUE standardisations, and that the following points should be taken into consideration:
  - i. While hooks between floats (HBF) provides some indication of setting depth, it is generally considered not to be a sufficient indicator of species targeting. HBF is just one aspect of the setting technique, which can vary by species, area, set-time, and other factors.
  - ii. Highly aggregated (e.g. 5x5 degrees) data can make it difficult to observe the factors driving CPUE in a fishery, in particular the targeting effects. Operational data provides additional information that may allow effort to be classified according to fishing strategy (e.g. using cluster analyses or regression trees to estimate species targeting as a function of spatial areas, bait type, catch species composition, set-time, vessel-identity, skipper, etc.). Operational data also permits vessel effects to be included in analyses.
  - iii. The inclusion of other species as factors in a Generalized Linear Model (GLM) standardization may be misleading, because the abundance of all species changes over time. Including these factors may also fail to resolve problems due to changes in targeting, particularly when modeling aggregated data. However, comparing models with and without the other species factors can be useful to identify whether there is likely to be a targeting problem.
- The SC **AGREED** that appropriate spatial structure needs to be considered carefully as fish density (and targeting practices) can be highly variable on a fine spatial scale, and it can be misleading to assume that large areas are homogenous when there are large shifts in the spatial distribution of effort. The following points should also be taken into consideration:
  - vi. Addition of finer scale (e.g. 1x1 degrees or latitude/longitude) fixed spatial effects in the model can help to account for heterogeneity within sub-regions.
  - vii. Efforts should be made to identify spatial units that are relatively homogeneous in terms of the population and fishery to the extent possible (e.g. uniform catch size composition and targeting practices).
  - viii. There may be advantages in conducting separate analyses for different sub-regions. The error distribution may differ by sub-region (e.g. proportion of zero sets), and there may be very different interactions among explanatory variables.
  - ix. If the selectivity differs among regions (e.g. due to spatial variability in the age composition of the population), it may not be appropriate to pool sub-regional indices into a regional index.
  - x. The possibility of defining a representative 'space-time' window: if this leads to the identification of a fishery with homogeneous targeting practices, it is probably worthwhile. However, it may not be possible to identify an appropriate window, or the window may be so small that it is not representative of the larger population (or has a high variance).
- The SC **NOTED** that the appropriate inclusion of environmental variables in CPUE standardization is an ongoing research topic. The SC **AGREED** that often these variables do not have as much explanatory power as, or may be confounded with, fixed spatial effects. This may indicate that model-derived environmental fields are not accurate enough at this time, or there may need to be careful consideration of the mechanisms of interaction to include the variable in the most informative way.

Analysis of Tagging Data

The SC **NOTED** that the sex of most large tagged yellowfin tuna and bigeye tuna recovered in Seychelles on the European purse seine fleet have been identified since July 2009. This program offers a unique potential to evaluate if adult yellowfin tuna and bigeye tuna male and female show a differential growth. The results already obtained tend to confirm the existence of such sex differential growth. Worldwide, this is the first time that tagged yellowfin tuna and bigeye tuna have been sexed by scientists. The SC **RECOMMENDED** that this sampling programme should be maintained as long as these tunas are recovered, in order to ideally sex 100% of the future recoveries.

The SC **RECOMMENDED** that more analyses on the tagging data should be undertaken in 2011 and 2012, and should include the estimation of mixing rates and tag induced mortality (in particular for the small-scale projects). These analyses should be done in advance of the next Session of the WPTT in order to be included in future analyses and stock assessments.

The SC **RECOMMENDED** that analysis of the tagging data carried out in preparation for the Tagging Symposium and presented at the next WPTT meeting.

Effect of Piracy on Tropical Tuna Catches

The SC **RECOMMENDED** that given the potential impacts of piracy on fisheries in other areas of the Indian Ocean through the relocation of longliners to other fishing grounds, specific analysis should be carried out and presented at the next WPTT meeting by CPCs most affected by these activities, including Japan, Republic of Korea and Taiwan,China.

Methods

The SC also **ENCOURAGED** data to be used in stock assessments, including CPUE standardisations, be made available not less than three months before each meeting by CPCs and where possible, data summaries no later than two months prior to each meeting, from the IOTC Secretariat; and **RECOMMENDED** that data to be used in stock assessments, including CPUE standardisations by CPCs be made available not less than 30 days before each meeting.

Working Party on Ecosystems and Bycatch

Data available

Noting that the information on retained catches and discards of sharks contained in the IOTC database remains very incomplete for most fleets, and that catch-and-effort as well as size data are essential to assess the status of shark stocks, the SC **RECOMMENDED** all CPCs to collect and report catches of sharks (including historical data), landings and biological data on sharks so that more detailed analysis can be undertaken for the next WPEB meeting.

The SC **RECOMMENDED** that data on marine mammal interactions with IOTC fisheries are collected and reported by CPCs to the IOTC Secretariat.

The SC **NOTED** the main bycatch data issues that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix VI [Report of the WPEB07], and **RECOMMENDED** that the CPCs listed in Appendix VI, make efforts to remedy the data issues identified and to report back to the WPEB at its next meeting.

The SC **RECOMMENDED** that the actions outlined in Appendix VII [Report of the WPEB07] should be undertaken by each CPC to improve the standing of the data on sharks, seabirds, marine turtles and marine mammals currently available at the IOTC Secretariat. In general, these recommendations are made over and above the existing obligations and technical specifications relating to the reporting of data.

The SC **RECOMMENDED** that, in addition to the implementation of the Regional Observer Scheme, the collection of scientific data by all other means available including auto-sampling (collection of data by trained crew) and electronic monitoring (sensors and video cameras) be encouraged and developed, and for CPCs to report on progress at the next WPEB meeting.

The SC further **NOTED** that this could be estimated through the deployment of video monitoring system on the upper deck, however, the SC **RECOMMENDED** that intensive sampling with two observers are conducted, whenever possible, in order to better evaluate this potential bias and to report progress and findings to the next WPEB meeting.

The SC **RECOMMENDED** that further research into the effectiveness of circle hooks adopt a multi-species approach, so as to avoid, as far as possible, promoting a mitigation measure for one bycatch taxon that might exacerbate bycatch problems for other taxa.

The SC **RECOMMENDED** that IOTC CPCs eventually translate, print and disseminate the IOTC identifications cards for marine turtles, seabirds and sharks as a priority to their observers accredited for the Regional Observer Scheme and field samplers (Resolution 11/04), and to a larger extent to their fishing fleets targeting tuna, tuna-like and shark species. This would allow accurate observer, sampling and logbook data on marine turtles, seabirds and sharks to be recorded and reported as per IOTC requirements.

The SC **RECOMMENDED** that scientists from all CPCs having fleets using driftnets in the Indian Ocean shall provide at the next session of the WPEB a report summarizing the known information on bycatch in driftnet fisheries, including sharks and marine mammals, with estimates of their likely order of magnitude where more detailed data are not available.

The SC **RECOMMENDED** that CPCs explore means to undertake research cruises using driftnet vessels in the Indian Ocean aimed at documenting and quantifying the nature and extent of bycatch in these fisheries and for results to be presented at the next Session of the WPEB.

Noting the lack of data on bycatch of these fleets, the SC **REMINDED** coastal countries with gillnet fisheries of their responsibilities to monitor catches and bycatch of these fisheries and **RECOMMENDED** them to improve sampling of landings, to develop and implement their observer schemes, to seek support from the IOTC to develop such activities if necessary and report on progress at the next Session of the WPEB.

Sharks and rays

The SC **NOTED** the absence of information on shark catches from artisanal fisheries in Mozambique and **RECOMMENDED** that information on bycatch from artisanal fisheries is provided at the next Session of the WPEB.

Noting the absence of data on fishing effort, numbers and species of sharks caught, the SC **RECOMMENDED** that the data collection system in Madagascar is strengthened in order to provide catch and effort reports that are consistent with IOTC standards and **ENCOURAGED** Madagascar to work with the IRD of La Réunion to develop a specific logbook for their new longline fleet.

The SC **RECOMMENDED** that all available data and/or indicators on oceanic whitetip shark abundance and population trends are compiled in order to assess current stock status and the level of decline for discussion at the next WPEB and SC.

The SC **RECOMMENDED** further research on silky sharks, including the possible construction of a data series of silky shark abundance from purse seine associated school fisheries.

The WPEB **NOTED** that it is important to collect data from all major gears catching silky sharks, including but not restricted to purse seines, longlines and gillnets and the SC **RECOMMENDED** that indicators of the relative abundance of silky sharks are developing to better quantify changes in abundance.

The SC **NOTED** that a protocol of 'best practices' for shark handling and release onboard purse seiners will be developed by the MADE project and ISSF to minimize the risk of injury of vessel crew and will increase shark survival opportunities and **RECOMMENDED** that these guidelines are presented at the next session of the WPEB.

The SC **RECOMMENDED** that more research is conducted on other mitigation methods to be used prior to the sharks being brought onboard, as well as on post-release mortality of sharks.

The SC **RECOMMENDED** that the recommendations from the KOBE bycatch technical working group are considered to encourage research and development of best practice with regard to setting nets on whale sharks to determine the impacts of the practice. It was noted that these practices are generally recorded in logbooks for the purse seine fleet and the whale sharks are also extracted from the net by fishers, however, it was agreed it would be useful to have information on the extent of the practice and to develop best practice methods through direct collaboration with WCPFC.

Noting the summary of available information on the oceanic whitetip shark (Appendix XI) [Report of the WPEB07] indicating a decline in abundance over the last past two decades, the SC **RECOMMENDED** an urgent need for a more quantitative approach to the assessment of this species.

The SC **RECOMMENDED** research and development of mitigation measures to minimize bycatch of the oceanic whitetip shark and its unharmed release for all types of fishing gears and that CPCs with data on oceanic whitetip sharks (i.e. total annual catches, CPUE time series and size data) to make these available to the next meeting in 2012 when the SC **AGREED** to revisit the status of oceanic whitetip sharks and management options be proposed if appropriate.

Noting that the data holdings of the IOTC Secretariat for sharks are limited and would not facilitate stock assessments, the SC **RECOMMENDED** that historic datasets held by CPCs be provided to the IOTC Secretariat as a matter of urgency, in disaggregated forms.

Seabirds

The SC **RECOMMENDED** that targeted observer effort be deployed in specific fisheries where high seabird bycatch is known or suspected.

The meeting **NOTED** that the development of the mitigation measures outlined in the papers presented [at the WPEB07] was the result of excellent collaboration between fishers, seabird experts and mitigation technologists with specialist expertise. Many IOTC members will lack capacity to collect such data, but it is imperative that this be done if further progress is to be made. The SC **RECOMMENDED** that CPCs look to establish collaborative relationships with other CPCs, NGOs and IGOs with the relevant skill set to provide the necessary training and build capacity.

Marine turtles

The SC further **RECOMMENDED** that data on incidental catches of marine turtles should be better recorded in the artisanal and coastal fisheries of the Indian Ocean.

The SC **NOTED** that no new information regarding the development and implementation of any national management plans for the reduction of marine turtle bycatch in tuna fisheries was presented and **RECOMMENDED** that CPCs develop such a plan and that the scientists participating in the WPEB report on progress at the next session of the WPEB.

The SC **RECOMMENDED** that all fleets, including longline, purse seine and gillnet fleets, shall report on interactions between marine turtles and fisheries for tuna and tuna-like species, at the next session of the WPEB.

The SC **RECOMMENDED** that the development and adoption of improved FAD designs to reduce the incidence of entanglement of marine turtles and sharks, including the use of biodegradable materials, be undertaken by the main fleets using FADs, noting that the use of these FADs could become mandatory in the future.

Other bycatch and byproduct species

Noting the potential negative impacts of fish aggregation devices (FADs) on bycatch in fisheries for tuna and tuna-like species in the Indian Ocean, the SC **RECOMMENDED** that CPCs utilizing anchored FADs undertake research aimed as assessing the effect of anchored FADs on bycatch, and for the results to be reported to the next session of the WPEB.

Depredation

Noting that there is currently no mandatory requirement to report incidences of depredation, the SC **RECOMMENDED** that data collection capacity be strengthened, with regard to depredation, in longlines and other major fisheries (i.e. drift gillnets and purse seines). In addition, the use of other data collection methods, such as questionnaires and interviews (which are an important, inexpensive and rapid method for highlighting problems), should be encouraged.

Noting that depredation has been reported to be high in some areas of the Indian Ocean (e.g. 19% in the Seychelles longline fishery: IOTC–2011–WPB09–R), which is much higher than in other regions of the Indian Ocean and would lead to bias in the CPUE series, the SC **RECOMMENDED** that the main longline fleets in the Indian Ocean (Taiwan,China, Japan, Indonesia, EU,Spain, EU,Portugal) carry out research and monitoring programs aimed at determining the level of depredation in a range of areas and under different fishing conditions, and for the results to be presented at the next session of the WPEB.

The SC **RECOMMENDED** that research be carried out by EU scientists to analyse the incidental encirclement of whales, through logbooks and observer data from EU flagged vessels, specifically when setting on whales prior to the mid-1990s and in association with whales after the mid-1990s. These results should be presented to the next session of the WPEB.

Depredation

The SC **NOTED** the development of handling guidelines for cetacean by the WCPFC and **RECOMMENDED** that these be presented and discussed at the session of the WPEB.

Noting that the IOTC Secretariat has received limited information to date on marine mammal interactions with driftnet fisheries in the Indian Ocean, the SC **RECOMMENDED** that all CPCs using drift gillnets to report all interactions between marine mammals and drift gillnet fisheries in the Indian Ocean.

Noting that there is no mandatory requirement to record and report incidental catches of marine mammals, the SC **RECOMMENDED** all CPCs to collect and report marine mammal incidental catches through their observer programmes and **ENCOURAGED** that these interactions are recorded in the logbook of fleets catching species under the IOTC Agreement and reported to the IOTC Secretariat.

Ecosystem approaches

Noting with concern the high levels of shark byproduct and bycatch reported in many National Reports to the Scientific Committee, and considering that future management decisions would benefit from collated bycatch data in an attempt to quantify cumulative bycatch impacts, the SC **RECOMMENDED** that research be undertaken as a high priority to assess the cumulative impacts of IOTC fishing operations on bycatch species, with a particular emphasis on shark species, noting that the data required to do this is already present in the National Reports of CPCs.

Working Party on Neritic Tunas

Review of data available for neritic tuna species

The SC **NOTED** the main neritic tuna data issues that are considered to negatively affect the quality of the statistics available at the IOTC, by type of dataset and fishery, which are provided in Appendix V [Report of the WPNT01], and **RECOMMENDED** that the CPCs listed in the Appendix, make efforts to remedy the data issues identified and to report back to the WPNT at its next meeting.

Noting that the nominal catch (NC) data provided at the WPNT01 meeting was found to conflict with the NC data history provided by Malaysia to the IOTC Secretariat, the SC **RECOMMENDED** that Malaysia liaise with the IOTC Secretariat in order to verify and provide a revised catch history which will replace the data currently held by the IOTC Secretariat before the next WPNT meeting in 2012.

Noting that substantial data sets, i.e. catch and length frequencies, have been collected in India and that several studies analysing these data sets have already been undertaken, the SC **RECOMMENDED** that this data be reported to the IOTC Secretariat as per the requirements adopted by all IOTC Members through Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties*.

Noting that the paper presented by Indian scientists did not contain information on narrow-barred Spanish mackerel (*Scomberomorus* commerson) and Indo-Pacific king mackerel (*S. guttatus*) which are covered under the mandate of the WPNT, the SC **RECOMMENDED** that fishery information on these mackerel species caught in Indian fisheries be presented at the next meeting of the WPNT.

The SC **AGREED** that there appears to be large datasets available on neritic tuna species caught by fleets of the coastal countries, in particular from India, Indonesia, Malaysia and Thailand, however most of this information has not been provided to the IOTC Secretariat. As such, the SC **RECOMMENDED** that these countries, as well as other CPCs, provide these data sets for neritic tunas, noting that this is already a mandatory requirement as per the IOTC Resolution 10/02 adopted by the IOTC Members, as this would allow a better assessment of the status of these stocks.

Review of information on the status of longtail tuna

Noting that some countries have collected large data sets over long time periods, the SC **RECOMMENDED** that this data, as well as data from other countries, be submitted to the IOTC Secretariat as per the requirements adopted by its members in Resolution 10/02. This would allow the WPNT to develop stock status indicators or a more comprehensive stock assessment of longtail tuna in the future.

Review of information on the status of narrow-barred Spanish mackerel

Noting that some countries have collected large data sets over long time periods, the SC **RECOMMENDED** that this data, as well as data from other CPCs, be submitted to the IOTC Secretariat as per the requirements adopted by its members in Resolution 10/02. This would allow the WPNT to develop stock status indicators or a more comprehensive stock assessment for narrow-barred Spanish mackerel in the future.

Review of information on the status of other neritic tuna species

Noting that some countries have collected large data sets over long time periods, the SC **RECOMMENDED** that this data, as well as data for other CPCs, be submitted to the IOTC Secretariat as per the requirements adopted by its members in Resolution 10/02. This would allow the WPNT to develop stock status indicators or a more comprehensive stock assessments of other neritic tuna species in the future.

Working Party on Data Collection and Statistics

Discrepancy in the size frequency data available from Japan and Taiwan,China for major IOTC species (yellowfin tuna, bigeye tuna, albacore, swordfish)

Noting the information presented by the IOTC Secretariat on the conflicting estimates of average weight derived from operational catch and size frequency datasets for the longline fisheries of Japan and Taiwan,China over their time series, and the concerning effect that the problems identified may have on the assessments of tuna and billfish species, the SC **RECOMMENDED** that Japan and Taiwan,China work with the IOTC Secretariat in order to clarify these issues, and report on their findings at the next meeting of the WPDCS and any other relevant working party meetings (e.g. WPB, WPTmT and the WPTT).

Update on national Statistics Systems

Noting that while the data collection systems in the Maldives are considered to be appropriately designed, the system continues to rely on summary reports from Island/Atoll Offices until such time the logbook reporting is fully established. Given that quality of the reports from Island/Atoll Offices are deteriorating, the SC **RECOMMENDED** that the Maldives considers implementing a sampling program in order to validate these reports, including the recent logbook data.

The SC **RECOMMENDED** that the Maldives estimate the quantity of bigeye tuna being caught by its fisheries, in particular those operating around anchored FADs.

Recommendations to Improve the Quality of the Statistics at the IOTC

The SC recalled its **RECOMMENDATION** that as resources become available, the IOTC Secretariat commence the process to develop a scoring system to assess the quality of data being reported to the Secretariat, noting that the allocation of scores to all data items in the IOTC databases will require a substantial investment of resources by Secretariat. The process shall be implemented gradually, with yellowfin tuna, bigeye tuna and swordfish data as priorities.

The SC **RECOMMENDED** that countries having sampling schemes or planning to implement such schemes, assess the precision of estimates of catches from those schemes considering different levels of coverage and report the results to the WPDCS.

Noting that paragraph 9 of Resolution 10/04 contains provisions for the reporting of numbers of fishing vessels monitored and the coverage achieved by gear type, by year to both, the Executive Secretary and the Scientific Committee, the SC **RECOMMENDED** that this information is also provided along with the statistics reported to the IOTC (IOTC Resolution 10/02).

The SC recalled its **RECOMMENDATION** for scientists from the EU and Thailand to explore the use of size data collected on EU vessels for the same areas and periods to adjust the species composition from logbooks reported by Thai purse seiners, and to report progress to the next WPDCS meeting.

The SC recalled its **RECOMMENDATION** that Indonesia reported size frequency data for its longline fleet for 2009 and 2010.

APPENDIX IX
CONSOLIDATED RECOMMENDATIONS TO THE IOTC SECRETARIAT, CHAIRS AND NGO'S

Working Party on Billfish

Data inconsistencies for the Japanese and Taiwan,China swordfish catches

The SC **RECOMMENDED** that the IOTC Secretariat finalize the study aimed at assessing the consistency of average weights derived from the available catch and effort data, as derived from logbooks, and size data provided by Japan, Taiwan,China, Seychelles and EU,Spain and to report final results at the next WPB meeting.

Data collection and reporting systems

The SC **RECOMMENDED** that the IOTC Secretariat travel to India and Pakistan in order to assess the status of data collection and reporting systems in those countries, and to report back to the WPB at its 2012 session.

The SC **RECOMMENDED** that the IOTC Secretariat further assist India and Pakistan in the strengthening of data collection and reporting systems, where required, so as to facilitate reporting of statistics for billfish species as per IOTC standards.

Species identification

The SC **RECOMMENDED** that the IOTC Secretariat, in collaboration with relevant experts, develop species identification cards for marlins and sailfish by the next meeting of the WPB.

Length-age keys and other information

The SC **RECOMMENDED** that as a matter of priority, the IOTC Secretariat formally request, and provide assistance where necessary, CPCs that have important fisheries for billfish (EU, Taiwan,China, Japan, Indonesia and Sri Lanka) to collect and provide the basic data that would be used to establish length-age keys and non-standard measurements to standard measurements keys for billfish species, and sex ratio data, by sex and area.

The SC **RECOMMENDED** that the IOTC Secretariat develop a priority list of measurements to be collected for the purposes of developing length-age keys and other measurement keys, and to communicate this to CPCs before the end of the year.

Sampling coverage

The SC **RECOMMENDED** that the IOTC Secretariat assess levels of reporting for Japan upon receiving size data for 2010 and report back to the next meeting of the WPB.

Logbook coverage

The SC **RECOMMENDED** that the IOTC Secretariat request countries include levels of precision in their reports of catch-and-effort for billfish species.

The SC **RECOMMENDED** that the IOTC Secretariat follow-up on the results of the study with Japan and Taiwan,China and to report to the next WPB meeting.

The SC **RECOMMENDED** that the IOTC Secretariat liaise with the EU,Spain in order to assess the status of catch-and-effort data for marlins and sailfish.

Other data matters

The SC **RECOMMENDED** that the IOTC Secretariat liaise with the Republic of Korea to inform them about the new nominal catches estimated for its longline fishery.

NOTING that Japanese scientists are assisting the Republic of Korea in the review of catch-and-effort data series for longline vessels under the flag of Korea; The SC **RECOMMENDED** that the IOTC Secretariat follow-up with Japan and the Republic of Korea in order to obtain a new catch-and-effort data series from the Republic of Korea as soon as possible.

Sports fisheries

The SC **RECOMMENDED** that the IOTC Secretariat develop a project aimed at enhancing data recovery from sports and other recreational fisheries in the region, in collaboration with Kenya and other interested parties, and to report progress at the next WPB meeting.

The SC **RECOMMENDED** that as a matter of priority, the Chair of the WPB, in collaboration with the IOTC Secretariat, participating billfish foundations and other interested parties, facilitate the acquisition of catch-and-effort and size data from sport fisheries, by developing and disseminating reporting forms to Sport Fishing Centres in the region and to report back to the WPB at its meeting in 2012.

The SC **RECOMMENDED** that the IOTC Secretariat provide contact details for purse seine and longline fleets obtained during the Regional Tuna Tagging Project-Indian Ocean (RTTP-IO), to participating billfish foundations so that they may improve their own outreach and awareness campaigns.

The SC **RECOMMENDED** that the African Billfish Foundation (ABF) work with the IOTC Secretariat to facilitate engagement between the ABF and IOTC scientists on issues from data analysis to the collection and dissemination of biological information on billfish species.

India longline fishery: Indo-Pacific sailfish

The SC **RECOMMENDED** that as a matter of priority, the IOTC Secretariat liaise with India, Oman, Indonesia, Philippines and Malaysia in order to improve the quality of the data reported from their longline fleets, by species, and to report back to the WPB at its next meeting.

Indonesian longline fishery

The SC **RECOMMENDED** that the IOTC Secretariat send a mission to Indonesia to assist in the reporting of catch-and-effort data and to report progress to the WPB at its next meeting.

Sri Lankan billfish fisheries

The SC **RECOMMENDED** that the IOTC-OFCF Project assist Sri Lanka to strengthen sampling efforts on its coastal and off-shore fisheries in late 2011, where required.

Working Party on Tropical Tunas

Review of the data available for tropical tuna species

Noting that an IOTC mission to Pakistan was scheduled but had to be postponed due to the situation in the country, the SC **RECOMMENDED** that the IOTC Secretariat travel to Pakistan once the situation improves, in order to assess the status of data collection and reporting systems in this country and to report back to the WPTT at its 2012 session.

The SC **NOTED** the plans from the IOTC-OFCF Project to hold a Catch Estimation Workshop in Indonesia in March 2012, in order to assess data collection and reporting systems for Indonesia's coastal and longline fisheries. The WPTT thanked the IOTC-OFCF Project for this initiative and **RECOMMENDED** that the outcomes of the Workshop be reported to the next Session of the WPTT.

The SC **RECOMMENDED** that as a matter of priority, the IOTC Secretariat liaise with India, Oman, Indonesia, Philippines and Malaysia to implement the minimum requirements of IOTC Resolution 08/04 *concerning the recording of catch by longline vessels in the IOTC area*, in order to improve the quality of the data reported from their longline fleets, by species, and to report back to the WPTT at its next meeting.

The SC **RECOMMENDED** that the IOTC Secretariat continue working with the Iranian authorities towards improving reporting from their purse seine fleet, and to report progress to the WPTT at its next meeting.

Noting the difficulties that the IOTC Secretariat has experienced in completing the review of datasets for tropical tunas, including the implementation of a scoring system and further use of those scores to derive alternative series of catches for tropical tuna species, the SC **RECOMMENDED** that the Secretariat makes every possible effort to finalize this work before the next meeting of the WPTT in 2012.

Noting the preliminary results of a study conducted by the IOTC Secretariat comparing average weights, as derived from the length frequency, and time area catches in number and weight available for the longline fleets of Japan and Taiwan,China, the SC **RECOMMENDED** that the IOTC Secretariat complete this study and present results to the next meeting of the WPDCS.

Review of new information on the status of yellowfin tuna

The SC thanked Dr. Adam Langley (consultant) for his contributions and expertise on integrated stock assessment models, and **RECOMMENDED** that his engagement be renewed for the coming year.

The SC **RECOMMENDED** that the IOTC stock assessment scientist and consultant work in collaboration with Japanese scientists and other interested participants to produce an SS3 assessment for yellowfin tuna in 2012 for presentation to the WPTT.

Working Party on Ecosystems and Bycatch

KOBE process

The SC **RECOMMENDED** that the Secretariat maintain its involvement in the KOBE process and to lead and/or facilitate the IOTCs involvement with the Bycatch Joint Technical Working Group.

Noting paragraph 14 of Resolution 11/04 *on a Regional Observer Scheme* which states that "*The funds available from the IOTC balance of funds may be used to support the implementation of this programme in developing States, notably the training of observers and field samplers*", and that the IOTC Secretariat has hired a consultant to carry out an evaluation of the data collection and reporting capabilities of a number of developing coastal state CPCs, the SC **RECOMMENDED** that the IOTC Secretariat facilitate the training of observers and field samplers according to the IOTC Regional Observer Scheme Manual and Observer Trip Report Template.

The SC **RECOMMENDED** that all CPCs comply with the requirements of Resolution 09/06 *on Marine Turtles* which states that "*CPCs with longline vessels that fish for species covered by the IOTC Agreement shall: Ensure that the operators of all longline vessels carry line cutters and de-hookers in order to facilitate the appropriate handling and prompt release of marine turtles caught or entangled, and that they do so in accordance with IOTC Guidelines to be developed. CPCs shall also ensure that operators of such vessels are required to carry and use, where appropriate, dip-nets, in accordance with guidelines to be adopted by the IOTC*.", and that the IOTC Secretariat develop guidelines for handling and de-hooking marine turtles caught on longliners, and for these to be distributed to all CPCs before the next WPEB meeting.

The SC **RECOMMENDED** that the IOTC Secretariat develop an identification guide for hooks used in IOTC fisheries, and to distribute the guide to all CPCs once completed.

The SC **RECOMMENDED** that the IOTC Secretariat print and disseminate the IOTC identifications cards for marine turtles, seabirds and sharks using the remaining funds allocated to the task and to distribute these to developing coastal states as a priority, for use by observers accredited for the Regional Observer Scheme and field samplers (Resolution 11/04), and to a larger extent to their fishing fleets targeting tuna, tuna-like and shark species. This would allow accurate observer, sampling and logbook data on marine turtles, seabirds and sharks to be recorded and reported as per IOTC requirements.

The SC **REITERATED** that CPCs should fulfill their FAO obligation to assess the need for an NPOA-Sharks and develop plans if appropriate. The SC **RECOMMENDED** that to assist in this, the IOTC Secretariat should revise annually the table summarising progress towards the development of NPOA-Sharks by CPCs for the consideration as each WPEB and the Scientific Committee meeting.

The SC **RECOMMENDED** a databank of geo-referenced photographs of sharks (and other species groups) caught in the Indian Ocean be established at the IOTC Secretariat with contributions by scientists and observers from the region. The SC **NOTED** that this would be a useful tool for verification of species identifications.

Marine turtles

The SC **RECOMMENDED** that the comprehensive 'Assessment of the conservation status of the leatherback turtle in the Indian Ocean and South-East Asia', prepared by IOSEA in 2006, be reviewed, especially with regard to its recommended follow-up.

Working Party on Data Collection and Statistics

The SC **RECOMMENDED** that the IOTC Secretariat makes an evaluation of the costs associated with data management of the observer data (e.g. development and maintenance of a database, data entry etc.).

IOTC Data Summary and Field Manual

Noting that the IOTC Secretariat has not resumed the publication of the IOTC Data Summary due to a lack of resources, the SC **RECOMMENDED** that the IOTC Secretariat design a new Data Summary and present an example at the next meeting of the WPDCS and for publication on the new IOTC website once completed.

APPENDIX X
EXECUTIVE SUMMARY: ALBACORE TUNA

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi

Status of the Indian Ocean Albacore Tuna Resource (*Thunnus alalunga*)

TABLE 1. Status of albacore (*Thunnus alalunga*) in the Indian Ocean.

Area[1]	**Indicators – 2011 assessment**		**2011 stock status determination 2010**[2]
Indian Ocean	Catch 2010:	43,711 t	(orange)
	Average catch 2006–2010:	41,074 t	
	MSY (1 model):	29,900 t (21,500–33,100 t)	
	F_{2010}/F_{MSY} (1 model):	1.61 (1.19–2.22)*	
	B_{2010}/B_{MSY} (1 model):	0.89 (0.65–1.12)*	
	B_{2010}/B_{1980} (1 model):	0.39 (n.a.)	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]The stock status refers to the most recent years' data used for the assessment.
*(Note: at this time the WPTmT had limited confidence in the assessment results (refer to paragraphs 71–77 in the report of the WPTmT03 (IOTC–2011–WPTmT03–R) for further clarification).

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)	(red)	(orange)
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)	(yellow)	(green)

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

The SC **RECOMMENDED** the following management advice for albacore in the Indian Ocean noting that there remains considerable uncertainty about the relationship between abundance and the standardized CPUE series, and about the total catches over the past decade.

Stock status. Trends in the Taiwan,China CPUE series suggest that the longline vulnerable biomass has declined to about 39% of the level observed in 1980. There were 20 years of moderate fishing before 1980, and the catch has more than doubled since 1980. Catches have increased substantially since the previous albacore assessment when there was considered to be a risk that $SB<SB_{MSY}$, so the risk will have increased further. It is considered likely that recent catches have been above MSY, recent fishing mortality exceeds F_{MSY} ($F_{2010}/F_{MSY} > 1$). There is a moderate risk that total biomass is below B_{MSY} ($B_{2010}/B_{MSY} \approx 1$) (Table 1, Fig. 1).

Outlook. Maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE. The impacts of piracy in the western Indian Ocean has resulted in the displacement of a substantial portion of longline fishing effort into the traditional albacore fishing areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on albacore will decline in the near future.

The SC **RECOMMENDED** the following:

- The available evidence indicates considerable risk to the stock status at current effort levels.
- The two primary sources of data that drive the assessment, total catches and CPUE are highly uncertain and should be investigated further as a priority.
- Current catches (average ~41,000 t over the last five years, ~44,000 t in 2010) likely exceed MSY (29,900 t, range: 21,500–33,100 t). Maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE.
- A Kobe 2 Strategy matrix was calculated to quantify the risk of different future catch scenarios. However, a number of inconsistencies between the model and data were noted for future investigation (matrix not presented here as a result).

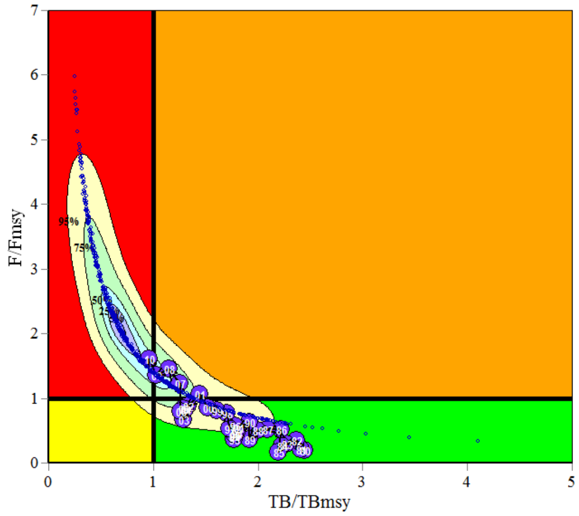

Fig. 1. ASPIC Aggregated Indian Ocean assessment Kobe plot (95% Confidence surfaces shown around 2010 estimate). Fixed B/K=0.9. Blue circles indicate the trajectory of the point estimates for the TB ratio and F ratio for each year 1980–2010 (Note: at this time the WPTmT had limited confidence in the assessment results (refer to paragraphs 71–77 in the report of the WPTmT03 (IOTC–2011–WPTmT03–R) for further clarification).

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Temperate Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Albacore (*Thunnus alalunga*) in the Indian Ocean are currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/07 *concerning a record of licensed foreign vessels fishing for tunas and swordfish in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

Overall, the biology of albacore stock in the Indian Ocean is not well known and there is relatively little new information on albacore stocks. Albacore (*Thunnus alalunga*) life history characteristics, including a relatively late maturity, long life and sexual dimorphism, make the species vulnerable to over exploitation. Table 2 outlines some of the key life history traits of albacore specific to the Indian Ocean.

Catch trends

Albacore are currently caught almost exclusively using drifting longlines (98%), and between 20°S and 40°S, with remaining catches recorded using purse seines and other gears (Fig. 2). Between 1983 and 1992, a large portion of albacore catches were taken by the Taiwan,China fleet using drifting gillnets (Fig. 2; Table 3) which targeted juvenile albacore in the southern Indian Ocean (30°S to 40°S). In 1992 the United Nations worldwide ban on the use of drifting gillnets effectively closed this gillnet fishery.

Catches of albacore were relatively stable until the mid-1980s, except for high catches recorded in 1973 and 1974 (Fig. 2). The catches increased markedly during the mid-1980's due to the use of drifting gillnets by Taiwan,China, with total catches in excess of 30,000 t. Following the removal of the drifting gillnet fleet, catches dropped to less than 20,000 t by 1993. However, catches more than doubled over the period from 1993 (less than 20,000 t) to 2001

(44,000 t). Record catches of albacore were reported in 2007, at around 45,000 t, and again in 2008, at 48,000 t. Catches for 2009 are estimated to be approximately 40,000 t, while preliminary catches for 2010 amount to 43,711 t (Table 3).

TABLE 2. Biology of Indian Ocean albacore (*Thunnus alalunga*)

Parameter	Description
Range and stock structure	A temperate tuna living mainly in the mid oceanic gyres of the Pacific, Indian and Atlantic oceans. 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, distributed from 5°N to 40°S, 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. 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. For the purposes of stock assessments, one pan-ocean stock has been assumed.
Longevity	8 years (reported to 10 years in the Pacific)
Maturity (50%)	**Age**: females 5–6 years; males n.a. **Size**: females n.a.; males n.a.
Spawning season	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. Like other tunas, adult albacore spawn in warm waters (SST>25°C).
Size (length and weight)	n.a.

n.a. = not available. SOURCES: Froese & Pauly (2009); Xu & Tian (2011)

Catches of albacore in recent years have come almost exclusively from vessels flagged in Indonesia and Taiwan,China, although the catches of albacore reported for the fresh tuna longline fishery of Indonesia have increased considerably since 2003 to around 17,000 t (Fig. 3), which represents approximately 40% of the total catches of albacore in the Indian Ocean.

Longliners from Japan and Taiwan,China have been operating in the Indian Ocean since the early 1950s (Fig. 3). 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 a change in the target species, mainly to southern bluefin tuna and bigeye tuna. Albacore became a bycatch species for the Japanese fleet with catches between 200 t and 2,500 t. In recent years the Japanese albacore catch has been around 2,000 to 6,000 t.

In contrast to the Japanese longliners, catches by Taiwan,China 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. Between 2003 and 2010 the albacore catches by Taiwan,China longliners have been between 10,000 and 18,000 t, with catches appearing to be on the increase in recent years. There has been a shift in the proportion of catches of albacore by deep-freezing and fresh-tuna longliners in recent years, with increasing catches of fresh-tuna (68% of the total catches for 2008–2010) as opposed to deep-freezing longliners (Fig. 2; Table 3).

While most of the catches of albacore have traditionally come from the western Indian Ocean, in recent years a larger proportion of the catch has come from the southern and eastern Indian Ocean (Fig. 4; Table 4). The relative increase in catches in the eastern Indian Ocean since the early 2000's is mostly due to increased activity of fresh-tuna longliners from Taiwan,China and Indonesia (Indonesia not represented in Fig. 4 as spatial catch-and-effort data is not available or highly uncertain for these fleets). In the western Indian Ocean, the catches of albacore mostly result from the activities of deep-freezing longliners and purse seiners.

Fleets of oceanic gillnet vessels from Iran and Pakistan and gillnet and longline vessels from Sri Lanka have extended their area of operation in recent years, to operate on the high seas closer to the equator. The lack of catch-and-effort data from these fleets makes it impossible to assess whether they are operating in areas where catches of juvenile albacore are likely to occur.

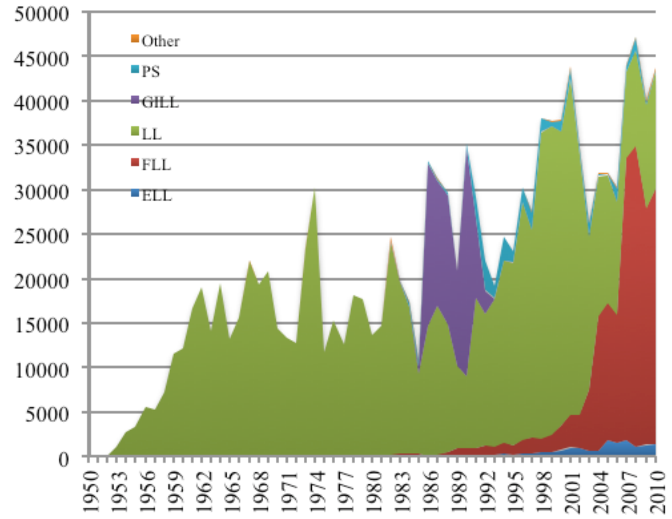

Fig. 2. Annual catches of albacore by gear recorded in the IOTC Database (1961–2010) (Data as of August 2011). Other gears nei (Other); Purse seine (PS); Freezing-longline (LL); Fresh-tuna longline (FLL); Swordfish-longline (ELL).

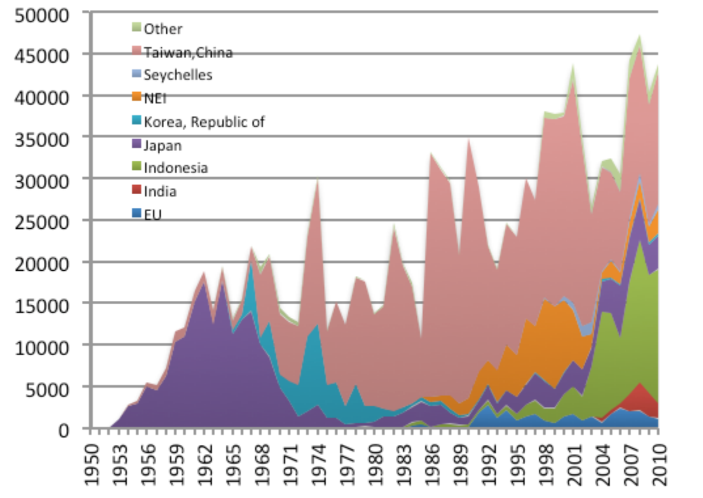

Fig. 3. Annual catches of albacore by fleet recorded in the IOTC Database (1961–2010) (Data as of August 2011).

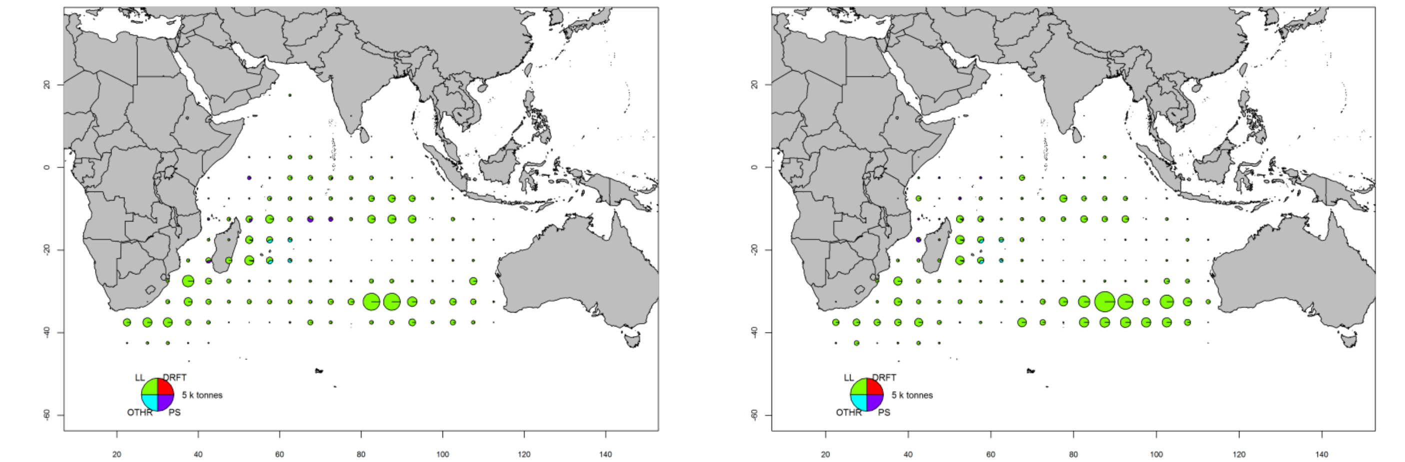

Fig. 4a–b. Time-area catches (total combined in tonnes) of albacore estimated for 2009 (left) and 2010 (right) by type of gear: Longline (LL, green), Driftnet (DFRT, red), Purse seine (PS, purple), Other fleets (OTHER, blue). Time-area catches are not available for all fleets; catches for those were assigned by 5x5 square and month using information from other fleets. Catches of fresh-tuna longliners are not represented (Data as of August 2011).

TABLE 3. Best scientific estimates of the catches of albacore (*Thunnus alalunga*) by gear and main fleets [or type of fishery] by decade (1950–2000) and year (2001–2010), in tonnes. Data as of October 2011. Catches by decade represent the average annual catch, noting that some gears were not used for all years (refer to Fig. 2).

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
DN				5,823	3,735											
LL	3,715	17,231	16,900	15,212	21,876	20,283	38,664	29,998	17,818	16,283	16,149	14,123	11,468	11,704	12,874	14,498
FLL			80	314	1,329	15,493	3,728	3,920	6,910	15,242	15,524	14,455	31,759	33,969	26,619	28,752
FS				195	1,578	855	1,030	755	1,493	230	149	1,388	705	1,391	366	166
LS				8	105	65	251	17	3	2	15	160	21	33	26	42
OT	5	9	24	67	61	148	172	139	131	150	143	108	107	91	293	254
Total	**3,721**	**17,240**	**17,005**	**21,620**	**28,684**	**36,844**	**43,845**	**34,829**	**26,355**	**31,906**	**31,979**	**30,234**	**44,059**	**47,189**	**40,178**	**43,711**

Fisheries: Driftnet (**DN**; Taiwan,China); Freezing-longline (**LL**); Fresh-tuna longline (**FLL**); Purse seine free-school (**FS**); Purse seine associated school (**LS**); Other gears nei (**OT**). Note: LL includes the ELL catches shown in Fig. 2.

TABLE 4. Best scientific estimates of the catches of albacore (*Thunnus alalunga*) by fishing area for the period 1950–2009 (in metric tons). Data as of October 2011.

Area	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
N	3,369	8,275	7,659	5,486	8,525	21,597	20,526	13,867	14,049	19,538	19,809	18,625	34,248	30,189	29,827	23,257
S	351	8,965	9,346	16,134	20,158	15,247	23,319	20,962	12,306	12,368	12,170	11,609	9,811	17,000	10,351	20,454
Total	**3,721**	**17,240**	**17,005**	**21,620**	**28,684**	**36,844**	**43,845**	**34,829**	**26,355**	**31,906**	**31,979**	**30,234**	**44,059**	**47,189**	**40,178**	**43,711**

Areas: North of 10ºS (**N**); South of 10ºS (**S**)

Uncertainty of catches

Retained catches are fairly well known (Fig. 5); however catches are uncertain for:

- Longliners of Indonesia, India and Malaysia operating in Southern waters: To date, Indonesian, Indian and Malaysian longline vessels operating in Southern waters have not reported catches of albacore, noting that the Secretariat has estimated these catches at around 3000 t annually.
- Fleets using gillnets on the high seas, in particular Iran, Pakistan and Sri Lanka: Catches are likely to be less than 1000 t.
- Non-reporting industrial longliners (NEI): Refers to catches from longliners operating under flags of non-reporting countries. Historically high catches, however thought to be between 1000 and 2000 t in recent years.

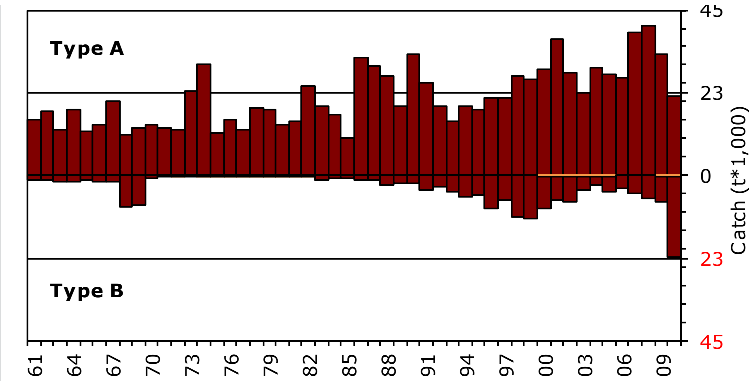

Fig. 5. Uncertainty of annual catch estimates for albacore (1950–2010) (Data as of August 2011).

*Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (**Type A**) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.*

- The catch series for albacore in recent years has changed substantially, especially since 2003. This change was due to a review of the data series for Indonesian longliners (Fig. 6).
- Levels of discards are believed to be low although they are unknown for industrial fisheries other than European (EU) purse seiners.

- Catch-and-effort series are available from various industrial fisheries. Nevertheless, catch-and-effort are not available from some fisheries or they are considered to be of poor quality, especially during the last decade, for the following reasons:
  - uncertain data from significant fleets of longliners, including India, Indonesia and Philippines.
  - non-reporting by industrial purse seiners and longliners (NEI).

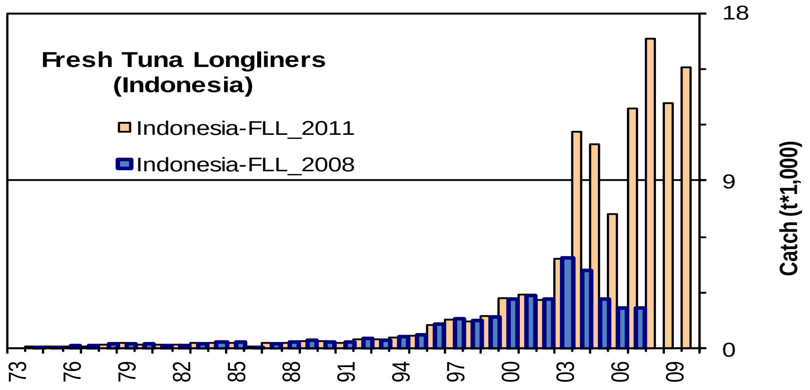

Fig. 6. Catches of fresh-tuna longline vessels based in Indonesia (domestic and foreign) estimated in 2011 (1973–2010) versus catches estimated in 2008 (1973–2006). The revised Indonesian nominal catch series data was estimated by the IOTC Secretariat.

Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid from 2007 to 2010 are provided in Fig. 7, and total effort from purse seine vessles flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2007 to 2010 are provided in Fig. 8.

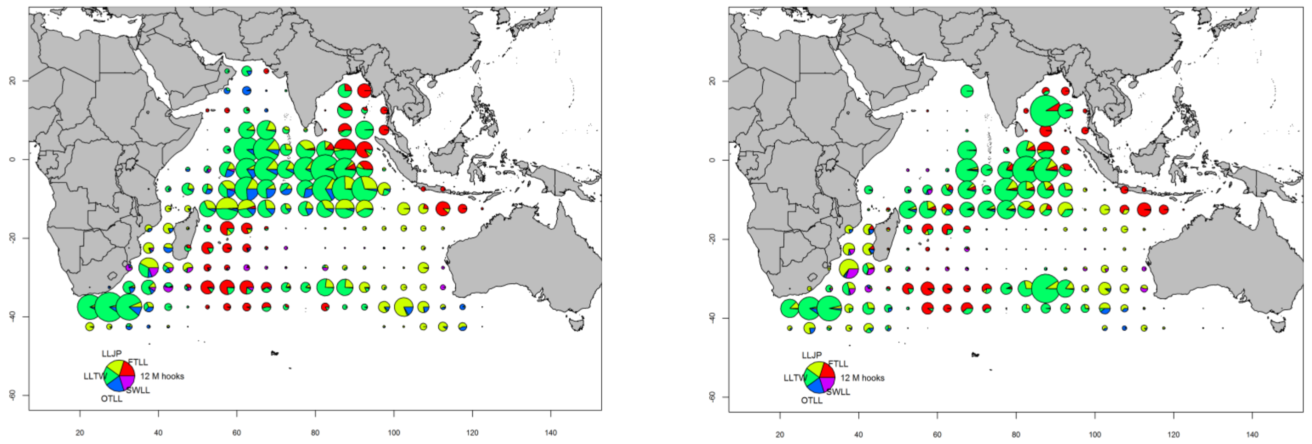

Fig. 7. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

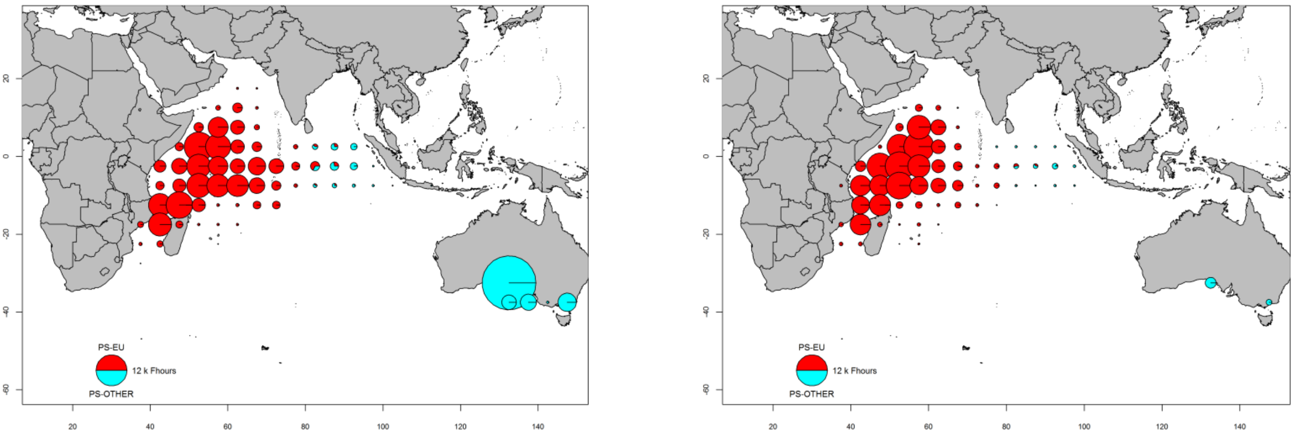

Fig. 8. Number of hours of fishing(Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

Standardised catch–per–unit–effort (CPUE) trends

The CPUE series available for assessment purposes are shown in Fig. 9, although only the Taiwan,China series was used in the stock assessment model for 2011 for the reasons discussed in IOTC–2011–WPTmT03–R.

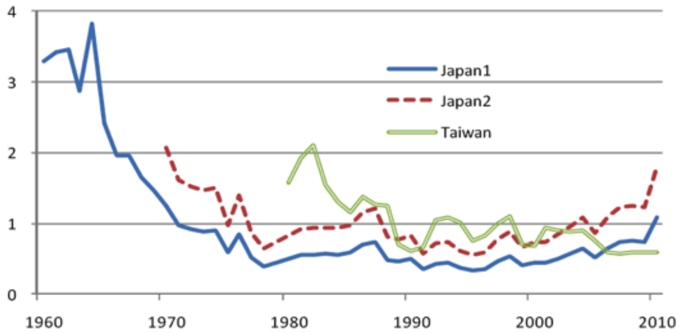

Fig. 9. Comparison of the three CPUE series for Indian Ocean albacore. Series have been rescaled relative to their respective means from 1960–2010.

Fish size or age trends (e.g. by length, weight, sex and/or maturity)

The size frequency data for the Taiwanese deep-freezing longline fishery for the period 1980–2009 is 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.

- Trends in average weight can be assessed for several industrial fisheries although they are incomplete or of poor quality for most fisheries before 1980, between 1986 and 1991, and in recent years, for the fleets referred to above (Fig. 10).
- Catch-at-Size(Age) tables are available but the estimates are highly uncertain for some periods and fisheries including:
    - all industrial longline fleets before the mid-60s, from the early-1970s up to the early-1980s and most fleets in recent years, in particular fresh-tuna longliners.
    - the paucity of catch by area data available for some industrial fleets (Taiwan,China, NEI, India and Indonesia).

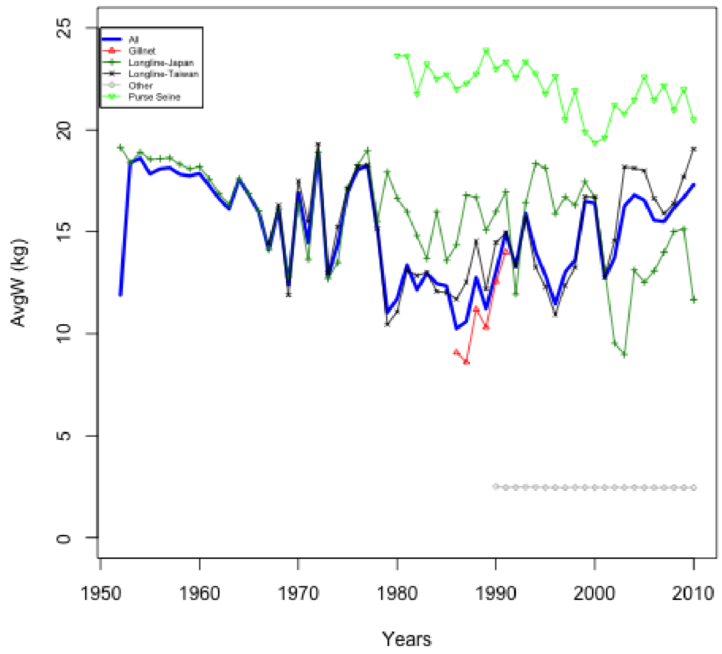

Fig. 10. Average weight in kg of the catches of all fleets (blue), gillnet (red), LL-JPN (dark green), LL-TWN (black), Purseine (green) and other gears (grey) from 1950 to 2010.

STOCK ASSESSMENT

A single quantitative modelling method, a highly aggregated "A Stock Production Model Including Covariate" (ASPIC) surplus production model, was applied to the albacore assessment in 2011.

The following is worth noting with respect to the modelling approach used:

- The Taiwan,China CPUE standardisation should be used over the Japanese CPUE series because the Japanese CPUE demonstrates strong targeting shifts away from albacore (1960s) and toward albacore in recent years (as a consequence of piracy in the western Indian Ocean), that was not accounted for in the standardization analysis.
- The Fox model had problems converging to a sensible solution when catch data prior to 1980 were included, when the Japanese CPUE were given substantial weight, and/or when the initial biomass was constrained to be less than or equal to the carrying capacity. The Working paper IOTC–2011–WPTmT03–19: *A note on the ASPIC Fox model and Indian Ocean albacore assessment*, examined this issue and found that the long catch time series tends to result in MSY estimates that approach 0. This causes a numerical failure. However, it appears that a range of MSY values may be reasonably consistent with the data.

The Fox model should be given a realistic biological constraint of B(1980) < carrying capacity (B(1980)/K=0.9), otherwise the model estimates B(1980) >> K. There was some incompatibility among the CPUE series, catch data and the Fox model. The structural rigidity of the Fox model limits the number of ways in which the error processes can be examined, and it was felt that this limited the scope of the analysis. Attempts to resolve the limitations are encouraged, as is the use of alternative models.

The general population trends and MSY parameters estimated by the Fox model appeared to be plausibly consistent with the general perception of the fishery and the data. However, these results are considered to be highly uncertain because of i) uncertainty in the catch rate standardization, ii) uncertainty in recent catches, and iii) limited ability to explore alternative interpretations of the data due to software constraints. The WPTmT had limited confidence in the assessment results.

TABLE 5. Albacore (*Thunnus alalunga*) stock status summary.

Management Quantity	**Aggregate Indian Ocean**
2010 catch estimate	43,700 t
Mean catch from 2006–2010	41,100 t
MSY (80% CI)	29,900 t (21,500–33,100)
Data period used in assessment	1980–2010
F_{2010}/F_{MSY} (80% CI)	1.61 (1.19–2.22)
B_{2010}/B_{MSY} (80% CI)	0.89 (0.65–1.12)
SB_{2010}/SB_{MSY}	–
B_{2010}/B_{1980} (80% CI)	0.39 (n.a.)
SB_{2010}/SB_{1980}	–
$B_{2010}/B_{1980,\ F=0}$	–
$SB_{2010}/SB_{1980,\ F=0}$	–

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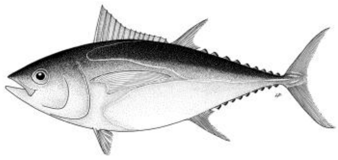
Froese R, & Pauly DE 2009. *FishBase*, version 02/2009, FishBase Consortium, <www.fishbase.org>.
Xu L & Tian SQ 2011. A study of fisheries biology for albacore based on Chinese observer data, IOTC–2011–WPTmT03–11.

APPENDIX XI
EXECUTIVE SUMMARY: BIGEYE TUNA

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean bigeye tuna resource (*Thunnus obesus*)

TABLE 1. Status of bigeye tuna (*Thunnus obesus*) in the Indian Ocean.

Area[1]	**Indicators – 2011 assessment**			**2011 stock status determination 2009**[2]
		SS3[3]	ASPM[4]	
Indian Ocean	Catch:	102,000 t	71,500 t	
	Average catch last 5 years:	104,700 t	104,700 t	
	MSY:	114,000 (95,000–183,000 t)	102,900 t (86,600–119,300 t)	
	F_{curr}/F_{MSY}:	0.79 (0.50–1.22)	0.67 (0.48–0.86)	
	SB_{curr}/SB_{MSY}:	1.20 (0.88–1.68)	1.00 (0.77–1.24)	
	SB_{curr}/SB_0:	0.34 (0.26–0.40)	0.39	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]The stock status refers to the most recent years' data used for the assessment.
[3]Central point estimate is adopted from the 2010 SS3 model, percentiles are drawn from a cumulative frequency distribution of MPD values with models weighted as in Table 12 of 2010 WPTT report (IOTC–2010–WPTT12–R); the range represents the 5th and 95th percentiles.
[4]Median point estimate is adopted from the 2011 ASPM model using steepness value of 0.5 which is the most conservative scenario (values of 0.6, 0.7 and 0.8, which are more optimistic, are considered to be as plausible as these values but are not presented for simplification); the range represents the 90 percentile Confidence Interval.
Current period ($_{curr}$) = 2009 for SS3 and 2010 for ASPM.

Colour key	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. Both assessments suggest that the stock is above a biomass level that would produce MSY in the long term and that current fishing mortality is below the MSY-based reference level (i.e. $SB_{current}/SB_{MSY} > 1$ and $F_{current}/F_{MSY} < 1$) (Table 1 and Fig. 1). Current spawning stock biomass was estimated to be 34–40 % (Table 1) of the unfished levels. The central tendencies of the stock status results from the WPTT 2011 when using different values of steepness were similar to the central tendencies presented in 2010.

Outlook. The recent declines in longline effort, particularly from the Japanese, Taiwan,China and Republic of Korea longline fleets, as well as purse seiner effort have lowered the pressure on the Indian Ocean bigeye tuna stock, indicating that current fishing mortality would not reduce the population to an overfished state.

Catches in 2010 (71,489 t) were lower than MSY values and catches in 2009 (102,664 t) were at the lower range of MSY estimates. The mean catch over the 2008–2010 period was 93,761 t which is lower than estimated MSY.

The Kobe strategy matrix (Combined SS3 and ASPM) illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions (Table 2). Based on the ASPM projections this year (2011) with steepness 0.5 value for illustration, there is relatively a low risk of exceeding MSY-based reference points by 2020 both when considering current catches of 71,489 t (maximum of 15% risk of $B<B_{MSY}$) or 2009 catches of 102,664 t (<40% risk that $B_{2020}<B_{MSY}$ and $F_{2020}>F_{MSY}$). Moreover, the SS3 projections from last year (2010) show that there is a low risk of exceeding MSY-based reference points by 2019 if catches are maintained at the lower range of MSY levels or at the catch level of 102,664 t from 2009 (< 30% risk that $B_{2019}<B_{MSY}$ and < 25% risk that $F_{2019}>FMSY$) (Table 1).

The SC **RECOMMENDED** the following:

- The Maximum Sustainable Yield estimate for the Indian Ocean ranges between 102,900 and 114,000 t (range expressed as the median value for 2010 SS3 and steepness value of 0.5 for 2011 ASPM for illustrative purposes (see Table 1 for further description)). Annual catches of bigeye tuna should not exceed the lower range of this estimate which corresponds to the 2009 catches and last year management advice.
- If the recent declines in effort continue, and catch remains substantially below the estimated MSY of 102,900–114,000 t, then immediate management measures are not required. However, continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in assessments.

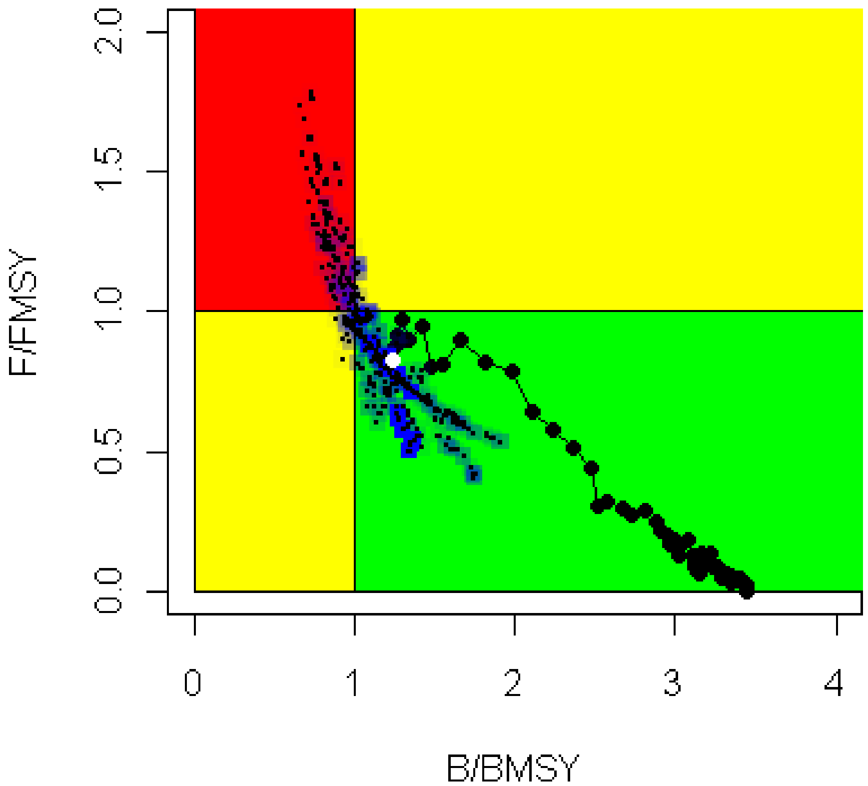


Fig. 1. SS3 Aggregated Indian Ocean assessment Kobe plot. Black circles represent the time series of annual median values from the weighted stock status grid (white circle is 2009). Blue squares indicate the MPD estimates for 2009 corresponding to each individual grid C model, with colour density proportional to the weighting (each model is also indicated by a small black point, as the squares from highly down weighted models are not otherwise visible).

TABLE 2. Bigeye tuna: Combined 2010 SS3 and 2011 ASPM Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based reference points for five constant catch projections (2009 and 2010 catch levels, ± 20% and ± 40%) projected for 3 and 10 years. K2SM adopted from the 2011 ASPM model using steepness value of 0.5 (values of 0.6, 0.7 and 0.8 are considered to be as plausible as these values but are not presented for simplification).

Reference point and projection timeframe	**Alternative catch projections (relative to 2009) and probability (%) of violating reference point**				
			2010 SS3		
	60% (61,200 t)	**80%** (81,600 t)	**100%** (102,000 t)	**120%** (122,400 t)	**140%** (142,800 t)
$SB_{2012} < SB_{MSY}$	19	24	28	40	50
$F_{2012} > F_{MSY}$	<1	<6	22	50	68
$SB_{2019} < SB_{MSY}$	19	24	30	55	73
$F_{2019} > F_{MSY}$	<1	<6	24	58	73

Reference point and projection timeframe	Alternative catch projections (relative to 2010) and probability (%) of violating reference point				
	2011 ASPM[1]				
	60% (42,900t)	**80%** (57,200t)	**100%** (71,500t)	**120%** (85,800t)	**140%** (100,100t)
$SB_{2013} < SB_{MSY}$	4	8	15	24	35
$F_{2013} > F_{MSY}$	<1	<1	1	8	33
$SB_{2020} < SB_{MSY}$	<1	<1	1	11	41
$F_{2020} > F_{MSY}$	<1	<1	<1	5	38

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Tropical Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Bigeye tuna (*Thunnus obesus*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission:

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/01 *for the conservation and management of tropical tunas stocks in the IOTC area of competence*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/07 *concerning a record of licensed foreign vessels fishing for tunas and swordfish in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 10/13 *On the implementation of a ban on discards of skipjack tuna, yellowfin tuna, bigeye tuna, and non targeted species caught by purse seiners*.
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

Bigeye tuna *(Thunnus obesus)* inhabit the tropical and subtropical waters of the Pacific, Atlantic and Indian Oceans in waters down to around 300 m. Table 3 outlines some of the key life history traits of bigeye tuna relevant for management.

[1] Projections were undertaken with a steepness value at 0.5 which is the most conservative scenario. (values of 0.6, 0.7 and 0.8, which are more optimistic, are considered to be as plausible as these values but are not presented for simplification).

TABLE 3. Biology of Indian Ocean bigeye tuna (*Thunnus obesus*).

Parameter	Description
Range and stock structure	Inhabits 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. The tag recoveries from the RTTP-IO provide evidence of rapid and large scale movements of juvenile bigeye tuna in the Indian Ocean, thus supporting the current assumption of a single stock for the Indian Ocean. The average minimum distance between juvenile tag-release-recapture positions is estimated at 657 nautical miles. The range of the stock (as indicated by the distribution of catches) includes tropical areas, where reproduction occurs, and temperate waters which are believed to be feeding grounds.
Longevity	15 years
Maturity (50%)	Age: females and males 3 years. Size: females and males 100 cm.
Spawning season	Spawning season from December to January and also in June in the eastern Indian Ocean.
Size (length and weight)	Maximum length: 200 cm FL; Maximum weight: 210 kg. Newly recruited fish are primarily caught by the purse seine fishery on floating objects. The sizes exploited in the Indian Ocean range from 30 cm to 180 cm fork length. Smaller fish (juveniles) form mixed schools with skipjack tuna and juvenile yellowfin tuna and are mainly limited to surface tropical waters, while larger fish are found in sub-surface waters.

SOURCES: Nootmorn (2004); Froese & Pauly (2009)

Catch trends

Bigeye tuna are mainly caught by industrial purse seine and longline fisheries and appears only occasionally in the catches of other fisheries (Fig. 2). However, in recent years the amounts of bigeye tuna caught by gillnet fisheries are likely to be considerably higher than what is reported, due to the major changes experienced in some of these fleets, notably changes in boat size, fishing techniques and fishing grounds.

Total annual bigeye tuna 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 (Fig. 2). Total annual catches averaged 130,849 t over the period 2001–2005 and 104,635 t over the period 2006–2010 (Table 4). In 2010, preliminary catches of bigeye tuna have been estimated to be at around 71,489 t, representing a large decrease in catches with respect to those estimated for 2009 and previous years (Figs. 2, 3).

The recent drop in catches of bigeye tuna could be related to the expansion of piracy in the western tropical Indian Ocean, which has led to a marked drop in the levels of longline effort in the core fishing area of the species (Figs. 4a, b).

Bigeye tuna has been caught by industrial longline fleets since the early 1950's, but before the mid-1970’s they only represented an incidental component of the total catch. With the introduction of fishing practices that improved the access to the bigeye tuna resource and the emergence of a sashimi market in the mid-1970’s, bigeye tuna became an important target species for the main industrial longline fleets (Figs. 2, 3). The catches estimated for 2010 are at around 46,000 t, representing less than half the longline catches of bigeye tuna recorded before the onset of piracy in the Indian Ocean.

The total catch of bigeye tuna by purse seiners in the Indian Ocean reached 40,700 t in 1999, but the average annual catch for the period 2006–2010 was 26,000 t (25,000 t for 2001–2005) (Fig. 2). Purse seiners mainly take small juvenile bigeye tuna (averaging around 5–6 kg) whereas longliners catch much larger and heavier fish; and therefore while purse seiners take much lower tonnages of bigeye tuna compared to longliners, they take larger numbers of individual fish.

Although the activities of purse seiners have been affected by piracy in the Indian Ocean, the effects have not been as marked as with longliners. The main reason for this is the presence of security personnel onboard purse seine vessels since the mid-2009, which has made it possible for purse seiners to operate in the northwest Indian Ocean without a reduction in fishing effort (Fig. 4). However, in the IOTC area an approximate 30% reduction of the number of purse seiner has been observed since 2006.

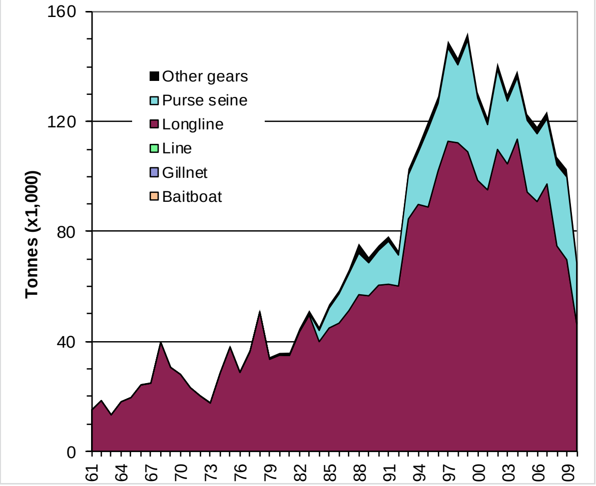


Fig. 2. Annual catches of bigeye tuna by gear recorded in the IOTC Database (1961–2010) (Data as of September 2011).

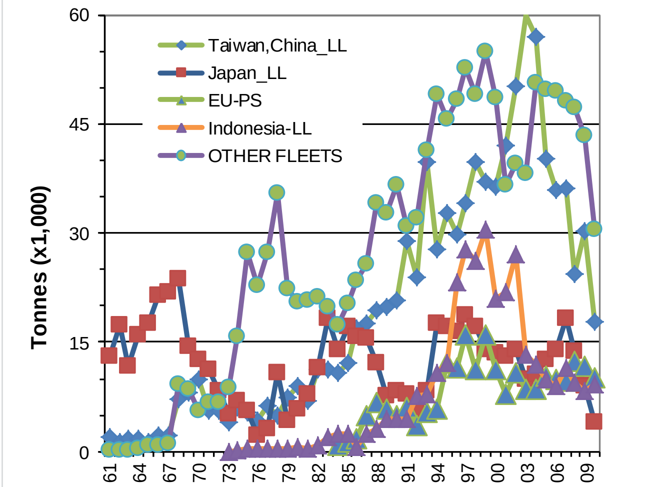


Fig. 3. Annual catches of bigeye tuna by fleet recorded in the IOTC Database (1961–2010) (Data as of September 2011).

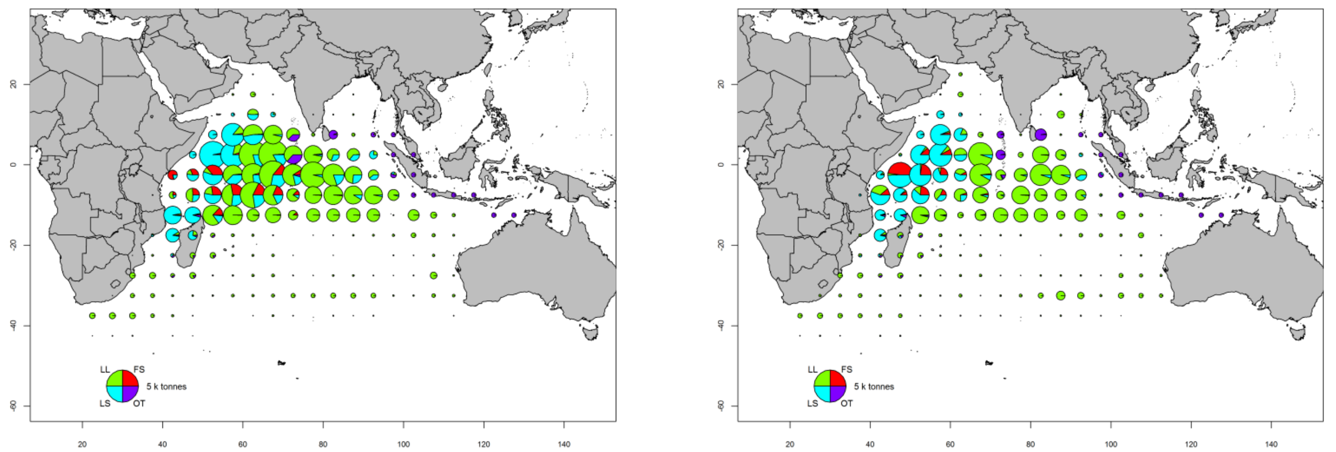


Fig. 4a–b. Time-area catches (total combined in tonnes) of bigeye tuna estimated for 2009 and 2010 by type of gear: Longline (LL), Purse seine free-schools (FS), Purse seine associated-schools (LS), and other fleets (OT), including pole-and-line, drifting gillnets, and various coastal fisheries (Data as of September 2011).

TABLE 4. Best scientific estimates of the catches of bigeye tuna (*Thunnus obesus*) by gear and main fleets [or type of fishery] by decade (1950–2000) and year (2001–2010), in tonnes. Data as of October 2011. Catches by decade represent the average annual catch, noting that some gears were not used for all years (refer to Fig. 2).

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LL-TW	6,008	18,684	23,647	28,226	19,759	14,699	14,693	14,091	11,217	13,288	15,299	17,261	19,630	14,336	9,812	4,490
LL-JP	481	3,288	6,820	17,716	68,347	80,201	80,472	95,807	93,398	100,341	79,064	73,632	77,695	60,417	59,917	41,875
FS	0	0	0	2,067	4,808	6,042	4,260	4,099	7,172	3,658	8,501	6,406	5,670	9,648	5,317	3,827
LS	0	0	0	4,234	18,224	20,147	19,457	24,944	15,662	18,749	17,568	18,249	18,066	19,831	24,773	18,438
OT	154	279	575	1,544	2,298	2,577	2,564	2,504	2,573	2,549	2,315	2,616	2,667	2,897	2,846	2,859
Total	**6,642**	**22,252**	**31,043**	**53,787**	**113,437**	**123,666**	**121,447**	**141,445**	**130,023**	**138,584**	**122,748**	**118,164**	**123,728**	**107,129**	**102,664**	**71,489**

Fisheries: Longline Taiwan,China and assimilated fleets (LL-TW); Longline Japan and assimilated fleets (LL-JP); Purse seine free-school (**FS**); Purse seine associated school (**LS**); Other gears nei (**OT**).

Uncertainty of catches

Retained catches are thought to be well known for the major fleets (Fig. 5); but are uncertain for the fleets listed below, noting that catches for these fleets are considered to represent a small proportion of total catches:

- Non-reporting industrial purse seiners and longliners (NEI) and for other industrial fisheries (longliners of India and Philippines).

- Some artisanal fisheries including the pole-and-line fishery in the Maldives.
- The gillnet fisheries of Iran and Pakistan.
- The gillnet/longline fishery in Sri Lanka.
- The artisanal fisheries in Indonesia, Comoros and Madagascar.

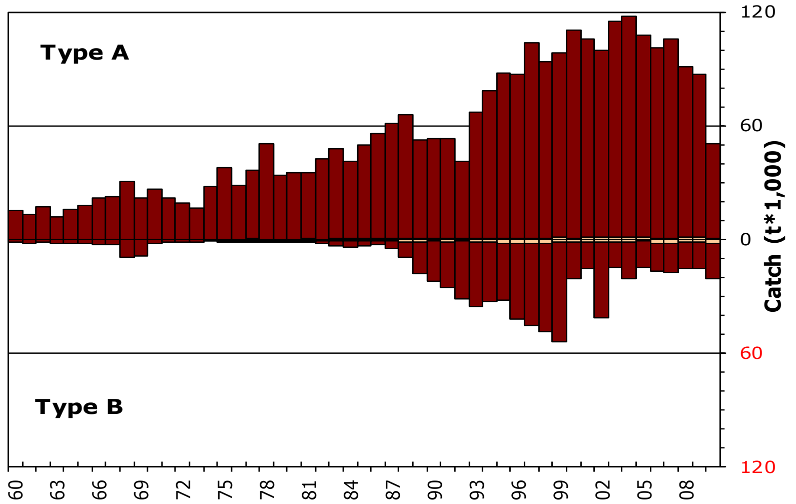


Fig. 5. Uncertainty of annual catch estimates for bigeye tuna (Data as of September 2011).

Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

- The catch series for bigeye tuna has not been significantly revised since the WPTT12 in 2010.
- Levels of discards are believed to be low although they are unknown for most industrial fisheries, excluding industrial purse seiners flagged in EU countries for the period 2003–2007.
- Catch-and-effort series are generally available from the major industrial fisheries. However, these data are not available from some fisheries or they are considered to be of poor quality, especially throughout the 1990s and in recent years, for the following reasons:
    - non-reporting by industrial purse seiners and longliners (NEI).
    - no data are available for the fresh-tuna longline fishery of Indonesia, over the entire time series, and very little data available for the fresh-tuna longline fishery of Taiwan,China.
    - uncertain data from significant fleets of industrial purse seiners from Iran and longliners from India, Indonesia, Malaysia, Oman, Philippines, and Taiwan,China (fresh tuna up to 2006).
    - no data available for the highseas gillnet fisheries of Iran and Pakistan and the gillnet/longline fishery of Sri Lanka, especially in recent years.

Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid from 2007 to 2010 are provided in Fig. 6, and total effort from purse seine vessles flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2007 to 2010 are provided in Fig. 7. The total number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2009 and 2010 are provided in Fig. 8.

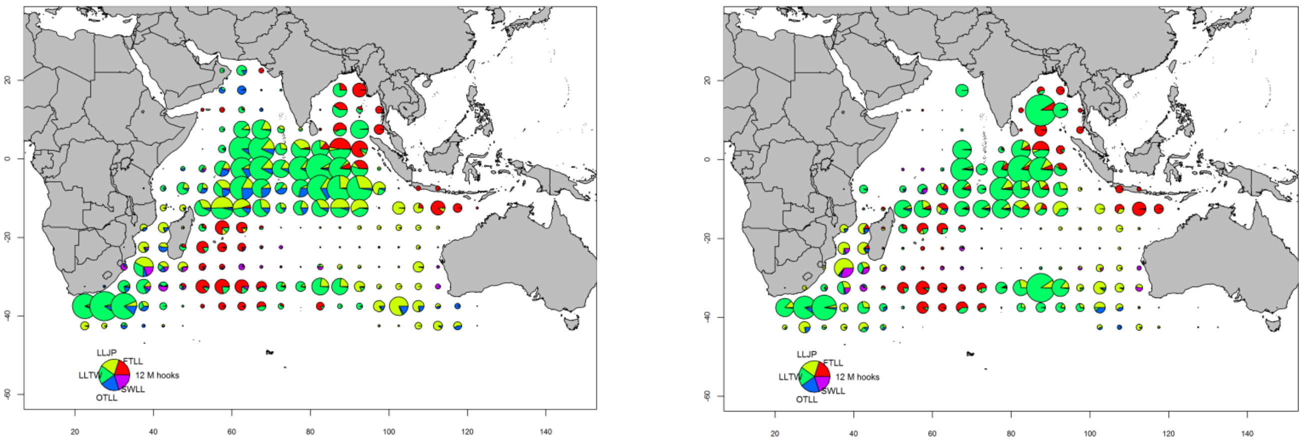


Fig. 6. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

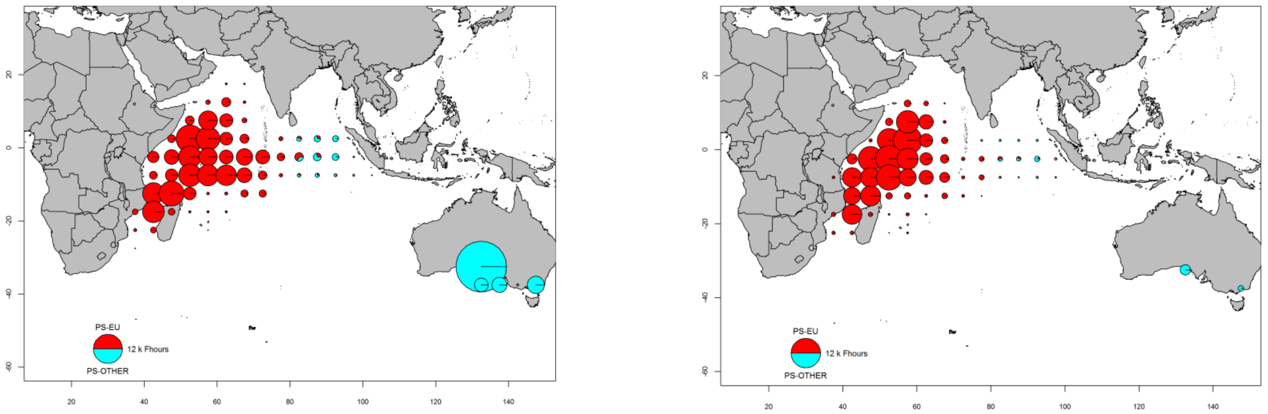


Fig. 7. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

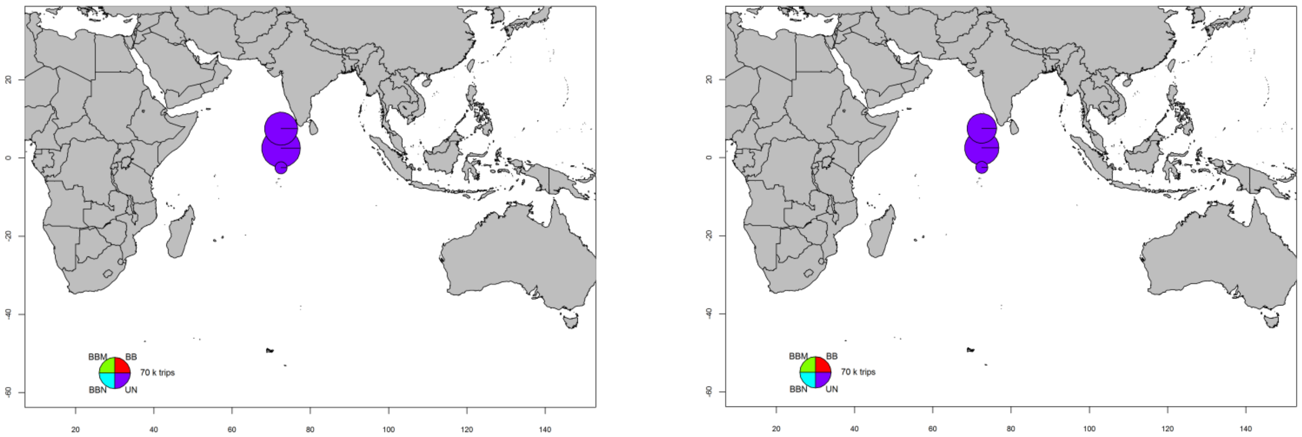


Fig. 8. Number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
BBN (blue): Baitboat non-mechanized; BBM (Green): Baitboat mechanized; BB (Red): Baitboat unspecified; UN (Purple): Unclassified gears
Note that the above maps were derived using the available catch-and-effort data in the IOTC database, which is limited to the number of baitboat calls (trips) by atoll by month for Maldivian baitboats for the period concerned. Note that some trips may be fully devoted to handlining, trolling, or other activities (data by gear type are not available since 2002). No data are available for the pole-and-line fisheries of India (Lakshadweep) and Indonesia.

Standardised catch–per–unit–effort (CPUE) trends

Of the CPUE series available for assessment purposes, listed below, only the Japanese series from the tropical areas of the Indian Ocean was used in the stock assessment model for 2011 (shown in Fig. 10).

- Taiwan,China data (1980–2010): Series from document IOTC–2011–WPTT13–39 (Fig. 9).
- Japan data (1960–2010): Series 2 from document IOTC–2011–WPTT13–52. Whole Indian Ocean (Figs. 9 and 10).
- Rep. of Korean data (1977–2009): Series from document IOTC–2011–WPTT13–38 (Fig. 9).
- Japan data (1960–2010): Series1 from document IOTC–2011–WPTT13–52. Tropical area of Indian Ocean (Fig. 10).

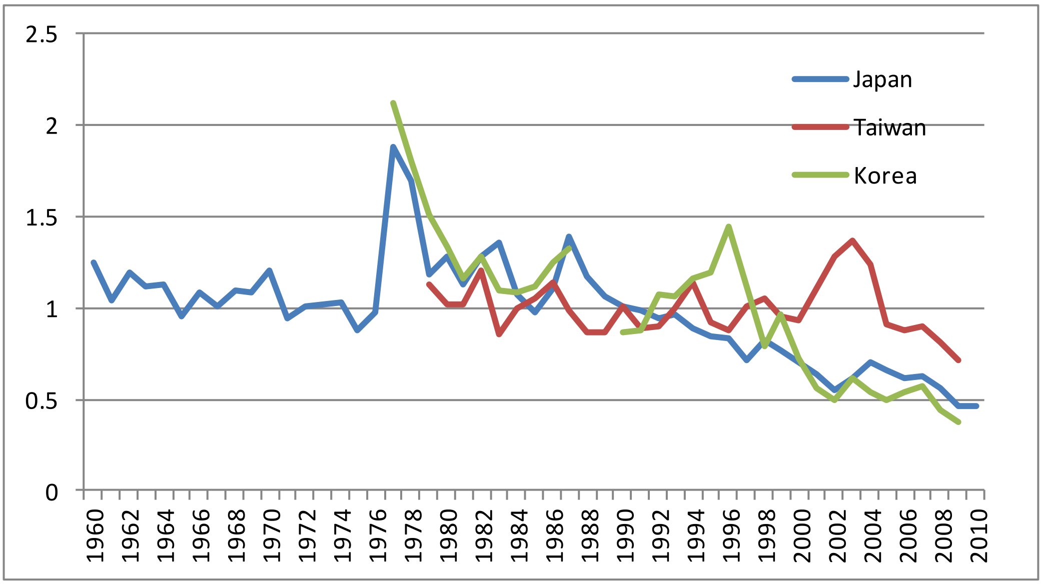


Fig. 9. Comparison of the three standardised CPUE series for Indian Ocean bigeye tuna. Series have been rescaled relative to their respective means from 1960–2010.

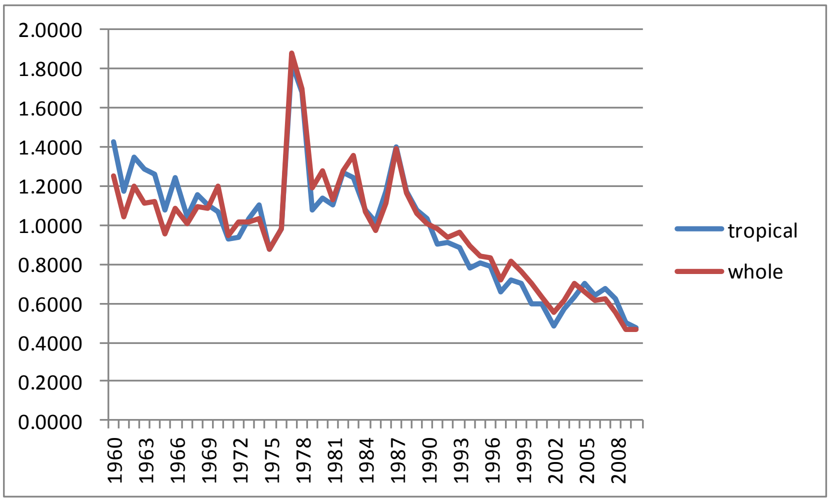


Fig. 10. Comparison of two Japanese standardised CPUE series for Indian Ocean bigeye tuna, one for the whole Indian Ocean and one for the tropical area only. Series have been rescaled relative to their respective means from 1960–2010.

The large increase in both the nominal and standardized bigeye tuna CPUEs for longline fleets in the Indian Ocean (as well as in the Atlantic) (Figs. 9 and 10). The increase in CPUEs may be due (1) to a large increase in the adult stock biomass, or (2) more probably to the introduction of deep longline in 1977. The fishery data does not allow to estimate a fully realistic trend of adult BET biomass during the seventies.

Fish size or age trends (e.g. by length, weight, sex and/or maturity)

Trends in average weight (Fig. 11) can be assessed for several industrial fisheries although they are incomplete or of poor quality for most fisheries before the mid-1980s and for some fleets in recent years (e.g. Japan longline) (see paper IOTC–2011–WPTT13–08).

Fig. 11. Changes in average weight (kg) of bigeye tuna from 1950 to 2010 – all fisheries combined (Data as of September 2011).

- Catch-at-Size and Age tables are available but the estimates are highly uncertain for some periods and fisheries including:
    - the paucity of size data available from industrial longliners before the mid-60s, from the early-1970s up to the mid-1980s and in recent years (Japan).
    - the paucity of catch by area data available for some industrial fleets (NEI, India, Indonesia, Iran, Sri Lanka).

Tagging data

The WPTT **NOTED** that a total of 35,971 bigeye tuna were tagged during the Indian Ocean Tuna Tagging Programme (IOTTP) which represented a 17.8% of the total number of fish tagged. Most of the bigeye tuna tagged (96.1%) were tagged during the main EU-funded Regional Tuna Tagging Project-Indian Ocean (RTTP-IO) and were primarily released off the coast of Tanzania (Fig. 12) between May 2005 and September 2007. The remaining were tagged during small-scale projects around the Maldives, India and the southwest and eastern Indian Ocean by institutions with the support of IOTC. To date 5,563 (15.7%) of tagged fish have been recovered and reported to the IOTC Secretariat.

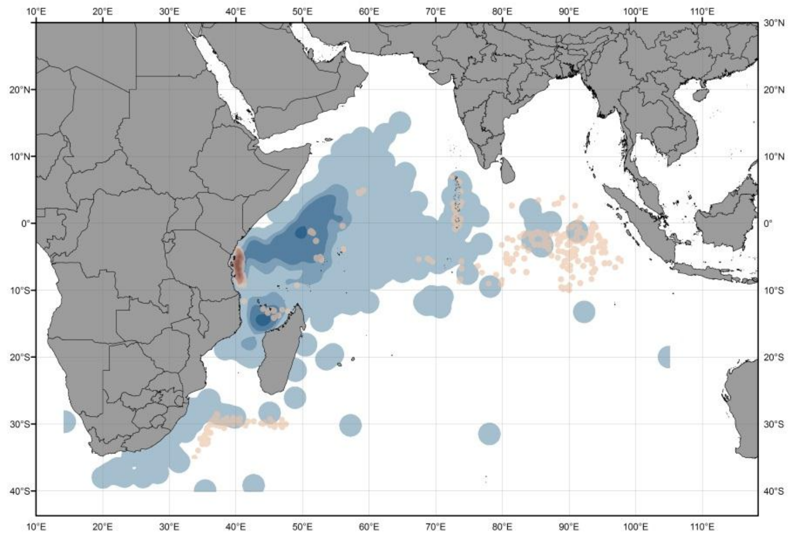


Fig. 12. Densities of releases (in red) and recoveries (in blue) of bigeye tuna. Data as of September 2011.

STOCK ASSESSMENT

A single quantitative modelling method (ASPM) was applied to the bigeye tuna assessment in 2011, using data from 1950–2010. The following is worth noting with respect to the modelling approach used:

- The steepness value (h=0.5) was selected on the basis of the likelihood and was near the lower boundary of what would be considered plausible for bigeye tuna. Selection of steepness on the basis of the likelihood was not considered reliable because i) steepness is difficult to estimate in general, and ii) substantial autocorrelation in the recruitment deviates was ignored in the likelihood term.
- Cohort-slicing to estimate ages from lengths introduces substantial errors, for long-living species such as bigeye tuna, except for the youngest ages.
- Uncertainty in natural mortality was not considered.

It is essential to include uncertainty in the steepness parameter as a minimum requirement for the provision of management advice. The general population trends and MSY parameters estimated by the ASPM model appeared to be plausibly consistent with the general perception of the fishery and the data. However, these results are considered to be uncertain because of i) uncertainty in the catch rate standardization, and ii) uncertainty in recent catches.

Management advice for bigeye tuna was based on the 2010 SS3 stock assessment and various steepness scenarios of the current 2011 ASPM stock assessment results (Tables 1, 5). For last year's SS3 assessment, the data did not seem to be sufficiently informative to justify the selection of any individual model and the results were combined on the basis of a model weighting scheme that was proposed to, and agreed by, the WPTT in 2010.

Key assessment results for the 2010 SS3 and 2011 ASPM stock assessments are shown in Tables 1, 2 and 5; Fig. 1.

Table 5. Key management quantities from the 2010 SS3 and 2011 ASPM assessments for bigeye tuna in the Indian Ocean.

Management Quantity	2010 SS3	2011 ASPM
2009 (SS3) and 2010 (ASPM) catch estimate	102,000 t	71,500 t
Mean catch from 2006–2010	104,700 t	104,700 t
MSY	114,000 t (95,000–183,000)	102,900 t (86,600–119,300) [(2)]
Data period used in assessment	1952–2009	1950–2010
F_{curr}/F_{MSY} [(3)]	0.79 [(1)] Range[(1)]: 0.50 – 1.22	0.67 (0.48–0.86) [(2)]
B_{curr}/B_{MSY} [(3)]	–	–
SB_{curr}/SB_{MSY} [(3)]	1.20 [(1)] Range[(1)]: 0.88 – 1.68	1.00 (0.77–1.24) [(2)]
B_{curr}/B_0 [(3)]	–	0.43 (n.a.)
SB_{curr}/SB_0 [(3)]	0.34[(1)] Range[(1)]: 0.26 – 0.40	0.39[(2)]
$B_{curr}/B_{0,\ F=0}$ [(3)]	–	–
$SB_{curr}/SB_{0,\ F=0}$ [(3)]	–	–

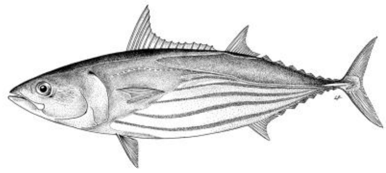
[1] Central point estimate is adopted from the 2010 SS3 model, percentiles are drawn from a cumulative frequency distribution of MPD values with models weighted as in Table 12 of 2010 WPTT report (IOTC–2010–WPTT12–R); the range represents the 5th and 95th percentiles.
[2] Median point estimate is adopted from the 2011 ASPM model using steepness value of 0.5 (values of 0.6, 0.7 and 0.8 are considered to be as pausible as these values but are not presented for simplification); the range represents the 90 percentile Confidence Interval.
[3] Current period ($_{curr}$) = 2009 for SS3 and 2010 for ASPM.

LITERATURE CITED

Froese R, & Pauly DE, 2009. *FishBase,* version 02/2009, FishBase Consortium, <www.fishbase.org>.
Nootmorn, P., 2004. Reproductive biology of bigeye tuna in the eastern Indian Ocean. IOTC–2004–WPTT04–05.

APPENDIX XII
EXECUTIVE SUMMARY: SKIPJACK TUNA

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean skipjack tuna Resource (*Katsuwonus pelamis*)

TABLE 1. Status of skipjack tuna (*Katsuwonus pelamis*) in the Indian Ocean.

Area[1]	Indicators – 2011 assessment		2011 stock status determination 2009[2]
Indian Ocean	Catch 2010:	428,719 t	
	Average catch 2006–2010:	489,385 t	
	MSY (1 model):	564,000 t (395,000–843,000 t)	
	C_{2009}/MSY (1 model)[3]:	0.81 (0.54–1.16)	
	SB_{2009}/SB_{MSY} (1 model):	2.56 (1.09–5.83)	
	SB_{2009}/SB_0 (1 model):	0.53 (0.29–0.70)	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]The stock status refers to the most recent years' data used for the assessment.
[3]Due to numerical problems in the F_{MSY} calculations for this population, the proxy reference point C/MSY is reported instead of F/FMSY, which should be interpreted with caution for the following reasons: it may incorrectly suggest $F>F_{MSY}$ when there is a large biomass (early development of the fishery or large recruitment event); it may incorrectly suggest that $F<F_{MSY}$ when the stock is highly depleted; due to a flat yield curve, C could be near MSY even if $F << F_{MSY}$.

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing(C_{year}/MSY> 1)		
Stock not subject to overfishing (C_{year}/MSY≤ 1)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. The weighted results suggest that the stock is not overfished ($B>B_{MSY}$) and that overfishing is not occurring (C<MSY, used as a proxy for $F<F_{MSY}$) (Table 1 and Fig. 1). Spawning stock biomass was estimated to have declined by approximately 47 % in 2009 from unfished levels (Table 1).

Outlook. The recent declines in catches are thought to be caused by a recent decrease in purse seine effort as well as due to a decline in CPUE of large skipjack tuna in the surface fisheries. However, the WPTT does not fully understand the recent declines of pole and line catch and CPUE, which may be due to the combined effects of the fisheries and environmental factors affecting recruitment or catchability. Catches in 2009 (455,999 t) and 2010 (428,719 t) as well as the average level of catches of 2006–2010 (489,385 t) were lower than median value of MSY.

The Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions. Based on the SS3 assessment, there is a low risk of exceeding MSY-based reference points by 2020 if catches are maintained at the current levels (< 20 % risk that B2019 < BMSY and 30 % risk that C2019>MSY as proxy of F > FMSY) and even if catches are maintained below the 2006–2010 average (489,385 t).

The SC **RECOMMENDED** the following:

- The median estimates of the Maximum Sustainable Yield for the skipjack tuna Indian Ocean stock is 564,000 t (Table 1) and considering the average catch level from 2005–2009 was 512,305 t, catches of skipjack tuna should not exceed the average of 2005–2009.
- If the recent declines in effort continue, and catch remains substantially below the estimated MSY, then urgent management measures are not required. However, recent trends in some fisheries, such as Maldivian pole-and-line, suggest that the situation of the stock should be closely monitored.
- The Kobe strategy matrix (Table 2) illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.

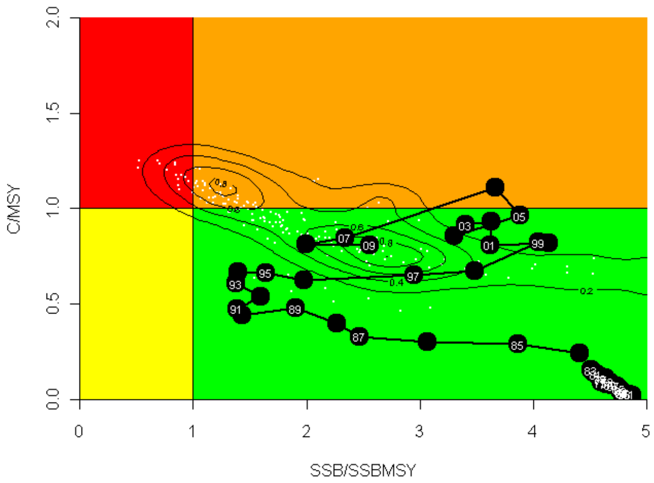


Fig. 1. SS3 Aggregated Indian Ocean assessment Kobe plot. Black circles indicate the trajectory of the weighted median of point estimates for the SB ratio and C/MSY ratio for each year 1950–2009. Probability distribution contours are provided only as a rough visual guide of the uncertainty (e.g. the multiple modes are an artifact of the coarse grid of assumption options). Due to numerical problems in the F_{MSY} calculations for this population, the proxy reference point C/MSY is reported instead of F/F_{MSY}, which should be interpreted with caution for the reasons given under Table 1 above.

TABLE 2. SS3 Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Weighted probability (percentage) of violating the MSY-based reference points for five constant catch projections (2009 catch level, ± 20% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to 2009) and weighted probability (%) scenarios that violate reference point**				
	60% (274,000 t)	**80%** (365,000 t)	**100%** (456,000 t)	**120%** (547,000 t)	**140%** (638,000 t)
$SB_{2013} < SB_{MSY}$	<1	5	5	10	18
$C_{2013} > MSY$ (proxy for F_{2009}/F_{MSY})	<1	<1	31	45	72
$SB_{2020} < SB_{MSY}$	<1	5	19	31	56
$C_{2020} > MSY$ (proxy for F_{2009}/F_{MSY})	<1	<1	31	45	72

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Tropical Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Skipjack tuna (*Katsuwonus pelamis*) in the Indian Ocean are currently subject to a number of conservation and management measures adopted by the Commission:

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/07 *concerning a record of licensed foreign vessels fishing for tunas and swordfish in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 10/13 *On the implementation of a ban on discards of skipjack tuna, yellowfin tuna, bigeye tuna, and non targeted species caught by purse seiners*.
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

Skipjack tuna (*Katsuwonus pelamis*) life history characteristics, including a low size and age at maturity, short life and high productivity/fecundity, make it resilient and not easily prone to overfishing. Table 3 outlines some of the key life history traits of skipjack tuna.

TABLE 3. Biology of Indian Ocean skipjack tuna (*Katsuwonus pelamis*).

Parameter	Description
Range and stock structure	Cosmopolitan species found in the tropical and subtropical waters of the Indian, Pacific and Atlantic Oceans. It generally forms large schools, often in association with other tunas of similar size such as juveniles of yellowfin tuna and bigeye tuna. The tag recoveries from the RTTP-IO provide evidence of rapid, large scale movements of skipjack tuna in the Indian Ocean, thus supporting the current assumption of a single stock for the Indian Ocean. Skipjack recoveries indicate that the species is highly mobile, and covers large distances. The average distance between skipjack tagging and recovery positions is estimated at 640 nautical miles. Skipjack tuna in the Indian Ocean are considered a single stock for assessment purposes.
Longevity	7 years
Maturity (50%)	Age: females and males <2 years. Size: females and males 41–43 cm. Unlike in *Thunnus* species, sex ratio does not appear to vary with size. Most of skipjack tuna taken by fisheries in the Indian Ocean have already reproduced.
Spawning season	High fecundity. Spawns opportunistically throughout the year in the whole inter-equatorial Indian Ocean (north of 20°S, with surface temperature greater than 24°C) when conditions are favourable.
Size (length and weight)	Maximum length: 110 cm FL; Maximum weight: 35.5 kg. The average weight of skipjack tuna caught in the Indian Ocean is around 3.0 kg for purse seine, 2.8 kg for the Maldivian baitboats and 4–5 kg for the gillnet. 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. It was noted that the mean weight for purse seine catch exhibited a strong decrease since 2006 (3.1 kg) until 2009 (2.4 kg), for both free (3.8 kg to 2.4 kg) and log schools (3.0 kg to 2.4 kg).

SOURCES: Collette & Nauen (1983); Froese & Pauly (2009); Grande et al. (2010). NOAA (http://www.nmfs.noaa.gov/fishwatch/species/atl_skipjack.htm, 14/12/2011).

Catch trends

Catches of skipjack tuna increased slowly from the 1950s, reaching around 50,000 t during the mid-1970s, mainly due to the activities of pole-and-lines and gillnets (Fig. 2 and 3). The catches increased rapidly with the arrival of purse seiners in the early 1980s, and skipjack tuna became one of the most important tuna species in the Indian Ocean.

The increase in purse seine caught skipjack tuna post 1984 (Figs. 2 and 3) was due to the development of a fishery in association with Fish Aggregating Devices (FADs). Since the 1990's, 85% of the skipjack tuna caught by purse seine vessels was taken in association with FADs. Following the peak catches taken in 2002 (240,000 t) and 2006 (247,000 t), catches dropped markedly, probably as a consequence of exceptional purse seine catch rates on free schools of yellowfin tuna. In 2007 purse seine catches dropped by around 100,000 t (145,000 t), with similar catches recorded in 2008 and have remained low (150,000–160,000 t).

The constant increase in catches and catch rates of purse seiners until 2006 are believed to be associated with increases in fishing power and in the number of FADs used in the fishery. The sharp decline in purse seine catches shown since 2007 (resulting partially from an approximate 30% decline of effort) coincided with a similar decline in the catches of Maldivian pole-and-line vessels (Fig. 3). The Maldivian fishery effectively increased its fishing effort with the mechanisation of its pole-and-line fishery from 1974, including an increase in boat size and power and the use of anchored FADs (AFADs) since 1981. The decrease in catches of both fisheries may also be the result of a sharp decrease in the mean skipjack tuna weight during this period, from 3 kg in 2006 to 2.3 kg in 2010. It should be noted that during the period 2006–2010, the gillnet fishery was catching over 100,000 tons of large skipjack tuna (~4.3 kg).

Several fisheries using gillnets have reported large catches of skipjack tuna in the Indian Ocean (Fig. 3), including the gillnet/longline fishery of Sri Lanka, driftnet fisheries of Iran and Pakistan, and gillnet fisheries of India and Indonesia. In recent years gillnet catches have represented as much as 20–30% of the total catches of skipjack tuna in the Indian Ocean. Although it is known that vessels from Iran and Sri Lanka have been using gillnets on the high seas in recent years, reaching as far as the Mozambique Channel, the activities of these fleets are poorly understood, as no time-area catch-and-effort series have been made available for those fleets to date.

The majority of the catches of skipjack tuna originate from the western Indian Ocean (Fig. 4). Since 2007 the catches of skipjack tuna in the western Indian Ocean have dropped considerably, especially in areas off Somalia, Kenya, Tanzania and around the Maldives. Although the drop in catches could be partially explained by a drop in catch rates and fishing effort by the purse seine fishery, due to the effects of piracy in the western Indian Ocean region, drops in the catches of other fisheries, in particular for the Maldives, are not fully understood.

The absolute price of skipjack tuna in the world tuna market, as well as its relative value compared to yellowfin tuna prices, has been greatly increased during recent years: 80% increase of average landing values between the 2000–2006 (758 USD/t) and 2007–2011 (1355 USD/t) periods. It was considered that the high value had contributed to an increase in the fishing pressure and targeting on skipjack tuna during recent years.

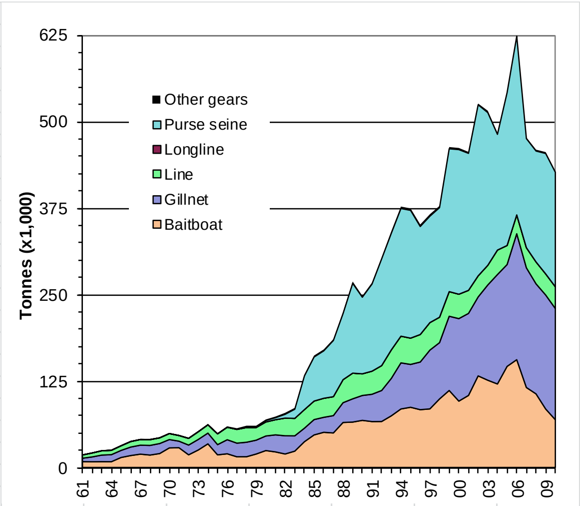


Fig. 2. Annual catches of skipjack tuna by gear recorded in the IOTC Database (1961–2010) (Data as of September 2011).

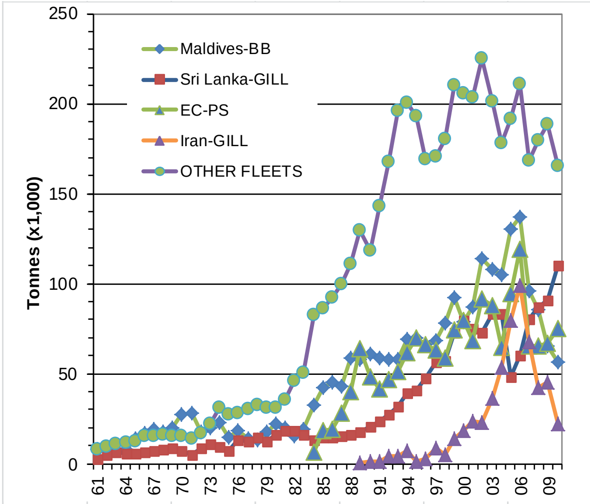


Fig. 3. Annual catches of skipjack tuna by fleet recorded in the IOTC Database (1961–2010) (Data as of September 2011).

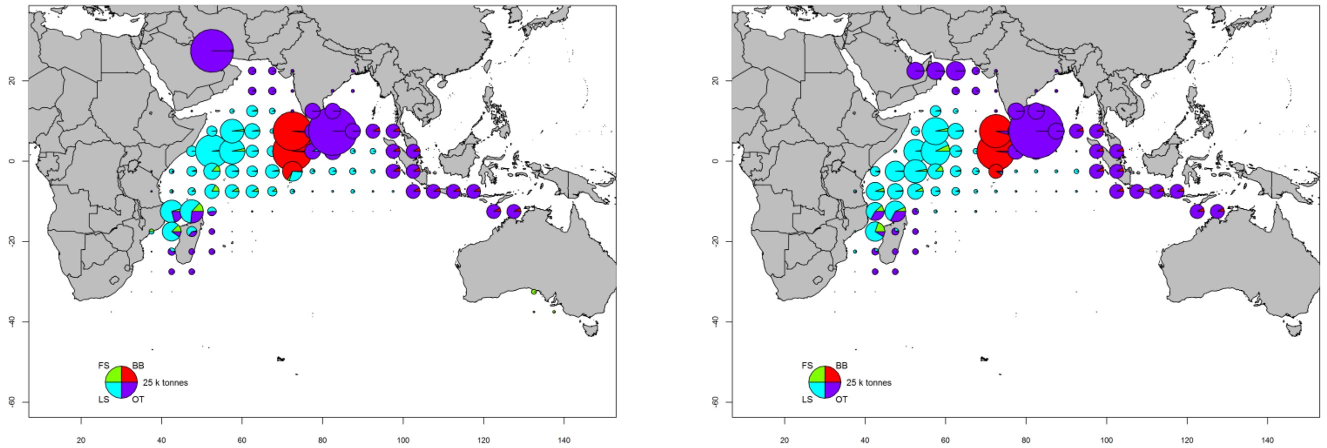


Fig. 4a–b. Time-area catches (total combined in tonnes) of skipjack tuna estimated for 2009 and 2010 by type of gear: Purse seine free-schools (FS), Purse seine associated-schools (LS), pole-and-line (BB), and other fleets (OT), including longline, drifting gillnets, and various coastal fisheries (Data as of September 2011).

TABLE 4. Best scientific estimates of the catches of skipjack tuna (*Katsuwonus pelamis*) by gear and main fleets [or type of fishery] by decade (1950–2000) and year (2001–2010), in tonnes. Data as of October 2011. Catches by decade represent the average annual catch, noting that some gears were not used for all years (refer to Fig. 2).

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BB	9,292	13,176	22,305	40,579	82,592	118,783	104,130	132,426	126,131	120,718	146,133	155,841	115,599	106,388	84,532	69,032
FS			41	15,551	30,651	25,922	28,919	22,801	30,992	18,565	43,123	34,954	24,198	16,277	10,458	8,826
LS			125	33,570	124,096	164,300	159,646	215,781	180,556	137,882	168,012	211,940	120,925	128,596	148,717	141,797
OT	7,054	17,546	31,665	55,763	109,775	191,540	163,586	155,170	178,094	206,559	186,447	222,339	216,498	208,254	212,292	209,064
Total	**16,346**	**30,721**	**54,136**	**145,464**	**347,115**	**500,545**	**456,281**	**526,179**	**515,774**	**483,724**	**543,715**	**625,074**	**477,220**	**459,515**	**455,999**	**428,719**

Fisheries: Pole-and-Line (**BB**); Purse seine free-school (**FS**); Purse seine associated school (**LS**); Other gears nei (**OT**).

TABLE 5. Best scientific estimates of the catches of skipjack tuna (*Katsuwonus pelamis*) in the Western and Eastern Indian Ocean areas for the period 1950–2010 (in metric tons). Data as of October 2011.

Area	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
W	10,846	17,569	28,595	96,868	249,919	322,664	326,695	407,328	387,233	349,945	451,617	516,652	342,066	307,021	299,140	258,257
E	5,499	13,153	25,541	48,596	97,196	139,308	129,586	118,851	128,541	133,780	92,098	108,422	135,155	152,494	156,859	170,462

Uncertainty of catches

Retained catches are generally well known for the industrial fisheries but are less certain for many artisanal fisheries (Fig. 5), notably because:

- Catches are not being reported by species.
- There is uncertainty about the catches from some important fleets including the Sri Lankan coastal fisheries, and the coastal fisheries of Comoros and Madagascar.
- Approximately 10–12 % of the reported catches from some coastal fisheries are uncertain.
- the catch series for skipjack tuna has not been substantially revised since the WPTT12 in 2010.
- levels of discards are believed to be low although they are unknown for most industrial fisheries, excluding industrial purse seiners flagged in EU countries for the period 2003–2007.

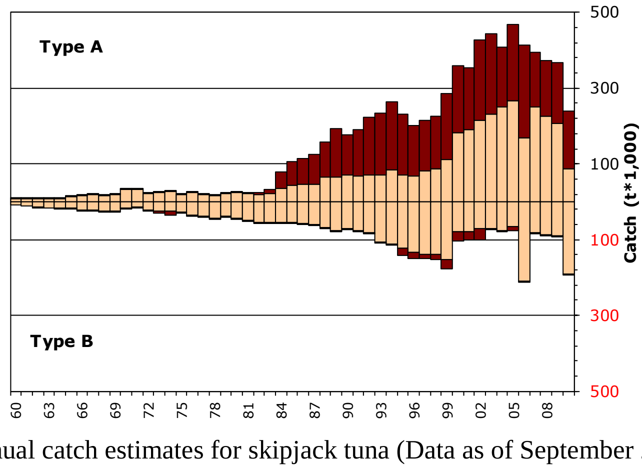


Fig. 5. Uncertainty of annual catch estimates for skipjack tuna (Data as of September 2011).

*Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (**Type A**) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.*

- catch-and-effort series are available from various industrial and artisanal fisheries. However, these data are not available from some important fisheries or they are considered to be of poor quality, for the following reasons:
    - no data are available for the gillnet fishery of Pakistan.
    - although Iran has provided catch and effort data, it is not reported as per the IOTC standards.
    - the poor quality effort data for the significant gillnet/longline fishery of Sri Lanka.
    - no data are available from important coastal fisheries using hand and/or troll lines, in particular Indonesia, Madagascar and Comoros.

Effort trends

Total effort from purse seine vessles flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2007 to 2010 are provided in Fig. 6. The total number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2009 and 2010 are provided in Fig. 7.

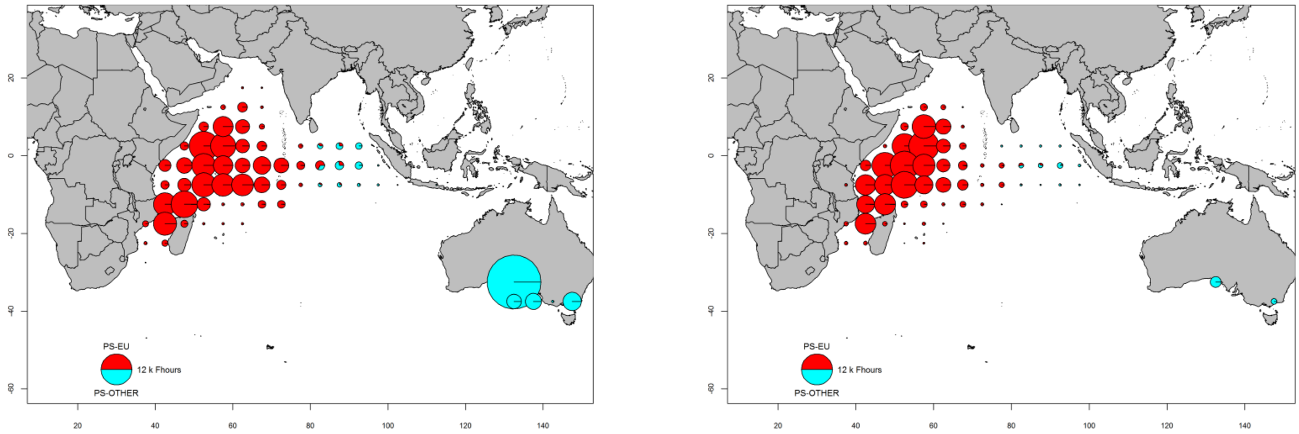


Fig. 6. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

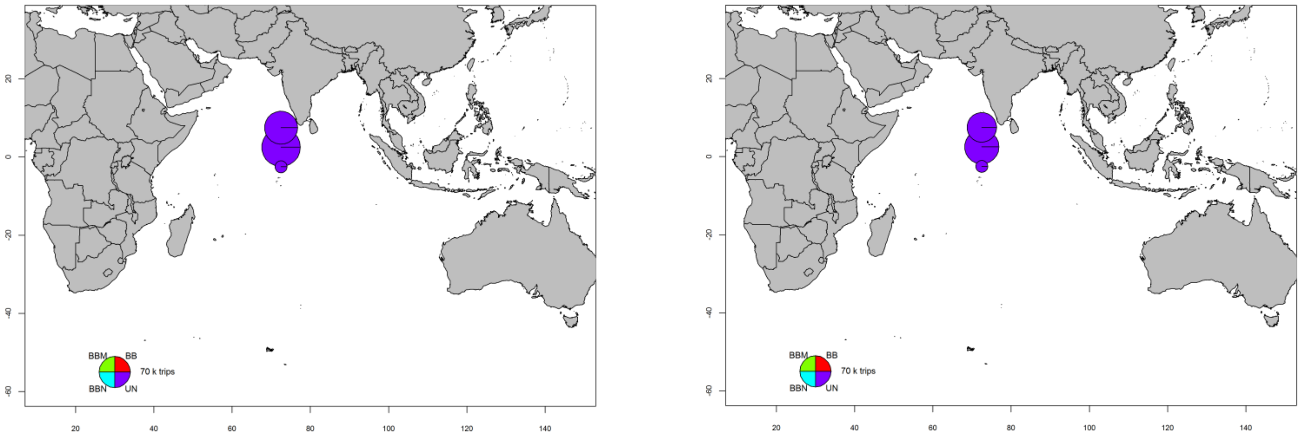


Fig. 7. Number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
BBN (blue): Baitboat non-mechanized; BBM (Green): Baitboat mechanized; BB (Red): Baitboat unspecified; UN (Purple): Unclassified gears
Note that the above maps were derived using the available catch-and-effort data in the IOTC database, which is limited to the number of baitboat calls (trips) by atoll by month for Maldivian baitboats for the period concerned. Note that some trips may be fully devoted to handlining, trolling, or other activities (data by gear type are not available since 2002). No data are available for the pole-and-line fisheries of India (Lakshadweep) and Indonesia.

Standardised catch–per–unit–effort (CPUE) trends

The CPUE series available for assessment purposes are shown in Fig. 8 and 9, although only the 'Pole-and-line series (Fig.8)–was used in the stock assessment model for 2011.

- Maldives data (2004–2010): Series1 from document IOTC–2011–WPTT13–29 and 31.
- EU purse seine free and log school data (1991–2010) (Fig.9): Series from document IOTC–2011–WPTT13–27. These series were not used in the assessment because they were not standardized and likely subject to problems as noted in paragraphs 133 and 141 of the WPTT13 report (IOTC–2011–WPTT13–R).

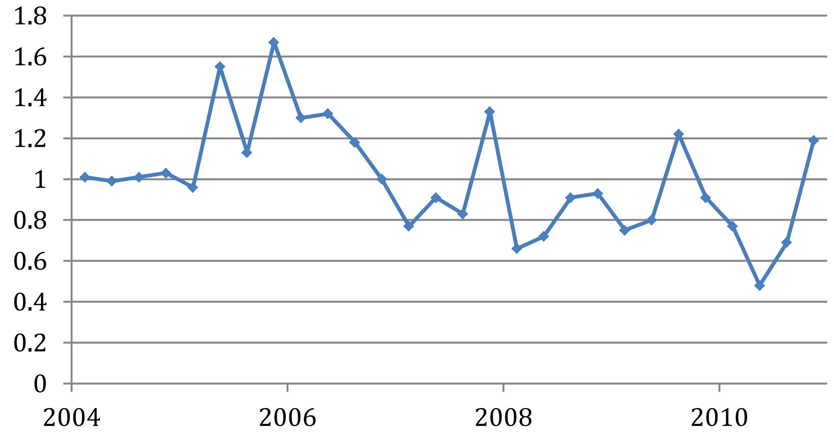


Fig. 8. Standardised Maldivian pole-and-line CPUE series for Indian Ocean skipjack tuna from 2004 to 2011. The series have been rescaled relative to their respective means from 2004–2010.

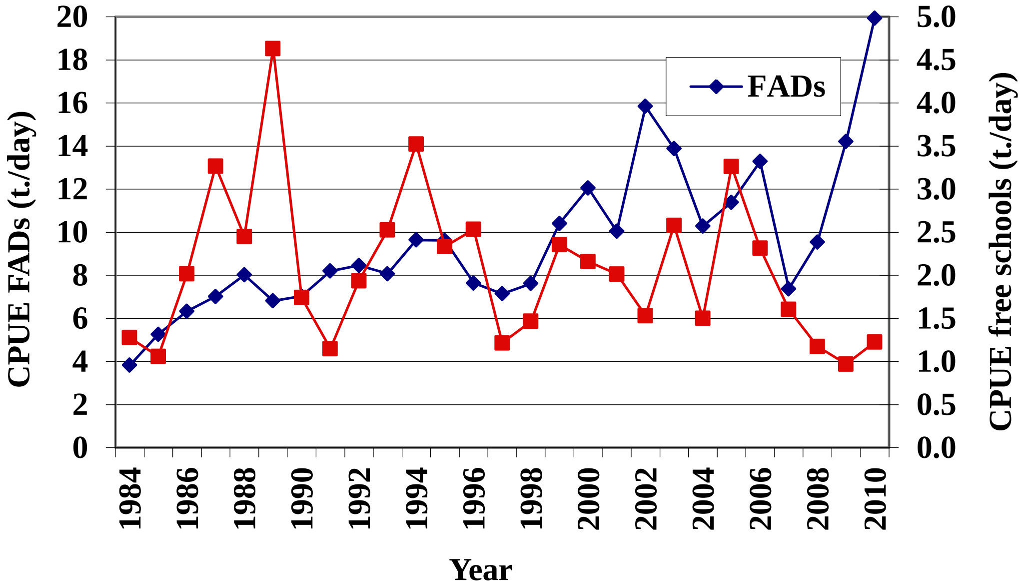


Fig. 9. Comparison of the European purse seine CPUE series for Indian Ocean skipjack caught on free and FAD associated school from 1984 to 2010.

Fish size or age trends (e.g. by length, weight, sex and/or maturity)

Trends in average weight (Fig. 10) cannot be accurately assessed before the mid-1980s and are incomplete for most artisanal fisheries post-1980, namely hand lines, troll lines and many gillnet fisheries (Indonesia) (see paper IOTC–2011–WPTT13–08). While the average weight seems to be stable for all fisheries combined, baitboat and purse seiner are showing a decreasing trends during the last 5 years.

Catch-at-Size and Age tables are available but the estimates are uncertain for some years and fisheries due to:

- the lack of size data before the mid-1980s.
- the paucity of size data available for some artisanal fisheries, notably most hand lines and troll lines (Madagascar, Comoros) and many gillnet fisheries (Indonesia, Sri Lanka).

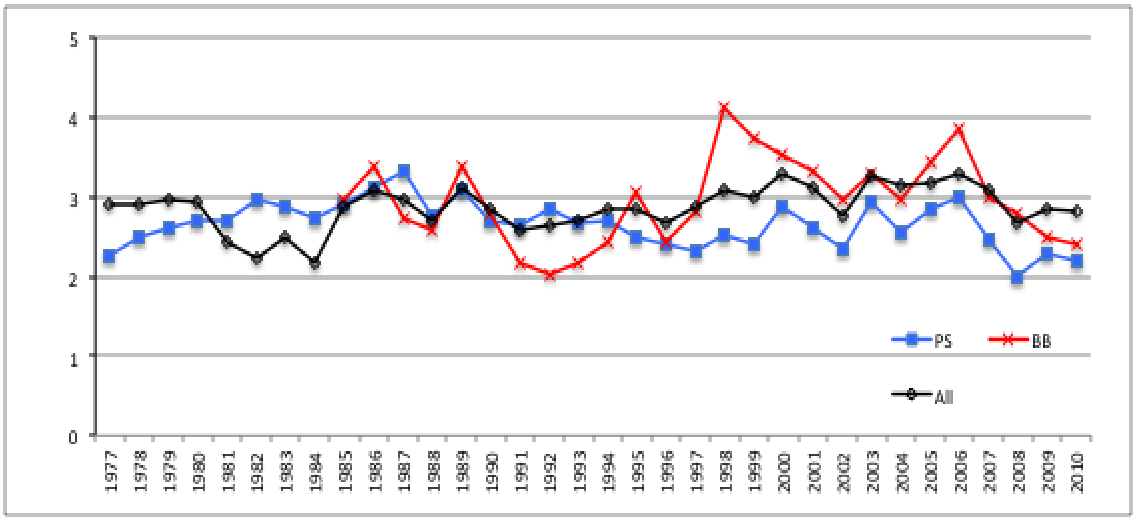


Fig. 10. Changes in average weight (kg) of skipjack tuna from 1977 to 2010 for Maldivian baitboat (BB) and purse seine (PS) as well as all fisheries combined (ALL). (Data as of September 2011).

Skipjack tuna – tagging data

A total of 100,620 skipjack tuna were tagged during the Indian Ocean Tuna Tagging Programme (IOTTP) which represented 49.8% of the total number of fish tagged. Most of the skipjack tuna tagged (77.8%) were tagged during the main Regional Tuna Tagging Project-Indian Ocean (RTTP-IO) and were primarily released off the coasts of the Seychelles and Tanzania and in the Mozambique Channel (Fig. 11) between May 2005 and September 2007. The remaining were tagged during small-scale projects around the Maldives, India and the southwest and eastern Indian Ocean by institutions with the support of IOTC. To date 15,270 (15.2%) of the tagged fish have been recovered and reported to the IOTC Secretariat.

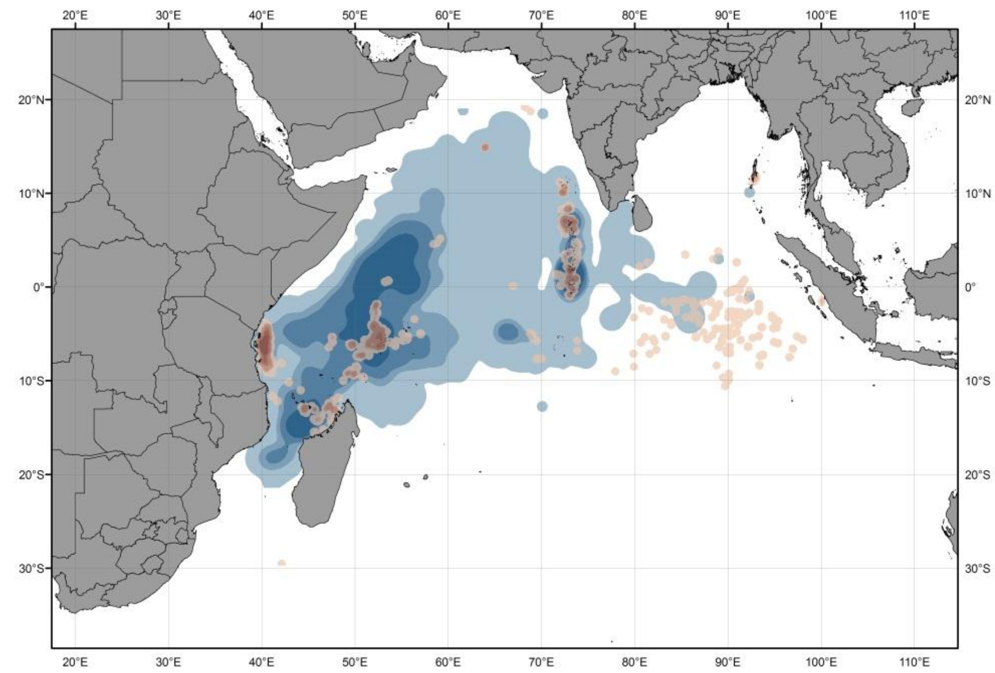


Fig. 11. Densities of releases (in red) and recoveries (in blue) of skipjack tuna. Data as of September 2011.

STOCK ASSESSMENT

A single quantitative modelling method, a "Stock Synthesis III" (SS3), was applied to the skipjack tuna assessment in 2011, using data from 1950–2009. The model was age-structured, iterated on a quarterly time-step, spatially aggregated, with four fishing fleets and Beverton-Holt recruitment dynamics. Model parameters (virgin recruitment, selectivity by fleet, recruitment deviations, and M in some cases) were estimated by fitting predictions and observations of Maldivian pole-and-line CPUE (2004–2010), length frequency data for all fleets, and tag recoveries (for the purse seine fleets, and in some cases, the Maldivian pole-and-line fleet). The uncertainties and interactions among a range of assumptions was examined (including a range of fixed values for parameters that are known to be difficult to estimate). The stock status estimates represented a synthesis from 180 models (balanced factorial design of 5 assumptions, including i) 3 M options (estimated internally, fixed at point estimates from the preliminary Brownie analysis (IOTC–2011–WPTT13–30), or fixed at ICCAT values), ii) 5 stock recruit steepness options (h = 0.55–0.95), iii) 2 tagging program release/recovery options (RTTP or combined RTTP and small-scale), iv) 2 growth curve options and v) 3 tag recovery overdispersion options.

The following is worth noting with respect to the modelling approach used:

- The models estimate a steep biomass decline between 1980 and 1990 followed by a steep biomass increase. At this stage, there are no CPUE series during this period to inform the model. The catch increased in this period due to the onset of purse seine fishing and industrialization of the Maldivian pole and line fishery and thus, trends in recruitment are required to explain the biomass patterns. The biomass/recruitment trends were supported only by the length frequency data, and it is not likely that these data are sufficiently informative to estimate this trend. Furthermore, the trend is not evident in the nominal CPUE series from either the pole and line or purse seine fisheries.
- Due to numerical problems in the F_{MSY} calculations for this population, the proxy reference point C/MSY is reported instead of F/F_{MSY}, which should be interpreted with caution for the following reasons:
    - it may incorrectly suggest $F>F_{MSY}$ when there is a large biomass (early development of the fishery or large recruitment event)
    - it may incorrectly suggest that $F<F_{MSY}$ when the stock is highly depleted
    - due to a flat yield curve, C could be near MSY even if $F << F_{MSY}$.
- Although CPUE from the EU,France fleet targeting free school was only reliable for yellowfin tuna and bigeye tuna after 1991, due to species misidentification, for skipjack tuna this series could be extended back to 1983, as misidentification would not have occurred between this species and the others. It was noted, however, that this nominal series would not take into account changes in fishing/gear efficiency and so could still be unsuitable as an index of abundance for the earlier years. These restrictions also apply to the post–1991 series. However, it should be taken into account that the free school catch of purse seiners is relatively small in comparison to FAD-associated fishing (less than 10%) and the fishery is seasonal, located mainly in the Mozambique Channel during the first quarter of the year.
- Most of the natural mortality assumptions included in the assessment were lower than those assumed in other oceans. The values estimated within the model only using the WPTT tagging data were unrealistically low for ages 0–1. The values estimated within the model appeared plausible when the small-scale tagging data was included with the RTTP data. The values adopted from the independent Brownie analysis using only RTTP data showed a similar pattern of M(age) to the SS3 RTTP+small-scale estimates, but were substantially lower. It was noted that there were some differences in the way that the SS3 model and Brownie analysis estimated M, but it was not obvious why either of the approaches would be biased.

TABLE 6. Key management quantities from the SS3 assessment, for the aggregate Indian Ocean. Estimates represent 50th (5th–95th) percentiles from the weighted distribution of MPD results. Due to numerical problems in the F_{MSY} calculations for this population, the proxy reference point C/MSY is reported instead of F/F_{MSY}, which should be interpreted with caution for the reasons given in Table 1.

Management Quantity	Aggregate Indian Ocean
2009 catch estimate	456,000 t
Mean catch from 2005–2009	512,000 t
MSY (90% CI)	564,000 t (395,000–843,000)
Data period used in assessment	1950–2009
$C_{2009}/_{MSY}$ (90% CI) (proxy for F_{2009}/F_{MSY})	0.81 (0.54–1.16)
B_{2009}/B_{MSY}	–
SB_{2009}/SB_{MSY} (90% CI)	2.56 (1.09–5.83)
B_{2009}/B_0	–
SB_{2009}/SB_0 (90% CI)	0.53 (0.29–0.70)
$B_{2009}/B_{1950,\ F=0}$	–
$SB_{2009}/SB_{1950,\ F=0}$	0.53 (0.29–0.70)

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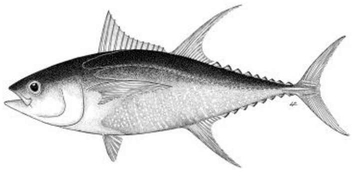
APPENDIX XIII
EXECUTIVE SUMMARY: YELLOWFIN TUNA

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean yellowfin tuna resource (*Thunnus albacares*)

TABLE 1. Status of yellowfin tuna (*Thunnusalbacares*) in the Indian Ocean.

Area[1]	Indicators – 2011 assessment		2011 stock status determination 2009[2]
Indian Ocean	Catch 2010: Average catch 2006–2010 (1000 t): MSY: F_{2009}/F_{MSY}: SB_{2009}/SB_{MSY}: SB_{2009}/SB_0 :	299,074 t 326,556 t 357 (290–435) 0.84 (0.63–1.10) 1.61 (1.47–1.78) 0.35 (0.31–0.38)	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]The stock status refers to the most recent years' data used for the assessment.

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. The stock assessment model used in 2011 suggests that the stock is currently not overfished ($B_{2009}>B_{MSY}$) and overfishing is not occurring ($F_{2009}<F_{MSY}$) (Table 1 and Fig. 1). Spawning stock biomass in 2009 was estimated to be 35% (31–38%) (from Table 1) of the unfished levels. However, estimates of total and spawning stock biomass show a marked decrease over the last decade, accelerated in recent years by the high catches of 2003–2006. It was noted that the current assessment does not explain the high catches of yellowfin tuna from 2003 to 2006, as it does not show peaks in fishing mortality or biomass for this period. Recent reductions in effort and, hence, catches has halted the decline.

The main mechanism that appears to be behind the very high catches in the 2003–2006 period is an increase in catchability by surface and longline fleets due to a high level of concentration across a reduced area and depth range. This was likely linked to the oceanographic conditions at the time generating high concentrations of suitable prey items that yellowfin tuna exploited. A possible increase in recruitment in previous years, and thus in abundance, cannot be completely ruled out, but no signal of it is apparent in either data or model results. This means that those catches probably resulted in considerable stock depletion.

Outlook. The decrease in longline and purse seiner effort in recent years has substantially lowered the pressure on the Indian Ocean stock as a whole, indicating that current fishing mortality has not exceeded the MSY-related levels in recent years. If the security situation in the western Indian Ocean were to improve, a rapid reversal in fleet activity in this region may lead to an increase in effort which the stock might not be able to sustain, as catches would then be likely to exceed MSY levels. Catches in 2010 (299,074 t) are within the lower range of MSY values The current assessment indicates that catches of about the 2010 level are sustainable, at least in the short term. However, the stock is unlikely to support higher yields based on the estimated levels of recruitment from over the last 15 years.

In 2011, the WPTT undertook projections of yellowfin tuna stock status under a range of management scenarios for the first time, following the recommendation of both the Kobe process and the Commission, to harmonise technical advice to managers across RFMOs by producing Kobe II management strategy matrices. The purpose of the table is to quantify the future outcomes from a range of management options (Table 2). The table describes the presently estimated probability of the population being outside biological reference points at some point in the future, where "outside" was assigned the default definitions of $F>F_{MSY}$ or $B<B_{MSY}$. The timeframes represent 3 and 10 year projections (from the last data in the model), which corresponds to predictions for 2013 and 2020. The management options represent three different levels of constant catch projection: catches 20% less than 2010, equal to 2010 and 20% greater than 2010.

The projections were carried out using 12 different scenarios based on similar scenarios used in the assessment for the combination of those different MFCL runs: LL selectivity flat top vs. dome shape; steepness values of 0.7, 0.8 and 0.9; and computing the recruitment as an average of the whole time series vs. 15 recent years (12 scenarios). The probabilities in the matrices were computed as the percentage of the 12 scenarios being $B>B_{MSY}$ and $F<F_{MSY}$ in each year. In that sense, there are not producing the uncertainty related to any specific scenario but the uncertainty associated to different scenarios.

The SC **RECOMMENDED** the following:

- The Maximum Sustainable Yield estimate for the whole Indian Ocean is 357,000 t with a range between 290,000–435,000 t (Table 1), and annual catches of yellowfin tuna should not exceed the lower range of MSY (300,000 t) in order to ensure that stock biomass levels could sustain catches at the MSY level in the long term.
- Recent recruitment is estimated to be considerably lower than the whole time series average. If recruitment continues to be lower than average, catches below MSY would be needed to maintain stock levels.

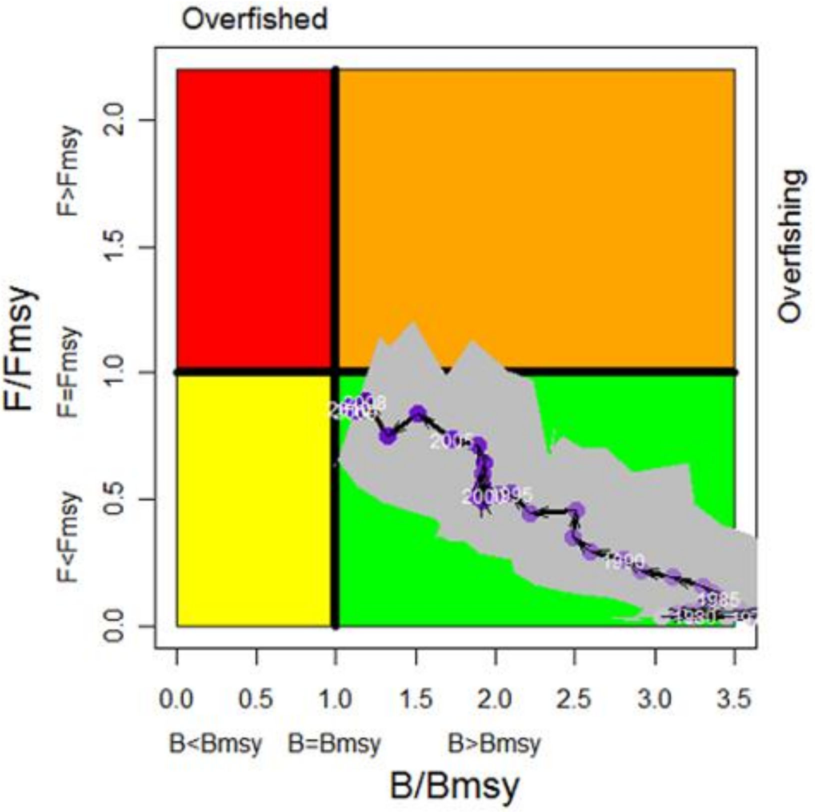


Fig. 1. MULTIFAN-CL Indian Ocean yellowfin tuna stock assessment Kobe plot. Blue circles indicate the trajectory of the point estimates for the B ratio and F ratio for each year 1972–2009. The equal weighted mean trajectory of the scenarios investigated in the assessment. The range is given by the different scenarios investigated..

TABLE 2. MULTIFAN-CL Indian Ocean yellowfin tuna stock assessment Kobe II Strategy Matrix. Percentage probability of violating the MSY-based reference points for five constant catch projections (2010 catch level, ± 20% and ± 40%) projected for 3 and 10 years. In the projection, however, 12 scenarios were investigated: the six scenarios investigated above as well as the same scenarios but with a lower mean recruitment assumed for the projected period.

Reference point and projection timeframe	**Alternative catch projections (relative to 2010) and probability (%) of violating reference point**				
	60% (165,600 t)	**80%** (220,800 t)	**100%** (276,000 t)	**120%** (331,200 t)	**140%** (386,400 t)
$B_{2013}<B_{MSY}$	<1	<1	<1	<1	<1
$F_{2013}>F_{MSY}$	<1	<1	58.3	83.3	100
$B_{2020}<B_{MSY}$	<1	<1	8.3	41.7	91.7
$F_{2020}>F_{MSY}$	<1	41.7	83.3	100	100

There was considerable discussion on the ability of the WPTT to carry out projections with Multifan-FCL for yellowfin tuna. For example, it was not clear how the projection redistributed the recruitment among the different regions, as the recent recruitment distribution, assumed in the projections, was different from the historical one. The WPTT agreed that the true uncertainty remains unknown and that the current characterization is not complete. However, the WPTT feels that the projections may provide a relative ranking of different scenarios outcomes. The WPTT recognised that, at this time, the Kobe 2 matrices do not represent the full range of uncertainty from the assessments. Therefore, the inclusion of these matrices at this time is primarily intended to familiarise the Commission with the format and method of presenting management advice.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Tropical Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Yellowfin tuna (*Thunnus albacares*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission:

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/01 *for the Conservation and Management of tropical tunas stocks in the IOTC area of competence*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/07 *concerning a record of licensed foreign vessels fishing for tunas and swordfish in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 10/13 *On the implementation of a ban on discards of skipjack tuna, yellowfin tuna, bigeye tuna, and non targeted species caught by purse seiners*.
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

Yellowfin tuna *(Thunnusalbacares)* is a cosmopolitan species distributed mainly in the tropical and subtropical oceanic waters of the three major oceans, where it forms large schools. Table 3 outlines some of the key life history traits of yellowfin tuna relevant for management.

TABLE 3. Biology of Indian Ocean yellowfin tuna (*Thunnus albacares*).

Parameter	Description
Range and stock structure	A cosmopolitan species distributed mainly in the tropical and subtropical oceanic waters of the three major oceans, where it forms large schools. Feeding behaviour has been extensively studied and it is largely opportunistic, with a variety of prey species being consumed, including large concentrations of crustaceans that have occurred recently in the tropical areas and small mesopelagic fishes which are abundant in the Arabian Sea. It has also been observed that large individuals can feed on very small prey, thus increasing the availability of food for this species. Archival tagging of yellowfin tuna has shown that this species can dive very deep (over 1000 m) probably to feed on meso-pelagic prey. Longline catch data indicates that yellowfin tuna are distributed throughout the entire tropical Indian Ocean. The tag recoveries of the RTTP-IO provide evidence of large movements of yellowfin tuna, thus supporting the assumption of a single stock for the Indian Ocean. The average distance travelled by yellowfin between being tagging and recovered is 710 nautical miles, and showing increasing distances as a function of time at sea.
Longevity	9 years
Maturity (50%)	Age: females and males 3–5 years. Size: females and males 100 cm.
Spawning season	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.

Size (length and weight)	Maximum length: 240 cm FL; Maximum weight: 200 kg. 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 140 cm (this is also the case in other oceans). The sizes exploited in the Indian Ocean range from 30 cm to 180 cm fork length. Smaller fish (juveniles) form mixed schools with skipjack tuna 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 tuna are seldom taken in the industrial fisheries, but are abundant in some artisanal fisheries, mainly in the Arabian Sea.

SOURCES: Froese & Pauly (2009)

Catch trends

Contrary to the situation in other oceans, the artisanal fishery (*i.e.* vessels less than 24m fishing inside their EEZ) component of yellowfin tuna catches in the Indian Ocean is substantial, taking approximately 20–25% of the total catch landed. Catches of yellowfin tuna remained more or less stable between the mid-1950s and the early-1980s, ranging between 30,000 and 70,000 t, owing to the activities of longliners and, to a lesser extent, gillnetters (Fig. 2).

Catches of yellowfin tuna increased rapidly with the arrival of the purse seine fleets in the early 1980s (Figs. 2 and 3), along with increased activity by longline vessels, with more than 400,000 t landed in 1993. Purse seiners typically take fish ranging from 40–140 cm fork length and smaller fish are more common in the catches taken north of the equator.

The purse seine fishery is characterized by the use of two different fishing modes: a fishery on drifting objects (FADs), which catches large numbers of small yellowfin in association with skipjack tuna and juvenile bigeye tuna, and a fishery on free swimming schools, which catches larger yellowfin tuna on multi-specific or mono-specific 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 tuna catch by weight (59–76% of the total catch). The proportion of yellowfin tuna caught (in weight) on free-schools during 2003–2006 (64%) was much higher than in previous (49% for 1999–2002) or following years (55% for 2007–2009).

The longline fishery primarily catches large fish, from 80–160 cm fork length, although smaller fish in the size range 60–100 cm have been taken and reported 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 tuna and bigeye tuna being the main target species in tropical waters. The longline fishery can be subdivided into a deep-freezing longline component (large scale deep-freezing longliners operating on the high seas from Japan, Rep. of Korea and Taiwan,China) and a fresh-tuna longline component (small to medium scale fresh tuna longliners from Indonesia and Taiwan,China). As was the case with purse seine fisheries, since 2005 longline catches have decreased substantially with current catches estimated to be at around 41,000 t, representing a more than three-fold decrease over the catches in 2005 (Fig. 2).

Total yellowfin tuna catches dropped markedly from the peak catches taken in 2006, with the lowest catches recorded since the early 1990's reported in 2009, at around 275,955 t. Preliminary catch levels in 2010 are estimated to be around 299,074 t (Tables 4, 5).

The recent drop in catches of yellowfin tuna could be related, at least in part, to the expansion of piracy in the western tropical Indian Ocean, which has led to a marked drop in the levels of longline effort in the core fishing area of the species (Figs. 4a, b) as well as to the decline in the number of purse seiners in the Indian Ocean (~30% reduction).

Catches by other gears, i.e. pole-and-line, gillnet, troll, hand line and other minor gears, have increased steadily since the 1980s (Fig. 2). In recent years the total artisanal yellowfin tuna catch has been between 140,000–160,000 t, with the catch by gillnets (the dominant artisanal gear) at around 80,000 t.

Most yellowfin tuna are caught in the Indian Ocean, north of 12°S, and in the north of the Mozambique Channel (Figs. 4a, b). In recent years the catches of yellowfin tuna in the western Indian Ocean have dropped considerably, especially in areas off Somalia, Kenya and Tanzania and in particular between 2008 and 2010. The drop in catches is the consequence of a generalised drop in fishing effort due to the effect of piracy in the western Indian Ocean region.

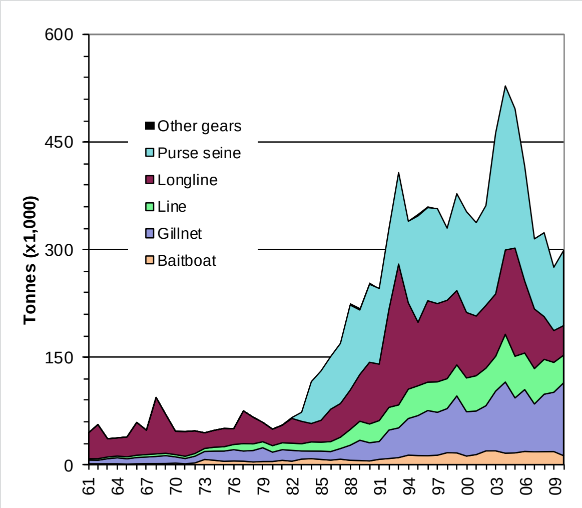


Fig. 2. Annual catches of yellowfin tuna by gear recorded in the IOTC Database (1961–2010) (Data as of September 2011).

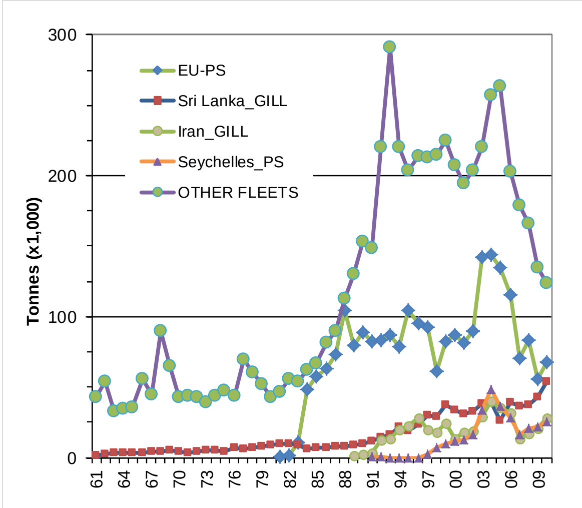


Fig. 3. Annual catches of yellowfin tuna by fleet recorded in the IOTC Database (1961–2010) (Data as of September 2011).

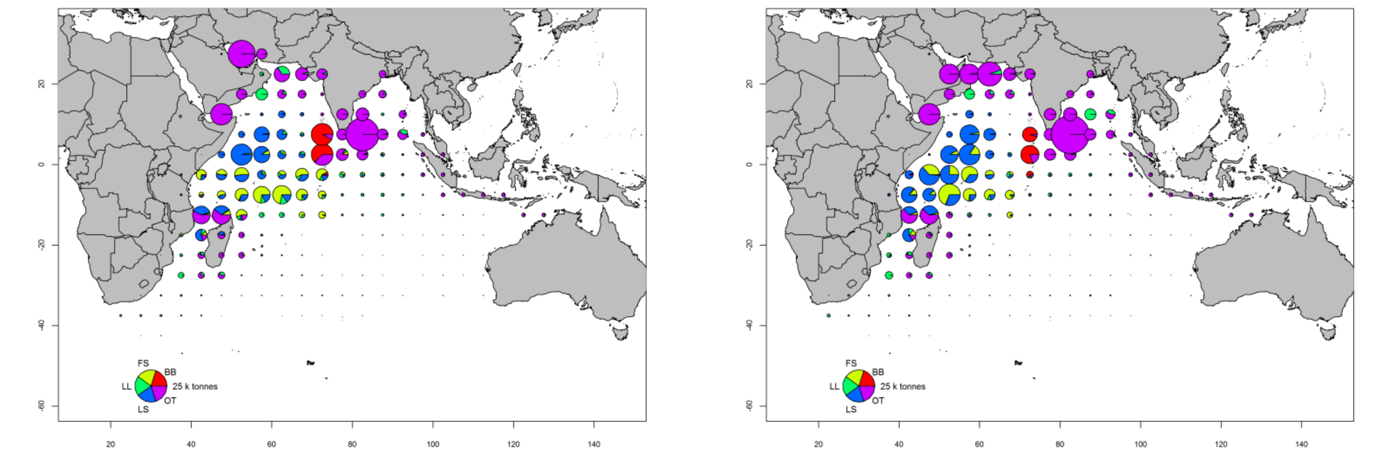


Fig. 4a–b. Time-area catches (total combined in tonnes) of yellowfin tuna estimated for 2009 and 2010 by type of gear: Longline (LL), Purse seine free-schools (FS), Purse seine associated-schools (LS), pole-and-line (BB), and other fleets (OT), including drifting gillnets, and various coastal fisheries (Data as of September 2011).

TABLE 4. Best scientific estimates of the catches of yellowfin tuna (*Thunnus albacares*)by gear and main fleets [or type of fishery] by decade (1950–2000) and year (2001–2010), in tonnes. Data as of October 2011. Catches by decade represent the average annual catch, noting that some gears were not used for all years (refer to Fig. 2).

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
FS	0	0	18	32,590	64,942	89,761	78,969	77,059	137,492	168,799	124,024	85,021	53,529	74,990	36,263	31,951
LS	0	0	17	18,090	56,304	61,909	50,997	61,933	86,585	59,597	69,873	74,454	43,843	41,453	51,565	72,199
LL	21,990	41,256	29,512	33,889	66,689	57,668	43,932	53,132	55,741	86,415	116,847	69,831	54,414	29,128	21,242	17,130
LF	0	0	615	4,286	47,570	32,827	39,323	34,429	31,292	31,125	33,991	30,475	28,752	30,424	23,157	24,089
BB	1,754	1,452	4,380	6,621	11,765	17,162	14,233	19,393	19,451	16,177	16,607	18,644	18,133	18,351	18,463	12,755
GI	2,604	7,569	12,861	15,261	50,192	76,053	60,748	62,982	83,283	99,254	76,660	86,286	66,693	80,086	82,695	101,418
HD	679	1,175	2,615	6,990	20,002	31,762	29,790	34,093	31,105	40,820	38,993	31,789	30,274	28,895	23,952	20,472
TR	832	1,514	3,502	7,193	16,825	19,479	19,453	18,288	17,270	25,798	19,136	19,160	19,061	19,770	17,682	18,177
OT	118	130	497	1,275	1,344	1,107	543	463	1,396	1,734	1,123	1,436	1,290	1,567	936	883
Total	**27,978**	**53,096**	**54,017**	**126,193**	**335,634**	**387,728**	**337,988**	**361,772**	**463,615**	**529,719**	**497,254**	**417,096**	**315,989**	**324,664**	**275,955**	**299,074**

Fisheries: Purse seine free-school (**FS**); Purse seine associated school (**LS**); Deep-freezing longline (**LL**); Fresh-tuna longline (**LF**); Pole-and-Line (**BB**); Gillnet (**GI**); Hand line (**HD**); Trolling (**TR**); Other gears nei (**OT**).

TABLE 5. Best scientific estimates of the catches of yellowfin tuna (*Thunnus albacares*)in the Western and Eastern Indian Ocean areas for the period 1950–2010 (in metric tons). Data as of October 2011.

Area*	By decade (average)						By year (last ten years)									
	1950s	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
R1	2,164	5,430	9,376	18,462	73,169	83,578	65,544	73,160	82,854	119,183	129,226	92,860	74,179	72,600	62,861	65,123
R2	11,899	23,101	20,921	72,400	143,122	183,679	156,045	164,369	265,456	278,103	248,113	204,035	126,450	135,499	100,973	111,041
R3	919	7,857	4,483	9,646	28,681	33,100	32,009	34,377	31,004	36,490	33,887	33,480	35,123	30,867	28,990	27,545
R4	918	1,799	1,370	1,075	3,314	2,122	3,376	3,328	2,387	3,802	2,904	1,363	540	507	427	498
R5	12,079	14,909	17,869	24,611	87,347	85,250	81,014	86,538	81,914	92,141	83,124	85,358	79,697	85,191	82,704	94,867
Total	**27,978**	**53,096**	**54,017**	**126,193**	**335,634**	**387,728**	**337,988**	**361,772**	**463,615**	**529,719**	**497,254**	**417,096**	**315,989**	**324,664**	**275,955**	**299,074**

*See Fig. 9 for a description of the areas

Uncertainty of catches

Retained catches are generally well known for the major fleets (Fig. 5); but are less certain for:

- Many coastal fisheries, notably those from Indonesia, Sri Lanka, Yemen, Madagascar and Comoros.
- The gillnet fishery of Pakistan.
- Non-reporting industrial purse seiners and longliners (NEI), and commercial longliners from India.

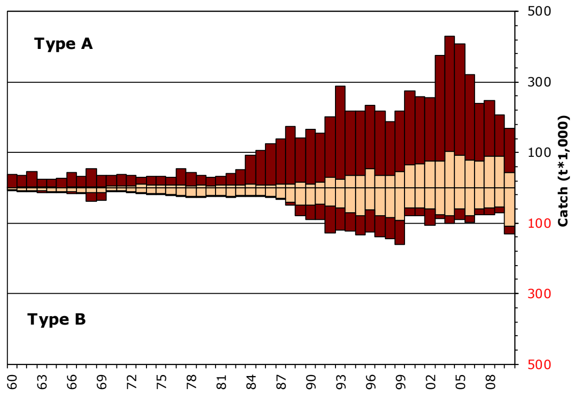


Fig. 5.Uncertainty of annual catch estimates for yellowfin tuna (Data as of September 2011).
Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

- the catch series for yellowfin tuna has not been significantly revised since the WPTT12 in 2010, although there has been some revision to the time series of catch from the fisheries of India leading to changes in catches by gear.
- levels of discards are believed to be low although they are unknown for most industrial fisheries, excluding industrial purse seiners flagged in EU countries for the period 2003–2007.
- catch-and-effort series are available from the major industrial and artisanal fisheries. However, these data are not available for some important artisanal fisheries or they are considered to be of poor quality for the following reasons:
  - no data are available for the fresh-tuna longline fishery of Indonesia, over the entire time series, and very little data available for the fresh-tuna longline fishery of Taiwan,China.
  - no data are available for the gillnet fisheries of Pakistan.
  - although Iran has provided catch and effort data, it is not reported as per the IOTC standards.
  - the poor quality effort data for the significant gillnet/longline fishery of Sri Lanka.
  - no data are available from important coastal fisheries using hand and/or troll lines, in particular Yemen, Indonesia, Madagascar and Comoros.

Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid from 2007 to 2010 are provided in Fig. 6, and total effort from purse seine vessles flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2007 to 2010 are provided in Fig. 7. The total number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2009 and 2010 are provided in Fig. 8.

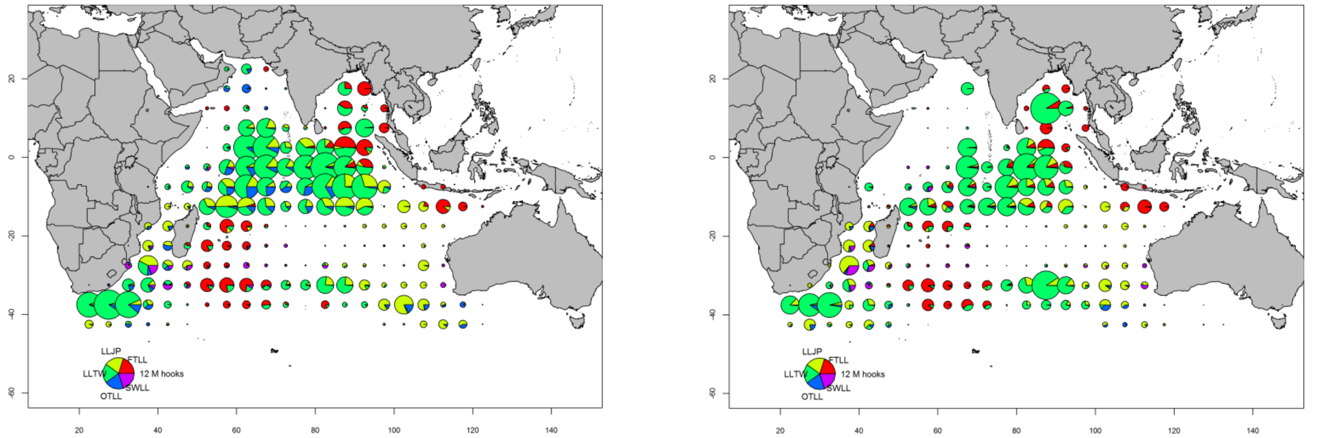


Fig. 6. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).

LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

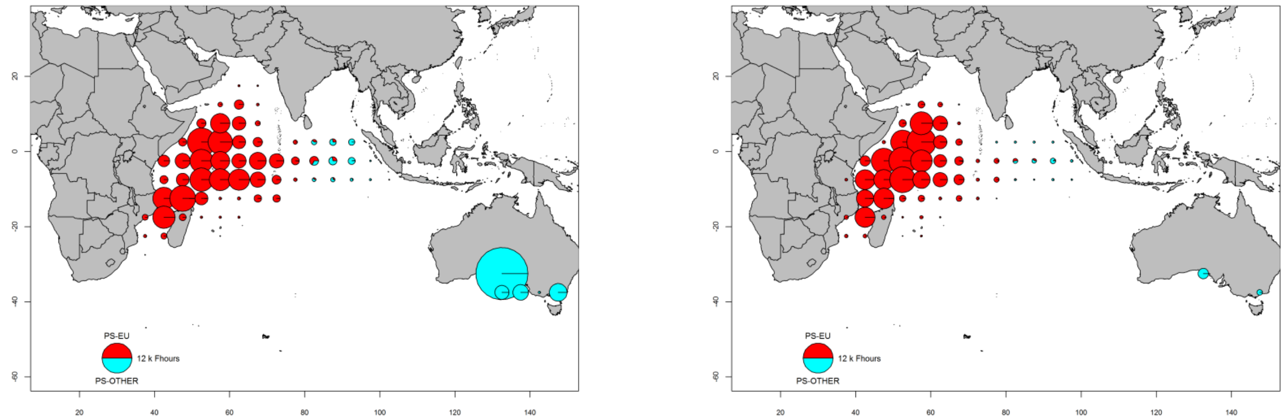


Fig. 7. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).

PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

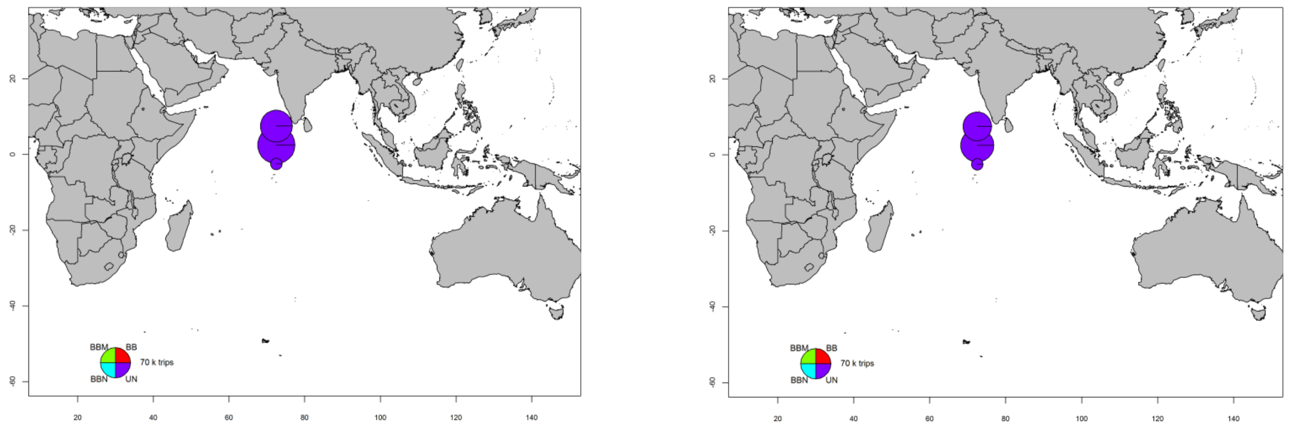


Fig. 8. Number of fishing tripsby vessels flagged to the Maldives by 5 degree square grid,type of boat and gear, for the years 2009 (left) and 2010 (right) (Data as of August 2011).

BBN (blue): Baitboat non-mechanized; BBM (Green): Baitboat mechanized; BB (Red): Baitboat unspecified; UN (Purple): Unclassified gears
Note that the above maps were derived using the available catch-and-effort data in the IOTC database, which is limited to the number of baitboat calls (trips) by atoll by month for Maldivian baitboats for the period concerned. Note that some trips may be fully devoted to handlining, trolling, or other activities (data by gear type are not available since 2002). No data are available for the pole-and-line fisheries of India (Lakshadweep) and Indonesia.

Standardised catch–per–unit–effort (CPUE) trends

For the longline fisheries (LL fisheries in regions 1–5; Fig. 9), CPUE indices were derived using generalized linear models (GLM) from the Japanese longline fleet (LL regions 2–5) and for the Taiwanese longline fleet (LL region 1) to be used in the stock assessment. Standardised longline CPUE indices for the Taiwanese fleet were available for 1979–2008. The GLM analysis used to standardise the Japanese longline CPUE indices was refined for the 2011 assessment to include a spatial (latitude*longitude) variable. The resulting CPUE indices were generally comparable to the indices derived from the previous model and were adopted as the principal CPUE indices for the 2011 assessment (Fig. 10). There is considerable uncertainty associated with the Japanese CPUE indices for region 2 in the most recent year (2010) and no CPUE indices are available for region 1 for 2009–10.

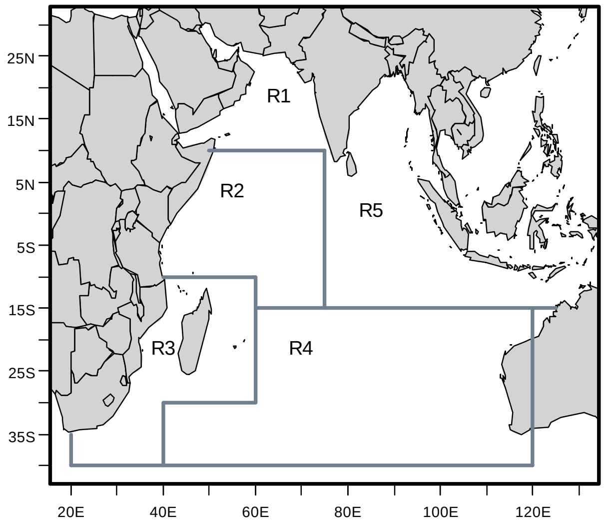


Fig. 9. Spatial stratification of the Indian Ocean for the MFCL assessment model.

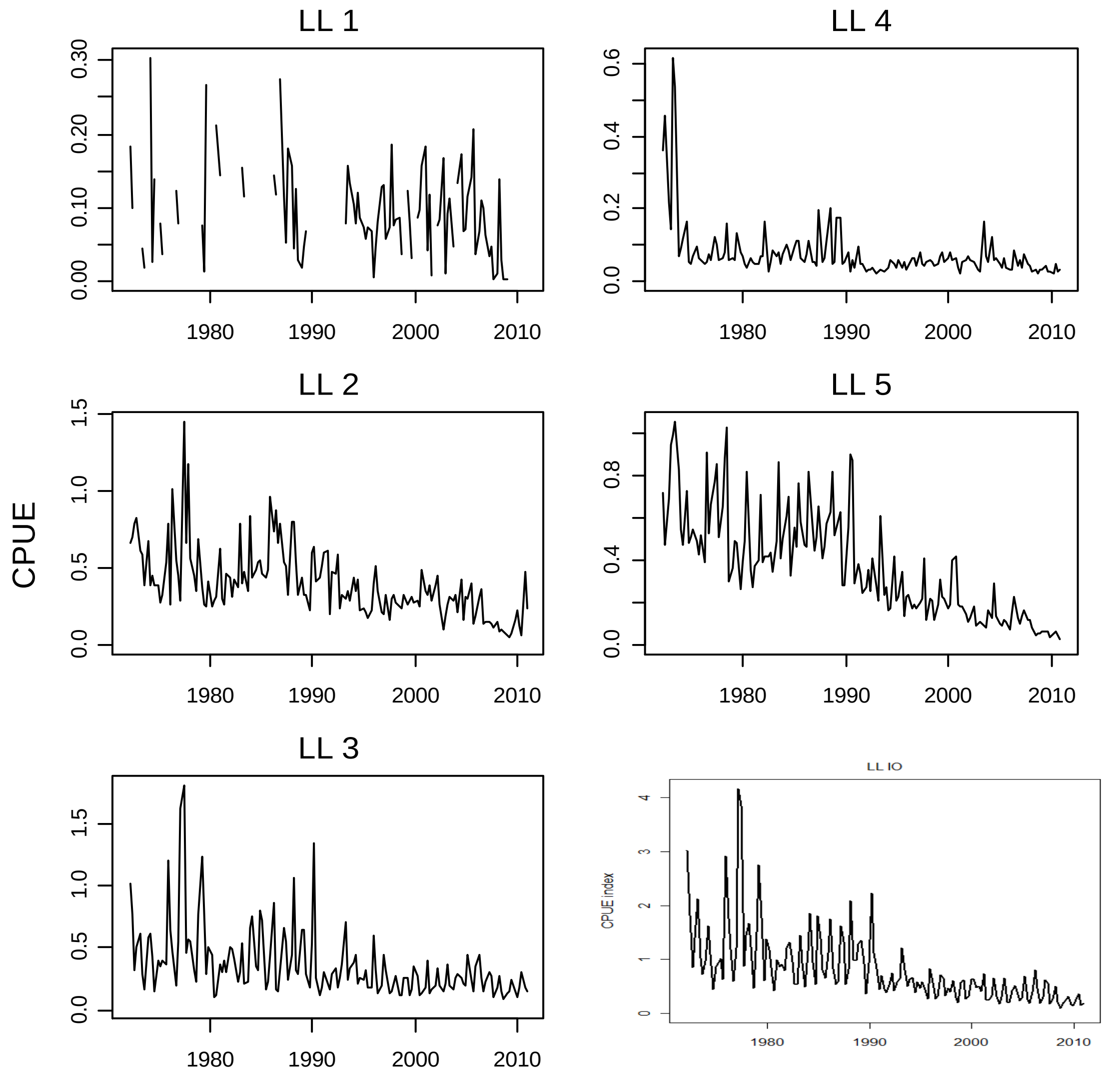


Fig. 10. Annualised GLM standardised catch-per-unit-effort (CPUE) for the principal longline fisheries (longline region 1: Taiwan,China and longline regions 2–5: Japan) and the whole Indian Ocean (IO), scaled by the respective region scalars.

Fish size or age trends (e.g. by length, weight, sex and/or maturity)

- trends in average weight (Fig. 11) can be assessed for several industrial fisheries but they are very incomplete or of poor quality for some fisheries, namely hand lines (Yemen, Comoros, Madagascar), troll lines (Indonesia) and many gillnet fisheries (see paper IOTC–2011–WPTT13–08).

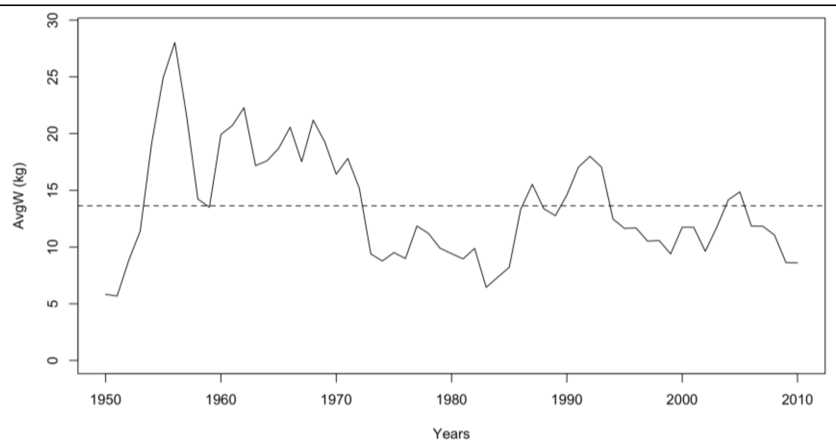


Fig. 11.Changes in average weight (kg) of yellowfin tuna from 1950 to 2010 – all fisheries combined (Data as of September 2011).

- catch-at-Size and Age tables are available although the estimates are more uncertain in some years and some fisheries due to:
  - size data not being available from important fisheries, notably Yemen, Pakistan, Sri Lanka and Indonesia (lines and gillnets) and Comoros and Madagascar (lines).
  - the paucity of size data available from industrial longliners from the late-1960s up to the mid-1980s.
  - the paucity of catch by area data available for some industrial fleets (NEI, Iran, India, Indonesia, Malaysia).

Tagging data

A total of 63,310 yellowfin tuna were tagged during the Indian Ocean Tuna Tagging Programme (IOTTP) which represented 31.4% of the total number of fish tagged. Most of the yellowfin tuna tagged (86.4%) were tagged during the main Regional Tuna Tagging Project-Indian Ocean (RTTP-IO) and were primarily released off the coasts of the Seychelles, in the Mozambique Channel, along the coast of Oman and off the coast of Tanzania (Fig. 12) between May 2005 and September 2007. The remaining were tagged during small-scale projects around the Maldives, India and the southwest and eastern Indian Ocean by institutions with the support of IOTC. To date 10,560 (16.7%) tagged fish have been recovered and reported to the IOTC Secretariat.

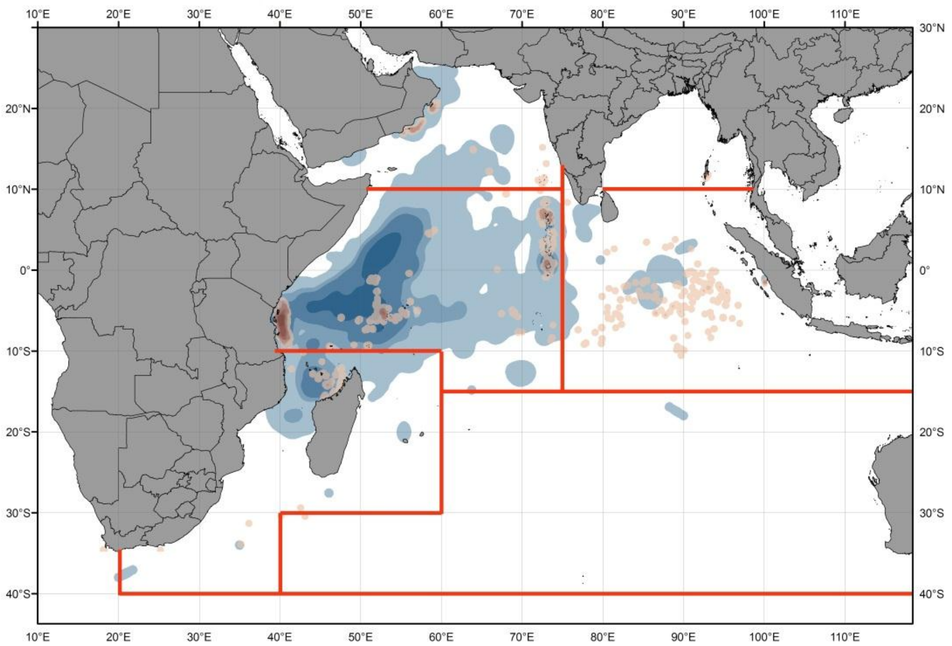


Fig. 12.Densities of releases (in red) and recoveries (in blue) of yellowfin tuna. Data as of September 2011.

STOCK ASSESSMENT

A single quantitative modelling method (MULTIFAN-CL) was applied to the yellowfin tuna assessment in 2011, using data from 1972–2010.The following is worth noting with respect to the modelling approach used:

- The main features of the model in the 2010 assessment included a fixed growth curve (with variance) with an inflection, an age-specific natural mortality rate profile (M), the modelling of 24 fisheries including the separation of two purse seine fisheries into three time blocks, using a cubic spline method to estimate longline selectivities in the place of a logistic curve, the down-weighting of length frequency data in the fitting, separation of the analysis into five regions of the Indian Ocean and the specification of four steepness parameters for the stock recruitment relationship (h=0.6, 0.7, 0.8 and 0.9).
- In addition to another year of data, the 2011 assessment included several changes to the previous assessment: the longline CPUE indices were modified (Japanese updated with latest year which included information about latitude and longitude in the standardisation process for Regions 2–5 was supplied and the Taiwan,China index was revised for region 1); major historical catch revisions for fisheries in Region 5, splitting the longline fleet in Region 5 into distant water and fresh tuna logline fleets leaving 25 total fleets in the model; and the range of steepness evaluated was expanded to h=0.55-0.95.

While the biomass trends were very similar between the 2010 and 2011 assessments, the estimates of stock productivity and thus, the status, differed. There were several reasons for this: there was poor convergence in the 2010 assessment, thus the fits were suboptimal and alternative solutions were near optimal. Refitting the 2010 assessment is now more optimistic. Also, fitting the 2010 model to 2011 data was more optimistic. Thus, revisiting of key parameters and the inclusion of the latest year of data in the 2011 assessment appeared to be important. These issues are difficult to explore in the MFCL framework. The WPTT reviewed several alternative model structures and parameter formulations for the model that were presented in the assessment. These included: the new longline model structure for Region 5; alternative Japanese CPUE indices; a single region model where all 5 Regions were collapsed into one; a Region 2 model estimated separately from other Regions; the 5 values of steepness and alternative tag mixing periods (1–4 quarters). Additionally, an attempt was made to estimate age-specific M's. In regards to the latter, this parameter was not well estimated and the WPTT adopted the low M profile as the most appropriate way to proceed.

The problems identified in the catch data from some fisheries, and especially on the length frequencies in the catches of various fleets, a very important source of information for stock assessments. Length frequency data is almost unavailable for some fleets, while in other cases sample sizes are too low to reliably document changes in abundance and selectivity by age. Moreover, in general, catch data from some coastal fisheries is considered as poor.

The available tagging data has provided the WPTT with relevant information on various biological parameters, such as natural mortality and growth. Further use of these data should better support the analyses conducted by the WPTT.

In the previous assessment purse seine selectivity in the period 2003–2007 was separated into three blocks of time surrounding 2005 to accommodate the unusually large catches in the middle of that time period. This was continued in the current assessment. However, the WPTT questioned whether this was the most appropriate way to do this. An alternative was suggested in which the time blocks of PS fleet were removed and the same selectivity was applied throughout the period. This was explored in new model runs. Results were not demonstrably different.

Longline selectivity will be revisited in 2012 as it was suggested that this selectivity might still be best described by a logistic (flat-topped) model instead of a cubic spline approach, whereby the resulting selectivity was dome-shaped. This option reinvigorated a long standing debate that has yet to be resolved. A run whereby logistic selectivities were imposed was evaluated.

Generally, the runs with alternative parameter and model structures did not suggest large differences in the approach and resulted in qualitatively predictable outcomes. The WPTT felt that the alternative outcomes were an expression of uncertainties in the model, data and assessment. Therefore, the WPTT focused on following basic alternatives for characterizing the uncertainty: logistic versus cubic spline longline selectivity; using the low M profile; alternative steepness of the stock-recruitment relationship of 0.7, 0.8 and 0.9, and estimation of MSY based reference points using the average recruitment for the whole time series. It was determined that with current knowledge outcomes using these alternatives are equally likely and a combined evaluated was generated based upon this.

The final range of model options adopted by the WPTT included the 2 alternative parametrization of longline selectivity (cubic spline and logisitic) and three steepness options (0.7, 0.8 and 0.9). For the cubic spline model option, there is a strong temporal trend in recruitment and recent recruitments (average of the last 15 years) is estimated to be lower (80%) than the long term recruitment level. On that basis, it was agreed to also derived alternative MSY estimates based on the recent levels of recruitment for comparative purposes.Key assessment results for the MFCL stock assessment areshown in Tables 1, 2 and 6; Fig. 1.

It was noted that some of the results of the Multifan-CL model selected were not intuitive and have been discussed extensively by the WPTT and the SC. The SC **NOTED** the following points:

- the movements of yellowfin tuna, between the five regions used in the stock assessment, estimated by the model show insignificant mixing between some regions which may infer three nearly independent different stocks in the Arabian sea (area 1), the South-East Indian Ocean (area 5) and the rest of the Indian Ocean. However, this result seems to be in contradiction with the biological knowledge of the stock and with the recent tagging results suggesting wide and fast movements between all areas.
- the levels and trends of biomass estimated by the model in each of the 5 areas seem unrealistic:
    - the very high initial biomass in the South-East area (area 5) and its major decline during recent years
    - the biomass in the South-West Indian Ocean (area 3) being larger than that of the Western equatorial Indian Ocean (area 2), which is recognized as the main yellowfin fishing area and consequently, where biomass should be at a much higher level.

Table 6. Key management quantities from the MFCL assessment, for the agreed scenarios of yellowfin tuna in the Indian Ocean.Values represent an equal weighting mean of the scenarios investigated. The range is described by the range values between those scenarios.

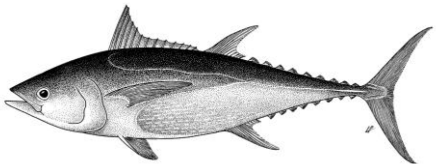
Management Quantity	**Indian Ocean**
2010 catch estimate	299,100 t
Mean catch from 2006–2010	326,600 t
MSY	357,000 t (290,000–435,000)
Data period used in assessment	1972–2010
F_{2009}/F_{MSY}	0.84 (0.63–1.10)
B_{2009}/B_{MSY}	1.46 (1.35–1.59)
SB_{2009}/SB_{MSY}	1.61 (1.47–1.78)
B_{2009}/B_0	0.49
SB_{2009}/SB_0	0.35 (0.31–0.38)
$B_{2009}/B_{0,\ F=0}$	0.58
$SB_{2009}/SB_{0,\ F=0}$	–

LITERATURE CITED

Froese R, &Pauly DE 2009. *FishBase,* version 02/2009, FishBaseConsortium, <www.fishbase.org>.

APPENDIX XIV
EXECUTIVE SUMMARY: LONGTAIL TUNA

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean longtail tuna resource (*Thunnus tonggol*)

TABLE 1. Status of longtail tuna (*Thunnus tonggol*) in the Indian Ocean.

Area[1]	**Indicators – 2011 assessment**		**2011 stock status determination 2010**[2]
Indian Ocean	Catch[3] 2010:	141,937 t	**UNCERTAIN**
	Average catch[3] 2006–2010:	115,973 t	
	MSY:	unknown	
	F_{2010}/F_{MSY}:	unknown	
	SB_{2010}/SB_{MSY}:	unknown	
	SB_{2010}/SB_0:	unknown	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]The stock status refers to the most recent years' data used for the assessment.
[3]Nominal catches represent those estimated by the IOTC Secretariat. If these data are not reported by CPCs, the IOTC Secretariat estimates total catch from a range of sources including: partial catch and effort data; data in the FAO FishStat database; catches estimated by the IOTC from data collected through port sampling; data published through web pages or other means; data reported by other parties on the activity of vessels; and data collected through sampling at the landing place or at sea by scientific observers.

Colour key	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

The SC **RECOMMENDED** the following management advice for longtail tuna in the Indian Ocean, noting that there remains considerable uncertainty about stock structure and about the total catches.

Stock status. No quantitative stock assessment is currently available for longtail tuna in the Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock indicators can be used. Therefore stock status remains *uncertain* (Table 1). However, aspects of the biology, productivity and fisheries for this species combined with the lack of data on which to base a more formal assessment are a cause for considerable concern.

Outlook. The continued increase of annual catches for longtail tuna in recent years has further increased the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource. The apparent fidelity of longtail tuna to particular areas/regions is a matter for concern as overfishing in these areas can lead to localised depletion. Research emphasis on improving indicators and exploration of stock structure and stock assessment approaches for data poor fisheries are warranted.

The SC **RECOMMENDED** the following:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Neritic Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Longtail tuna (*Thunnus tonggol*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

Longtail tuna (*Thunnus tonggol*) is an oceanic species that forms schools of varying sizes. It is most abundant over areas of broad continental shelf. Table 2 outlines some key life history parameters relevant for management.

TABLE 2. Biology of Indian Ocean longtail tuna (*Thunnus tonggol*).

Parameter	**Description**
Range and stock structure	An oceanic species that forms schools of varying sizes. It is most abundant over areas of broad continental shelf. Feeds on a variety of fish, cephalopods, and crustaceans, particularly stomatopod larvae and prawns. No information is available on the stock structure of longtail tuna in the Indian Ocean.
Longevity	~20 years
Maturity (50%)	**Age**: n.a.; females n.a. males n.a. **Size:** females and males ~40 cm FL (Pacific Ocean).
Spawning season	The spawning season varies according to location. Off the west coast of Thailand there are two distinct spawning seasons: January-April and August-September.
Size (length and weight)	Maximum: Females and males 145 cm FL; weight 35.9 kgs. Most common size in Indian Ocean ranges 40–70 cm. Grows rapidly to reach 40–46 cm in FL by age 1.

n.a. = not available. SOURCES: Froese & Pauly (2009); Griffiths et al. (2010a, b); Kaymaran et al. (2011)

Longtail tuna – Catch trends

Longtail tuna is caught mainly using gillnets and, to a lesser extent, purse seine and trolling (Fig. 1). The catch estimates for longtail tuna were derived from small amounts of information and are therefore uncertain. Estimated catches of longtail tuna increased steadily from the mid 1950's, reaching around 20,000 t in the mid-1970's and over 50,000 t by the mid-1980's. Catches reached record levels in 2010, at 141,937 t (preliminary estimate). The average annual catch estimated for the period 2006–2010 is 115,973 t (Table 3).

In recent years, the countries attributed with the highest catches of longtail tuna are the I.R. Iran (34%) and Indonesia (31%) and, to a lesser extent, Oman, Pakistan, Malaysia and India (22%) (Fig. 2). In particular, I.R. Iran has reported large increases in the catch of longtail tuna in 2009 and 2010. This may be the consequence of increased drifting gillnet effort in coastal waters due to the threat of Somali piracy in the western tropical Indian Ocean.

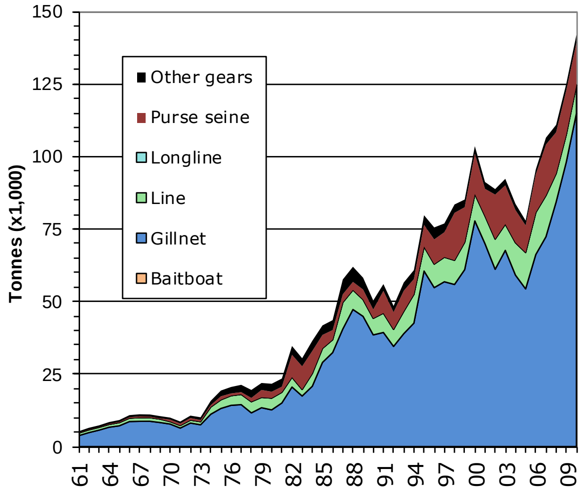


Fig. 1. Longtail tuna: Catches by gear recorded in the IOTC Database (1961–2010).

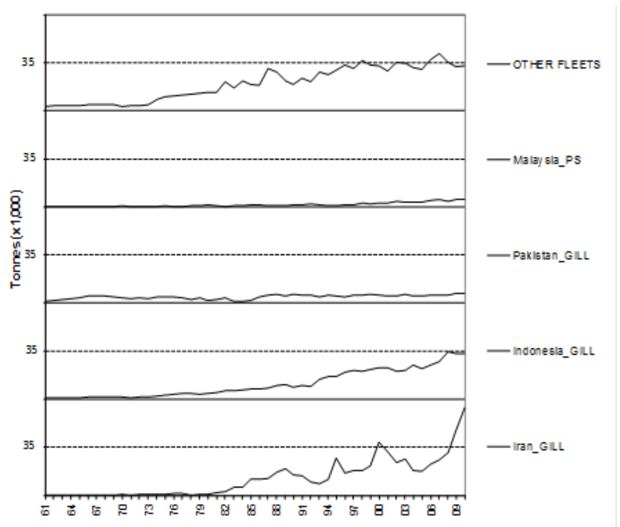


Fig. 2. Longtail tuna: Catches recorded in the IOTC Database for main fishing fleets (1961–2010).

TABLE 3. Best scientific estimates of the catches of longtail tuna by type of fishery for the period 1950–2010 (in metric tonnes). Data as of October 2011.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Purse seine	44	204	980	4,448	8,191	13,912	9,317	15,347	13,367	11,222	9,332	13,105	17,550	14,232	15,197	14,551
Gillnet	2,963	6,761	11,355	29,466	48,717	77,932	70,082	61,269	68,265	59,575	54,711	66,547	72,788	84,711	98,522	115,319
Line	846	1,089	2,379	4,898	7,887	9,278	9,599	10,425	9,053	11,209	12,552	14,527	14,243	9,849	9,530	9,758
Other	290	489	1,054	2,164	2,500	2,428	2,196	1,710	1,603	1,665	1,290	1,338	1,890	2,092	1,807	2,309
Total	**4,143**	**8,544**	**15,767**	**40,976**	**67,294**	**103,550**	**91,193**	**88,751**	**92,288**	**83,671**	**77,884**	**95,518**	**106,472**	**110,883**	**125,056**	**141,937**

Longtail tuna – Uncertainty of catches

Retained catches are uncertain (Fig. 3), notably for the following fisheries:

- Artisanal fisheries of Indonesia: Indonesia did not report catches of longtail tuna by species or by gear for 1950–2004; catches of longtail tuna, kawakawa and other species were reported aggregated for this period. The IOTC Secretariat used the catches reported since 2005 to break the aggregates for 1950–2004 by gear and species. The Indonesian catches estimated for longtail tuna represent more than 30% of the total catches of this species in the Indian Ocean in recent years.
- Artisanal fisheries of India and Oman: Although these countries report catches of longtail tuna, until recently the catches have not been reported by gear. The IOTC Secretariat used alternative information to assigning the catches reported by species. The catches of longtail tuna that had to be allocated by gear represented 12% of the total catches of this species in recent years.
- Artisanal fisheries of Mozambique, Myanmar, and Somalia: None of these countries have reported catches to the IOTC Secretariat. Catch levels are unknown but are not considered large.
- Other artisanal fisheries: The IOTC Secretariat estimated catches of longtail tuna for the artisanal fisheries of Yemen (no data reported to the IOTC Secretariat) and Malaysia (catches not reported by species). The catches estimated for longtail tuna represent 9% of the total catches of this species in recent years.
- Discard levels are believed to be very low although they are unknown for most fisheries.
- Changes to the catch series: There have been significant changes to the catches of longtail tuna since December 2010, following two reviews of catches for the coastal fisheries of India and, to a lesser extent, Indonesia, involving marked changes in catches by species. The new catches estimated are markedly lower than those previously recorded representing overall 65% and 75% of the catches recorded in the past for India and Indonesia, respectively.

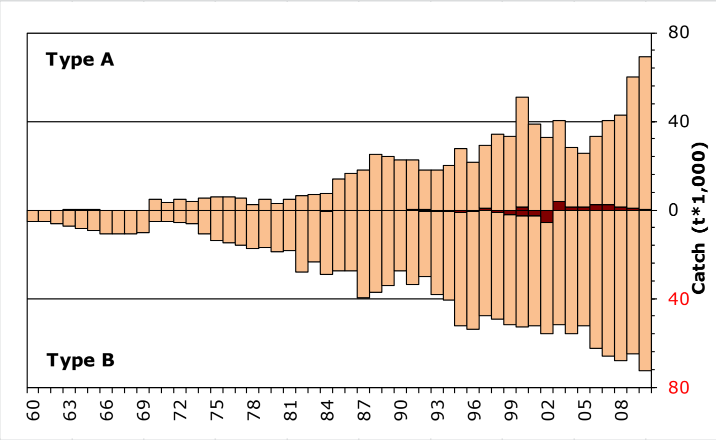


Fig. 3. Longtail tuna: Uncertainty of annual catch estimates (1961–2010) (Data as of October 2011).
*Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (**Type A**) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.*

Longtail tuna – Effort trends

Effort trends are unknown for longtail tuna in the Indian Ocean.

Longtail tuna – Catch–per–unit–effort (CPUE) trends

Standardised CPUE series have not yet been developed. Nominal CPUE series are however available from some fisheries but they are considered highly incomplete. In most cases catch-and-effort data are only available for short periods of time. Reasonably long catch and effort series (extending for more than 10 years) are only available for Thailand small purse seines and gillnets (Fig. 4). No catch and effort data are available from sports fisheries, other than for partial data from the sports fisheries of Kenya.

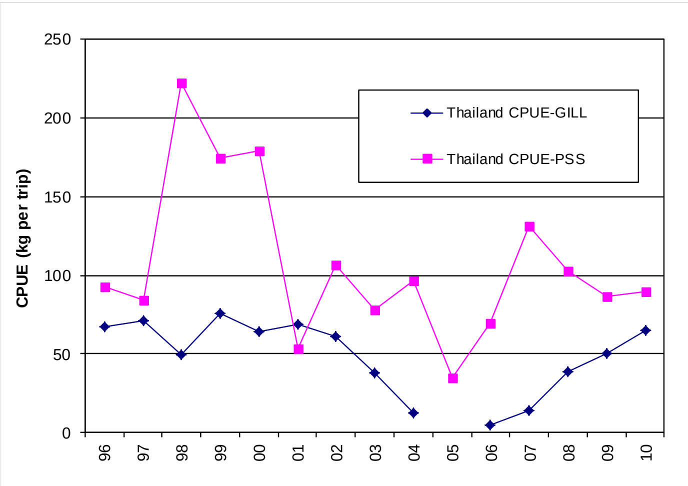


Fig. 4. Longtail tuna: Nominal CPUE series for the gillnet (GILL) and coastal purse seine (PSS) fisheries of Thailand derived from the available catches and effort data (1996–2010).

Longtail tuna – Fish size or age trends (e.g. by length, weight, sex and/or maturity)

- The size of longtail tuna taken by the Indian Ocean fisheries typically ranges between 15–120 cm depending on the type of gear used, season and location. The fisheries operating in the Andaman Sea (coastal purse seines and troll lines) tend to catch longtail tuna of small size (15–55cm) while the drifting gillnet fisheries operating in the Arabian Sea catch larger specimens (40–100cm).
- Trends in average weight can only be assessed for I.R. Iran drifting gillnets but the amount of specimens measured has been very low in recent years. The length frequency data available from the mid-eighties to the early nineties was obtained with the support of the IPTP (Indo-Pacific Tuna Programme). Unfortunately, data collection did not continue after the end of the IPTP activities.
- Catch-at-Size(Age) tables are not available for the longtail tuna due to the paucity of size data available from most fleets and the uncertain status of the catches for this species.

- Sex ratio data have not been provided to the Secretariat by CPCs.

STOCK ASSESSMENT

No quantitative stock assessment for longtail tuna in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Neritic Tunas. However, a preliminary estimation of stock indicators was attempted on the catch and effort datasets from the Thailand gillnet and purse seine fisheries (described above). However, there is considerable uncertainty about the degree to which this and other indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Longtail tuna (*Thunnus tonggol*) stock status summary.

Management Quantity	Aggregate Indian Ocean
2010 catch estimate	114,900 t
Mean catch from 2006–2010	116,000 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2010}/F_{MSY} (80% CI)	–
B_{2010}/B_{MSY} (80% CI)	–
SB_{2010}/SB_{MSY}	–
B_{2010}/B_0 (80% CI)	–
SB_{2010}/SB_0	–
$B_{2010}/B_{0,\ F=0}$	–
$SB_{2010}/SB_{0,\ F=0}$	–

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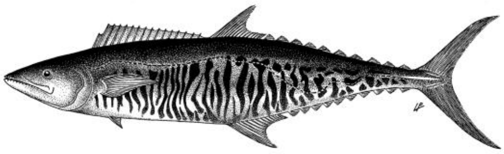
APPENDIX XV
EXECUTIVE SUMMARY: NARROW-BARRED SPANISH MACKEREL

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean narrow-barred Spanish mackerel resource (*Scomberomorus commerson*)

TABLE 1. Status of narrow-barred Spanish mackerel (*Scomberomorus commerson*) in the Indian Ocean.

Area[1]	Indicators – 2011 assessment		2011 stock status determination 2010[2]
Indian Ocean	Catch[3] 2010:	124,107 t	**UNCERTAIN**
	Average catch[3] 2006–2010:	116,444 t	
	MSY:	unknown	
	F_{2010}/F_{MSY}:	unknown	
	SB_{2010}/SB_{MSY}:	unknown	
	SB_{2010}/SB_0:	unknown	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]The stock status refers to the most recent years' data used for the assessment.
[3]Nominal catches represent those estimated by the IOTC Secretariat. If these data are not reported by CPCs, the IOTC Secretariat estimates total catch from a range of sources including: partial catch and effort data; data in the FAO FishStat database; catches estimated by the IOTC from data collected through port sampling; data published through web pages or other means; data reported by other parties on the activity of vessels; and data collected through sampling at the landing place or at sea by scientific observers.

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

The SC **RECOMMENDED** the following management advice for narrow-barred Spanish mackerel in the Indian Ocean noting that there remains considerable uncertainty about stock structure and about the total catches.

Stock status. No quantitative stock assessment is currently available for narrow-barred Spanish mackerel in the Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock indicators can be used. Therefore stock status remains *uncertain* (Table 1). However, aspects of the fisheries for this species combined with the lack of data on which to base a more formal assessment are a cause for considerable concern. Although indicators from the Gulf and Oman Sea suggest that overfishing is occurring in this area, the degree of connectivity with other regions remains unknown.

Outlook. The continued increase of annual catches for narrow-barred Spanish mackerel in recent years has further increased the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource. The apparent fidelity of narrow-barred Spanish mackerel to particular areas/regions is a matter for concern as overfishing in these areas can lead to localised depletion. Research emphasis on improving indicators and exploration of stock structure and stock assessment approaches for data poor fisheries are warranted.

The SC **RECOMMENDED** the following:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Neritic Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Narrow-barred Spanish mackerel (*Scomberomorus commerson*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

The narrow-barred Spanish mackerel (*Scomberomorus commerson*) is a pelagic, top level predator found throughout tropical marine waters of the Indo-West Pacific. Table 2 outlines some key life history parameters relevant for management.

TABLE 2. Biology of Indian Ocean narrow-barred Spanish mackerel (*Scomberomorus commerson*).

Parameter	**Description**
Range and stock structure	A pelagic, top level predator found throughout tropical marine waters of the Indo-West Pacific. Juveniles inhabit shallow inshore areas whereas adults are found in coastal waters out to the continental shelf. Adults are usually found in small schools but often aggregate at particular locations on reefs and shoals to feed and spawn. Appear to undertake lengthy migrations. Feed primarily on small fishes such as anchovies, clupeids, carangids, also squids and shrimps. Genetic studies carried out on *S. commerson* from Djibouti, Oman and U.A.E. showed there were small genetic differences among stocks in these three places.
Longevity	~16 years
Maturity (50%)	**Age**: n.a.; females n.a. males n.a. **Size:** females ~81 cm FL and males ~52 cm FL.
Spawning season	Females are multiple spawners. Year-round spawning has been observed in east African waters, with peaks during late spring to summer (April-July) and autumn (September-November) coinciding with the two seasonal monsoons which generate high abundances of plankton and small pelagic fish.
Size (length and weight)	Maximum: Females and males 240 cm FL; weight 70 kgs.

n.a. = not available. SOURCES: Grandcourt et al. (2005); Froese & Pauly (2009); Darvishi et al. (2011)

Narrow-barred Spanish mackerel – Catch trends

Narrow-barred Spanish mackerel is targeted throughout the Indian Ocean by artisanal and recreational fishers. The main method of capture is gillnet, but significant numbers of are also caught trolling (Fig. 1).

The catch estimates for narrow-barred Spanish mackerel were derived from very small amounts of information and are therefore highly uncertain. The catches of narrow-barred Spanish mackerel increased from around 50,000 t the mid-1970's to over 100,000 t by the mid-1990's. The highest catches of Spanish mackerel were recorded in 2010, amounting to 124,107 t. In recent years, catches have been increasing, with average annual catches for 2006–2010 estimated to be at around 116,444 t (Table 3). Narrow-barred Spanish mackerel is caught in both Indian Ocean basins, with higher catches recorded in the West.

In recent years, the countries attributed with the highest catches of Spanish mackerel are India (29%) and Indonesia (23%) and, to a lesser extent, Iran, Pakistan, and Madagascar (20%) (Fig. 2).

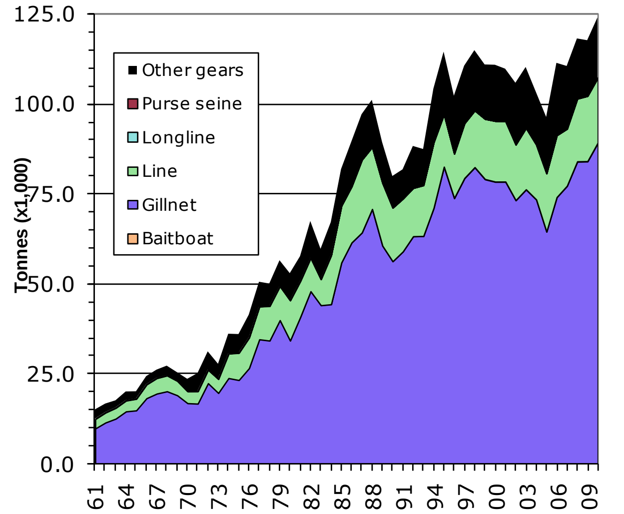


Fig. 1. Narrow-barred Spanish mackerel: Catches by gear recorded in the IOTC Database (1961–2010).

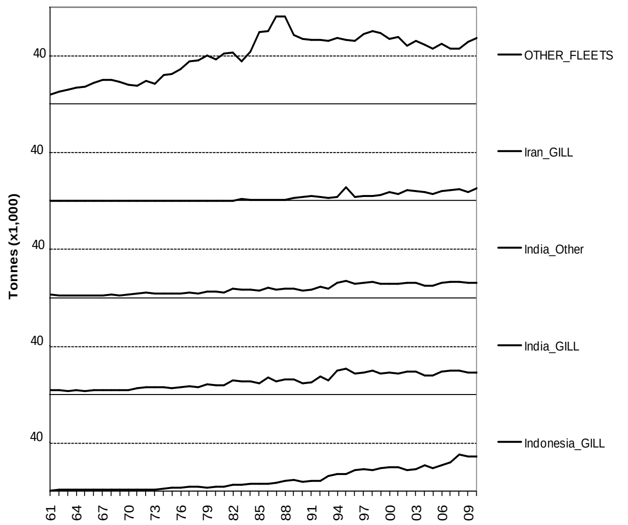


Fig. 2. Narrow-barred Spanish mackerel: Catches recorded in the IOTC Database for main fishing fleets (1961–2010).

TABLE 3. Best scientific estimates of the catches of narrow-barred Spanish mackerel by type of fishery for the period 1950–2010 (in metric tonnes). Data as of October 2011.

Fishery	By decade (average)						By year (last ten years)									
	1950s	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Purse seine	0	0	237	1,141	2,571	1,782	1,404	1,928	2,325	1,590	2,116	3,926	1,877	1,951	1,920	2,874
Gillnet	7,164	15,184	26,883	54,952	71,418	78,404	78,408	73,231	76,410	73,571	64,618	74,173	77,371	84,124	84,225	89,352
Line	2,330	3,350	6,529	13,733	14,964	16,823	16,773	15,420	17,023	15,214	16,145	17,137	15,811	17,394	18,099	18,045
Other	1,368	2,012	4,255	6,635	10,616	13,932	13,264	15,354	14,566	12,996	13,537	16,239	15,547	14,793	13,527	13,836
Total	**10,862**	**20,546**	**37,904**	**76,462**	**99,570**	**110,941**	**109,849**	**105,933**	**110,324**	**103,370**	**96,416**	**111,475**	**110,605**	**118,262**	**117,770**	**124,107**

Narrow-barred Spanish mackerel – uncertainty of catches

Retained catches are uncertain (Fig. 3), notably for the following fisheries:

- Artisanal fisheries of India and Indonesia: India and Indonesia have only recently reported catches of narrow-barred Spanish mackerel by gear, including catches by gear for the years 2005–2008 and 2007–2008, respectively. In both cases, the IOTC Secretariat used the catches reported by gear to break previous catches of this species by gear. The catches of narrow-barred Spanish mackerel estimated for this component represent more than 52% of the total catches of this species in recent years.
- Artisanal fisheries of Madagascar: Madagascar has never reported catches of narrow-barred Spanish mackerel to the IOTC Secretariat. During 2010 the IOTC Secretariat conducted a review aiming to break the catches recorded in the FAO database as narrow-barred Spanish mackerel by species, on the assumption that all catches of nertitic tunas had been combined under this name. The new catches estimated are thought to be very uncertain.
- Artisanal fisheries of Mozambique, Myanmar and Somalia: None of these countries have ever reported catches to the IOTC Secretariat. Catch levels are unknown.
- Other artisanal fisheries: Oman and the United Arab Emirates do not report catches of narrow-barred Spanish mackerel by gear. Although most of the catches are believed to be taken by gillnets, some fish may be also caught by using small surrounding nets, lines or other artisanal gears. Thailand and Malaysia report catches of narrow-barred Spanish mackerel and Indo-Pacific king mackerel aggregated.
- All fisheries: In some cases the catches of seerfish species are mislabelled, the catches of Indo-Pacific king mackerel and, to a lesser extent, other seerfish species, labelled as narrow-barred Spanish mackerel. Similarly, the catches of wahoo in some longline fisheries are thought to be mislabelled as narrow-barred Spanish mackerel. This mislabelling is thought to have little impact in the case of the narrow-barred Spanish mackerel but may be important for other seerfish species.
- Discard levels are believed to be low although they are unknown for most fisheries.
- Changes to the catch series: The catch series of narrow-barred Spanish mackerel has changed since those estimated in 2010, following reviews of catches for the coastal fisheries in Indonesia and India, involving

marked changes in catches by species. Overall, the new catches estimated represent the 98% of those recorded in the past.

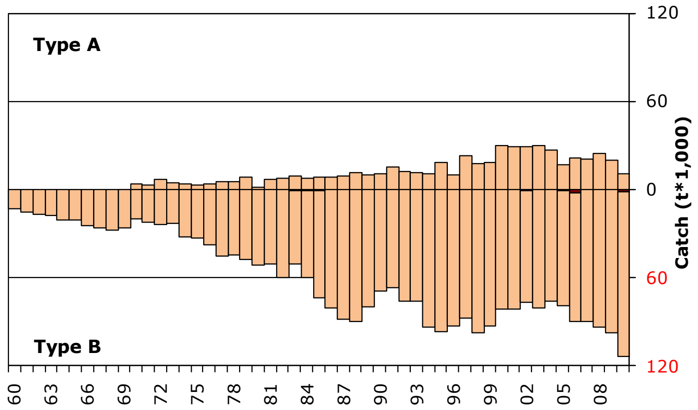


Fig. 3. Narrow-barred Spanish mackerel: Uncertainty of annual catch estimates (1960–2010) (Data as of November 2011).

Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

Narrow-barred Spanish mackerel – Effort trends

Effort trends are unknown for narrow-barred Spanish mackerel in the Indian Ocean.

Narrow-barred Spanish mackerel – Catch–per–unit–effort (CPUE) trends

Standardised CPUE series have not yet been developed. Nominal CPUE series are however available from some fisheries but they are considered highly incomplete. In most cases catch-and-effort data are only available for short periods. Reasonably long catch-and-effort data series (extending for more than 10 years) are only available for Sri Lanka gillnets (Fig. 4). The catches and effort recorded are, however, thought to be unrealistic due to the dramatic changes in CPUE recorded in 2003 and 2004.

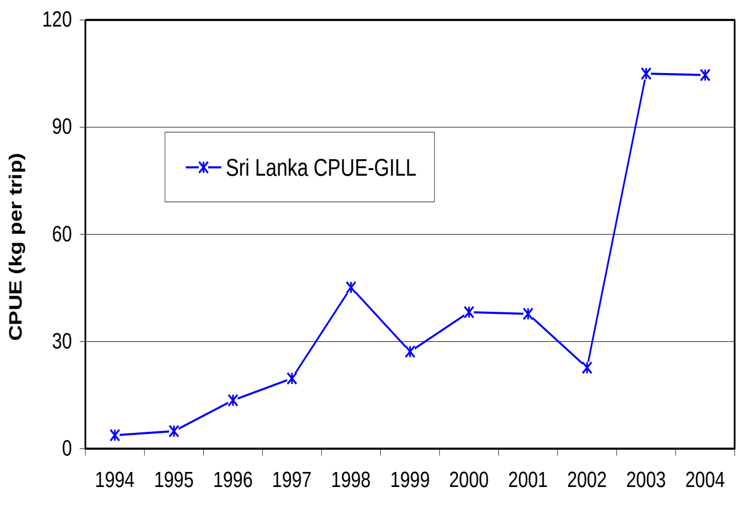


Fig. 4. Narrow-barred Spanish mackerel: Nominal CPUE series for the gillnet fishery of Sri Lanka derived from the available catches and effort data (1994–2004).

Narrow-barred Spanish mackerel – Fish size or age trends (e.g. by length, weight, sex and/or maturity)

- The size of narrow-barred Spanish mackerel taken by the Indian Ocean fisheries typically ranges between 30–140 cm depending on the type of gear used, season and location. The size of narrow-barred Spanish mackerel taken varies by location with 32–119 cm fish taken in the Eastern Peninsular Malaysia area, 17–39 cm fish taken in the East Malaysia area and 50–90 cm fish taken in the Gulf of Thailand. Similarly, Spanish mackerel caught in the Oman Sea are typically larger than those caught in the Persian Gulf.

- Trends in average weight can only be assessed for Sri Lankan gillnets but the amount of specimens measured has been very low in recent years. The length frequency data available from the mid-eighties to the early nineties was obtained with the support of the IPTP (Indo-Pacific Tuna Programme). Unfortunately, data collection did not continue after the IPTP activities came to an end.
- Catch-at-Size(Age) tables are not available for narrow-barred Spanish mackerel due to the paucity of size data available from most fleets and the uncertain status of the catches for this species.
- Sex ratio data have not been provided to the Secretariat by CPCs.

STOCK ASSESSMENT

No quantitative stock assessment for narrow-barred Spanish mackerel in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Neritic Tunas. However, a preliminary estimation of stock indicators was attempted on the catch and effort datasets from the Sri Lankan gillnet fishery (described above). However, there is considerable uncertainty about the degree to which this and other indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Narrow-barred Spanish mackerel (*Scomberomorus commerson*) stock status summary.

Management Quantity	Aggregate Indian Ocean
2010 catch estimate	124,100 t
Mean catch from 2006–2010	116,400 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2010}/F_{MSY} (80% CI)	–
B_{2010}/B_{MSY} (80% CI)	–
SB_{2010}/SB_{MSY}	–
B_{2010}/B_0 (80% CI)	–
SB_{2010}/SB_0	–
$B_{2010}/B_{0, F=0}$	–
$SB_{2010}/SB_{0, F=0}$	–

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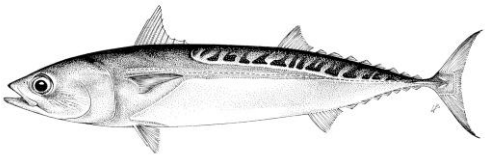
APPENDIX XVI
EXECUTIVE SUMMARY: BULLET TUNA

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean Bullet tuna Resource (*Auxis rochei*)

TABLE 1. Status of bullet tuna (*Auxis rochei*) in the Indian Ocean.

Area[1]	**Indicators – 2011 assessment**		**2011 stock status determination 2010**[2]
Indian Ocean	Catch[3] 2010:	4,188 t	**UNCERTAIN**
	Average catch[3] 2006–2010:	2,884 t	
	MSY:	unknown	
	F_{2010}/F_{MSY}:	unknown	
	SB_{2010}/SB_{MSY}:	unknown	
	SB_{2010}/SB_0:	unknown	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]The stock status refers to the most recent years' data used for the assessment.
[3]Nominal catches represent those estimated by the IOTC Secretariat. If these data are not reported by CPCs, the IOTC Secretariat estimates total catch from a range of sources including: partial catch and effort data; data in the FAO FishStat database; catches estimated by the IOTC from data collected through port sampling; data published through web pages or other means; data reported by other parties on the activity of vessels; and data collected through sampling at the landing place or at sea by scientific observers.

Colour key	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

The SC **RECOMMENDED** the following management advice for bullet tuna in the Indian Ocean noting that there remains considerable uncertainty about stock structure and about the total catches.

Stock status. No quantitative stock assessment is currently available for bullet tuna in the Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock indicators can be used. Therefore stock status remains *uncertain* (Table 1). However, aspects of the fisheries for this species combined with the lack of data on which to base a more formal assessment are a cause for considerable concern.

Outlook. The continued increase of annual catches for bullet tuna is likely to have further increased the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource. Research emphasis on improving indicators and exploration of stock structure and stock assessment approaches for data poor fisheries are warranted.

The SC **RECOMMENDED** the following:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Neritic Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Bullet tuna (*Auxis rochei*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

Bullet tuna (*Auxis rochei*) is an oceanic species found in the equatorial areas of the major oceans. It is a highly migratory species with a strong schooling behaviour. Table 2 outlines some key life history parameters relevant for management.

TABLE 2. Biology of Indian Ocean bullet tuna (*Auxis rochei*).

Parameter	**Description**
Range and stock structure	Little is known on the biology of bullet tuna in the Indian Ocean. An oceanic species found in the equatorial areas of the major oceans. It is a highly migratory species with a strong schooling behaviour. Adults are principally caught in coastal waters and around islands that have oceanic salinities. No information is available on the stock structure in Indian Ocean. Bullet tuna feed on small fishes, particularly anchovies, crustaceans (commonly crab and stomatopod larvae) and squids. Cannibalism is common. Because of their high abundance, bullet tunas are considered to be an important prey for a range of species, especially the commercial tunas.
Longevity	Females n.a; Males n.a.
Maturity (50%)	**Age**: 2 years; females n.a. males n.a. **Size:** females and males ~35 cm FL.
Spawning season	It is a multiple spawner with fecundity ranging between 31,000 and 103,000 eggs per spawning (according to the size of the fish). Larval studies indicate that bullet tuna spawn throughout its range.
Size (length and weight)	Maximum: Females and males 50 cm FL; weight n.a.

n.a. = not available. SOURCES: Froese & Pauly (2009)

Bullet tuna – Catch trends

Bullet tuna is caught mainly using gillnet, handline, and trolling gears across the broader Indian Ocean area (Fig. 1). This species is also an important catch for artisanal purse seiners. The catch estimates for bullet tuna were derived from very small amounts of information and are therefore highly uncertain.

Estimated catches of bullet tuna reached around 1,000 t in the early 1990's, increasing markedly in the following years to reach a peak in 1998, at around 2,800 t. The catches decreased sharply in the following years and remained at values of around 2,000 t until the mid-2000's, to increase again sharply up to the 4,188 t recorded in 2010, the highest catches ever recorded for this species (Table 3). The average annual catch estimated for the period 2006 to 2010 is 2,884 t (Table 3). However, the high catches of bullet tuna recorded since 2006, compared to previous years, are thought to be unrealistic. The difference in catches may come from improved identification of specimens of frigate tuna and bullet tuna in recent years, leading to higher catches of bullet tuna reported to the IOTC. Bullet tuna and frigate tuna are very similar and mislabelling is thought to be overspread. In recent years, the countries attributed with the highest catches of bullet tuna are Sri Lanka and India (Fig. 2).

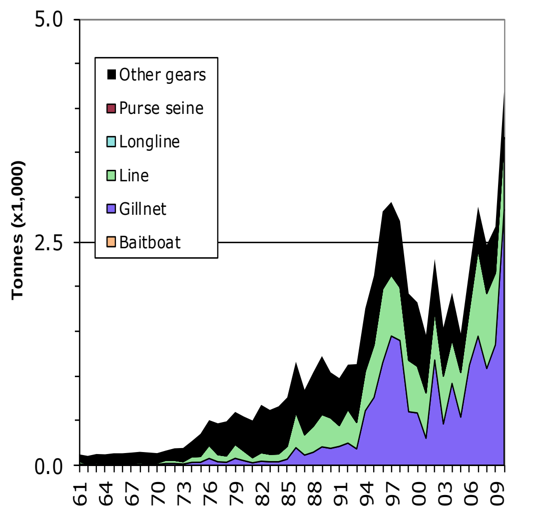


Fig. 1. Bullet tuna: Catches of by gear recorded in the IOTC Database (1961–2010).

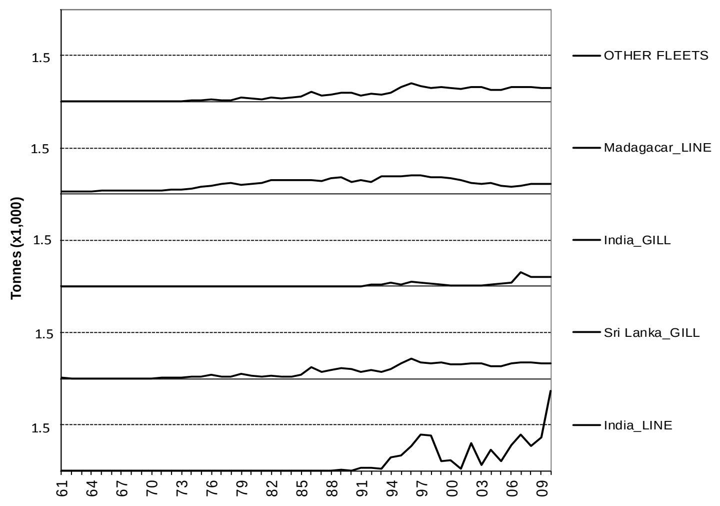


Fig. 2. Bullet tuna: Catches recorded in the IOTC Database for main fishing fleets (1960–2010).

TABLE 3. Best scientific estimates of the catches of bullet tuna by type of fishery for the period 1950–2010 (in metric tonnes). Data as of October 2011.

Fishery	By decade (average)						By year (last ten years)									
	1950s	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Purse seine	0	3	10	81	151	194	184	205	204	165	165	204	208	209	194	194
Gillnet	5	8	36	94	680	586	303	1179	463	918	540	1,121	1,447	1,084	1,351	2,866
Line	11	16	71	186	497	525	509	560	537	495	501	626	974	841	804	804
Other	61	103	221	443	533	520	464	367	339	355	270	242	268	335	323	323
Total	**78**	**129**	**337**	**803**	**1,861**	**1,825**	**1,460**	**2,311**	**1,543**	**1,933**	**1,476**	**2,193**	**2,897**	**2,469**	**2,673**	**4,188**

Bullet tuna – Uncertainty of catches

Retained catches are highly uncertain (Fig. 3), for all fisheries:

- Aggregation: Bullet tunas are usually not reported by species, being aggregated with frigate tunas or, less frequently, other small tuna species.
- Mislabelling: Bullet tunas are usually mislabelled as frigate tuna, their catches reported under the latter species.
- Under reporting: the catches of bullet tuna by industrial purse seiners are rarely, if ever, reported.

It is for the above reasons that the catches of bullet tuna in the IOTC database are thought to represent only a small fraction of the total catches of this species in the Indian Ocean. In particular, catches reported by India in recent years are unreliable and need to be verified.

- Discard levels are moderate for industrial purse seine fisheries. The EU recently reported discard levels of bullet tuna for its purse seine fleet, for 2003–2008, estimated using observer data.
- Changes to the catch series: The catch series of bullet tuna has changed substantially since estimates made in 2010, following reviews of catches for the coastal fisheries in Indonesia and, to a lesser extent India, involving marked changes in catches by species.

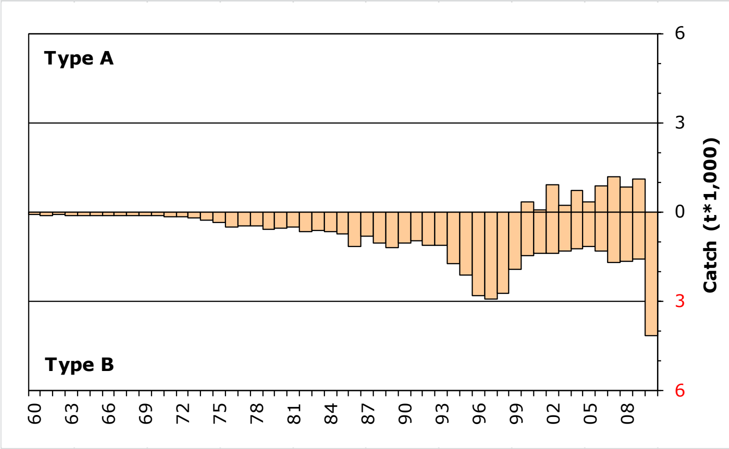


Fig. 3. Bullet tuna: Uncertainty of annual catch estimates (1960–2010) (Data as of October 2011).
Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

Bullet tuna – Effort trends

Effort trends are unknown for bullet tuna in the Indian Ocean.

Bullet tuna – Catch–per–unit–effort (CPUE) trends

Standardised CPUE series have not yet been developed. Nominal CPUE series are however available from some fisheries but they are considered highly incomplete and are usually considered to be of poor quality for the fisheries having reasonably long catch-and-effort data series, as it is the case with the gillnet fisheries of Sri Lanka (Fig. 4).

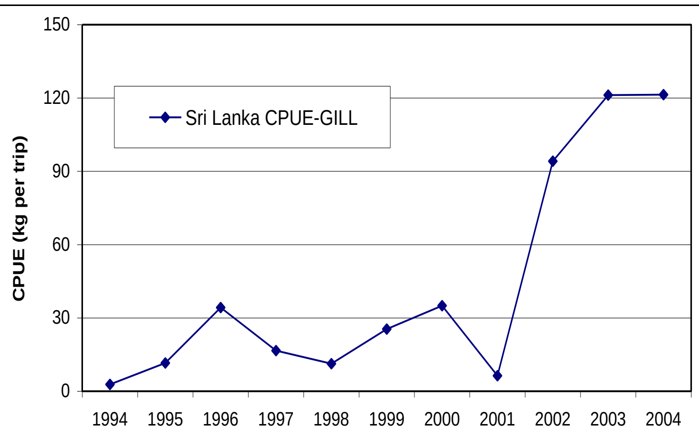


Fig. 4. Bullet tuna: Nominal CPUE series for the gillnet fishery of Sri Lanka derived from the available catches and effort data (1994–2004).

Bullet tuna – Fish size or age trends (e.g. by length, weight, sex and/or maturity)

- The size of bullet tuna taken by the Indian Ocean fisheries typically ranges between 13–48 cm depending on the type of gear used, season and location.
- Trends in average weight cannot be assessed for most fisheries. Reasonable long series of length frequency data are only available for Sri Lankan gillnets and lines but the amount of specimens measured has been very low in recent years.
- Catch-at-Size(Age) tables are not available for bullet tuna due to the paucity of size data available from most fleets and the uncertain status of the catches for this species.
- Sex ratio data have not been provided to the Secretariat by CPCs.

STOCK ASSESSMENT

No quantitative stock assessment for bullet tuna in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Neritic Tunas. However, a preliminary estimation of stock indicators was attempted on the catch and effort datasets from the Sri Lankan gillnet fleet (described above). However, there is considerable uncertainty about the degree to which this and other indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Bullet tuna (*Auxis rochei*) stock status summary.

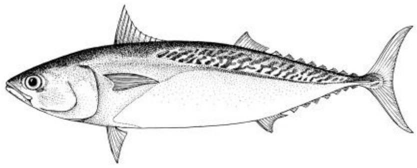
Management Quantity	Aggregate Indian Ocean
2010 catch estimate	4,200 t
Mean catch from 2006–2010	2,900 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2010}/F_{MSY} (80% CI)	–
B_{2010}/B_{MSY} (80% CI)	–
SB_{2010}/SB_{MSY}	–
B_{2010}/B_0 (80% CI)	–
SB_{2010}/SB_0	–
$B_{2010}/B_{0,\ F=0}$	–
$SB_{2010}/SB_{0,\ F=0}$	–

LITERATURE CITED

Froese R & Pauly DE, 2009.FishBase, version 02/2009, FishBase Consortium, <www.fishbase.org>.

APPENDIX XVII
EXECUTIVE SUMMARY: FRIGATE TUNA

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean Frigate tuna resource (*Auxis thazard*)

TABLE 1. Status of frigate tuna (*Auxis thazard*) in the Indian Ocean.

Area[1]	Indicators – 2011 assessment		2011 stock status determination 2010[2]
Indian Ocean	Catch[3] 2010:	71,023 t	UNCERTAIN
	Average catch[3] 2006–2010:	64,245 t	
	MSY:	unknown	
	F_{2010}/F_{MSY}:	unknown	
	SB_{2010}/SB_{MSY}:	unknown	
	SB_{2010}/SB_0:	unknown	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]The stock status refers to the most recent years' data used for the assessment.
[3]Nominal catches represent those estimated by the IOTC Secretariat. If these data are not reported by CPCs, the IOTC Secretariat estimates total catch from a range of sources including: partial catch and effort data; data in the FAO FishStat database; catches estimated by the IOTC from data collected through port sampling; data published through web pages or other means; data reported by other parties on the activity of vessels; and data collected through sampling at the landing place or at sea by scientific observers.

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

The SC **RECOMMENDED** the following management advice for frigate tuna in the Indian Ocean noting that there remains considerable uncertainty about stock structure and about the total catches.

Stock status. No quantitative stock assessment is currently available for frigate tuna in the Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock indicators can be used. Therefore stock status remains *uncertain* (Table 1). However, aspects of the fisheries for this species combined with the lack of data on which to base a more formal assessment are a cause for considerable concern.

Outlook. The continued increase of annual catches for frigate tuna is likely to have further increased the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource. Research emphasis on improving indicators and exploration of stock structure and stock assessment approaches for data poor fisheries are warranted.

The SC **RECOMMENDED** the following:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Neritic Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Frigate tuna (*Auxis thazard*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and*

cooperating non-contracting parties.

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

Frigate tuna (*Auxis thazard*) is a highly migratory species found in both coastal and oceanic waters. It is highly gregarious and often schools with other Scombrids. Table 2 outlines some key life history parameters relevant for management.

TABLE 2. Biology of Indian Ocean frigate tuna (*Auxis thazard*).

Parameter	**Description**
Range and stock structure	Little is known on the biology of frigate tuna in the Indian Ocean. Highly migratory species found in both coastal and oceanic waters. It is highly gregarious and often schools with other Scombrids. Frigate tuna feeds on small fish, squids and planktonic crustaceans (e.g. decapods and stomatopods). Because of their high abundance, frigate tuna are considered to be an important prey for a range of species, especially the commercial tunas. No information is available on the stock structure of frigate tuna in Indian Ocean.
Longevity	Females n.a; Males n.a.
Maturity (50%)	**Age**: n.a.; females n.a. males n.a. **Size:** females and males ~29–35 cm FL.
Spawning season	In the southern Indian Ocean, the spawning season extends from August to April whereas north of the equator it is from January to April. Fecundity ranges between 200,000 and 1.06 million eggs per spawning (depending on size).
Size (length and weight)	Maximum: Females and males 60 cm FL; weight n.a.

n.a. = not available. SOURCES: Froese & Pauly (2009)

Frigate tuna – Catch trends

Frigate tuna is taken from across the Indian Ocean area using drifting gillnets, pole-and-lines, handlines and trolling (Fig. 1). This species is also an important bycatch for industrial purse seiners and is the target of some ring net fisheries. The catch estimates for frigate tuna were derived from very small amounts of information and are therefore highly uncertain.

Estimated catches have increased steadily since the late 1970's, reaching around 15,000 t in the early 1980's and over 45,000 t by the mid-1990's. Catches increased markedly from 2006 and have been in excess of 65,000 t from 2008 (Fig. 2). The average annual catch estimated for the period 2006 to 2010 is 64,245 t with the highest catches recorded in 2010 of 71,023 t (Table 3).

In recent years, the countries attributed with the highest catches are Indonesia (60%), India (17%), I.R. Iran (8%) and the Maldives (6%).

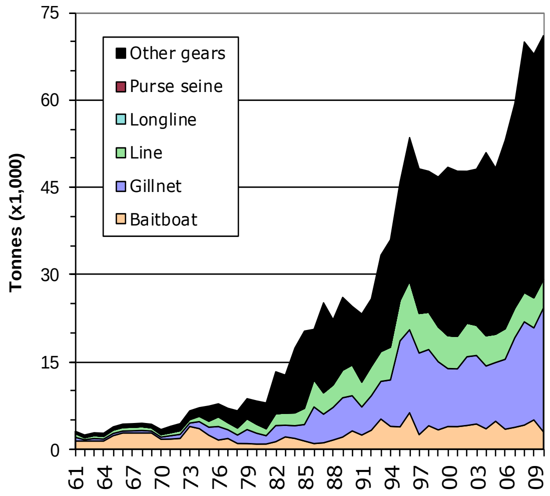


Fig. 1. Frigate tuna: Catches by gear recorded in the IOTC Database (1961–2010).

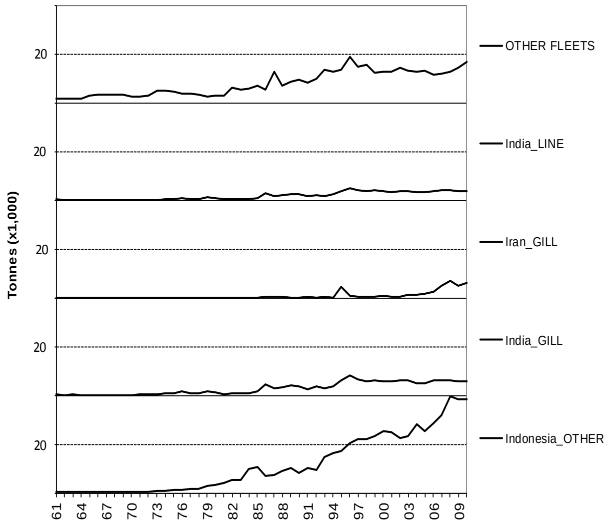


Fig. 2. Frigate tuna: Catches recorded in the IOTC Database for main fishing fleets (1961–2010).

TABLE 3. Best scientific estimates of the catches of frigate tuna by type of fishery for the period 1950–2010 (in metric tonnes). Data as of October 2011.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Purse seine	0	12	895	7,260	16,206	26,427	26,124	24,302	25,149	29,707	27,186	31,173	33,847	41,434	40,262	40,294
Gillnet	265	406	1,268	3,713	9,958	9,978	9,949	11,840	11,816	10,830	10,156	12,051	15,390	17,758	15,864	21,291
Line	372	560	1,015	2,889	5,997	5,653	5,592	5,778	5,197	5,214	4,867	5,257	5,088	5,046	5,169	4,919
Other	1,721	2,477	3,088	3,514	6,319	6,360	6,081	5,808	5,926	5,186	6,074	4,576	5,017	5,715	6,555	4,519
Total	**2,358**	**3,456**	**6,265**	**17,376**	**38,479**	**48,419**	**47,746**	**47,728**	**48,089**	**50,938**	**48,283**	**53,057**	**59,342**	**69,954**	**67,849**	**71,023**

Frigate tuna – Uncertainty of catches

Retained catches are uncertain (Fig. 3), notably for the following fisheries:

- Artisanal fisheries of Indonesia: Indonesia did not report catches of frigate tuna by species or by gear for 1950–2004; catches of frigate tuna, bullet tuna and other species were reported aggregated for this period. The IOTC Secretariat used the catches reported since 2005 to break the aggregates for 1950–2004 by gear and species. The Indonesian catches estimated for frigate tuna represent around 60% of the total catches of this species in the Indian Ocean in recent years.
- Artisanal fisheries of India: Although India reports catches of frigate tuna they are not always reported by gear. The IOTC Secretariat has allocated the catches of frigate tuna by gear for years in which this information was not available. In recent years, the catches of frigate tuna in India have represented 17% of the total catches of this species in the Indian Ocean.
- Artisanal fisheries of Mozambique, Myanmar and Somalia: None of these countries have reported catches to the IOTC Secretariat, thus catch levels are unknown.
- Other artisanal fisheries: The catches of frigate tuna and bullet tuna are seldom reported by species and, when reported by species, they usually refer to both species (due to mislabelling, with all catches assigned to the frigate tuna).
- Industrial fisheries: The catches of frigate tuna recorded for industrial purse seiners are thought to be a fraction of those retained on board. Due to this species being a bycatch, its catches are seldom recorded in the logbooks, nor can they be monitored in port. The EU recently reported catch levels of frigate tuna for its purse seine fleet, for 2003–2007, estimated using observer data.
- Discard levels are moderate for industrial purse seine fisheries. The EU recently reported discard levels of frigate tuna for its purse seine fleet, for 2003–2007, estimated using observer data.
- Changes to the catch series: The catch series of frigate tuna has changed substantially from those estimated in 2010, following reviews of catches for the coastal fisheries in Indonesia and, to a lesser extent India, involving marked changes in catches by species. Overall, the new catches estimated for Indonesian fisheries are three times higher than those recorded in the past.

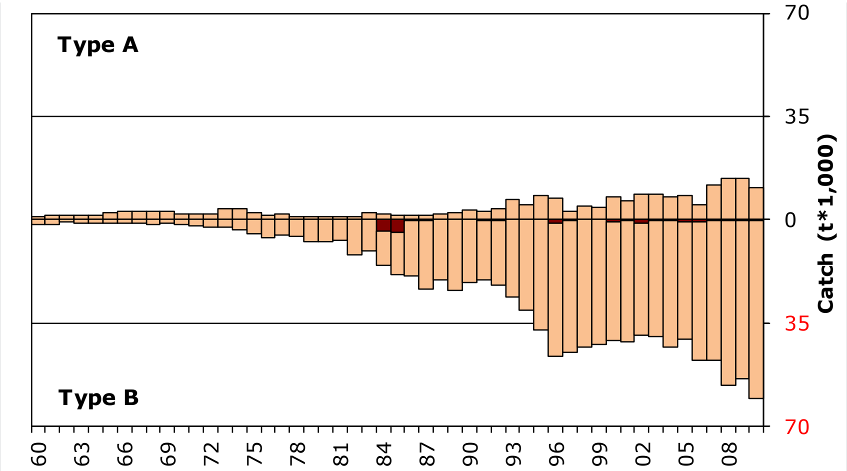


Fig. 3. Frigate tuna: Uncertainty of annual catch estimates (1960–2010) (Data as of October 2011)
Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

Frigate tuna – Effort trends

Effort trends are unknown for frigate tuna in the Indian Ocean.

Frigate tuna – Catch–per–unit–effort (CPUE) trends

Standardised CPUE series have not yet been developed. Catch-and-effort series are available from some fisheries but they are considered highly incomplete. In most cases catch-and-effort data are only available for short periods. Reasonably long catch-and-effort series (extending for more than 10 years) are only available for Maldives baitboats and troll lines (Fig. 4) and Sri Lanka gillnets. The catches and effort recorded for Sri Lankan gillnets are, however, thought to be inaccurate due to the dramatic changes in CPUE recorded between consecutive years.

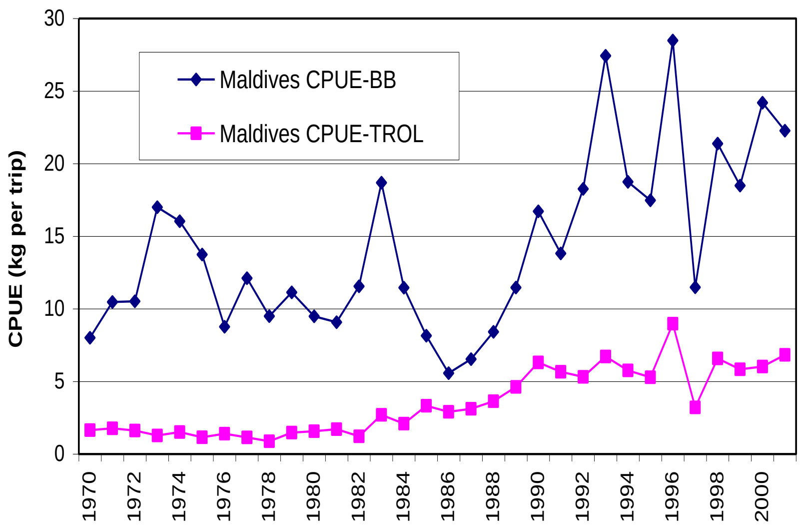


Fig. 4. Frigate tuna: Nominal CPUE series for the baitboat (BB) and line (LINE) fisheries of Maldives derived from the available catches and effort data (1970–2001).

Frigate tuna – Fish size or age trends (e.g. by length, weight, sex and/or maturity)

- The size of frigate tuna taken by Indian Ocean fisheries typically ranges between 20–50 cm depending on the type of gear used, season and location. The fisheries operating in the Andaman Sea (coastal purse seines and troll lines) tend to catch frigate tuna of small to medium size (15–40cm) while the gillnet, baitboat and other fisheries operating in the Indian Ocean catch usually larger specimens (25–50cm). Length frequency data for the bullet tuna is only available for some Sri Lanka fisheries and periods. These fisheries catch bullet tuna ranging between 15–35 cm.

- Trends in average weight can only be assessed for Sri Lankan gillnets and Maldivian pole-and-lines but the amount of specimens measured has been very low in recent years. The length frequency data available from the mid-eighties to the early nineties was obtained with the support of the IPTP (Indo-Pacific Tuna Programme). Unfortunately, data collection did not continue in most countries after the end of the IPTP activities.
- Catch-at-Size(Age) tables are not available for the frigate tuna due to the paucity of size data available from most fleets and the uncertain status of the catches for this species.
- Sex ratio data have not been provided to the Secretariat by CPCs.

STOCK ASSESSMENT

No quantitative stock assessment for frigate tuna in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Neritic Tunas. However, a preliminary estimation of stock indicators was attempted on the catch and effort datasets from the Maldives baitboat and line fisheries (described above). However, there is considerable uncertainty about the degree to which this and other indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Frigate tuna (*Auxis thazard*) stock status summary.

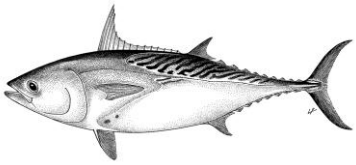
Management Quantity	Aggregate Indian Ocean
2010 catch estimate	71,000 t
Mean catch from 2006–2010	64,200 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2010}/F_{MSY} (80% CI)	–
B_{2010}/B_{MSY} (80% CI)	–
SB_{2010}/SB_{MSY}	–
B_{2010}/B_0 (80% CI)	–
SB_{2010}/SB_0	–
$B_{2010}/B_{0,\ F=0}$	–
$SB_{2010}/SB_{0,\ F=0}$	–

LITERATURE CITED

Froese R & Pauly DE, 2009. FishBase, version 02/2009, FishBase Consortium, <www.fishbase.org>.

APPENDIX XVIII
EXECUTIVE SUMMARY: KAWAKAWA

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean Kawakawa tuna Resource (*Euthynnus affinis*)

TABLE 1. Status of kawakawa (*Euthynnus affinis*) in the Indian Ocean.

Area[1]	**Indicators – 2011 assessment**		**2011 stock status determination 2010**[2]
Indian Ocean	Catch[3] 2010: Average catch[3] 2006–2010: MSY: F_{2010}/F_{MSY}: SB_{2010}/SB_{MSY}: SB_{2010}/SB_0:	128,871 t 122,895 t unknown unknown unknown unknown	**UNCERTAIN**

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]The stock status refers to the most recent years' data used for the assessment.
[3]Nominal catches represent those estimated by the IOTC Secretariat. If these data are not reported by CPCs, the IOTC Secretariat estimates total catch from a range of sources including: partial catch and effort data; data in the FAO FishStat database; catches estimated by the IOTC from data collected through port sampling; data published through web pages or other means; data reported by other parties on the activity of vessels; and data collected through sampling at the landing place or at sea by scientific observers.

Colour key	Stock overfished(SB_{year}/SB_{MSY}< 1)	Stock not overfished (SB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

The SC **RECOMMENDED** the following management advice for kawakawa in the Indian Ocean noting that there remains considerable uncertainty about stock structure and about the total catches.

Stock status. No quantitative stock assessment is currently available for kawakawa in the Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock indicators can be used. Therefore stock status remains *uncertain* (Table 1). However, aspects of the fisheries for this species combined with the lack of data on which to base a more formal assessment are a cause for considerable concern.

Outlook. The continued increase of annual catches for kawakawa is likely to have further increased the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource. Research emphasis on improving indicators and exploration of stock structure and stock assessment approaches for data poor fisheries are warranted.

The SC **RECOMMENDED** the following:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Neritic Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Kawakawa (*Euthynnus affinis*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

Kawakawa (*Euthynnus affinis*) lives in open waters close to the shoreline and prefers waters temperatures ranging from 18° to 29°C. Table 2 outlines some key life history parameters relevant for management.

TABLE 2. Biology of Indian Ocean kawakawa (*Euthynnus affinis*).

Parameter	**Description**
Range and stock structure	Lives in open waters close to the shoreline and prefers waters temperatures ranging from 18° to 29°C. Kawakawa form schools by size with other species sometimes containing over 5,000 individuals. Kawakawa are often found with yellowfin, skipjack and frigate tunas. Kawakawa are typically found in surface waters, however, they may range to depths of over 400 m (they have been reported under a fish-aggregating device employed in 400 m), possibly to feed. Kawakawa larvae are patchy but widely distributed and can generally be found close to land masses. Large changes in apparent abundance are linked to changes in ocean conditions. This species is a highly opportunistic predator feeding on small fishes, especially on clupeoids and atherinids; also squid, crustaceans and zooplankton. No information is available on stock structure of kawakawa in Indian Ocean.
Longevity	n.a.
Maturity (50%)	**Age**: n.a; females n.a. males n.a. **Size:** females and males ~45–50 cm FL.
Spawning season	Spawning occurs mostly during summer. A 1.4 kg female (48 cm FL) may spawn approximately 0.21 million eggs per batch (corresponding to about 0.79 million eggs per season).
Size (length and weight)	Maximum: Females and males 100 cm FL; weight 14 kgs. Juveniles grow rapidly reaching lengths between 50–65 cm by 3 years of age.

n.a. = not available. SOURCES: Froese & Pauly (2009); Taghavi et al. (2010).

Kawakawa – Catch trends

Kawakawa is caught mainly by coastal purse seines, gillnets and, to a lesser extent, handlines and trolling (Fig. 1) and may be also an important by-catch of the industrial purse seiners. The catch estimates for kawakawa were derived from very small amounts of information and are therefore highly uncertain.

Annual estimates of catches for kawakawa increased markedly from around 10,000 t in the mid-1970's to reach the 50,000 t mark in the mid-1980's and 130,634 t in 2009, the highest catches ever recorded for this species. Since 2006, catches have been over 100,000 t. The average annual catch estimated for the period 2006 to 2010 is 122,895 t (Table 3). Catches in 2010 were around 128,871 t. The majority of catches of kawakawa are taken in the East Indian Ocean, representing around 60% of the total catches in recent years. In recent years, the countries attributed with the highest catches are Indonesia (35%), India (19%), Iran (13%), and Malaysia (10%) (Fig. 2).

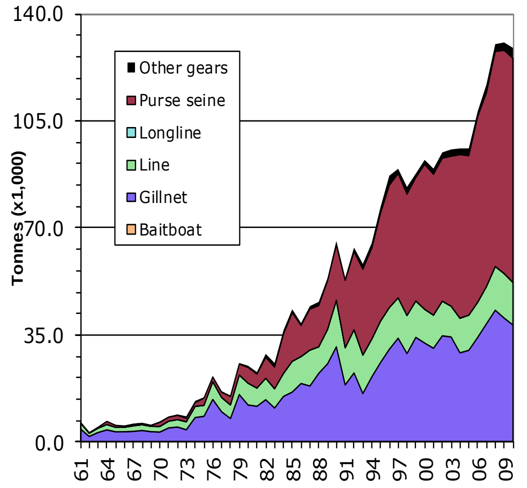


Fig. 1. Kawakawa: Catches by gear recorded in the IOTC Database (1960–2010).

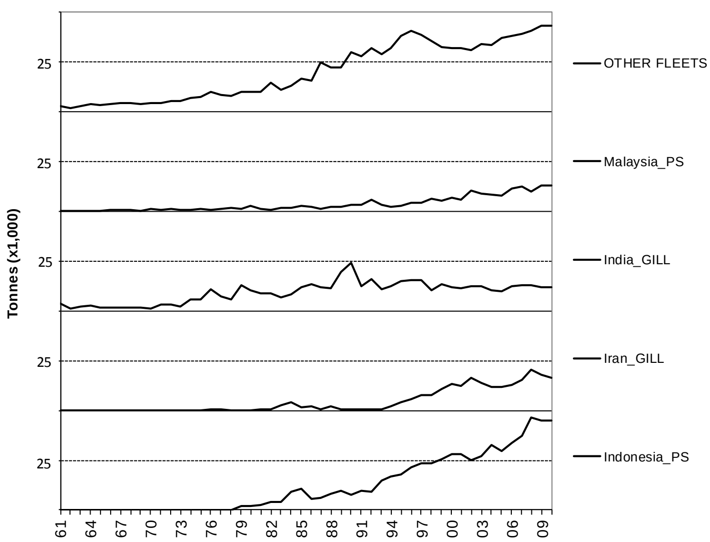


Fig. 2. Kawakawa: Catches recorded in the IOTC Database for main fishing fleets (1960–2010).

TABLE 3. Best scientific estimates of the catches of kawakawa by type of fishery for the period 1950–2010 (in metric tonnes). Data as of October 2011.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Purse seine	100	385	1,824	10,526	31,909	47,382	46,054	46,729	49,018	53,443	52,131	60,627	63,373	70,283	72,941	73,248
Gillnet	1,907	3,408	8,130	16,799	26,457	32,409	30,710	34,775	34,578	29,332	30,175	34,358	38,786	43,225	40,678	38,422
Line	1,154	1,628	3,761	8,441	13,115	11,029	10,825	11,334	10,060	11,318	11,507	11,476	12,188	14,301	14,555	13,914
Other	0	60	279	737	1,581	1,424	1,797	1,851	2,006	1,897	2,188	1,546	2,539	2,271	2,461	3,286
Total	**3,161**	**5,481**	**13,995**	**36,502**	**73,062**	**92,245**	**89,385**	**94,690**	**95,662**	**95,990**	**96,001**	**108,006**	**116,885**	**130,078**	**130,634**	**128,871**

Kawakawa – Uncertainty of catches

Retained catches are uncertain (Fig. 3), notably for the following fisheries:

- Artisanal fisheries of Indonesia: Indonesia did not report catches of kawakawa by species or by gear for 1950–2004; catches of kawakawa, longtail tuna and, to a lesser extent, other species were reported aggregated for this period. The IOTC Secretariat used the catches reported since 2005 to break the aggregates for 1950–2004 by gear and species. The catches of kawakawa estimated for this component represent around 35% of the total catches of this species in recent years.
- Artisanal fisheries of India: Although India reports catches of kawakawa they are not always reported by gear. The IOTC Secretariat has allocated the catches of kawakawa by gear for years in which this information was not available. The catches of kawakawa have represented 19% of the total catches of this species in the Indian Ocean in recent years.
- Artisanal fisheries of Mozambique, Myanmar and Somalia: None of these countries have ever reported catches to the IOTC Secretariat. Catch levels are unknown.
- Other artisanal fisheries: The catches of kawakawa are usually not reported by species, being combined with catches of other small tuna species like skipjack tuna and frigate tuna (coastal purse seiners of Malaysia and Thailand).
- Industrial fisheries: The catches of kawakawa recorded for industrial purse seiners are thought to be a fraction of those retained on board. Due to this species being a bycatch, its catches are seldom recorded in the logbooks, nor are they monitored in port. The EU recently reported catch levels of frigate tuna for its purse seine fleet, for 2003–2007, estimated using observer data.
- Discard levels are moderate for industrial purse seine fisheries. The EU recently reported discard levels of kawakawa for its purse seine fleet, for 2003–2007, estimated using observer data.
- Changes to the catch series: The catch series of kawakawa has changed substantially since those estimated in 2010, following reviews of catches for the coastal fisheries in Indonesia and, to a lesser extent India, involving marked changes in catches by species. Overall, the new catches estimated for Indonesian fisheries represent the 60% of those recorded in the past.

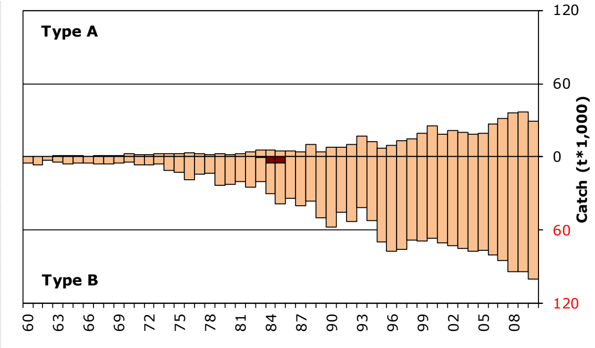


Fig. 3. Kawakawa: Uncertainty of annual catch estimates (1960–2010).
*Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (**Type A**) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.*

Kawakawa – Effort trends

Effort trends are unknown for kawakawa in the Indian Ocean.

Kawakawa – Catch–per–unit–effort (CPUE) trends

Standardised CPUE series have not yet been developed. Nominal CPUE series are however available from some fisheries but they are considered incomplete. In most cases catch-and-effort data are only available for short periods. Reasonably long catch-and-effort data series (extending for more than 10 years) are only available for Maldives baitboats and troll lines and Sri Lanka gillnets (Fig. 4). The catch-and-effort data recorded for Sri Lankan gillnets are, however, thought to be inaccurate due to the dramatic changes in CPUE recorded between consecutive years.

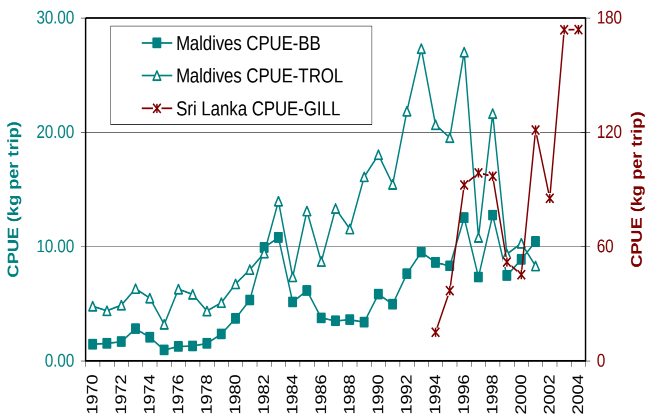


Fig. 4. Kawakawa: Nominal CPUE series for the baitboat (BB) and troll line (TROL) fisheries of Maldives (left axis; 1970–2001) and the gillnet fishery of Sri Lanka (right axis; 1994–2004) derived from the available catches and effort data.

Kawakawa – Fish size or age trends (e.g. by length, weight, sex and/or maturity)

- Trends in average weight can only be assessed for Sri Lankan gillnets but the amount of specimens measured has been very low in recent years. The length frequency data available from the mid-eighties to the early nineties was obtained with the support of the IPTP (Indo-Pacific Tuna Programme). Unfortunately, data collection did not continue after the end of the IPTP activities.
- The size of kawakawa taken by the Indian Ocean fisheries typically ranges between 20–60 cm depending on the type of gear used, season and location. The coastal purse seine fisheries operating in the Andaman Sea tend to catch kawakawa of small size (15–30 cm) while the gillnet, baitboat and other fisheries operating in the Indian Ocean catch usually larger specimens (25–55 cm).
- Catch-at-Size(Age) tables are not available for kawakawa due to the paucity of size data available from most fleets and the uncertain status of the catches for this species.
- Sex ratio data have not been provided to the Secretariat by CPCs.

STOCK ASSESSMENT

No quantitative stock assessment for kawakawa in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Neritic Tunas. However, a preliminary estimation of stock indicators was attempted on the catch and effort datasets from the Maldives baitboat and troll line fisheries (described above). However, there is considerable uncertainty about the degree to which this and other indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Kawakawa (*Euthynnus affinis*) stock status summary.

Management Quantity	**Aggregate Indian Ocean**
2010 catch estimate	128,900 t
Mean catch from 2006–2010	122,900 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2010}/F_{MSY} (80% CI)	–
B_{2010}/B_{MSY} (80% CI)	–
SB_{2010}/SB_{MSY}	–
B_{2010}/B_0 (80% CI)	–
SB_{2010}/SB_0	–
$B_{2010}/B_{0,\ F=0}$	–
$SB_{2010}/SB_{0,\ F=0}$	–

LITERATURE CITED

Froese R & Pauly DE, 2009. FishBase, version 02/2009, FishBase Consortium, www.fishbase.org.

Taghavi Motlagh SA, Hashemi SA and Kochanian P, 2010. Population biology and assessment of kawakawa (*Euthynnus affinis*) in coastal waters of the Persian Gulf and Sea of Oman (Hormozgan Province).

APPENDIX XIX
EXECUTIVE SUMMARY: INDO-PACIFIC KING MACKEREL

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
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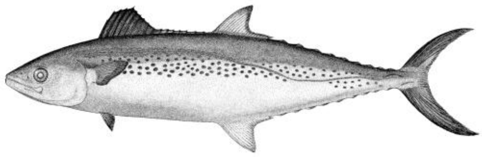

Status of the Indian Ocean Indo-Pacific king mackerel Resource (*Scomberomorus guttatus*)

TABLE 1. Status of Indo-Pacific king mackerel (*Scomberomorus guttatus*) in the Indian Ocean.

Area[1]	Indicators – 2011 assessment		2011 stock status determination 2010[2]
Indian Ocean	Catch[3] 2010:	37,257 t	**UNCERTAIN**
	Average catch[3] 2006–2010:	37,980 t	
	MSY:	unknown	
	F_{2010}/F_{MSY}:	unknown	
	SB_{2010}/SB_{MSY}:	unknown	
	SB_{2010}/SB_0:	unknown	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]The stock status refers to the most recent years' data used for the assessment.
[3]Nominal catches represent those estimated by the IOTC Secretariat. If these data are not reported by CPCs, the IOTC Secretariat estimates total catch from a range of sources including: partial catch and effort data; data in the FAO FishStat database; catches estimated by the IOTC from data collected through port sampling; data published through web pages or other means; data reported by other parties on the activity of vessels; and data collected through sampling at the landing place or at sea by scientific observers.

Colour key	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

The SC **RECOMMENDED** the following management advice for Indo-Pacific king mackerel in the Indian Ocean noting that there remains considerable uncertainty about stock structure and about the total catches.

Stock status. No quantitative stock assessment is currently available for Indo-Pacific king mackerel in the Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock indicators can be used. Therefore stock status remains *uncertain* (Table 1). However, aspects of the fisheries for this species combined with the lack of data on which to base a more formal assessment are a cause for considerable concern.

Outlook. The continued increase of annual catches for Indo-Pacific king mackerel is likely to have further increased the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource. Research emphasis on improving indicators and exploration of stock structure and stock assessment approaches for data poor fisheries are warranted.

The SC **RECOMMENDED** the following:
- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Neritic Tunas and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Indo-Pacific king mackerel (*Scomberomorus guttatus*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:
- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and*

cooperating non-contracting parties.

- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

The Indo-Pacific king mackerel (*Scomberomorus guttatus*) is a migratory species that forms small schools and inhabits coastal waters, sometimes entering estuarine areas. Table 2 outlines some key life history parameters relevant for management.

TABLE 2. Biology of Indian Ocean Indo-Pacific king mackerel (*Scomberomorus guttatus*).

Parameter	Description
Range and stock structure	A migratory species that forms small schools and inhabits coastal waters, sometimes entering estuarine areas. It is found in waters from the Persian Gulf, India and Sri Lanka, Southeast Asia, as far north as the Sea of Japan. The Indo-Pacific king mackerel feeds mainly on small schooling fishes (e.g. sardines and anchovies), squids and crustaceans. No information is available on the stock structure of Indo-Pacific king mackerel stock structure in Indian Ocean.
Longevity	n.a.
Maturity (50%)	**Age**: 1–2 years; females n.a. males n.a. **Size:** females and males ~40–52 cm FL.
Spawning season	Based on the occurrence of ripe females and the size of maturing eggs, spawning probably occurs from April to July in southern India and in May in Thailand waters. Fecundity increases with age in the Indian waters, ranging from around 400,000 eggs at age 2 years to over one million eggs at age 4 years.
Size (length and weight)	Maximum: Females and males 76 cm FL; weight n.a.

n.a. = not available. SOURCES: Froese & Pauly (2009)

Indo-Pacific king mackerel – Catch trends

Indo-Pacific king mackerel is mostly caught by gillnet fisheries in the Indian Ocean but significant numbers are also caught trolling (Fig. 1). The catch estimates for Indo-Pacific King mackerel were derived from very small amounts of information and are therefore highly uncertain.

Estimated catches have increased steadily since the mid 1960's, reaching around 10,000 t in the early 1970's and over 25,000 t since the mid-1990's. Catches increased steadily since then until 1995, the year in which the highest catches for this species were recorded, at around 43,000 t. The catches of Indo-Pacific king mackerel between 1997 and 2005 were more or less stable, estimated at around 30,000 t. Current catches have been higher, close to 40,000 t. The average annual catch estimated for the period 2006 to 2010 is 37,980 t (Table 3).

In recent years, the countries attributed with the highest catches are India (47%) and Indonesia (28%) and, to a lesser extent, Iran and Thailand (15%) (Fig. 2).

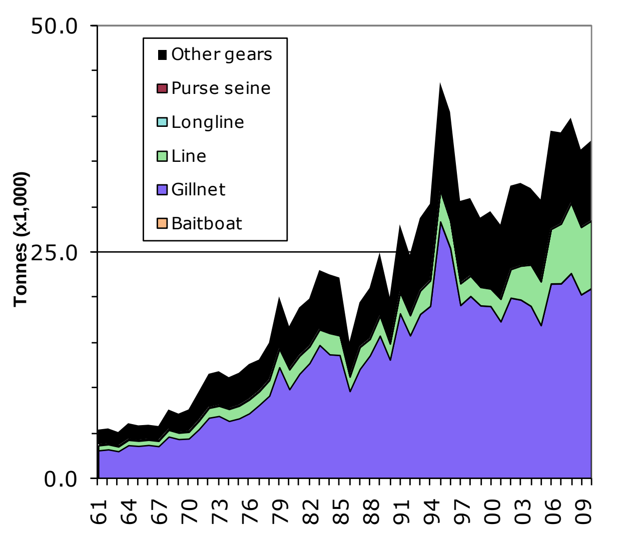

Fig. 1. Indo-Pacific king mackerel: Catches by gear recorded in the IOTC Database (1960–2010).

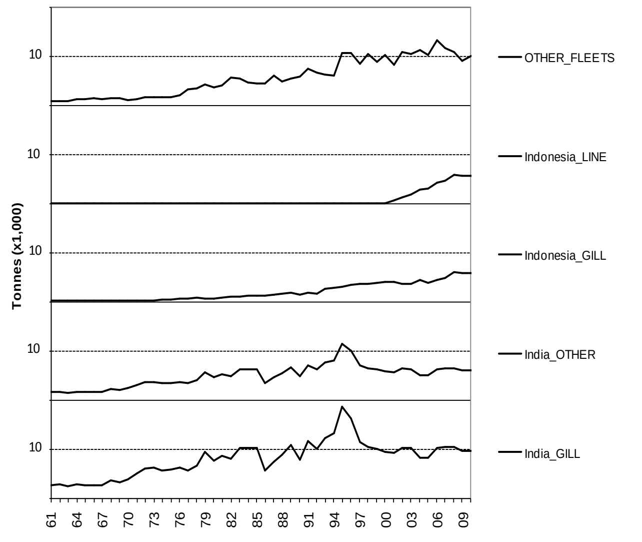

Fig. 2. Indo-Pacific king mackerel: Catches recorded in the IOTC Database for main fishing fleets (1960–2010).

TABLE 3. Best scientific estimates of the catches of Indo-Pacific king mackerel by type of fishery for the period 1950–2010 (in metric tonnes). Data as of October 2011.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Purse seine	0	0	48	240	484	276	189	283	349	220	226	293	260	266	265	262
Gillnet	2,310	3,542	7,325	12,731	19,655	19,035	17,343	19,955	19,747	19,055	16,922	21,524	21,543	22,675	203,19	20,996
Line	453	581	1,326	2,014	2,473	1,915	2,467	3,132	3,726	4,532	4,805	5,995	6,570	7,756	7,423	7,441
Other	1,193	1,657	3,641	5,324	7,994	8,236	7,981	8,915	8,772	8,223	8,807	10,554	9,809	9,108	8,280	8,559
Total	**3,957**	**5,780**	**12,340**	**20,309**	**30,606**	**29,461**	**27,980**	**32,285**	**32,593**	**32,029**	**30,761**	**38,367**	**38,182**	**39,805**	**36,288**	**37,257**

Indo-Pacific king mackerel – Uncertainty of catches

Retained catches are highly uncertain (Fig. 3) for all fisheries due to:

- Aggregation: Indo-Pacific King mackerel is usually not reported by species, being aggregated with narrow-barred Spanish mackerels or, less frequently, other small tuna species.
- Mislabelling: Indo-Pacific King mackerels are usually mislabelled as narrow-barred Spanish mackerel, their catches reported under the latter species.
- Under reporting: the catches of Indo-Pacific King mackerel may be not reported for some fisheries catching them as a bycatch.
- It is for the above reasons that the catches of Indo-Pacific King mackerel in the IOTC database are thought to represent only a small fraction of the total catches of this species in the Indian Ocean.
- Discard levels are believed to be low although they are unknown for most fisheries.
- Changes to the catch series: There have not been significant changes to the estimated catches of Indo-Pacific King mackerel since 2010.

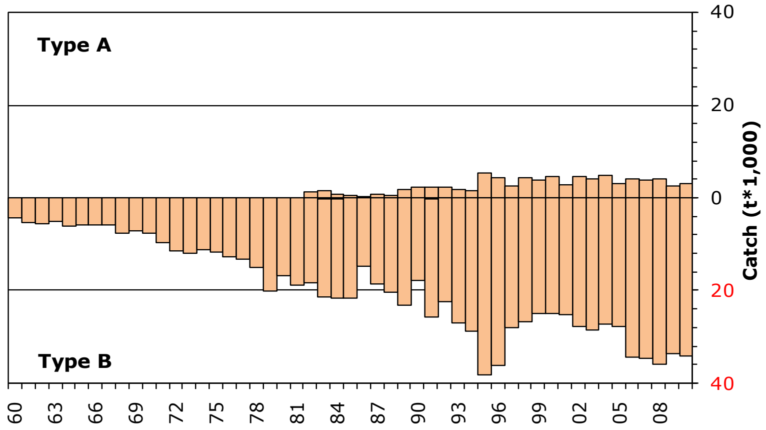

Fig. 3. Indo-Pacific king mackerel: Uncertainty of annual catch estimates (1960–2010) (Data as of October 2011). *Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (**Type A**) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.*

Indo-Pacific king mackerel – Effort trends

Effort trends are unknown for Indo-Pacific King mackerel in the Indian Ocean.

Indo-Pacific king mackerel – Catch–per–unit–effort (CPUE) trends

Standardised CPUE series have not yet been developed. Nominal CPUE series are however available from some fisheries but they are considered highly incomplete. In most cases catch-and-effort data are only available for short periods of time. This makes it impossible to derive any meaningful CPUE from the existing data.

Indo-Pacific king mackerel – Fish size or age trends (e.g. by length, weight, sex and/or maturity)

- Trends in average weight cannot be assessed for most fisheries. Samples of king mackerel are only available for the coastal purse seiners of Thailand and gillnets of Sri Lanka but they refer to very short periods and the numbers sampled are very small.
- Catch-at-Size(Age) tables are not available for the Indo-Pacific King mackerel due to the paucity of size data available from most fleets and the uncertain status of the catches for this species.
- Sex ratio data have not been provided to the Secretariat by CPCs.

STOCK ASSESSMENT

No quantitative stock assessment for Indo-Pacific king mackerel in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Neritic Tunas. Further work must be undertaken to derive stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Indo-Pacific king mackerel (*Scomberomorus guttatus*) stock status summary.

Management Quantity	**Aggregate Indian Ocean**
2010 catch estimate	37,300 t
Mean catch from 2006–2010	38,000 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2010}/F_{MSY} (80% CI)	–
B_{2010}/B_{MSY} (80% CI)	–
SB_{2010}/SB_{MSY}	–
B_{2010}/B_0 (80% CI)	–
SB_{2010}/SB_0	–
$B_{2010}/B_{0,\ F=0}$	–
$SB_{2010}/SB_{0,\ F=0}$	–

LITERATURE CITED

Froese R & Pauly DE, 2009. FishBase, version 02/2009, FishBase Consortium, www.fishbase.org.

APPENDIX XX
EXECUTIVE SUMMARY: SWORDFISH

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi

Status of the Indian Ocean Swordfish Resource (*Xiphias gladius*)

TABLE 1. Status of swordfish (*Xiphias gladius*) in the Indian Ocean.

Area[1]	**Indicators – 2011 assessment**		**2011 stock status determination 2009**[2]
Indian Ocean	Catch 2010:	18,956 t	
	Average catch 2006-2010:	23,799 t	
	MSY (4 models):	29,900 t–34,200 t	
	F_{2009}/F_{MSY} (4 models):	0.50–0.63	
	SB_{2009}/SB_{MSY} (4 models):	1.07–1.59	
	SB_{2009}/SB_0 (4 models):	0.30–0.53	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]The stock status refers to the most recent years' data used for the assessment.

Colour key	Stock overfished(SB_{year}/SB_{MSY}< 1)	Stock not overfished (SB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. All models suggest that the stock is above, but close to a biomass level that would produce MSY and current catches are below the MSY level. MSY-based reference points were not exceeded for the Indian Ocean population as a whole ($F_{2009}/F_{MSY} < 1$; $SB_{2009}/SB_{MSY} > 1$). Spawning stock biomass in 2009 was estimated to be 30–53% (from Table 1; Fig. 1) of the unfished levels.

Outlook. The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, indicating that current fishing mortality would not reduce the population to an overfished state. There is a low risk of exceeding MSY-based reference points by 2019 if catches reduce further or are maintained at current levels until 2019 (<11% risk that $B_{2019} < B_{MSY}$, and <9% risk that $F_{2019} > F_{MSY}$) (Table 2).

The SC **RECOMMENDED** that:

1) The Maximum Sustainable Yield estimate for the whole Indian Ocean is 29,900–34,200 t (range of best point estimates from Table 2) and annual catches of swordfish should not exceed this estimate.
2) if the recent declines in effort continue, and catch remains substantially below the estimated MSY of 30,000–34,000 t, then management measures are not required which would pre-empt current resolutions and planned management strategy evaluation. However, continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in assessments.
3) The Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.
4) Advice specific to the southwest region is provided below, as requested by the Commission.

TABLE 2. Aggregated Indian Ocean assessment - Kobe 2 Strategy Matrix, indicating a range of probabilities across four assessment approaches. Probability (percentage) of violating the MSY-based reference points for five constant catch projections (2009 catch level, ± 20% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to 2009) and probability (%) of violating reference point**				
	60%	**80%**	**100%**	**120%**	**140%**
$B_{2012} < B_{MSY}$	0–4	0–8	0–11	2–12	4–16
$F_{2012} > F_{MSY}$	0–1	0–2	0–9	0–16	6–27
$B_{2019} < B_{MSY}$	0–4	0–8	0–11	0–13	6–26
$F_{2019} > F_{MSY}$	0–1	0–2	0–9	0–23	7–31

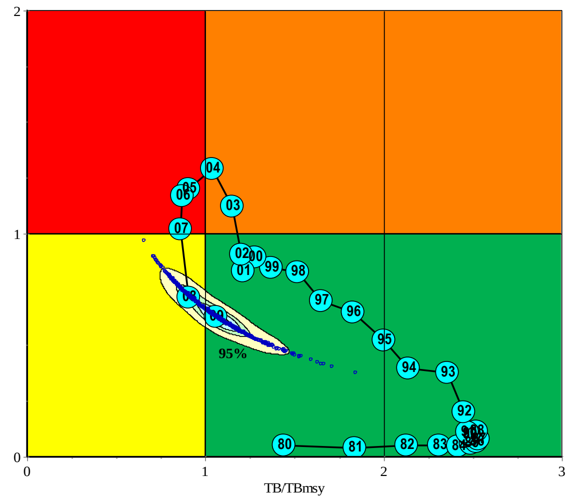

Fig. 1. ASPIC Aggregated Indian Ocean assessment Kobe plot (95% Confidence surfaces shown around 2009 estimate). Blue circles indicate the historical trajectory.

TABLE 3. Status of swordfish (*Xiphias gladius*) in the southwest Indian Ocean.

Area[1]	**Indicators – 2011 assessment**		**2011 stock status determination 2009**[2]
Southwest Indian Ocean	Catch 2010:	6,513 t	
	Average catch 2006-2010:	7,112 t	
	MSY (3 models):	7,100 t–9,400 t	
	F_{2009}/F_{MSY} (3 models):	0.64–1.19	
	SB_{2009}/SB_{MSY} (3 models):	0.73–1.44	
	SB_{2009}/SB_0 (3 models):	0.16–0.58	

[1]Boundaries for southwest Indian Ocean stock assessment are defined in IOTC–2011–WPB09–R.
[2]The stock status refers to the most recent years' data used for the assessment.

Colour key	Stock overfished ($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing ($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		

SOUTHWEST INDIAN OCEAN – MANAGEMENT ADVICE

Stock status. Most of the evidence provided to the WPB indicated that the resource in the southwest Indian Ocean has been overfished in the past decade and biomass remains below the level that would produce MSY (B_{MSY}). Recent declines in catch and effort have brought fishing mortality rates to levels below F_{MSY} (Table 3).

Outlook. The decrease in catch and effort over the last few years in the southwest region has reduced pressure on this resource. There is a low risk of exceeding MSY-based reference points by 2019 if catches reduce further or are maintained at current levels (<25% risk that $B_{2019} < B_{MSY}$, and <8% risk that F2019 > F_{MSY}). There is a risk of reversing the rebuilding trend if there is any increase in catch in this region (Table 4).

The SC **RECOMMENDED** that:

1) The Maximum Sustainable Yield estimate for the southwest Indian Ocean is 7,100–9,400 t (range of best point estimates from Table 3).
2) Catches in the southwest Indian Ocean should be maintained at levels at or below those observed in 2009 (6,678t), until there is clear evidence of recovery and biomass exceeds B_{MSY}.
3) The Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.

TABLE 4. Southwest Indian Ocean assessment - Kobe 2 Strategy Matrix, indicating a range of probabilities across three assessment approaches. Probability (percentage) of violating the MSY-based reference points for five constant catch projections (2009 catch level, ± 20% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to 2009) and probability (%) of violating reference point**				
	60%	**80%**	**100%**	**120%**	**140%**
$B_{2012} < B_{MSY}$	0-15	0-20	0-25	0-30	12-32
$F_{2012} > F_{MSY}$	0-1	0-5	0-8	0-18	13-34
$B_{2019} < B_{MSY}$	0-15	0-20	0-25	0-32	18-34
$F_{2019} > F_{MSY}$	0-1	0-5	0-8	0-18	19-42

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Billfish and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Swordfish in the Indian Ocean are currently subject to a single conservation and management measure adopted by the Commission: Resolution 09-02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*. This resolution applies a freezing of fishing capacity for fleets targeting swordfish in the Indian Ocean to levels applied in 2007. The resolution limits vessels access to those that were active (*effective presence*) or under construction during 2007, and were over 24 metres overall length, or under 24 meters if they fished outside the EEZs. At the same time the measure permits CPCs to vary the number of vessels targeting swordfish, as long as any variation is consistent with the national fleet development plan submitted to the IOTC, and does not increase effective fishing effort. This resolution is effective for 2010 and 2011.

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/07 *concerning a record of licensed foreign vessels fishing for tunas and swordfish in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 10/13 *On the implementation of a ban on discards of skipjack tuna, yellowfin tuna, bigeye tuna, and non targeted species caught by purse seiners*.
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

Swordfish (*Xiphias gladius*) is a large oceanic apex predator that inhabits all the world's oceans. Throughout the Indian Ocean, swordfish are primarily taken by longline fisheries, and commercial harvest was first recorded by the Japanese in the early 1950's as a bycatch/byproduct of their tuna longline fisheries. Swordfish life history characteristics, including a relatively late maturity, long life and sexual dimorphism, make the species vulnerable to over exploitation. Table 5 outlines some of the key life history traits of swordfish specific to the Indian Ocean.

TABLE 5. Biology of Indian Ocean swordfish (*Xiphias gladius*).

Parameter	Description
Range and stock structure	Northern coastal state waters to 50˚S. Juvenile swordfish are commonly found in tropical and subtropical waters and migrate to higher latitudes as they mature. Large, solitary adult swordfish are most abundant at 15–35˚S. Males are more common in tropical and subtropical waters. By contrast with tunas, swordfish is not a gregarious species, although densities increase in areas of oceanic fronts and seamounts. Extensive diel vertical migrations, from surface waters during the night to depths of 1000 m during the day, in association with movements of the deep scattering layer and cephalopods, their preferred prey. For the purposes of stock assessments, one pan-ocean stock has been assumed. However, spatial heterogeneity in stock indicators (catch–per–unit–effort trends) indicates the potential for localised depletion of swordfish in the Indian Ocean.
Longevity	30+ years
Maturity (50%)	**Age**: females 6–7 years; males 1–3 years **Size**: females ~170 cm lower-jaw FL; males ~120 cm lower-jaw FL
Spawning season	Highly fecund batch spawner. May spawn as frequently as once every three days over a period of several months in spring. Spawning occurs from October to April in the vicinity of Reunion Island.
Size (length and weight)	Maximum: 455 cm lower-jaw FL; 550+ kg total weight in the Indian Ocean. Sexual dimorphism in size, growth rates and size and age at maturity—females reach larger sizes, grow faster and mature later than males. Most swordfish larger than 200 kg are female. Recruitment into the fishery: varies by fishing method; ~60 cm lower-jaw FL for artisanal fleets and methods. By one year of age, a swordfish may reach 90 cm lower-jaw FL (~15 kg). The average size of swordfish taken in Indian Ocean longline fisheries is between 40 kg and 80 kg (depending on latitude).

SOURCES: Froese & Pauly (2009); Poisson & Fauvel (2009)

Catch trends

Swordfish are caught mainly using drifting longlines (95%) and gillnets (5%) (Fig. 2). Between 1950 and 1980, catches of swordfish in the Indian Ocean slowly increased in tandem with the level of coastal state and distant water fishing nation longline effort targeting tunas (Figs. 2 and 3). Swordfish were mainly a bycatch of industrial longline fisheries before the early 1990's with catches slightly increasing from 1950 to 1990 proportionally to the increase in the catches of target species (tropical and temperate tunas).

Since 2004, annual catches have declined steadily (Fig. 2), largely due to the continued decline in the number of active Taiwan,China longliners in the Indian Ocean. Annual catches since 2004 have been dominated by the Taiwan,China and EU fleets (Spain, UK, France and Portugal), with the fishery extending eastward due to the effects of piracy actions (Fig. 4).

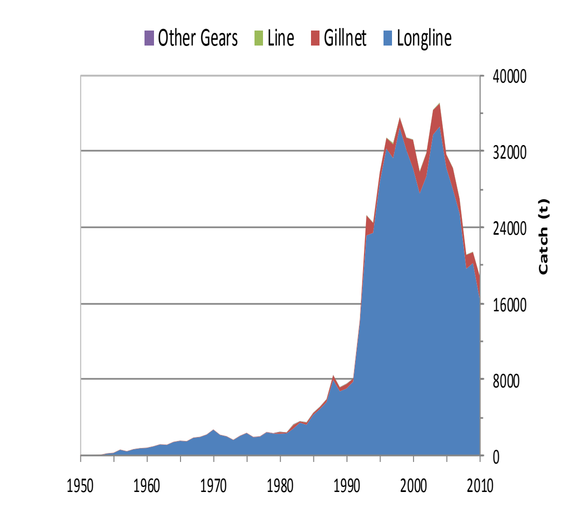

Fig. 2 Catches of swordfish per gear and year recorded in the IOTC Database (1960–2010).

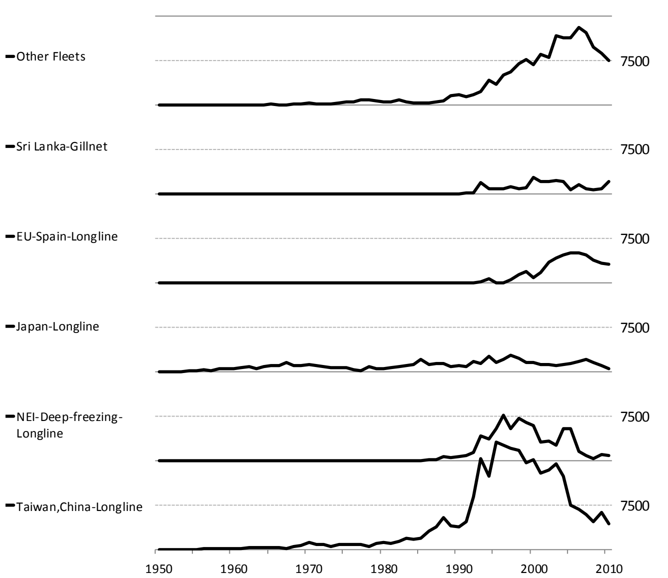

Fig. 3. Catches of swordfish by fleet recorded in the IOTC Database (1960–2010).

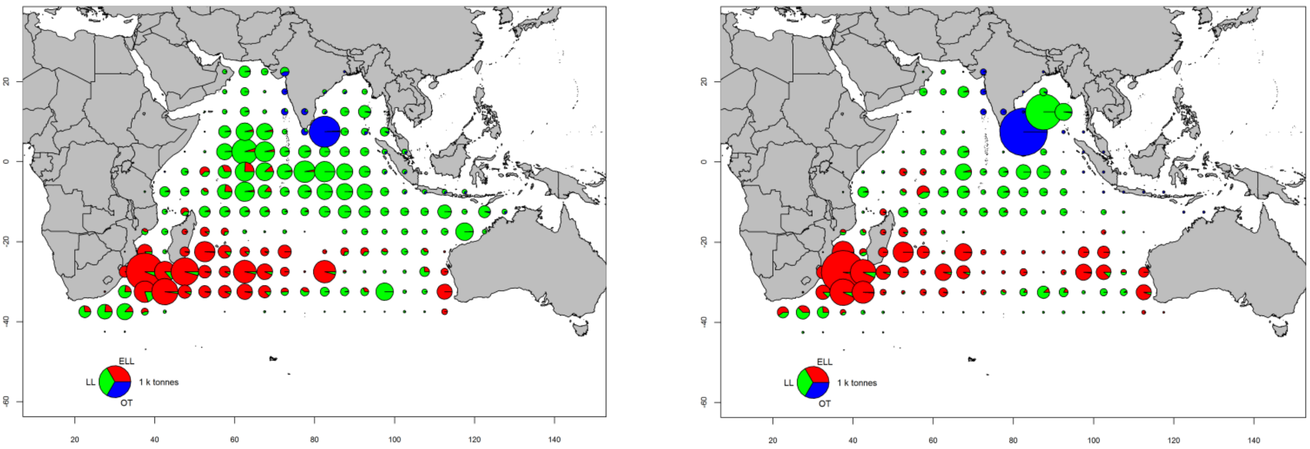

Fig. 4a–b. Time-area catches (total combined in tonnes) of swordfish estimated for 2009 and 2010, by year and type of gear. Swordfish longliners (**ELL**), Other longliners (**LL**), Other fleets (**OT**). Time-area catches are not available for non-longline fleets (OT, blue); catches for those were fully assigned to the one or more 5x5 squares lying within the EEZs of the countries concerned.

TABLE 6. Best scientific estimates of the catches of swordfish by type of fishery for the period 1950–2009 (in metric tons). Data as of October 2011.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
ELL				9	1,842	10,439	7,970	8,927	10,727	13,414	15,645	13,629	12,008	8,579	8,423	8,113
LL	282	1,426	2,135	4,337	21,580	17,475	19,600	20,453	23,032	21,206	14,630	14,350	13,443	11,064	11,825	8,373
OT	40	41	53	317	1,094	2,121	2,381	2,514	2,646	2,531	1,461	2,305	1,600	1,515	1,200	2,470
Total	**322**	**1,467**	**2,188**	**4,664**	**24,516**	**30,035**	**29,950**	**31,893**	**36,405**	**37,152**	**31,735**	**30,285**	**27,051**	**21,157**	**21,448**	**18,956**

Fisheries: Swordfish longline (**ELL**); Other longline (**LL**); Other fisheries (**OT**)

TABLE 7. Best scientific estimates of the catches of swordfish by fishing area for the period 1950–2009 (in metric tons). Data as of October 2011.

Area	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
NW	117	551	650	1,469	7,245	9,820	7,969	12,281	15,108	12,276	10,865	10,355	8,719	6,625	4,998	2,204
SW	14	256	405	620	8,599	7,591	8,887	7,359	3,969	6,293	9,680	8,833	7,349	6,188	6,678	6,513
NE	122	405	725	2,017	5,787	6,352	6,379	5,783	8,166	7,775	4,680	6,138	4,973	4,753	6,661	7,393
SE	27	167	271	342	2,518	5,644	6,051	5,737	8,297	9,729	5,753	4,337	5,258	3,507	3,014	2,788
OT	41	88	137	215	368	628	664	734	864	1,079	757	621	752	84	97	58
Total	**322**	**1,467**	**2,188**	**4,664**	**24,516**	**30,035**	**29,950**	**31,893**	**36,405**	**37,152**	**31,735**	**30,285**	**27,051**	**21,157**	**21,448**	**18,956**

Areas: Northwest Indian Ocean (**NW**); Southwest Indian Ocean (**SW**); Northeast Indian Ocean (**NE**); Southeast Indian Ocean (**SE**); Southern Indian Ocean (**OT**)

Uncertainty of time–area catches

Retained catches are fairly well known (Fig. 5); however catches are uncertain for:

- Drifting gillnet fisheries of Iran and Pakistan: To date, Iran has not reported catches of swordfish for its gillnet fishery. Although Pakistan has reported catches of swordfish they are considered to be too low for a driftnet fishery.
- Longline fishery of Indonesia: The catches of swordfish for the fresh tuna longline fishery of Indonesia may have been underestimated in recent years due to insufficient sampling coverage. Although the new catches estimated by the Secretariat are thought to be more accurate, swordfish catches remain uncertain, especially in recent years.
- Longline fishery of India: India has reported very incomplete catches and catch-and-effort data for its longline fishery. Although the new catches estimated by the IOTC Secretariat are thought to be more accurate, catches of swordfish remain uncertain.
- Longline fleets from non-reporting countries (NEI): The IOTC Secretariat had to estimate catches of swordfish for a fleet of longliners targeting tunas or swordfish and operating under flags of various non-reporting countries. The catches estimated since 2006 are, however, low.

- Changes to the catch series: There have not been significant changes to the catch series of swordfish since the WPB in 2010. Changes since the last WPB refer to revisions of historic data series for the artisanal fisheries of Indonesia and India. These changes, however, did not lead to significant changes in the total catch estimates.
- Discards are believed to be low although they are unknown for most industrial fisheries, mainly longliners. Discards of swordfish may also occur in the driftnet fishery of Iran, as this species has no commercial value in this country.

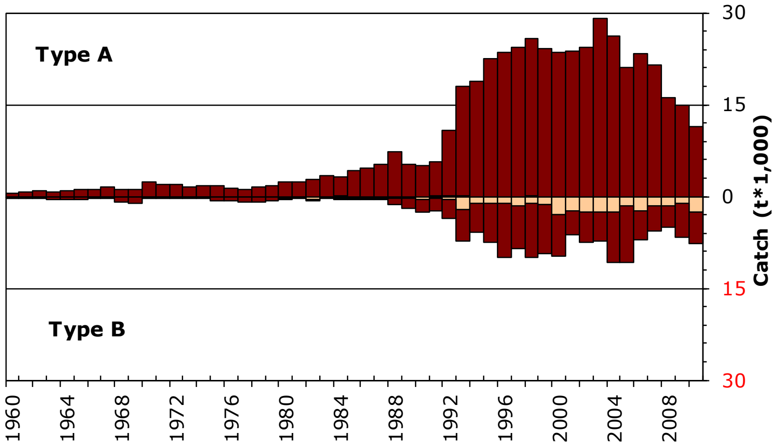

Fig. 5. Uncertainty of time-area catches for swordfish (Data as of October 2011).

*Catches below the zero-line (**Type B**) refer to fleets that do not report catch-and-effort data to the IOTC, do not report catch-and-effort data by gear and/or species or any of the other reasons provided in the document. Catches over the zero-line (**Type A**) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.*

Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid from 2007 to 2010 are provided in Fig. 6, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2007 to 2010 are provided in Fig. 7.

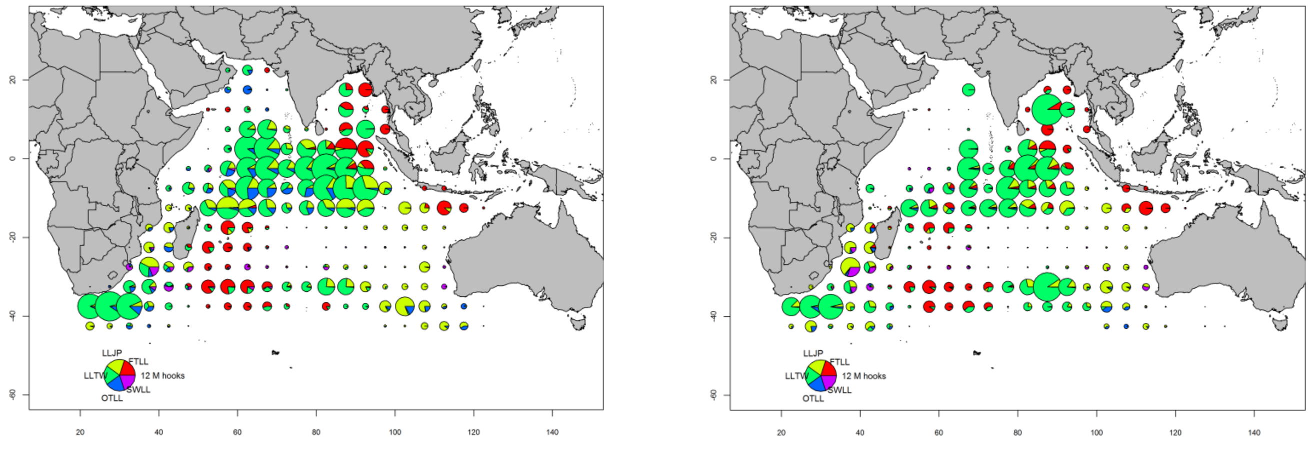

Fig. 6. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

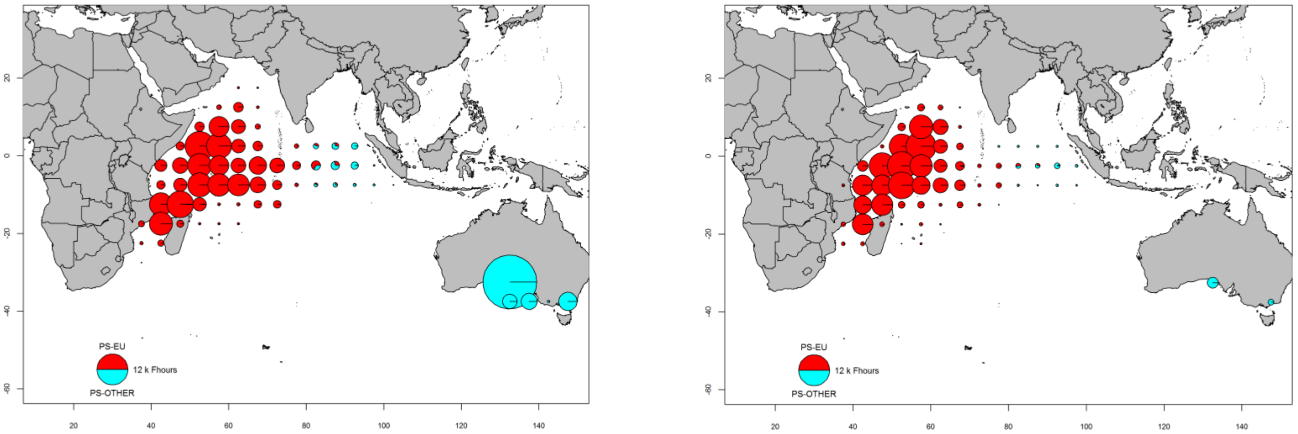

Fig. 7. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

Catch–per–unit–effort (CPUE) trends

The following CPUE series were used in the stock assessment models for 2011 (Figs. 8 and 9), while the relative weighting of the different CPUE series would be left to the individual analyst to determine and justify to participants:

- Japan data (1980–2009): Series 3.2 from document IOTC–2011–WPB09–14, which includes fixed latitude and longitude effects, plus environmental effects.
- Taiwan,China data (1995–2009): Model 10 from document IOTC–2011–WPB09–23, which includes fixed latitude and longitude effects, plus environmental effects.
- EU,Spain data (2001–2009): Series 5 from document IOTC–2011–WPB09–23, calculated for the southwest area only (includes sub-region factors and species ratio factors) area and run 1 for the assessment of whole Indian Ocean.
- EU,La Reunion data (1994–2000): Same series as last year (IOTC–2010–WPB–03).

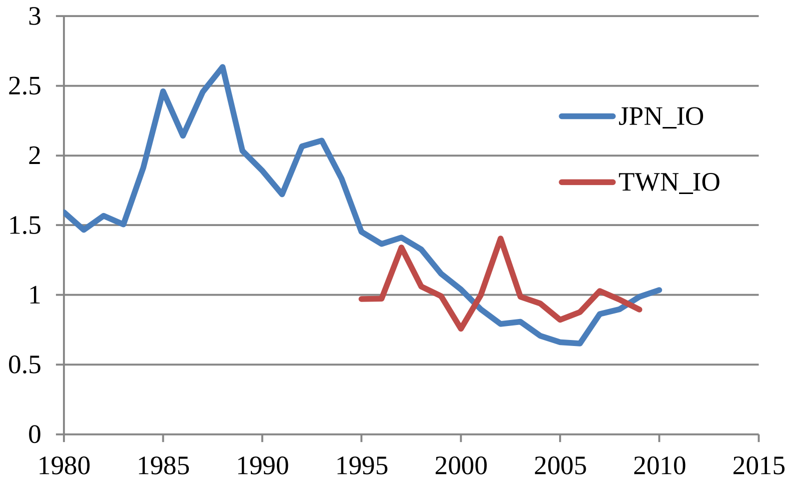

Fig. 8. Aggregate Indian Ocean CPUE series for swordfish. Series have been rescaled relative to their respective means from 1995–2009.

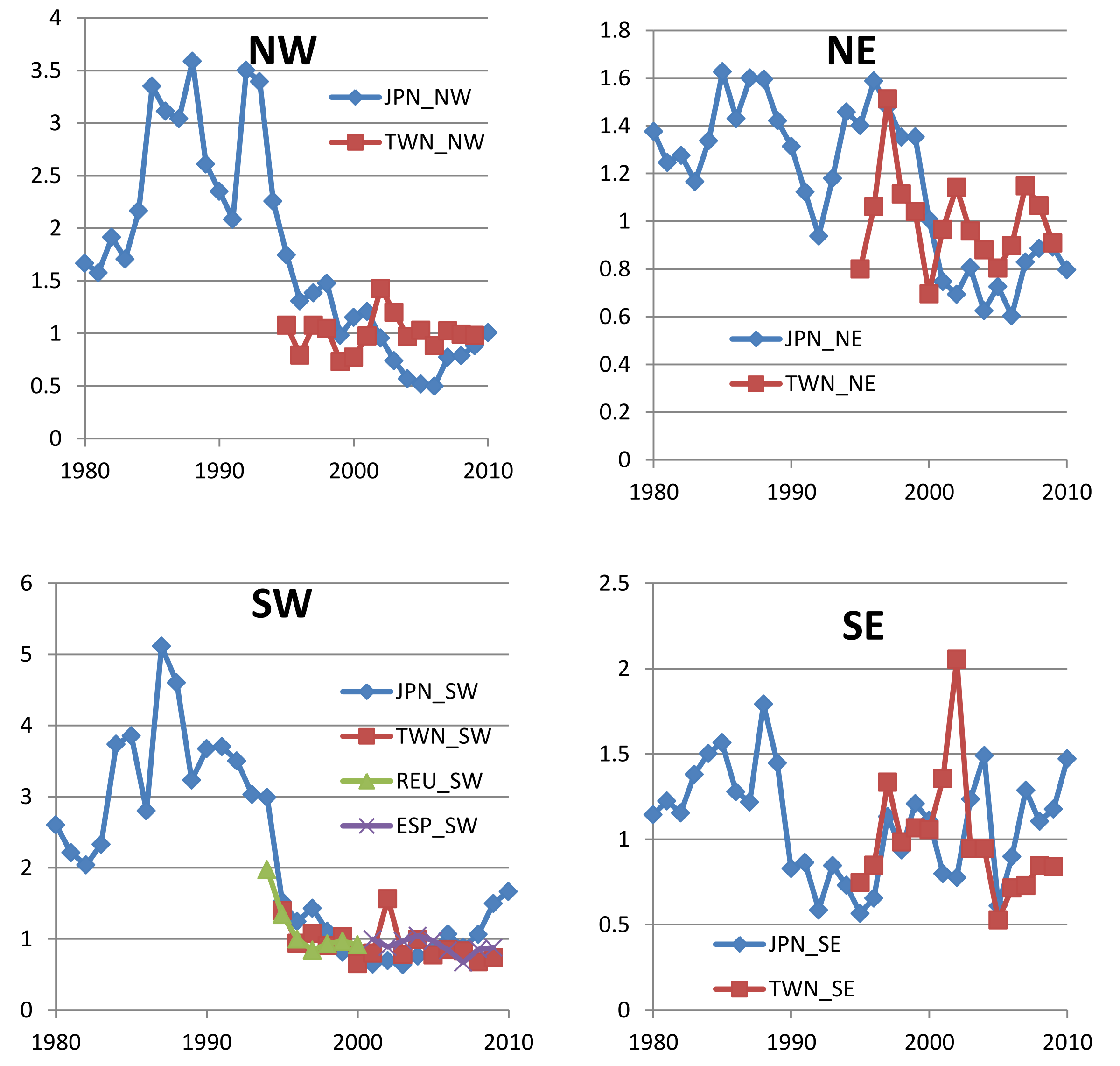

Fig. 9. CPUE series for Indian Ocean swordfish assessments by sub-region. Series have been rescaled relative to their respective means (for different overlapping time periods).

Fish size or age trends (e.g. by length, weight, sex and/or maturity)

In general, the amount of catch for which size data for the species are available before 2005 is still very low and the number of specimens measured per stratum has been decreasing in recent years.

- Average fish weight can be assessed for several industrial fisheries although they are incomplete or poor quality for most fisheries before the early-80s and in recent years (low sampling coverage and time-area coverage of longliners from Japan). The average weights of swordfish are variable but show no clear trend (Fig. 10). It is considered encouraging that there are no clear signals of declines in the size-based indices, but these indices should be carefully monitored, as females mature at a relatively large size, therefore, a reduction in the biomass of large animals could potentially have a strong effect on the spawning biomass.
- Catch-at-Size(Age) data are available but the estimates are thought to have been compromised for some years and fisheries due to:
    - the uncertainty in the catches of swordfish for the drifting gillnet fisheries of Iran and the fresh-tuna longline fishery of Indonesia.
    - the total lack of size data before the early-70s and poor coverage before the early-80s and for most artisanal fisheries (Pakistan, India, Indonesia).
    - the paucity of size data available from industrial longliners since the early-1990s (Japan, Philippines, India and China).
    - the lack of time-area catches for some industrial fleets (Indonesia, India, NEI).
    - the paucity of biological data available, notably sex-ratio and sex-length-age keys.

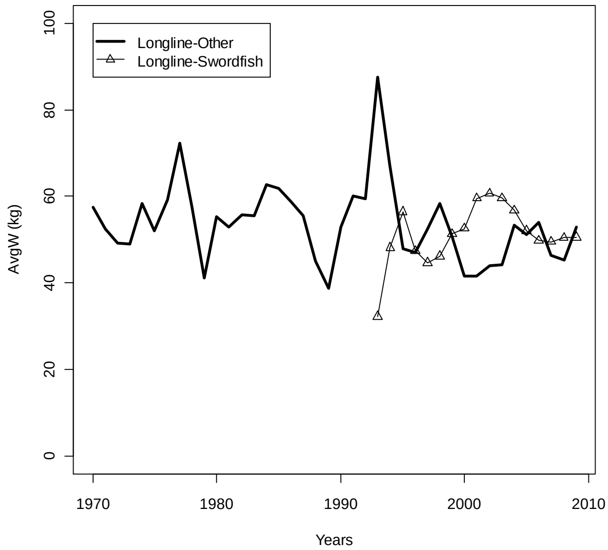

Fig. 10. Swordfish average weight (1970–2010) derived from catches-at-size estimated from the available length frequency samples of swordfish (average weights are shown only for years in which samples of swordfish are available).

STOCK ASSESSMENT

The stock structure of the Indian Ocean swordfish resource is under investigation, but currently uncertain. The southwest region was identified as a management unit of particular concern, because it seems to be more depleted than other regions in the Indian Ocean, and may have limited mixing with other regions.

A range of quantitative modelling methods were applied to the swordfish assessment in 2011, ranging from the highly aggregated ASPIC surplus production model to the age-, sex- and spatially-structured SS3 analysis. The different assessments were presented to the WPB in documents IOTC–2011–WPB09–17, 18, 19 and 20.

There is value in comparing different modelling approaches. The structured models are capable of a more detailed representation of complicated population and fishery dynamics, and integrate several sources of data and biological research that cannot be considered in the simple production models. However, there are a lot of uncertainties in basic swordfish biology (e.g. growth rates, M, stock recruitment relationship), and it is difficult to represent all of these uncertainties. In contrast, the production models often provide robust estimates regardless of uncertainties in basic biological characteristics. However, sometimes the ASPIC model can have difficulty fitting long time series, and production models in general cannot represent some important dynamics (e.g. arising from complicated recruitment variability).

The swordfish stock status was determined by qualitatively integrating the results of the various stock assessments undertaken in 2011 (Tables 1 and 8).
The following should be noted with respect to the various modelling approaches:

- There was more confidence in the abundance indices this year due to the additional CPUE analyses from Japan and Taiwan,China, and the addition of the EU,Spain series. This has led to improved confidence in the overall assessments and the southwest in particular.
- The southwest region should continue to be analysed as a special resource, as it appears to be highly depleted compared to the Indian Ocean as a whole. However the difference in depletion does not appear to be as extreme as analyses in previous years have suggested. A review of the spatial assumptions should be conducted following the final results of the IOSSS project.
- Further analysis is required on the appropriate way to use the size composition data in the integrated models. In particular, consideration of the large discrepancies between size composition data and mean weight data for Japanese and Taiwan,China fleets is needed.
- There is large uncertainty in swordfish growth rate estimates, and this has important implications for the integrated assessments. Most of these differences seem to be attributable to the interpretation of fin spine annulus counts, which have not been directly validated. Further information might be sought from growth increment data from the Atlantic tagging programs.
- It was recognised that the effects of depredation (at least from the southwest), and discarding should be examined in future analyses.
- It was recognised that the deterministic production models were only able to explore a limited number of modelling options. The structural rigidity of these simple models causes numerical problems when fit to long time series for some cases. It was suggested that truncating the catch and CPUE time series would allow more options to be explored. However, some participants of the WPB suggested that it

would be more appropriate to consider the model rather than discarding potentially informative data (e.g. the generation time of swordfish is such that a relatively long time series is required to make inferences about productivity).

TABLE 8. Key management quantities from the Stock Synthesis 3 assessments, for the aggregate and southwest Indian Ocean. Values represent the 50th (5th–95th) percentiles of the (plausibility-weighted) distribution of maximum posterior density estimates from the full range of the models examined.

Management Quantity	Aggregate Indian Ocean	Southwest Indian Ocean
2009 catch estimate	21,500 t	6,700 t
Mean catch from 2005–2009	26,300 t	77,700 t
MSY	31,000 t (20,000– 55,000)	9,400 t (6,500–13,500)
Data period used in assessment	1951–2009	1951–2009
F_{2009}/F_{MSY}	0.50 (0.23–1.08)	0.64 (0.27–1.27)
B_{2009}/B_{MSY}	–	–
SB_{2009}/SB_{MSY}	1.59 (0.94–3.77)	1.44 (0.61–3.71)
B_{2009}/B_0	–	–
SB_{2009}/SB_0	0.35 (0.22–0.42)	0.29 (0.15–0.43)
$B_{2009}/B_{0,\ F=0}$	–	–
$SB_{2009}/SB_{0,\ F=0}$	–	–

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Poisson F and Fauvel C, 2009.'Reproductive dynamics of swordfish (*Xiphias gladius*) in the southwestern Indian Ocean (Reunion Island), part 1, Oocyte development, sexual maturity and spawning', *Aquatic Living Resources*, vol. 22, pp. 45–58.

APPENDIX XXI
EXECUTIVE SUMMARY: BLACK MARLIN

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi

Status of the Indian Ocean Black Marlin Resource (*Makaira indica*)

TABLE 1. Status of the Indian Ocean Black Marlin (*Makaira indica*).

Area[1]	Indicators – 2011 assessment		2011 stock status determination 2010[2]
Indian Ocean	Catch 2010:	5,018 t	Uncertain
	Average catch 2006–2010:	4,689 t	
	MSY (range):	unknown	
	F_{2009}/F_{MSY} (range):	unknown	
	SB_{2009}/SB_{MSY} (range):	unknown	
	SB_{2009}/SB_0 (range):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence.
[2]The stock status refers to the most recent years' data used for the assessment.

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No quantitative stock assessment is currently available for black marlin in the Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock indicators can be used. Therefore stock status remains *uncertain* (Table 1). However, aspects of the biology, productivity and fisheries for this species combined with the lack of data on which to base a more formal assessment are a cause for considerable concern. Research emphasis on improving indicators and exploration of stock assessment approaches for data poor fisheries are warranted.

Outlook. The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource.
The Scientific Committee considers the following:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches of black marlin urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Billfish and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Black marlin (*Makaira indica*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

Black marlin (*Makaira indica*) is a large oceanic apex predator that inhabits tropical and subtropical Indo-Pacific oceans. Table 2 outlines some key life history parameters relevant for management. There is limited reliable information on the catches of black marlin and no information on the stock structure or growth and mortality in the Indian Ocean.

TABLE 2. Biology of Indian Ocean black marlin (*Makaira Indica*).

Parameter	Description
Range and stock structure	Little is known on the biology of the black marlin in the Indian Ocean. Thus, the information detailed here pertains to information from other oceans, primarily the Pacific. Black marlin is a highly migratory, large oceanic apex predator that inhabits tropical and subtropical waters of the Indian and Pacific oceans. Individuals have been reported in the Atlantic Ocean but there is no information to indicate the presence of a breeding stock in this area. Black marlin is mainly found in oceanic surface waters above the thermocline and typically near land masses, islands and coral reefs; however, they may range to depths of 1000 m. Thought to associate with schools of small tuna, which is one of its primary food sources (also reported to feed on other fishes, squids, cuttlefishes, octopods, and large decapod crustaceans). No information on stock structure is currently available in the Indian Ocean; thus for the purposes of assessment, one pan-ocean stock is assumed. However, spatial heterogeneity in stock indicators (catch–per–unit–effort trends) for other billfish species indicates that there is potential for localised depletion.
Longevity	Females: 11–12 years; Males: 5–6 years
Maturity (50%)	**Age**: unknown **Size**: females around 100 kg; males 50 to 80 kg total weight
Spawning season	No spawning grounds have been identified in the Indian or Pacific oceans, but in Australia spawning individuals apparently prefer water temperatures around 27-28°C. Highly fecund batch spawner. Females may produce up to 40 million eggs.
Size (length and weight)	Maximum: In other oceans can grow to more than 4.6 m FL and weigh 800 kg total weight. Young fish grow very quickly in length then put on weight later in life. In eastern Australian waters black marlin grows from 13 mm long at 13 days old to 180 cm and around 30 kg after 13 months. Sexual dimorphism in size, growth rates and size and age at maturity—females reach larger sizes, grow faster and mature later than males. Females: 326 cm lower-jaw FL, 800 kg total weight; Males: 255 cm lower-jaw FL, 300 kg total weight. Most black marlin larger than 200 kg are female. Recruitment into the fishery: varies by fishing method; ~60 cm lower-jaw FL for artisanal fleets and methods. The average size of black marlin taken in Indian Ocean longline fisheries is not available.

SOURCES: Cry et al. (1990); Froese & Pauly (2009); Nakamura (1985); Speare (2003); Sun et al. (2007)

Catch trends

Black marlin are caught mainly under drifting longlines (44%) and gillnets (49%) with remaining catches recorded under troll and hand lines (Fig. 1). Black marlin are the bycatch of industrial and artisanal fisheries. In recent years, the fleets of Taiwan,China (longline), Sri Lanka (gillnet), Indonesia (gillnets) and India (gillnets) are attributed with the highest catches of black marlin (Fig. 2). The minimum average annual catch estimated for the period 2006 to 2010 is around 4,689 t.

Between the early-1950s and the late-1980s part of the Japanese fleet was licensed to operate within the EEZ of Australia, and reported very high catches of black marlin in that area, in particular in waters off northwest Australia. In recent years, deep-freezing longliners from Japan and Taiwan,China have reported lower catches of black marlin, mostly in waters off the western coast of India and, to a lesser extent, the Mozambique Channel (Fig. 3).

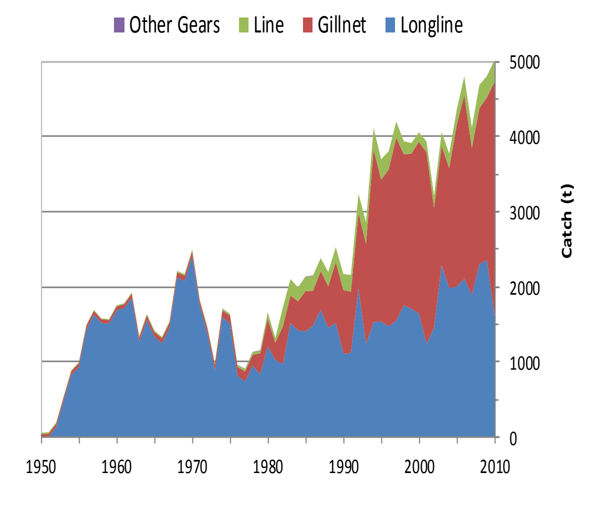

Fig. 1. Catches of black marlin per gear and year recorded in the IOTC Database (1960–2010).

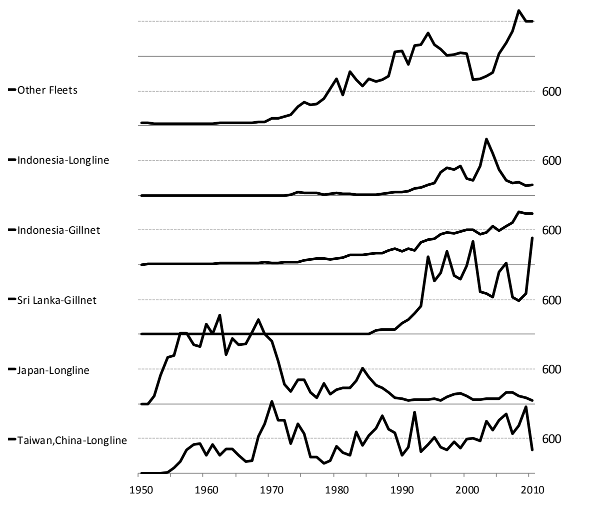

Fig. 2. Catches of black marlin by fleet recorded in the IOTC Database (1960–2010).

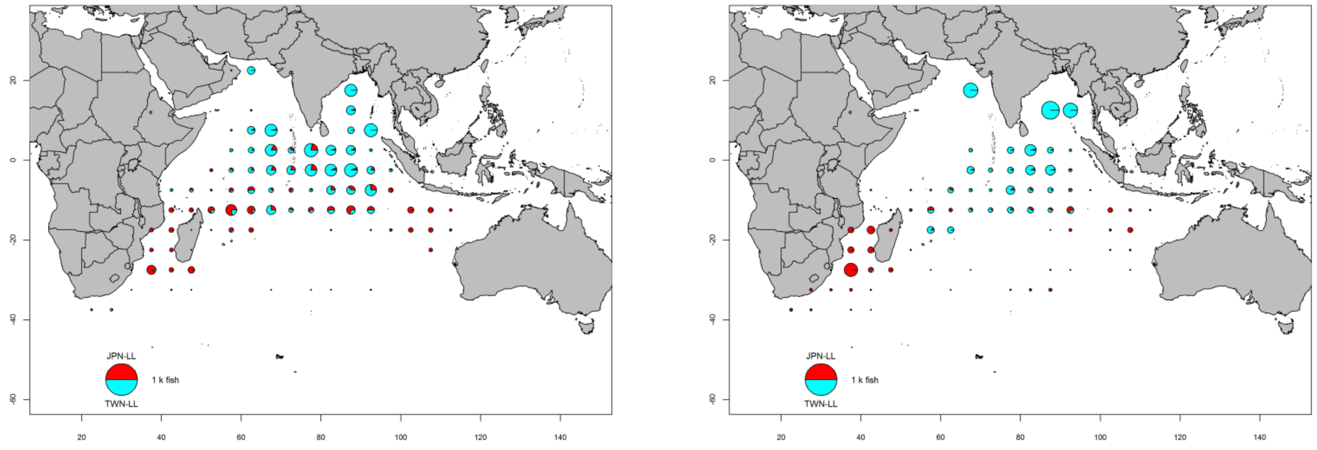

Fig. 3a–b. Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2009 and 2010 by fleet.

TABLE 3. Best scientific estimates of the catches of black marlin by type of fishery for the period 1950–2009 (in metric tonnes). Data as of May 2011.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Longline	846	1,633	1,288	1,370	1,501	1,646	1,243	1,454	2,291	1,985	2,002	2,110	1,894	2,302	2,359	1,612
Gillnet	47	60	115	473	1,680	2,287	2,549	1,600	1,589	1,596	2,157	2,446	1,955	2,080	2,165	3,121
Line	15	19	25	177	231	127	146	162	183	195	201	250	273	310	285	286
Other	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0
Total	**908**	**1,713**	**1,431**	**2,021**	**3,412**	**4,060**	**3,938**	**3,217**	**4,064**	**3,776**	**4,360**	**4,806**	**4,121**	**4,693**	**4,809**	**5,018**

Uncertainty of time–area catches

Minimum catch estimates have been derived from very small amounts of information and are therefore highly uncertain. Difficulties in the identification of marlins also contribute to the uncertainties of the information available to the Secretariat.

Retained catches are uncertain for some fisheries (Fig. 4), due to the fact that:

- catch reports often refer to total catches of all three marlin species combined; catches by species are estimated by the Secretariat for some artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, Iran and Pakistan) and industrial (longliners of Indonesia and Philippines) fisheries
- catches of non-reporting industrial longliners (India, NEI) and the gillnet fishery of Indonesia are estimated by the Secretariat using alternative information

- catches are likely to be incomplete for industrial fisheries for which the black marlin is not a target species
- conflicting catch reports: Longline catches from the Republic of Korea are reported as nominal catches, and catch and effort reports are conflicting, with higher catches recorded in the catch and effort table. For this reason, the Secretariat revised the catches of black marlin for the Republic of Korea over the time-series using both datasets. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of black marlin remain uncertain for this fleet.
- a lack of catch data for most sport fisheries.
- discards are unknown for most industrial fisheries, mainly longliners. Discards of black marlin may also occur in the driftnet fishery of I.R. Iran, as this species has no commercial value in this country.

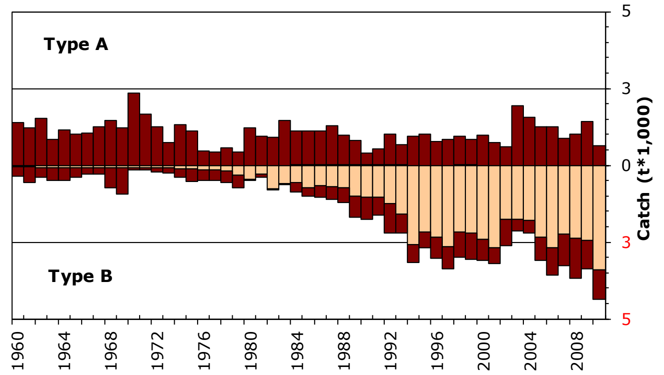

Fig. 4. Uncertainty of time-area catches for black marlin (Data as of October 2011).
Catches below the zero-line (Type B) refer to fleets that do not report catch-and-effort data to the IOTC, do not report catch-and-effort data by gear and/or species or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid from 2007 to 2010 are provided in Fig. 5, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2007 to 2010 are provided in Fig. 6.

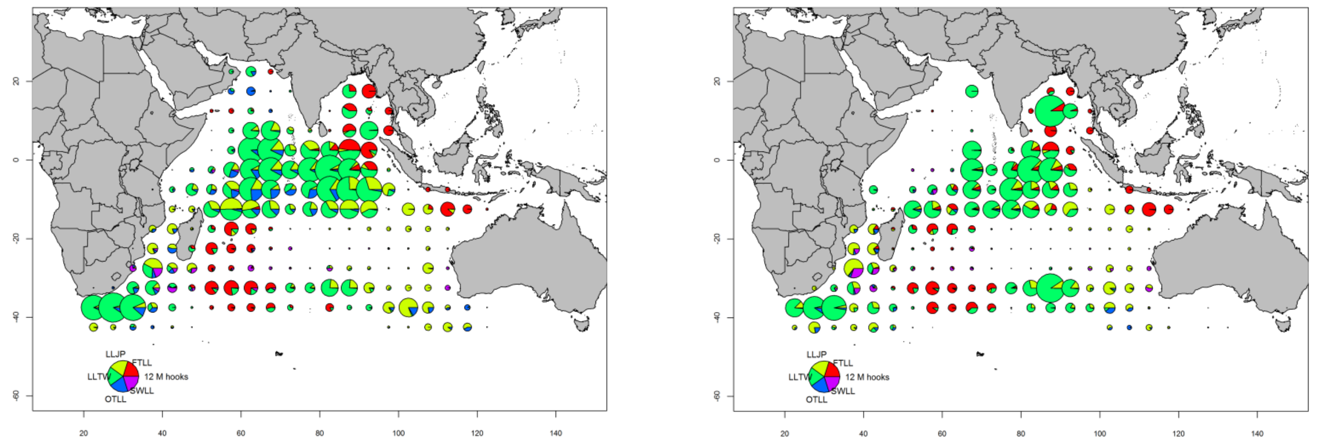

Fig. 5. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

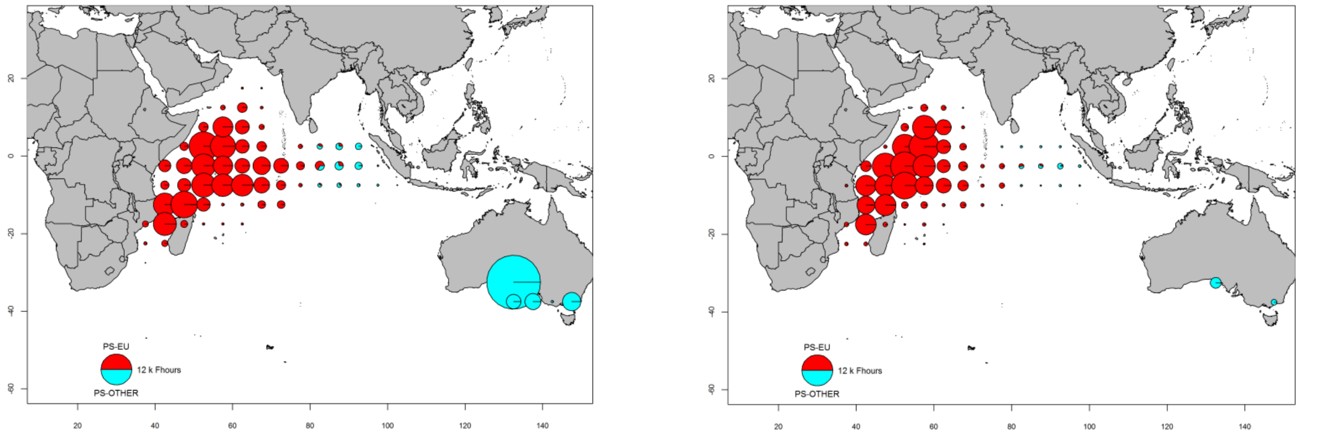

Fig. 6. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

Catch–per–unit–effort (CPUE) trends

Standardised CPUE series have not yet been developed. Nominal CPUE series are however available from some industrial longline fisheries (primarily the Japanese longline fleet; Figs. 7, 8) although catches are thought to be incomplete (catches of non-target species are not always recorded in logbooks). No catch and effort data are available from sports fisheries, other than for partial data from the sports fisheries of Kenya; or other artisanal (gillnet fisheries of Iran and Pakistan, gillnet/longlines of Sri Lanka, gillnets of Indonesia) or industrial fisheries (NEI longliners and all purse seiners).

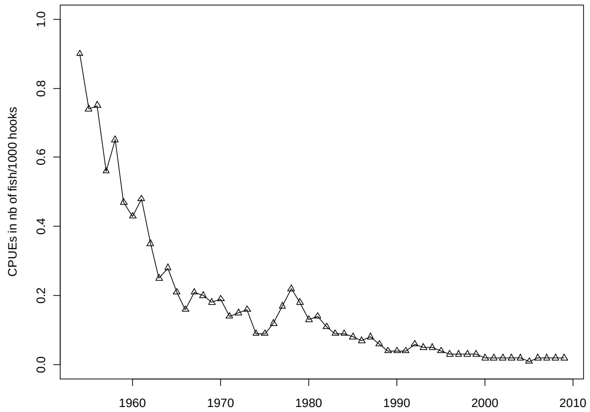

Fig. 7. Nominal CPUE (number of fish by 1,000 hooks) of black marlin caught by Japanese longliners off-Somalia.

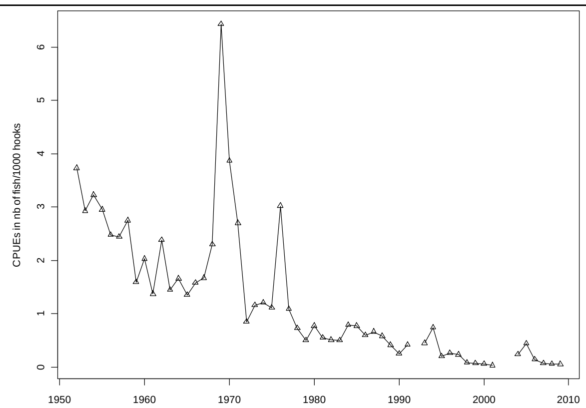

Fig. 8. Nominal CPUE (number of fish by 1,000 hooks) of black marlin caught by Japanese longliners northwest Australia.

Fish size or age trends (e.g. by length, weight, sex and/or maturity)

Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. The number of specimens measured on Japanese longliners in recent years is, however, very low.

Catch-at-Size(Age) tables have not been built for black marlin due to a lack of information reported by CPCs. Fish size is derived from various length and weight information, however the reliability of the size data is reduced when relatively few fish out of the total catch are measured.

Sex ratio data have not been provided to the Secretariat by CPCs.

STOCK ASSESSMENT

No quantitative stock assessment for black marlin in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Billfish. However, a preliminary estimation of stock indicators was attempted on the longline catch and effort datasets from Japan and Taiwan, China that represent the best available information. Nominal CPUE exhibited dramatic declines since the beginning of the fishery in two major fishing grounds (West Equatorial and north-west Australia) (Figs. 8 and 9) and catches in the initial core areas have also decreased substantially. However, there is considerable uncertainty about the degree to which these indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Black marlin (*Makaira indica*) stock status summary.

Management Quantity	Aggregate Indian Ocean
2010 catch estimate	5,000 t
Mean catch from 2006–2010	4,700 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2010}/F_{MSY} (80% CI)	–
B_{2010}/B_{MSY} (80% CI)	–
SB_{2010}/SB_{MSY}	–
B_{2010}/B_{1980} (80% CI)	–
SB_{2010}/SB_{1980}	–
$B_{2010}/B_{1980,\ F=0}$	–
$SB_{2010}/SB_{1980,\ F=0}$	–

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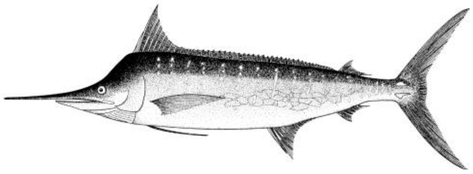
APPENDIX XXII
EXECUTIVE SUMMARY: INDO-PACIFIC BLUE MARLIN

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean Indo-Pacific Blue Marlin Resource (*Makaira mazara*)

TABLE 1. Status of Indo-Pacific blue marlin (*Makaira mazara*) in the Indian Ocean.

Area[1]	Indicators – 2011 assessment		2011 stock status determination 2010[2]
Indian Ocean	Catch 2010:	11,261 t	Uncertain
	Average catch 2006–2010:	9,508 t	
	MSY (range):	unknown	
	F_{2009}/F_{MSY} (range):	unknown	
	SB_{2009}/SB_{MSY} (range):	unknown	
	SB_{2009}/SB_0 (range):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]The stock status refers to the most recent years' data used for the assessment.

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No quantitative stock assessment is currently available for Indo-Pacific blue marlin in the Indian Ocean, and due to a lack of reliable fishery data for several gears, only very preliminary stock indicators can be used. The standardised CPUE suggest that there was a decline in the early 1980s, followed by an increase in abundance over the last 20 years. This contrasts with the majority of non-standardised indicators which suggest a decline in abundance since the 1980s. Therefore the stock status is determined as being *uncertain* (Table 1). However, aspects of species biology, productivity and fisheries combined with a lack of fisheries data on which to base a quantitative assessment is a cause for concern.

Outlook. The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource.

The SC **RECOMMENDED** the following:
- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches of Indo-Pacific blue marlin urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Billfish and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Indo-Pacific blue marlin (*Makaira mazara*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:
- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

Indo-Pacific blue marlin (*Makaira mazara*) is a large oceanic apex predator that inhabits tropical and subtropical waters of the Indian and Pacific oceans. Table 2 outlines some key life history parameters relevant for management.

TABLE 2. Biology of Indian Ocean Indo-Pacific blue marlin (*Makaira mazara*).

Parameter	**Description**
Range and stock structure	Little is known on the biology of the Indo-Pacific blue marlin in the Indian Ocean and the istinction between the blue marlin (*Makaira nigricans*) and Indo-Pacific blue marlin (*Makaira indica*) is not clear. Thus, the information detailed here pertains to information from other oceans, primarily the Pacific and Atlantic oceans. Indo-Pacific Blue marlin is a highly migratory, large oceanic apex predator that inhabits tropical and subtropical waters of the Indian and Pacific oceans. In the Pacific Ocean one tagged Indo-Pacific blue marlin is reported to have travelled 3000nm in 90 days. Indo-Pacific Blue marlin is a solitary species and prefers the warm offshore surface waters (>24°C); it is scarce in waters less than 100m in depth or close to land.The Indo-Pacific blue marlin's prey includes octopuses, squid and pelagic fishes such as blackfin tuna and frigate mackerel. Feeding takes place during the daytime, and the fish rarely gather in schools, preferring to hunt alone. No information on stock structure is currently available in the Indian Ocean; thus for the purposes of assessment, one pan-ocean stock is assumed. However, spatial heterogeneity in stock indicators (catch–per–unit–effort trends) for other billfish species indicates that there is potential for localised depletion.
Longevity	~28 years; Females n.a; Males n.a.
Maturity (50%)	**Age**: 2–4 years; females n.a. males n.a. **Size:** females ~50 cm lower-jaw FL (55 kgs whole weight); males ~80 cm lower-jaw FL (40 kgs total weight).
Spawning season	No spawning grounds have been identified in the Indian ocean. Females may produce up to 10 million eggs. In the Pacific ocean, Indo-Pacific blue marlin are thought to spawn between May and September off the coast of Japan.
Size (length and weight)	Maximum: Females 430 cm FL; 910 kgs whole weight; males 300 cm FL; 200 kgs whole weight. Young fish grow very quickly in length then put on weight later in life. Sexual dimorphism in size, growth rates and size and age at maturity—females reach larger sizes, grow faster and mature later than males.

n.a. = not available. SOURCES: Nakamura (1985); Cry et al. (1990); Shimose et al. (2008); Froese & Pauly (2009)

Catch trends

Indo-Pacific blue marlin are caught mainly under drifting longlines (60%) and gillnets (30%) with remaining catches recorded under troll and hand lines (Fig. 1). Indo-Pacific blue marlins are considered to be a bycatch of industrial and artisanal fisheries. The catches of Indo-Pacific blue marlin are typically higher than those of black marlin and striped marlin combined. In recent years, the fleets of Taiwan,China (longline), Indonesia (longline), Sri Lanka (gillnet) and India (gillnet) are attributed with the highest catches of Indo-Pacific blue marlin (Fig. 2). The distribution of Indo-Pacific blue marlin catches has changed since the 1980’s with most of the catch now taken in the western areas of the Indian Ocean.

Catch trends for Indo-Pacific blue marlin are variable; however, this may reflect the level of reporting. The catches of Indo-Pacific blue marlin under drifting longlines were more or less stable until the mid-80’s, at around 3,000 t, steadily increasing since then. The largest catches were recorded in 1997 (~14,000 t). Catches under drifting longlines have been recorded under Taiwan,China and Japan fleets and, recently, Indonesia and several NEI fleets (Fig. 2). In recent years, deep-freezing longliners from Japan and Taiwan,China have reported most of the catches of Indo-Pacific blue marlin in waters of the western and central tropical Indian Ocean and, to a lesser extent, the Mozambique Channel and the Arabian Sea (Fig. 3).

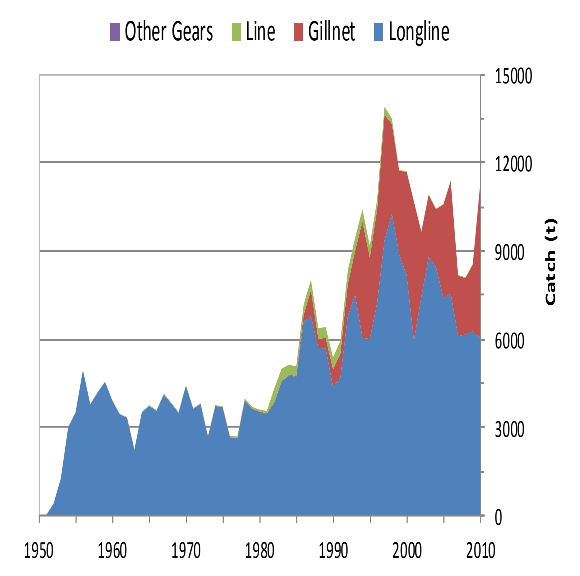


Fig. 1. Catches of Indo-Pacific blue marlin per gear and year recorded in the IOTC Database (1960–2010).

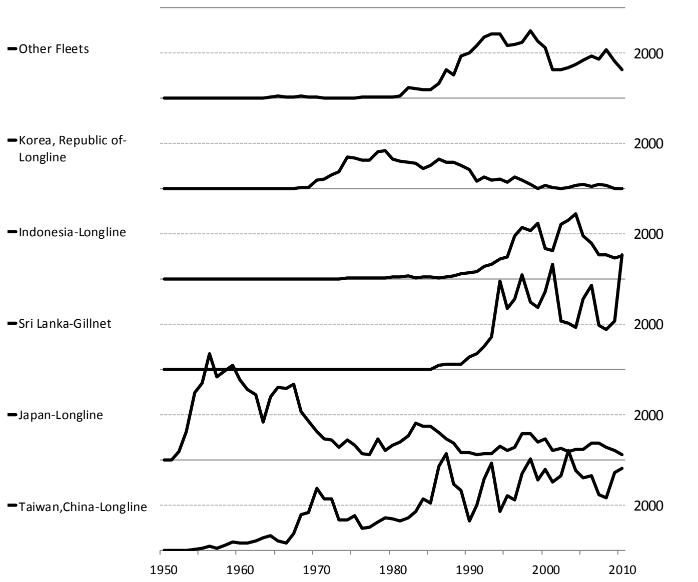


Fig. 2. Catches of Indo-Pacific blue marlin by fleet recorded in the IOTC Database (1960–2010).

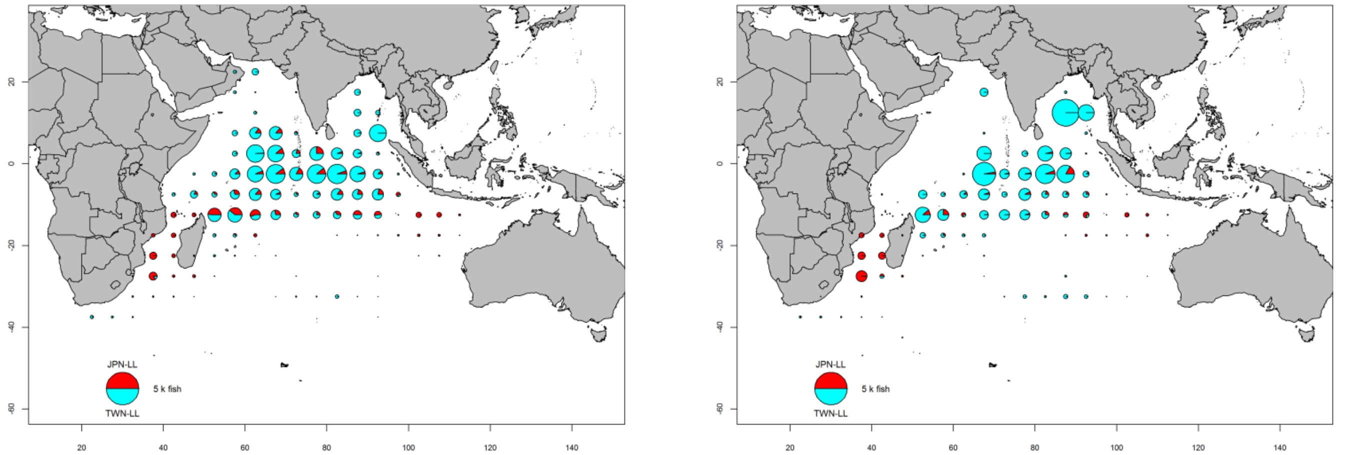


Fig. 3a–b. Time-area catches (in number of fish) of Indo-Pacific blue marlin as reported for the longline (LL) fisheries of Japan (JPN) and Taiwan,China (TWN) for 2009 and 2010 by fleet.

TABLE 3. Best scientific estimates of the catches of Indo-Pacific blue marlin by type of fishery for the period 1950–2010 (in metric tonnes). Data as of October 2011.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Longline	2,563	3,512	3,474	4,961	7,119	8,184	5,949	7,441	8,791	8,457	7,400	7,550	6,106	6,163	6,267	6,043
Gillnet	3	4	10	194	2,407	3,524	4,732	2,219	2,124	1,972	3,188	3,842	2,059	1,921	2,276	5,193
Line	11	23	34	313	341	27	27	26	25	24	17	21	25	26	23	25
Other	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**2,576**	**3,539**	**3,518**	**5,467**	**9,868**	**11,735**	**10,709**	**9,686**	**10,940**	**10,452**	**10,605**	**11,413**	**8,189**	**8,110**	**8,566**	**11,261**

Uncertainty of time–area catches

Minimum catch estimates have been derived from very small amounts of information and are therefore highly uncertain. Difficulties in the identification of marlins also contribute to the uncertainties of the information available to the Secretariat.

Retained catches are poorly known for most fisheries (Fig. 4) due to:

- catch reports often refer to total catches of all three marlin species combined; catches by species are estimated by the Secretariat for some artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, Iran and Pakistan) and industrial (longliners of Indonesia and Philippines) fisheries
- catches of non-reporting industrial longliners (India, NEI) and the gillnet fishery of Indonesia are estimated by the Secretariat using alternative information
- catches are likely to be incomplete for industrial fisheries for which the Indo-Pacific blue marlin is not a target species
- conflicting catch reports: Longline catches from the Republic of Korea are reported as nominal catches, and catch and effort reports are conflicting, with higher catches recorded in the catch and effort table. For this reason, the Secretariat revised the catches of blue marlin for the Republic of Korea over the time-series using both datasets. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of Indo-Pacific blue marlin remain uncertain for this fleet.
- a lack of catch data for most sport fisheries.
- discards are unknown for most industrial fisheries, mainly longliners. Discards of Indo-Pacific blue marlin may also occur in the driftnet fishery of I.R. Iran, as this species has no commercial value in this country.

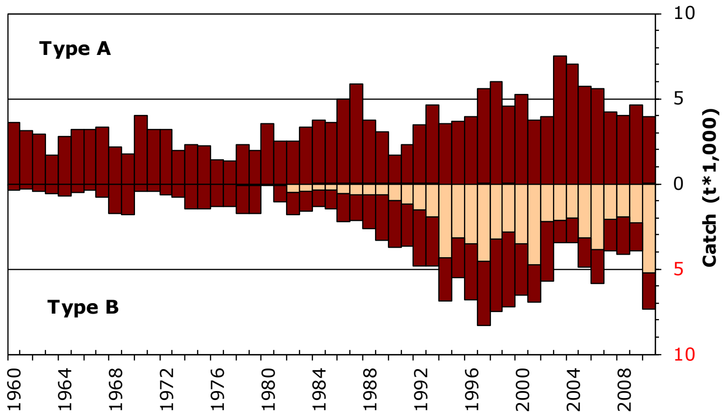


Fig. 4. Uncertainty of time-area catches for Indo-Pacific blue marlin (Data as of October 2011).
Catches below the zero-line (Type B) refer to fleets that do not report catch-and-effort data to the IOTC, do not report catch-and-effort data by gear and/or species or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid from 2007 to 2010 are provided in Fig. 5, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2007 to 2010 are provided in Fig. 6.

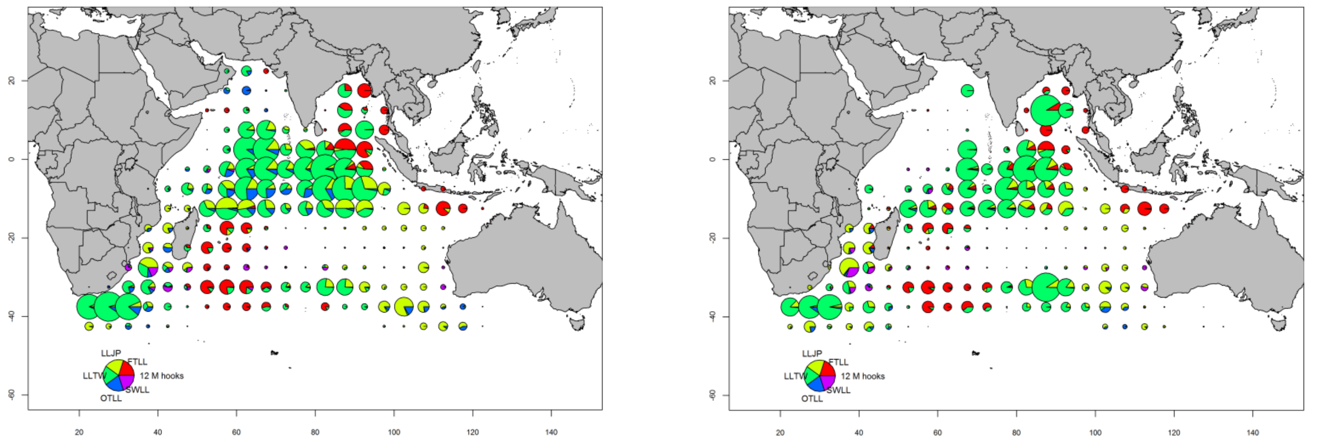


Fig. 5. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

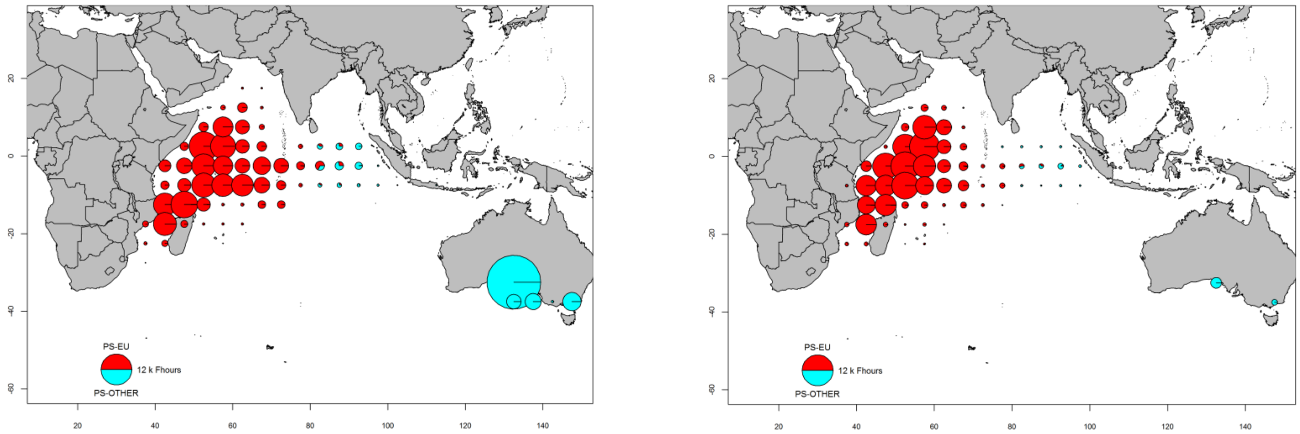


Fig. 6. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

Catch–per–unit–effort (CPUE) trends

A CPUE standardisation of Indo-Pacific blue marlin (*Makaira mazara*) caught by the Taiwan,China longline fishery in the Indian Ocean was considered in 2011. The results reveal similar trends of CPUE standardized based on three combinations of fishing areas definitions and data period.

The standardised CPUE for the whole Indian Ocean suggest that there was a decline in the early 1980s, followed by an increase in abundance over the last 20 years (Fig. 7). However, it was also noted that this contrasts with the majority of non-standardised indicators which suggest a decline in abundance since the 1980s (Figs. 8 and 9).

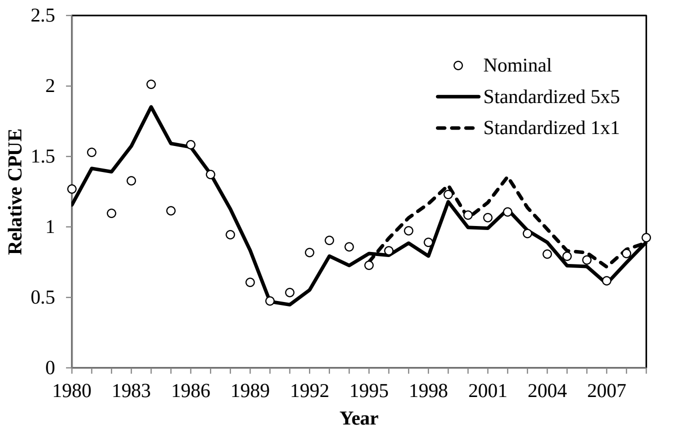


Fig. 7. Area-aggregated nominal and Standardised CPUE of Indo-Pacific blue marlin caught by Taiwan,China longline fleet based on four fishing areas.

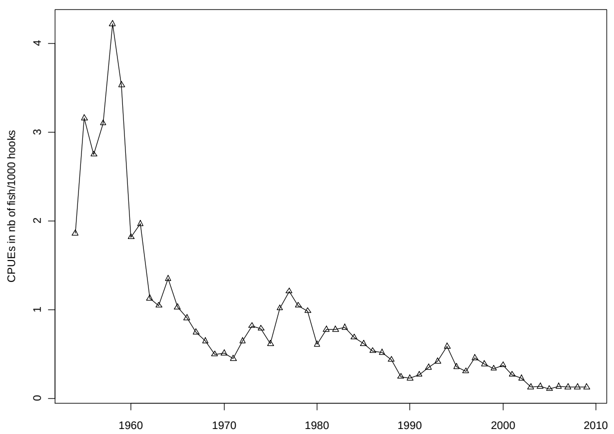


Fig. 8. Nominal CPUE (number of fish by 1,000 hooks) of Indo-Pacific blue marlin caught by Japanese longliners off-Somalia.

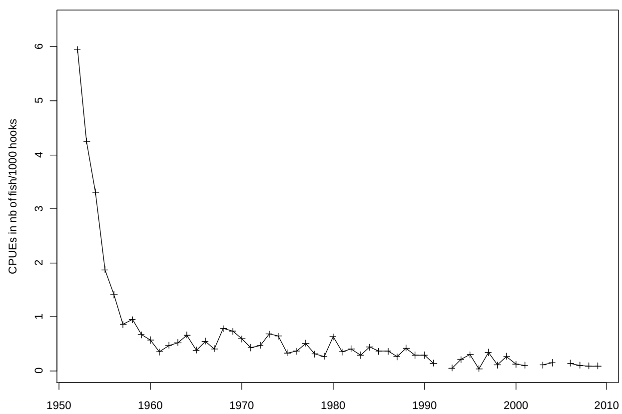


Fig. 9. Nominal CPUE (number of fish by 1,000 hooks) of Indo-Pacific blue marlin caught by Japanese longliners northwest Australia.

Fish size or age trends (e.g. by length, weight, sex and/or maturity)

Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. The number of specimens measured on Japanese longliners in recent years is, however, very low.

Catch-at-Size(Age) tables have not been built for Indo-Pacific blue marlin due to a lack of information reported by CPCs. Fish size is derived from various length and weight information, however the reliability of the size data is reduced when relatively few fish out of the total catch are measured.

Sex ratio data have not been provided to the Secretariat by CPCs.

STOCK ASSESSMENT

No quantitative stock assessment for Indo-Pacific blue marlin in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Billfish. However, a preliminary estimation of stock indicators was attempted on the longline catch and effort datasets from Japan and Taiwan,China that represent the best available information (described above). However, there is considerable uncertainty about the degree to which these indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Blue marlin (*Makaira mazara*) stock status summary.

Management Quantity	Aggregate Indian Ocean
2010 catch estimate	11,300 t
Mean catch from 2006–2010	9,500 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2010}/F_{MSY} (80% CI)	–
B_{2010}/B_{MSY} (80% CI)	–
SB_{2010}/SB_{MSY}	–
B_{2010}/B_{1980} (80% CI)	–
SB_{2010}/SB_{1980}	–
$B_{2010}/B_{1980,\ F=0}$	–
$SB_{2010}/SB_{1980,\ F=0}$	–

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Froese R & Pauly DE, 2009.FishBase, version 02/2009, FishBase Consortium, <www.fishbase.org>.

Kleiber P, Hinton MG & Uozumi Y, 2003. Stock assessment of blue marlin (*Makaira nigricans*) in the Pacific using MULTIFAN-CL. Mar Freshw Res 54:349–360.

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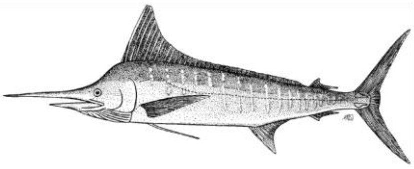
Shimose T, Fujita M, Yokawa K, Saito H and Tachihara K, 2008.Reproductive biology of blue marlin *Makaira nigricans* around Yonaguni Island, southwestern Japan. Fish Sci. 75: 109-119.

APPENDIX XXIII
EXECUTIVE SUMMARY: STRIPED MARLIN

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean Striped Marlin Resource (*Tetrapturus audax*)

TABLE 1. Status of striped marlin (*Tetrapturus audax*) in the Indian Ocean.

Area[1]	Indicators – 2011 assessment		2011 stock status determination 2010[2]
Indian Ocean	Catch 2010:	1,921 t	Uncertain
	Average catch 2006–2010:	2,542 t	
	MSY (range):	unknown	
	F_{2010}/F_{MSY} (range):	unknown	
	SB_{2010}/SB_{MSY} (range):	unknown	
	SB_{2010}/SB_0 (range):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]The stock status refers to the most recent years' data used for the assessment.

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No quantitative stock assessment is currently available for striped marlin in the Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock indicators can be used. Therefore stock status remains *uncertain* (Table 1). However, aspects of the biology, productivity and fisheries for this species combined with the lack of data on which to base a more formal assessment are a cause for considerable concern. Research emphasis on improving indicators and exploration of stock assessment approaches for data poor fisheries are warranted.

Outlook. The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource.

The Scientific Committee considers the following:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches of striped marlin urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Billfish and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Striped marlin (*Tetrapturus audax*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

Striped marlin (*Tetrapturus audax*) is a large oceanic apex predator that inhabits tropical and subtropical Indo-Pacific oceans. Table 2 outlines some key life history parameters relevant for management. There is limited reliable information on the catches of this species and no information on the stock structure or growth and mortality in the Indian Ocean.

TABLE 2. Biology of Indian Ocean striped marlin (*Tetrapturus audax*).

Parameter	**Description**
Range and stock structure	A large oceanic apex predator that inhabits sub-tropical waters of the Indian and Pacific oceans, and is rarely found in the Atlantic Ocean. Its distribution is different from other marlins in that it prefers more temperate or cooler waters and tends to be less migratory. In the Indian Ocean seasonal concentrations of striped marlin occur in four main regions: off the east African coast (0º-10ºS), the south and western Arabian Sea, the Bay of Bengal, and north-western Australian waters. The stock structure of striped marlin in the Indian Oceans is uncertain.
Longevity	~10 years. Females and males n.a.
Maturity (50%)	**Age**: 2–3 years. Females and males n.a.
Spawning season	Highly fecund batch spawner. Females may produce up to 20 million eggs. Unlike the other marlins which are serial spawners, striped marlin appear to spawn once per season.
Size (length and weight)	Maximum: 300+ cm FL; 240 kg total weight. Young fish grow very quickly in length then put on weight later in life. Striped marlin is the smallest of the marlin species; but unlike the other marlin species, striped marlin males and females grow to a similar size.

n.a. = not available. SOURCES: Nakamura (1985); Froese & Pauly (2009).

Catch trends

Striped marlin are caught almost exclusively under drifting longlines (98%) with remaining catches recorded under gillnets and troll lines (Fig. 1). Striped marlin are generally considered to be a bycatch of industrial fisheries. Catch trends for striped marlin are variable; however, this may reflect the level of reporting. The catches of striped marlin under drifting longlines have been changing over time, between 2,000 t and 8,000 t (Fig. 1).

Catches under drifting longlines have been recorded under Taiwan,China, Japan, Republic of Korea fleets and, recently, Indonesia and several NEI fleets (Fig. 2). Taiwan,China and Japan have reported large drops in the catches of striped marlin for its longline fleets in recent years. The reason for such decreases in catches is not fully understood. Between the early-50s and the late-80s part of the Japanese fleet was licensed to operate within the EEZ of Australia, reporting relatively high catches of striped marlin in the area, in particular in waters off northwest Australia. High catches of the species were also reported in the Bay of Bengal during this period, by both Taiwan,China and Japanese longliners. The distribution of striped marlin catches has changed since the 1980's with most of the catch now taken in the western areas of the Indian Ocean. In recent years, the fleets of Taiwan,China (longline) and to a lesser extent Indonesia (longline) are attributed with the highest catches of striped marlin.

In recent years, deep-freezing longliners from Japan and Taiwan,China have reported lower catches of striped marlin, mostly in the northwest Indian Ocean (Fig. 3). The minimum average annual catch estimated for the period 2006 to 2010 is around 2,542 t. These changes of fishing area and catches over the years are thought to be related to changes in the type of access agreements to EEZs of coastal countries in the Indian Ocean, rather than changes in the distribution of the species over time. Discards are believed to be low although they are unknown for most industrial fisheries, mainly longliners. Discards of striped marlin may also occur in the driftnet fishery of the I.R of Iran, as this species has no commercial value in this country.

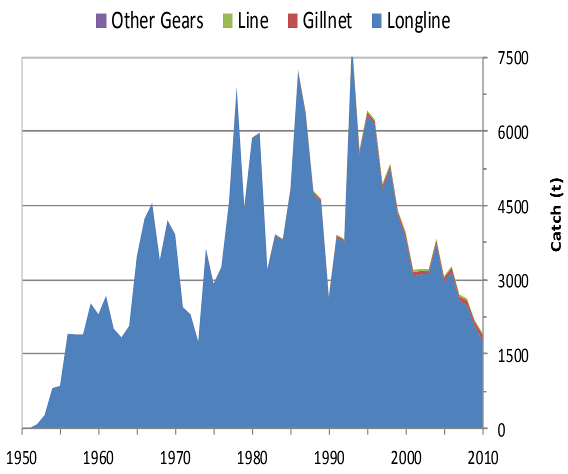


Fig. 1. Catches of striped marlin per gear and year recorded in the IOTC Database (1960–2010).

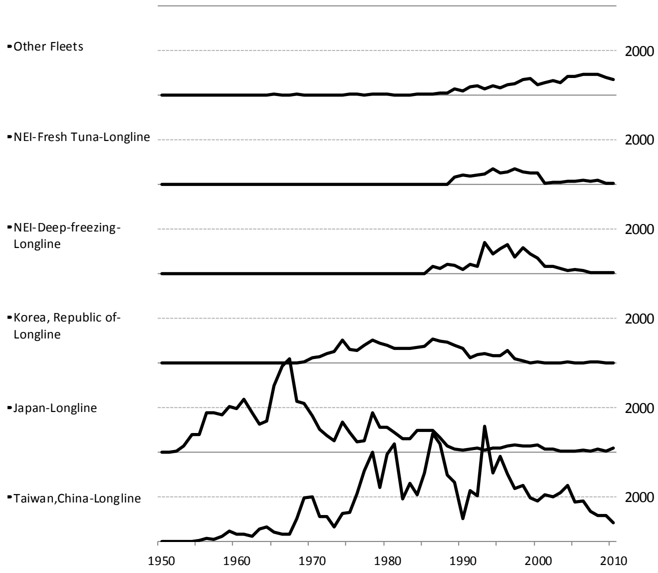


Fig. 2. Catches of striped marlin by fleet recorded in the IOTC Database (1960–2010).

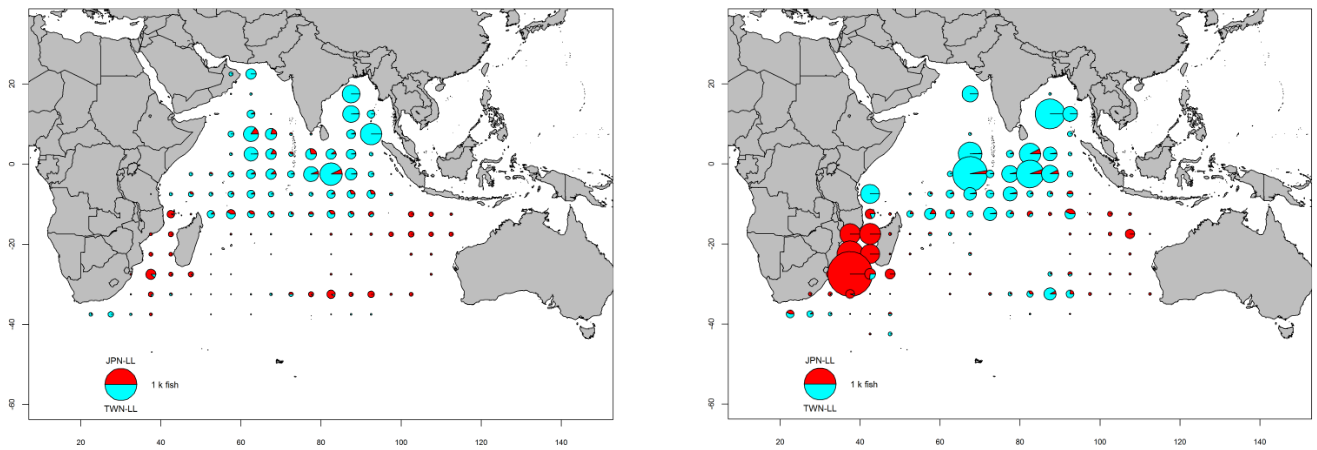


Fig. 3a–b. Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2009 and 2010 by fleet.

TABLE 3. Best scientific estimates of the catches of striped marlin by type of fishery for the period 1950–2010 (in metric tonnes). Data as of October 2011.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Longline	1,024	3,077	3,614	5,042	5,040	3,849	3,069	3,112	3,115	3,730	2,966	3,153	2,582	2,485	2,057	1,773
Gillnet	2	3	6	25	60	83	92	65	66	75	78	89	81	96	96	120
Line	0	0	1	11	35	44	46	38	38	35	36	36	41	41	29	29
Other	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0
Total	**1,026**	**30,80**	**3,625**	**5,079**	**5,135**	**3,975**	**3,207**	**3,216**	**3,219**	**3,839**	**3,079**	**3,279**	**2,705**	**2,622**	**2,182**	**1,921**

Uncertainty of time–area catches

Retained catches are reasonably well known (Fig. 4) although they remain uncertain for some fleets:

- Catch reports refer to total catches of all three marlin species; catches by species have to be estimated by the IOTC Secretariat for some industrial fisheries (longliners of Indonesia and Philippines).
- Catches of non-reporting industrial longliners (India, NEI) estimated by the IOTC Secretariat using alternative information. As they are not reported by the countries concerned, catches are likely to be incomplete for some industrial fisheries for which the striped marlin is seldom the target species.

- Conflicting catch reports: The catches for longliners flagged to the Republic of Korea, reported as nominal catches and catches and effort, are conflicting with higher catches recorded in the catch and effort table. For this reason, the IOTC Secretariat revised the catches of striped marlin over the time-series using both datasets. Although the new catches estimated by the IOTC Secretariat are thought to be more accurate, catches of striped marlin remain uncertain for this fleet.

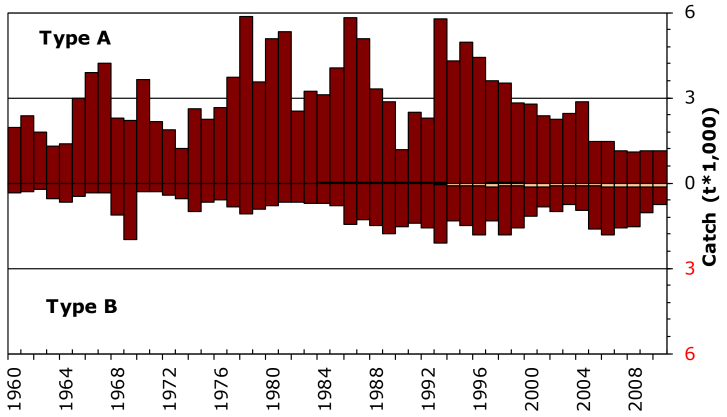


Fig. 4. Uncertainty of time-area catches for striped marlin (Data as of October 2011).
Catches below the zero-line (Type B) refer to fleets that do not report catch-and-effort data to the IOTC, do not report catch-and-effort data by gear and/or species or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid from 2007 to 2010 are provided in Fig. 5, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2007 to 2010 are provided in Fig. 6.

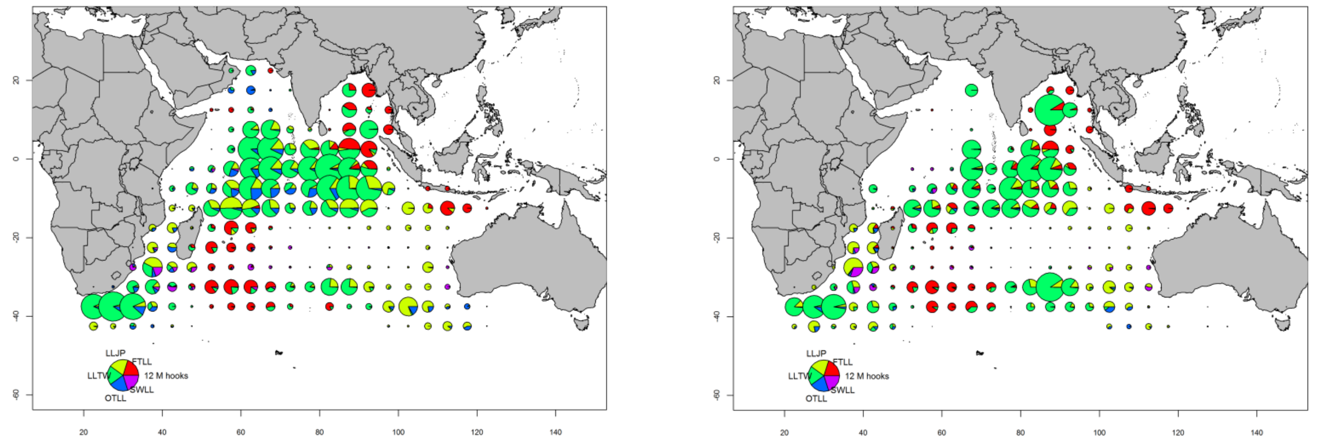


Fig. 5. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

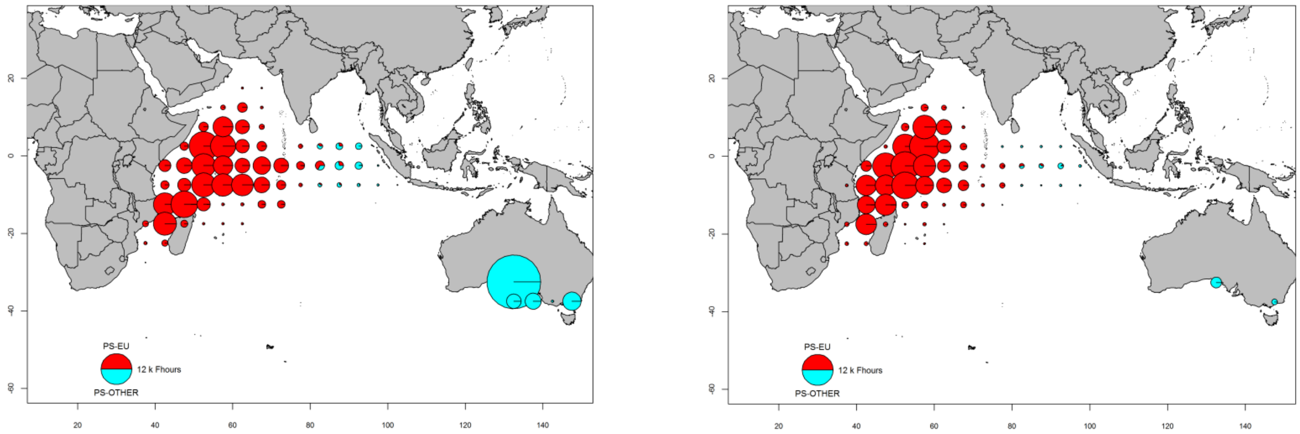


Fig. 6. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

Catch–per–unit–effort (CPUE) trends

Standardised CPUE series have not yet been developed. Nominal CPUE series are however available from some industrial longline fisheries (primarily the Japanese longline fleet; Figs. 7 and 8) although catches are thought to be incomplete (catches of non-target species are not always recorded in logbooks). No catch and effort data are available from sports fisheries, other than for partial data from the sports fisheries of Kenya; or other artisanal (gillnet fisheries of I.R. Iran and Pakistan, gillnet/longlines of Sri Lanka, gillnets of Indonesia) or industrial fisheries (NEI longliners and all purse seiners).

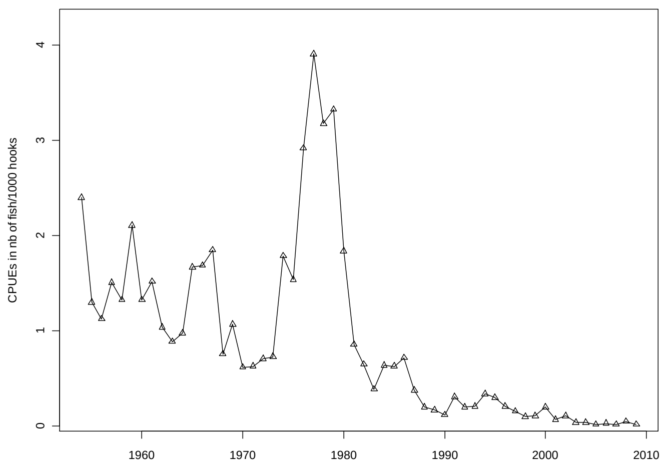


Fig. 7. Nominal CPUE (number of fish by 1,000 hooks) of striped marlin caught by Japanese longliners off-Somalia.

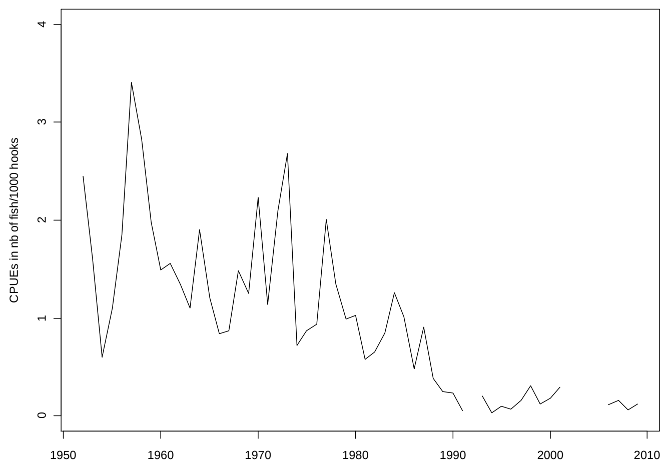


Fig. 8. Nominal CPUE (number of fish by 1,000 hooks) of striped marlin caught by Japanese longliners northwest Australia.

Fish size or age trends (e.g. by length, weight, sex and/or maturity)

Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. The number of specimens measured on Japanese longliners in recent years is, however, very low.

Catch-at-Size(Age) tables have not been built for this species due to a lack of information reported by CPCs. Fish size is derived from various length and weight information, however the reliability of the size data is reduced when relatively few fish out of the total catch are measured.

Sex ratio data have not been provided to the Secretariat by CPCs.

STOCK ASSESSMENT

No quantitative stock assessment for striped marlin in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Billfish. However, a preliminary estimation of stock indicators was attempted on the longline catch and effort datasets from Japan and Taiwan,China that represent the best available information. Nominal CPUE exhibited declines since the beginning of the fishery in two major fishing grounds (West Equatorial and north-west Australia) (Figs. 7 and 8) and catches in the initial core areas have also decreased substantially. However, there is considerable uncertainty about the degree to which these indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Striped marlin (*Tetrapturus audax*) stock status summary.

Management Quantity	**Aggregate Indian Ocean**
2010 catch estimate	1,900
Mean catch from 2006–2010	2,500
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2010}/F_{MSY} (80% CI)	–
B_{2010}/B_{MSY} (80% CI)	–
SB_{2010}/SB_{MSY}	–
B_{2010}/B_{1980} (80% CI)	–
SB_{2010}/SB_{1980}	–
$B_{2010}/B_{1980, F=0}$	–
$SB_{2010}/SB_{1980, F=0}$	–

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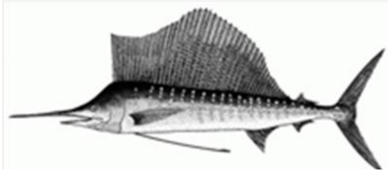
Nakamura I, 1985. FAO species catalogue. Billfish of the world. An annotated and illustrated catalogue of marlins, sailfishes, spearfishes, and swordfishes known to date. FAO Fish. Synop. 125(5), 65 p.

APPENDIX XXIV
EXECUTIVE SUMMARY: INDO-PACIFIC SAILFISH

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean Indo-Pacific Sailfish Resource (*Istiophorus platypterus*)

TABLE 1. Status of Indo-Pacific sailfish (*Istiophorus platypterus*) in the Indian Ocean.

Area[1]	Indicators – 2011 assessment		2011 stock status determination 2010[2]
Indian Ocean	Catch 2010:	25,498 t	Uncertain
	Average catch 2006–2010:	22,151 t	
	MSY (range):	unknown	
	F_{2010}/F_{MSY} (range):	unknown	
	SB_{2010}/SB_{MSY} (range):	unknown	
	SB_{2010}/SB_0 (range):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]The stock status refers to the most recent years' data used for the assessment.

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No quantitative stock assessment is currently available for Indo-Pacific sailfish in the Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock indicators can be used. Therefore stock status remains *uncertain* (Table 1). However, aspects of the biology, productivity and fisheries for this species combined with the lack of data on which to base a more formal assessment are a cause for considerable concern. Research emphasis on improving indicators and exploration of stock assessment approaches for data poor fisheries are warranted.

Outlook. The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource.

The Scientific Committee considers the following:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches of Indo-Pacific sailfish urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Billfish and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Indo-Pacific sailfish (*Istiophorus platypterus*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

Indo-Pacific sailfish (*Istiophorus platypterus*) is a large oceanic apex predator that inhabits tropical and subtropical Indo-Pacific oceans. Table 2 outlines some key life history parameters relevant for management. There is limited reliable information on the catches of this species and no information on the stock structure or growth and mortality in the Indian Ocean.

TABLE 2. Biology of Indian Ocean Indo-Pacific sailfish (*Istiophorus platypterus*).

Parameter	**Description**
Range and stock structure	Found throughout the tropical and subtropical regions of the Pacific and the Indian Oceans. It is mainly found in surface waters above the thermocline, close to coasts and islands in depths from 0 to 200 m. Indo–Pacific sailfish is a highly migratory species and renowned for its speed and (by recreational fishers) for its jumping behaviour — one individual has been reported swimming at speeds in excess of 110 km/h over short periods. The stock structure of Indo-Pacific sailfish in the Indian Oceans is uncertain. No information on stock structure is currently available in the Indian Ocean; thus for the purposes of assessment, one pan-ocean stock is assumed. However, spatial heterogeneity in stock indicators (catch–per–unit–effort trends) for other billfish species indicates that there is potential for localised depletion.
Longevity	Females: 11–13 years; Males: 7–8 years
Maturity (50%)	**Age**: females n.a.; males n.a. **Size**: females n.a.; males n.a.
Spawning season	Spawning in Indian waters occurs between December to June with a peak in February and June.
Size (length and weight)	Maximum: 350 cm FL and weight 100 kg total weight. The Indo-Pacific sailfish is one of the smallest-sized billfish species, but is relatively fast growing. Individuals may grow to over 3 m and up to 100kg, and live to around 7 years. Young fish grow very quickly in length then put on weight later in life. Sexual dimorphism in size, growth rates and size and age at maturity—females reach larger sizes, grow faster and mature later than males. Females: 300 cm lower-jaw FL, 50+ kg total weight; Males: 200 cm lower-jaw FL, 40+ kg total weight in the Indian Ocean. Recruitment into the fishery: varies by fishing method. The average weight of fish caught in the Kenyan sports fishery is ~25 kgs whole weight.

n.a. = not available. SOURCES: Nakamura (1985); Speare (2003); Hoolihan (2006); Sun et al. (2007); Froese & Pauly (2009); Ndegwa & Herrera (2011)

Catch trends

Indo-Pacific sailfish is caught mainly under gillnets (78%) with remaining catches recorded under troll and hand lines (15%), longlines (7%) or other gears (Fig. 1). The minimum average annual catch estimated for the period 2006 to 2010 is around 22,151 t. In recent years, the countries attributed with the highest catches of Indo-Pacific sailfish are situated in the Arabian Sea (India, Iran, Pakistan and Sri Lanka). Smaller catches are reported for line fishers in Comoros and Mauritius and by Indonesia longliners. This species is also a popular catch for sport fisheries (e.g. Kenya, Mauritius, Seychelles).

Catches of Indo-Pacific sailfish greatly increased since the mid-1980’s in response to the development of a gillnet/longline fishery in Sri Lanka (Fig. 2) and, especially, the extension in the area of operation of Iranian gillnet vessels to areas beyond the EEZ of I.R. Iran. The catches of Iranian gillnets (Fig. 2) increased dramatically, more than six-fold, after the late 1990’s, from the values averaging 2,000 t in the late 1980’s to a maximum of 12,600 t in 2005.

Catches of Indo-Pacific sailfish under drifting longlines and other gears do not show any specific trends in recent years, with total catches amounting to about 5,000 t. However, it is likely that longline fleets under report catches of this species due to its little commercial value. In recent years, deep-freezing longliners from Japan have reported catches of Indo-Pacific sailfish in the central western Indian Ocean, between Sri Lanka and the Maldives and the Mozambique Channel (Fig. 3).

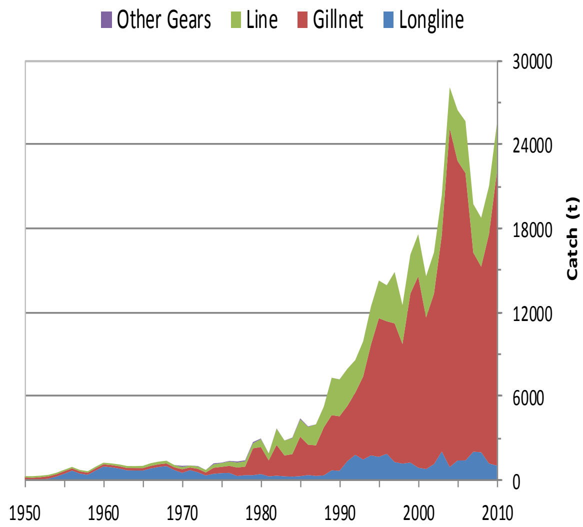


Fig. 1. Catches of Indo-Pacific sailfish per gear and year recorded in the IOTC Database (1960–2010).

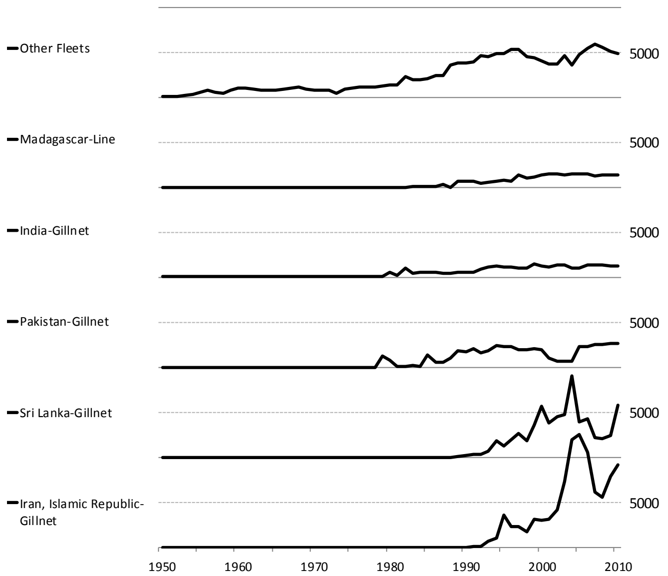


Fig. 2. Catches of Indo-Pacific sailfish by fleet recorded in the IOTC Database (1960–2010).

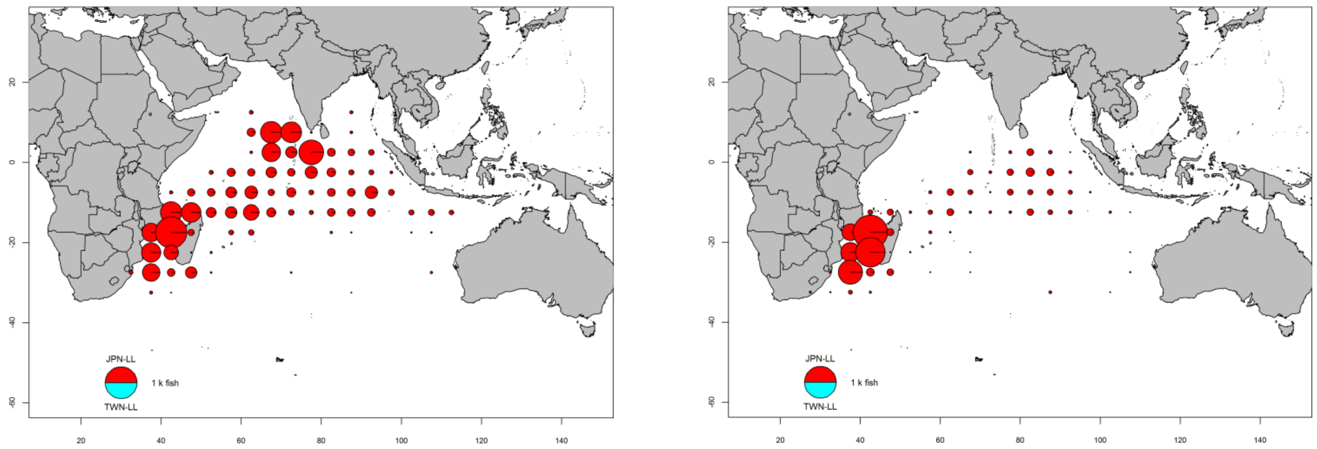


Fig. 3a–b. Time-area catches (in number of fish) of Indo-Pacific sailfish as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2009 and 2010 by fleet.

TABLE 3. Best scientific estimates of the catches of Indo-Pacific sailfish by type of fishery for the period 1950–2009 (in metric tonnes). Data as of October 2011.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Longline	299	819	450	343	1425	876	785	1,135	2,035	926	1,393	1,399	2,021	1,985	1,176	1,032
Gillnet	164	176	544	2,296	7,621	13,708	10,849	12,197	15,525	24,246	21,453	20,572	14,254	13,285	16,441	21,034
Line	106	155	259	1,260	2,739	3,010	2,947	2,954	2,842	2,947	3,635	3,714	3,474	3,500	3,427	3,429
Other	1	1	50	25	3	2	2	2	2	2	2	2	2	2	2	2
Total	**570**	**1,151**	**1,302**	**3,924**	**11,787**	**17,596**	**14,583**	**16,288**	**20,404**	**28,120**	**26,482**	**25,687**	**19,751**	**18,773**	**21,047**	**25,498**

Uncertainty of time–area catches

Minimum catch estimates have been derived from very small amounts of information and are therefore highly uncertain. Unlike the other billfish, Indo-Pacific sailfish are probably more reliably identified because of the large and distinctive first dorsal fin that runs most of the length of the body.

Retained catches are poorly known for most fisheries (Fig. 4) due to:

- Catch reports often refer to total catches of all three marlin species combined; catches by species are estimated by the Secretariat for some artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, Iran and Pakistan) and industrial (longliners of Indonesia and Philippines) fisheries.
- Catches likely to be incomplete for some artisanal fisheries (gillnets of Pakistan, pole and lines of Maldives) due to under-reporting.
- Catches are likely to be incomplete for industrial fisheries for which the Indo-Pacific sailfish is not a target species.
- A lack of catch data for most sport fisheries.
- Changes to the catch series: There have not been significant changes to the catches of Indo-Pacific sailfish since 2010. The changes recorded in recent years originated in a review (by the Secretariat) of the catches reported by Indonesia, resulting in catches slightly lower than those reported by Indonesia.
- Discards are unknown for most industrial fisheries, mainly longliners (for which they are presumed to be moderate-high).

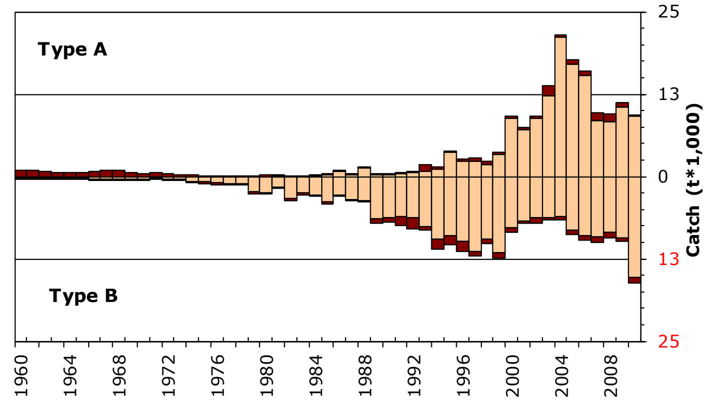


Fig. 4. Uncertainty of time-area catches for Indo-Pacific sailfish (Data as of October 2011).
Catches below the zero-line (Type B) refer to fleets that do not report catch-and-effort data to the IOTC, do not report catch-and-effort data by gear and/or species or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid from 2007 to 2010 are provided in Fig. 5, and total effort from purse seine vessles flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2007 to 2010 are provided in Fig. 6.

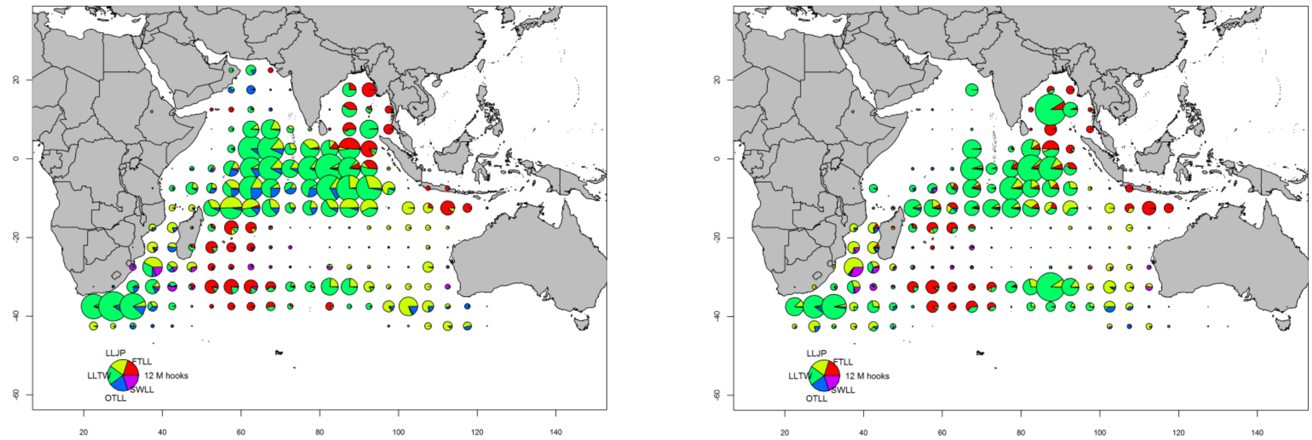


Fig. 5. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

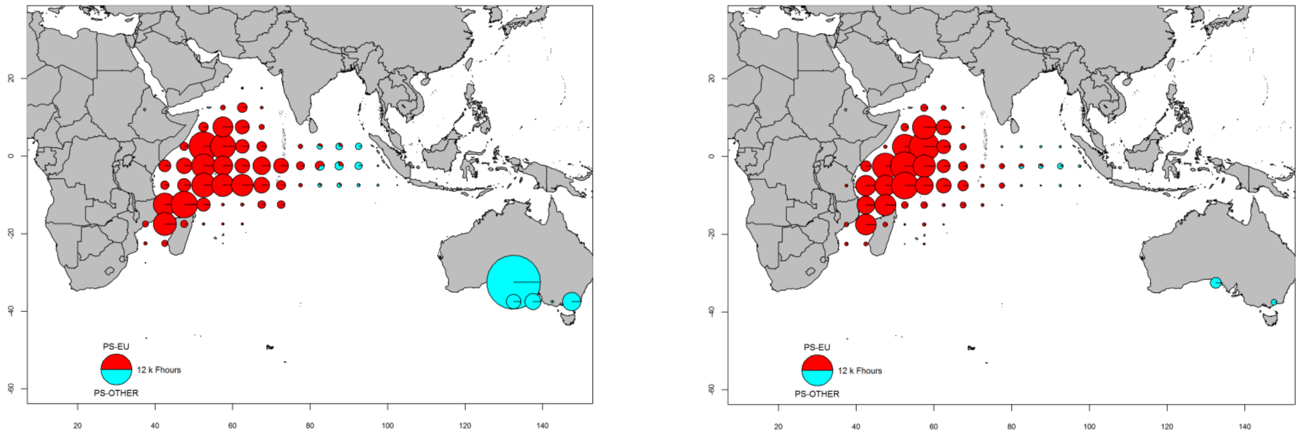


Fig. 6. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

Catch–per–unit–effort (CPUE) trends

Standardised and nominal CPUE series have not yet been developed. No catch and effort data are available from sports fisheries, other than for partial data from the sports fisheries of Kenya; or other artisanal (gillnet fisheries of I.R. Iran and Pakistan, gillnet/longlines of Sri Lanka, gillnets of Indonesia) or industrial fisheries (NEI longliners and all purse seiners).

Fish size or age trends (e.g. by length, weight, sex and/or maturity)

Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. The number of specimens measured on Japanese longliners in recent years is, however, very low. Furthermore, the specimens discarded might be not accounted for in industrial fisheries, where they are presumed to be of lower size (possible bias of existing samples).

Catch-at-Size(Age) tables have not been built for this species due to a lack of information reported by CPCs. Fish size is derived from various length and weight information, however the reliability of the size data is reduced when relatively few fish out of the total catch are measured.

Sex ratio data have not been provided to the Secretariat by CPCs.

STOCK ASSESSMENT

No quantitative stock assessment for striped marlin in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Billfish. However, a preliminary estimation of stock indicators was attempted on the longline catch and effort datasets from Japan and Taiwan,China that represent the best available information. Nominal CPUE exhibited declines since the beginning of the fishery in two major fishing grounds (West Equatorial and north-west Australia) (Figs. 7 and 8) and catches in the initial core areas have also decreased substantially. However, there is considerable uncertainty about the degree to which these indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Indo-Pacific sailfish (*Istiophorus platypterus*) stock status summary.

Management Quantity	Aggregate Indian Ocean
2010 catch estimate	25,500 t
Mean catch from 2006–2010	22,200 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2010}/F_{MSY} (80% CI)	–
B_{2010}/B_{MSY} (80% CI)	–
SB_{2010}/SB_{MSY}	–
B_{2010}/B_{1980} (80% CI)	–

SB_{2010}/SB_{1980}	–
$B_{2010}/B_{1980,\ F=0}$	–
$SB_{2010}/SB_{1980,\ F=0}$	–

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APPENDIX XXV
EXECUTIVE SUMMARY: MARINE TURTLES

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
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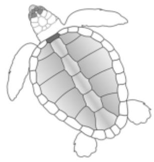

Status of Indian Ocean Marine Turtles

TABLE 1. IUCN threat status for all marine turtle species reported as caught in fisheries within the IOTC area of competence.

Common name	Scientific name	IUCN threat status[2]
Flatback turtle	*Natatordepressus*	Data deficient
Green turtle	*Cheloniamydas*	Endangered
Hawksbill turtle	*Eretmochelysimbricata*	Critically Endangered
Leatherback turtle	*Dermochelyscoriacea*	Critically Endangered
Loggerhead turtle	*Carettacaretta*	Endangered
Olive ridley turtle	*Lepidochelysolivacea*	Vulnerable

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No assessment has been undertaken by the IOTC WPEB for marine turtles due to the lack of data being submitted by CPCs. However, the current International Union for Conservation of Nature (IUCN) threat status for each of the marine turtle species reported as caught in IOTC fisheries to date is provided in Table 1. It is important to note that a number of international global environmental accords (e.g. Convention on Migratory Species (CMS), Convention on Biological Diversity (CBD)), as well as numerous fisheries agreements obligate States to provide protection for these species. While the status of marine turtles is affected by a range of factors such as degradation of nesting beaches and targeted harvesting of eggs and turtles, the level of mortality of marine turtles due to capture by gillnets and to a lesser extent purse seine fishing and longline is not known.

Outlook.Resolution 09/06 *on marine turtles* includes an evaluation requirement (para. 9) by the Scientific Committee in time for the 2011 meeting of the Commission (para.10). However, given the lack of reporting of marine turtle interactions by CPCs to date, such an evaluation was not able to be undertaken. Unless IOTC CPCs become compliant with the data collection and reporting requirements for marine turtles, the WPEB will continue to be unable to address this issue. Notwithstanding this, it is acknowledged that the impact on marine turtle populations from fishing for tuna and tuna-like species may increase if fishing pressure increases, or if the status of the marine turtle populations worsens due to other factors such as an increase in fishing pressure from other fisheries or anthropological or climatic impacts.

The SC **RECOMMENDED** the following:

- The available evidence indicates considerable risk to the status of marine turtles in the Indian Ocean.
- The primary source of data that drive the ability of the WPEB to determination a status for the Indian Ocean, total interactions by fishing vessels, is highly uncertain and should be addressed as a matter of priority.
- Current reported interactionsare a known to be a severe underestimate: 7 interactions reported in 2009.
- Maintaining or increasing effort in the Indian Ocean without appropriate mitigation measures in place, will likely result in further declines in biomass.
- That appropriate mechanisms are developed by the Compliance Commission to ensure CPCs comply with their data collection and reporting requirements for marine turtles.

[2] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Marine turtles in the Indian Ocean are currently subject to a number of conservation and management measures adopted by the Commission:

- Resolution 09/06 *On marine turtles*recognizes the threatened status of the populations of the six marine turtle species found in the Indian Ocean and that some tuna fishing operations carried out in the Indian Ocean can adversely impact marine turtles. This resolution makes mandatory the collection and provision of data on marine turtle interactions and the use of best handling practices to ensure the best chances of survival for any marine turtles returned to the sea after capture.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on marine turtle interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010, and aims to collect scientific observer data on catch and bycatch on, at least, 5% of the fishing operations of vessel over 24m and vessel under 24m fishing outside their EEZ. The requirement under Resolution 11/04 in conjunction with the reporting requirements under Resolution 09/06, means that all CPCs should be reporting marine turtle interactions as part of their annual report to the Scientific Committee.

Extracts from Resolutions 09/06 and 11/04

RESOLUTION 09/06 ON MARINE TURTLES

2. CPCs shall collect (including through logbooks and observer programs) and provide to the Scientific Committee all data on their vesselsinteractions with marine turtles in fisheries targeting the species covered by the IOTC Agreement. CPC shall also furnish available information to the Scientific Committee on successful mitigation measures and other impacts on marine turtles in the IOTC Area, such as the deterioration of nesting sites and swallowing of marine debris.

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency;

INDICATORS

Biology and ecology

Six species of marine turtles inhabit the Indian Ocean and likely interact with the fisheries for tuna and tuna-like species. The following section outlines some key aspects of their biology, distribution and historical exploitation.

Green turtle

The green turtle (*Cheloniamydas*) is the largest of all the hard-shelled marine turtles and is one of the most widely distributed and commonest of the marine turtle species in the Indian Ocean. The Indian Ocean hosts some of the largest nesting populations of green turtles in the world, particularly on oceanic islands in the southwest Indian Ocean and on islands in South East Asia. Many of these populations are now recovering after intense exploitation in the last century greatly reduced the populations; some populations are still declining.

During the 19th and 20thcenturies intense exploitation of green turtles provided onboard red meat for sustained cruises of sailing vessels before the time of refrigeration, as well as meat and calipee (i.e. yellow glutinous/cartilage part of the turtle found next to the lower shell) for an international market. Several nesting populations in the Indian Ocean were devastated as a result. Table 2 outlines some of the key life history traits of green turtles.

TABLE 2. Biology of the green turtle (*Chelonia mydas*).

Parameter	Description
Range and stock structure	Globally distributed and generally found in tropical and subtropical waters along continental coasts and islands between 30°N and 30°S. Green turtles primarily use three types of habitat: oceanic beaches (for nesting), convergence zones in the open ocean, and benthic feeding grounds in coastal areas. Adults migrate from foraging areas to mainland or island nesting beaches and may travel hundreds or thousands of kilometers each way. After emerging from the nest, hatchlings swim offshore, where they are believed to caught up in major oceanic current systems and live for several years, feeding close to the surface on a variety of pelagic plants and animals. Once the juveniles reach a certain age/size range, they leave the pelagic habitat and travel to nearshore foraging grounds.Adult green turtles are unique among marine turtles in that they are herbivorous, feeding on seagrasses and algae.
Longevity	unknown
Maturity (50%)	Exact age is unknown, it is believed that sexual maturity is reached between 25 and 30+ years
Spawning season	Females return to their natal beaches (i.e. the same beaches where they were born) every 2 to 4 years to nest, laying several clutches of about 125 eggs at roughly 14-day intervals several times in a season. However, very few hatchlings survive to reach maturity – perhaps fewer than one in 1,000.
Size (length and weight)	The largest of all the hard-shelled marine turtles, growing up to one meter long and weighing 130-160 kg.

SOURCES: FAO (1990); Mortimer (1984)

Hawksbill turtle

The hawksbill turtle (*Eretmochelysimbricata*) is small to medium-sized compared to other marine turtle species and is although generally not found in large concentrations, are widely distributed in the Indian Ocean. The keratinous (horn-like) scutes of the hawksbill are known as “tortoise shell,” and they were sought after for manufacture of diverse articles in both the Orient and Europe. In modern times hawksbill turtles are solitary nesters (although some scientists postulate that before their populations were devastated they may have nested on some beaches in concentrations) and thus, determining population trends or estimates on nesting beaches is difficult. Decades long protection programs in some places, particularly at several beaches in the Indian Ocean, have resulted in population recovery. Table 3 outlines some of the key life history traits of hawksbill turtles.

TABLE 3. Biology of the hawksbill turtle (*Eretmochelysimbricata*).

Parameter	Description
Range and stock structure	Circumtropical, typically occurring from 30°N to 30°S latitude. Adult hawksbill turtles are capable of migrating long distances between nesting beaches and foraging areas, which are generally shorter to migrations of green and loggerhead turtles.Hawksbill turtles use different habitats at different stages of their life cycle, but are most commonly associated with coral reefs. Post-hatchlings (oceanic stage juveniles) are believed to occupy the pelagic environment. After a few years in the pelagic zone, small juveniles recruit to coastal foraging grounds. This shift in habitat also involves a shift in feeding strategies, from feeding primarily at the surface to feeding below the surface primarily on animals associated with coral reef environments. Their narrow, pointed beaks allow them to prey selectively on soft-bodied animals like sponges and soft corals.
Longevity	unknown
Maturity (50%)	unknown
Spawning season	Female hawksbill turtles return to their natal beaches every 2-3 years to nest. A female may lay 3-5, or more, nests in a season, which contain an average of 130 eggs.The largest nesting populations of hawksbill turtles in or around the Indian Ocean (which are among the largest in the world) occur in the Seychelles, Indonesia and Australia.
Size (length and weight)	In the Indian Ocean, adults weigh 45 to 70 kg, but can grow to as large as 90 kg.

SOURCES: FAO (1990); Mortimer (1984)

Leatherback turtle

The leatherback turtle (*Dermochelyscoriacea*) is the largest turtle and the most widely distributed living reptile in the world. The leatherback turtle is the only marine turtle that lacks a hard shell: there are no large external keratinous scutes and the underlying bony shell is composed of a mosaic of hundreds of tiny bones. Table 4 outlines some of the key life history traits of leatherback turtles.

TABLE 4. Biology of the leatherback turtle (*Dermochelyscoriacea*).

Parameter	Description
Range and stock structure	The leatherback turtle is the most wide ranging marine turtle species, and regularly migrates enormous distances, e.g. between the Indian and south Atlantic Oceans. They are commonly found in pelagic areas, but they also forage in coastal waters in certain areas. The distribution and developmental habitats of juvenile leatherback turtles are poorly understood. While the leatherback turtle is not as common in the Indian Ocean as other species, important nesting populations are found in and around the Indian Ocean, including in Indonesia, South Africa, Sri Lanka and India's Andaman and Nicobar Islands.Adults are capable of tolerating water temperatures well below tropical and subtropical conditions, and special physiological adaptations allow them to maintain body temperature above cool water temperatures. They specialise on soft bodied invertebrates found in the water column, particularly jelly fish and other sorts of "jellies."
Longevity	unknown
Maturity (50%)	Exact age is unknown, it is believed that sexual maturity is reached between 3 and 4 years
Spawning season	Females lay clutches of approximately 100 eggs on sandy, tropical beaches. They nest several times during a nesting season.
Size (length and weight)	Mature males and females can grow to 2 m and weigh almost 900 kg.

SOURCES: FAO (1990); Mortimer (1984)

Loggerhead turtle

The loggerhead turtle (*Carettacaretta*) isglobally distributed. The hatchlings and juveniles are pelagic, living in the open ocean, while the adults forage in coastal areas. Table 5 outlines some of the key life history traits of loggerhead turtles.

TABLE 5. Biology of the loggerhead turtle (*Carettacaretta*).

Parameter	Description
Range and stock structure	Circumglobal, occurring throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. Studies in the Atlantic and Pacific Oceans show that loggerhead turtles can spend decades living on the high seas, crossing from one side of an ocean basin to another before taking up residence on benthic coastal waters. Their enormous heads and powerful jaws enable them to crush large marine molluscs, on which they specialise.
Longevity	unknown
Maturity (50%)	Exact age is unknown, it is believed that sexual maturity is reached between 12 and 30 years. Age at maturity was estimated at 21.6 years in Tongaland, South Africa, through tagging studies.
Spawning season	Many females nest every 2 to 3 year, once or twice a season, laying clutches of approximately 40 to 190 eggs. Loggerhead turtles nest in relatively few countries in the Indian Ocean and the number of nesting females is generally small, except on Masirah Island (Sultanate of Oman) which supports one of only two loggerhead turtles nesting beaches in the world that have greater than 10,000 females nesting per year.
Size (length and weight)	Mature males and females may grow to over one meter long and weigh around 110 kg or more.

SOURCES: FAO (1990); Mortimer (1984); Hughes (2010)

Olive ridley turtle

The olive ridley turtle (*Lepidochelysolivacea*) is considered the most abundant marine turtle in the world, with an estimated 800,000 nesting females annually. The olive ridley turtle has one of the most extraordinary nesting habits in the natural world. Large groups of turtles gather off shore of nesting beaches. Then, all at once, vast numbers of turtles come ashore and nest in what is known as an "arribada". During these arribadas, hundreds to thousands of females come ashore to lay their eggs. In the northern Indian Ocean, arribadas occur on three different beaches along the coast of Orissa, India. Gahirmatha used to be one of the largest arribada nesting sites in the world. However, arribada nesting events have been less frequent there in recent years and the average size of nesting females has been smaller, indicative of a declining population. Declines in solitary nesting of olive ridley turtles have been recorded in Bangladesh, Myanmar, Malaysia, and Pakistan. In particular, the number of nests in Terengganu, Malaysia has declined from thousands of nests to just a few dozen per year. Solitary nesting also occurs extensively throughout this species' range. Despite the enormous numbers of olive ridley turtles that nest in Orissa, this species is not generally common throughout much of the Indian Ocean. Table 6 outlines some of the key life history traits of olive ridley turtles.

TABLE 6. Biology of the olive ridley turtle (*Lepidochelysolivacea*).

Parameter	Description
Range and stock structure	The olive ridley turtle is globally distributed in the tropical regions of the South Atlantic, Pacific, and Indian Oceans. It is mainly a pelagic species, but it has been known to inhabit coastal areas, including bays and estuaries. Olive ridley turtles often migrate great distances between feeding and breeding grounds.They have an annual migration from pelagic foraging, to coastal breeding and nesting grounds, back to pelagic foraging. They can dive to depths of about 150 m to forage.
Longevity	unknown
Maturity (50%)	Reach sexual maturity in around 15 years, a young age compared to some other marine turtle species.
Spawning season	Many females nest every year, once or twice a season, laying clutches of approximately 100 eggs.
Size (length and weight)	Adults are relatively small, weighing on average around 45 kg.As with other species of marine turtles, their size and morphology varies from region to region.

SOURCES: FAO (1990); Mortimer (1984)

Flatback turtle

The flatback turtle (*Natatordepressus*) gets its name from its relatively flat, smooth shell, unlike other marine turtles which have a high domed shell. Flatback turtles have the smallest migratory range of any marine turtle species and this restricted range means that the flatback turtle is vulnerable to habitat loss, especially breeding sites.Table 7 outlines some of the key life history traits of flatback turtles.

TABLE 7. Biology of the flatback turtle (*Natatordepressus*).

Parameter	Description
Range and stock structure	Flatback turtle turtles are found in northern coastal areas, from Western Australia's Kimberley region to the Torres Strait extending as far south as the Tropic of Capricorn. Feeding grounds also extend to the Indonesian Archipelago and the Papua New Guinea Coast. Flatback turtles have the smallest migratory range of any marine turtle species, though they do make long reproductive migrations of up to 1300 km. Although flatback turtles do occur in open seas, they are common in inshore waters and bays where they feed on the soft-bottomed seabed.It is carnivorous, feeding mostly on soft-bodied prey such as sea cucumbers, soft corals, jellyfish, molluscs and prawns.
Longevity	unknown
Maturity (50%)	unknown
Spawning season	Many females nest every 1 to 5 years, once or twice a season, laying clutches of between 50 and 60 eggs. The flatback turtle nests exclusively along the northern coast of Australia.
Size (length and weight)	The flatback turtle is a medium-sized marine turtle, growing to up to one meter long and weighing up to 90 kg.

SOURCES: FAO (1990); Mortimer (1984)

Availability of information on the interactions between marine turtles and fisheries for tuna and tuna-like species in the Indian Ocean

The IOTC has implemented data collection measures using onboard observers to better understand the nature and extent of the interactions between fisheries for tuna and tuna-like species in the Indian Ocean and marine turtles. Subsequently, IOTC members have implemented a number of national observer programmes that are providing information on the levels of marine turtle bycatch. Observer data from all fleets and gears remains very low with only Australia and South Africa reporting levels of marine turtle interactions to date (Table 8). However, data from other sources and in other regions indicate that threats to marine turtles are highest from gillnets and longline gear, and to a lesser extent purse-seine gear.

TABLE 8. Members and Cooperating non-Contracting Parties reporting of marine turtle interactions for the years 2008–2010 to the IOTC (to be updated before the 14th Session of the SC in December 2011).

CPC's	2008	2009	2010	Remarks
Australia	4	7	1	
Belize	0	0	0	Nil discards reported; no observers on board
China			0	Non-raised observer data
Taiwan,China				
Comoros				Small-scale
European Union**			7	PS Observer programme discontinued (piracy). 7 interactions reported across period
Eritrea				
France (territories)			0	Nil discards reported; no observers
Guinea				
India				Bycatch levels reported for research vessels
Indonesia			51	51 turtles caught between 2005 and 2010 (non-raised observer data)
Iran, Islamic Republic of				
Japan			14	Non-raised observer data
Kenya				
Korea, Republic of		36		Non-raised observer data
Madagascar				
Malaysia				
Maldives, Republic of				
Mauritius				
Oman, Sultanate of				
Pakistan				
Philippines	0	0	0	Nil discards reported; no observers on board
Seychelles				
Sierra Leone				
Sri Lanka				
Sudan				
Tanzania				
Thailand				
United Kingdon (BIOT)	n.a	n.a.	n.a.	No active fleet
Vanuatu			0	Nil discards reported; no observers on board
Mozambique*	n.a.	n.a.		
Senegal*	n.a.	n.a.	n.a.	No activity since 2007
South Africa*	15	13	24	

Green = CPC reported level of marine turtle interactions; Red = CPC did not report level marine turtle interactions
*Cooperating non-Contracting Party
**Observer data was reported for the French purse-seine fleet for 2009 as well as for the La Réunion longline fleet. Moreover, the observer programme on-board the EU Purse-seine fleet has been discontinued because of piracy activities.
n.a. = not applicable

Purse seine

European Union observers (covering on average 5% of the operations annually from 2003 to 2007) reported 74 marine turtles caught by EU,France and EU,Spain purse seiners over the period 2003–2007[3]. The most common species reported was olive ridley, green and hawksbill turtles, and these were mostly caught on log (natural Fish Aggregation Devices – FAD) sets and returned to the sea alive (although there is no systematic information on survivorship after release).Mortality levels of marine turtles due to entanglement in drifting FADs set by the fishery are still unknown and need to be assessed. The EU has indicated that its purse-seine fleet is making progress towards improved FAD designs aimed at reducing the incidence of entanglement of marine turtles, including the use of biodegradable materials. EU,Francehas indicated that it is already deploying FADs that are likely to reduce the entangled of marine turtles in both the Atlantic and Indian Oceans, while EU,Spainhas indicated that it will conduct experiments in the Atlantic Ocean on several FADs designs aimed at reducing the incidence of entanglement of marine turtles, before recommending a final FAD design to replace current FADs.

[3]IOTC-2008-WPEB-08

Longline

Information on most of the major longline fleets in the IOTC is currently not available and it is not known if this fishing activity represents a serious threat to marine turtles, as is the case in most other regions of the world.

The South African longline fleets have reportedthat marine turtle bycatch mainly comprises leatherback turtles, with lesser amounts of loggerhead, hawksbill and green turtles[4]. Estimated average catch rates of marine turtles ranged from 0.005 to 0.3 marine turtles per 1000 hooks and varied by location, season and year. The highest catch rate reported in one trip was 1.7 marine turtles per 1000 hooks in oceanic waters.

Over the period 1997 to 2000, the Programme PalangreRéunionnais[5] examined marine turtle bycatch on 5,885 longline sets in the vicinity of Reunion Island (19-25° S, 48-54° E). The fishery caught 47leatherback, 30hawksbill, 16 green and 25 unidentified marine turtles, equating to an average catch rate of less than 0.02 marine turtles per 1000 hooks over the 4 year study period.

The Fishery Survey of India (FSI) carried out survey in the whole Indian EEZ using four longline vesselsfrom 2005 to 2009. During this period around 800,000 hooks were deployed in the Arabian Sea, in the Bay of Bengal and in the waters of Andaman and Nicobar. In total 87 marine turtles (79 olive ridley, 4 green and 2 hawksbill turtles) were caught. Catch rates were of 0.302 marine turtles per 1000 hooks in the Bay of Bengal area, 0.068 marine turtles per 1000 hooks in the Arabian sea and 0.008 marine turtles per 1000 hooks in the Andaman and Nicobar waters. The highest occurrence of incidental catches in the Bay of Bengal area is probably due to the large abundance of olive ridley turtles whose main nesting ground in the Indian Ocean is on the east coast of India, in the Orissa region.

Gillnets

Due to the nature of this gear, the incidental catch of marine turtles is thought to be relatively high compared to that of purse-seine and longline gears, however, quantified data for this gear type are almost non-existent.While the IOTC currently has virtually no information on interactions between marine turtles and gillnets, the IOSEA database indicates that the coastal mesh net fisheries occur in about 90% of IOSEA Signatory States in the Indian Ocean, and the fishery is considered to have moderate to relatively high impact on marine turtles in about half of those IOSEA member States. Given the widespread abundance of mesh net fisheries in the Indian Ocean, there is clearly an urgent need for careful, systematic information to be collected and report on this gear type and its impacts on marine turtles.

Other data sources

The IOTC and the Indian Ocean – South-East Asian Marine Turtle Memorandum of Understanding (IOSEA), an agreement under the Convention on Migratory Species, are actively collecting a range of information on fisheries and marine turtle interactions. The IOSEA database covers information from a wider range of fisheries and gears than those held by the IOTC. The IOSEA Online Reporting Facility[6] compiles information through IOSEA National Reports on potential marine turtle fisheries interactions, as well as various mitigation measures put in place by its Signatory States and collaborating organisations. For example, members provide information on fishing effort and perceived impacts of fisheries that may interact with marine turtles, including longlines, purse seines, FADs, and gillnets. While the information is incomplete for some countries and is generally descriptive rather than quantitative, it has begun to provide a general overview of potential fisheries interactions as well as their extent. No information is available for China, Taiwan,China, Japan, Republic of Korea (among others) which are not yet signatories to IOSEA. Information is also provided on such mitigation measures as appropriate handling techniques, gear modifications, spatial/temporal closures etc. IOSEA is collecting all of the above information with a view to providing a regional assessment of member States' compliance with the FAO Guidelines on reducing fisheries interactions with marine turtles.

ASSESSMENT

A number of comprehensive assessments of the status of Indian Ocean marine turtles are available, in addition to the IUCN threat status:

- Hawksbill turtle – Marine Turtle Specialist Group 2008 IUCN Red List status assessment[7].
- Loggerhead turtle – 2009 status review under the U.S. endangered species act[8].
- Leatherback turtle - Assessment of the conservation status of the leatherback turtle in the Indian Ocean and South-East Asia (IOSEA Marine Turtle MoU, 2006)[9].

[4] IOTC-2006-WPBy-15
[5] Poisson F. and Taquet M. (2001) L'espadon: de la recherche à l'exploitation durable. Programme palangre réunionnais, rapport final, 248 p. available in the website www.ifremer.fr/drvreunion
[6] (www.ioseaturtles.org/report.php)
[7] http://www.iucnredlist.org/documents/attach/8005.pdf
[8] http://www.nmfs.noaa.gov/pr/pdfs/statusreviews/loggerheadturtle2009.pdf
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APPENDIX XXVI
EXECUTIVE SUMMARY: SEABIRDS

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi

Status of Seabirds in the Indian Ocean

TABLE 1. IUCN threat status for all seabird species reported as caught in fisheries within the IOTC area of competence.

Common name	Scientific name	IUCN threat status[10]
Albatross		
Atlantic Yellow-nosed Albatross	*Thalassarche chlororynchos*	Endangered
Black-browed albatross	*Thalassarche melanophrys*	Endangered
Indian yellow-nosed albatross	*Thalassarche car teri*	Endangered
Shy albatross	*Thalassarche cauta*	Near Threatened
Sooty albatross	*Phoebetria fusca*	Endangered
Light-mantled albatross	*Phoebetria palpebrata*	Near Threatened
Amsterdam albatross	*Diomedea amsterdamensis*	Critically Endangered
Tristan albatross	*Diomedea dabbenena*	Critically Endangered
Wandering albatross	*Diomedia exulans*	Vulnerable
White-capped albatross	*Thalassarche steadi*	Near Threatened
Petrels		
Cape/Pintado petrel	*Daption capense*	Least Concern
Great-winged petrel	*Pterodroma macroptera*	Least Concern
Grey petrel	*Procellaria cinerea*	Near Threatened
Northern giant-petrel	*Macronectes halli*	Least Concern
White-chinned petrel	*Procellaria aequinoctialis*	Vulnerable
Others		
Cape gannet	*Morus capensis*	Vulnerable
Flesh-footed shearwater	*Puffinus carneipes*	Least Concern

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No assessment has been undertaken by the IOTC WPEB for seabirds due to the lack of data being submitted by CPCs. However, the current International Union for Conservation of Nature (IUCN) threat status for each of the seabird species reported as caught in IOTC fisheries to date is provided in Table 1. It is important to note that a number of international global environmental accords (e.g. Convention on Migratory Species (CMS), Convention on Biological Diversity (CBD)), as well as numerous fisheries agreements obligate States to provide protection for these species. While the status of seabirds is affected by a range of factors such as degradation of nesting habitats and targeted harvesting of eggs, the level of mortality of seabirds due to fishing gear in the Indian Ocean is poorly known, although where there has been rigorous assessment of impacts in areas south of 25 degrees (e.g. in South Africa), very high seabird bycatch rates have been recorded in the absence of a suite of proven bycatch mitigation measures.

Outlook. Resolution 10/06 *On Reducing the Incidental Bycatch of Seabirds in Longline Fisheries* includes an evaluation requirement (para. 8) by the Scientific Committee in time for the 2011 meeting of the Commission. However, given the lack of reporting of seabird interactions by CPCs to date, such an evaluation cannot be undertaken at this stage. Unless IOTC CPCs become compliant with the data collection and reporting requirements for seabirds, the WPEB will continue to be unable to address this issue. Notwithstanding this, it is acknowledged that the impact on seabird populations from fishing for tuna and tuna-like species, particularly using longline gear

[10] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

may increase if fishing pressure increases. Any fishing in areas with high abundance of procellariiform seabirds is likely to cause incidental capture and mortality of these seabirds unless measures that have been proven to be effective against Southern Ocean seabird assemblages are employed.

The SC **RECOMMENDED** consider the following:

- The available evidence indicates considerable risk to the status of seabirds in the Indian Ocean.
- The primary source of data that drive the ability of the WPEB to determination a status for the Indian Ocean, total interactions by fishing vessels, is highly uncertain and should be addressed as a matter of priority.
- Current reported interactions are a known to be a severe underestimate.
- That more research is conducting on the identification of hot spots of interactions between seabirds and fishing vessels.
- Maintaining or increasing effort in the Indian Ocean without refining and implementing appropriate mitigation measures, will likely result in further declines in biomass.
- That appropriate mechanisms are developed by the Compliance Commission to ensure CPCs comply with their data collection and reporting requirements for seabirds.
- Resolution 10/06 on reducing the incidental bycatch of seabirds in longline fisheries includes an evaluation requirement (para. 8) by the Scientific Committee in time for the 2011 meeting of the Commission, noting that this deadline is now overdue.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Seabirds in the Indian Ocean are currently subject to a number of conservation and management measures adopted by the Commission:

- Resolution 10/06 *On Reducing the Incidental Bycatch of Seabirds in Longline Fisheries* recognizes the threatened status of some of the seabird species found in the Indian Ocean and that longline fishing operations can adversely impact seabirds. The Resolution makes mandatory for vessels fishing south of 25°S, the use of at least two seabird bycatch mitigation measures selected from a table, including at least one measure from Column A (Table shown below) aimed at effectively reducing the mortality of seabirds due to longline operations. In addition, CPCs are required to provide to the Commission all available information on interactions with seabirds. However, it does not include a mandatory requirement for CPCs to record seabird interactions while fishing for tuna and tuna-like species in the IOTC area of competence, but rather to report "*all available information on interactions with seabirds*".

Column A	**Column B**
Night setting with minimum deck lighting	Night setting with minimum deck lighting
Bird-scaring lines (Tori Lines)	Bird-scaring lines (Tori Lines)
Weighted branch lines	Weighted branch lines
	Blue-dyed squid bait
	Offal discharge control
	Line shooting device

- Resolution 10/02 *Mandatory Statistical Requirements For IOTC Members and Cooperating non-Contracting Parties (CPC's)* encourages CPCs to record and report data on seabird interactions. However, if a CPC chooses not to record data on seabird interactions, as permitted under Resolution 10/02, then the requirements of Resolution 10/06 *on Reducing the Incidental Bycatch of Seabirds in Longline Fisheries* become void, as the wording of Resolution 10/06 only requires reporting of data where it is available.
- Resolution 11/04 *on a Regional Observer Scheme* (commenced on 1 July 2010) requires data on seabird interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) aims to collect scientific observer data on catch and bycatch on, at least, 5% of the fishing operations of vessel over 24m and vessel under 24m fishing outside their EEZ. The requirement under Resolution 11/04 in conjunction with the reporting requirements under Resolution 10/06, means that all CPCs should be reporting seabird interactions as part of their annual report to the Scientific Committee.

RESOLUTION 10/06 ON REDUCING THE INCIDENTAL BYCATCH OF SEABIRDS IN LONGLINE FISHERIES:

7. CPCs shall provide to the Commission, as part of their annual reports, information on how they are implementing this measure and all available information on interactions with seabirds, including bycatch by fishing vessels carrying their flag or authorised to fish by them. This is to include details of species where available to enable the Scientific Committee to annually estimate seabird mortality in all fisheries within the

IOTC area of competence;

RESOLUTION 10/02 MANDATORY STATISTICAL REQUIREMENTS FOR IOTC MEMBERS AND COOPERATING NON-CONTRACTING PARTIES (CPC'S):

3. Catch and effort data:

(…)CPC's are also encouraged to record and provide data on species other than sharks and tunas taken as bycatch.

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency.

CONSERVATION AND MANAGEMENT MEASURES IN OTHER REGIONS

Evidence from areas where seabird bycatch was formerly high but has been reduced (e.g. Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) and South Africa) has shown that it is important to employ, simultaneously, a suite of mitigation measures. Research conducted in South Africa by Japanese and US researchers (Melvin et al. 2010) showed that bird scaring lines (BSL, also known as tori or streamer lines) displace seabird attacks on baits, but only as far astern as the BSL extends. If baits are sufficiently close to the surface behind the aerial extent of the BSL, the rate of attack by seabirds on baited hooks, and hence risk of bycatch, remains high. This research shows clearly that appropriate sink rates must be used in tandem with BSLs and that unweighted branch lines or those with small weights placed well away from the hook pose the highest risks to seabirds. The research also suggests no negative effect of line-weighting on target catches, but limited sample sizes preclude definitive analysis (Melvin et al. 2010). In addition, experience from CCAMLR and elsewhere has indicated a number of additional factors contribute to successful reduction of seabird bycatch (FAO 2008; Waugh et al. 2008). These include research to optimise the effectiveness of mitigation measures and their ease of implementation, the use of onboard observer programs to collect seabird bycatch data and evaluate the effectiveness of bycatch mitigation measures, training of both fishermen and observers in relation to the problem and its solutions, and ongoing review of the effectiveness of these activities. Mitigation measures recommended by ACAP (Agreement on the Conservation of Albatrosses and Petrels) as effective include weighted branch lines that ensure that baits quickly sink below the reach of diving seabirds, night setting, and appropriate deployment of well designed BSLs.

Reduction of seabird bycatch may even bring benefits to fishing operations, for example by reducing the loss of bait to seabirds. Recent research in Brazil showed a reduction of 60% of the capture of seabirds and higher catch rates (20–30%) of target species when effective mitigation measures were applied (Mancini et al. 2009). However, more detailed economic assessments across a diversity of regions, fishing gears and seasons are required to get a fuller picture of economic benefits.

The International Commission for the Conservation of Atlantic Tunas (ICCAT) established a new conservation measure for seabirds at the November 2011 meeting of the Commission. In keeping with scientific advice given to the ICCAT, which is harmonious with the advice from the WPEB 2011, the new measure requires the use of only three technologies to reduce risk to seabirds, namely bird scaring lines, line weighting and night setting. In areas of high bycatch (or bycatch risk), currently defined in the South Atlantic as of 25˚S, longline fishing vessels are required to use two of the three measures.

INDICATORS – FOR SEABIRD SPECIES KNOWN OR LIKELY TO BE VULNERABLE TO MORTALITY FROM FISHING OPERATIONS IN THE IOTC AREA OF COMPETENCE.

Seabirds are species that derive their sustenance primarily from the ocean and which spend the bulk of their time (when not on land at breeding sites) at sea. Seventeen species of seabirds known to interact with longline fisheries for tuna and tuna-like species in the Indian Ocean are listed in Table 1. However, not all reports identify birds to species level and, overall, information on seabird bycatch in the IOTC area remains very limited (Gauffier 2007; IOTC–2011–SC13–R). Due to gaps in tracking and observer data, it is likely that there are other species at risk of bycatch which are not identified in this Executive Summary.

Worldwide, 17 of the 22 species of albatross are listed by the IUCN as globally threatened, with bycatch in fisheries identified as the key threat to the majority of these species (Robertson and Gales 1998). Impacts of longline fisheries on seabird populations have been demonstrated (e.g. Weimerskirch and Jouventin 1987; Weimerskirch et al. 1997; Croxall et al. 1990; Tuck et al. 2001; Nel et al. 2003). In general, other IOTC gear types (including purse seine, bait boats, troll lines, and gillnets) are considered to have low incidental catch of seabirds, however data remain limited. The Convention on Migratory Species (CMS) is finalising a global review of the bycatch levels in gillnet fisheries, and the findings of this report may be relevant to seabird bycatch in gillnet fisheries operating in the IOTC.

Range and stock structure

Eleven seabird families occur within the IOTC area of competence as breeding species. They are typically referred to as penguins (Spheniscidae), albatrosses (Diomedeidae), petrels and allies (Procellariidae), storm-petrels (Hydrobatidae), diving-petrels (Pelecanoididae), tropicbirds (Phaethonidae), gannets and boobies (Sulidae), cormorants (Phalocrocoracidae), frigatebirds (Fregatidae), skuas (Stercorariidae), gulls and terns (Laridae). Of these, the Order Procellariiformes (albatrosses and petrels) are most susceptible to being caught as bycatch in longline fisheries (Wooller et al. 1992, Brothers et al. 1999), and therefore are most susceptible to direct interactions with IOTC fisheries.

The southern Indian Ocean is of global importance in relation to albatross distribution: seven of the 18 species of southern hemisphere albatrosses have breeding colonies on Indian Ocean islands[11]. In addition, all but one[12] of the 18 southern hemisphere albatrosses forage in the Indian Ocean at some stage in their life cycle. The Indian Ocean is particularly important for Amsterdam albatross (*Diomedea amsterdamensis* – Critically Endangered) and Indian yellow-nosed albatross (*Thalassarche carteri* – Endangered), which are endemic to the southern Indian Ocean, white-capped albatross (*Thalassarche steadi* – endemic to New Zealand), shy albatross (*T. cauta* – endemic to Tasmania, and which forage in the area of overlap between IOTC and WCPFC), wandering albatross (*D. exulans* – 74% global breeding pairs), sooty albatross (*Phoebetria fusca* – 39% global breeding pairs), light-mantled sooty albatross (*P. palpebrata* – 32% global breeding pairs), grey-headed albatross (*T. chrysotoma* – 20% global breeding pairs) and northern and southern giant-petrel (*Macronectes halli and M. giganteus* – 26% and 30% global breeding pairs, respectively).

In the absence of data from observer programs reporting seabird bycatch, risk of bycatch has been identified through analysis of the overlap between albatross and petrel distribution and IOTC longline fishing effort, based on data from the Global Procellariiform Tracking Database (ACAP 2007). A summary map indicating distribution is shown in Figure 1 and the overlap between seabird distribution and IOTC longline fishing effort is shown in Table 2. The 2007 analysis of tracking data indicated that albatrosses breeding on Southern Indian Ocean islands spent 70–100% of their foraging time within areas overlapping with IOTC longline fishing effort. The analysis identified the proximity of the Critically Endangered Amsterdam albatross and Endangered Indian yellow-nosed albatross to high levels of pelagic longline effort. Wandering, shy, grey-headed and sooty albatrosses and white-chinned petrels showed a high overlap with IOTC longline effort. Data on distribution during the non-breeding season was lacking for many species, including black-browed albatrosses and white-capped albatrosses (known from bycatch data to be amongst the species most frequently caught).

In 2009 and 2010, new tracking data were presented to the Working Party on Ecosystems and Bycatch (WPEB) which filled a number of gaps from the 2007 analysis, particularly for sooty albatross, and for distributions of juveniles of wandering, sooty and Amsterdam albatrosses, white-chinned and northern giant petrels (Delord and Weimerskirch 2009; 2010). This analysis indicated substantial overlap with IOTC longline fisheries.

Longevity, maturity, breeding season

Seabirds are long-lived, with natural adult mortality typically very low. Seabirds are characterised as being late to mature and slow to reproduce; some do not start to breed before they are ten years old. Most lay a single egg each year, with some albatross species only breeding every second year. These traits make any increase in human-induced adult mortality potentially damaging for population viability, as even small increases in mortality can result in population decreases.

[11] Amsterdam, black-browed, grey-headed, Indian yellow-nosed, light-mantled, sooty and wandering albatrosses

[12] Atlantic yellow-nosed albatross (*Thalassarche chlororhynchos)*

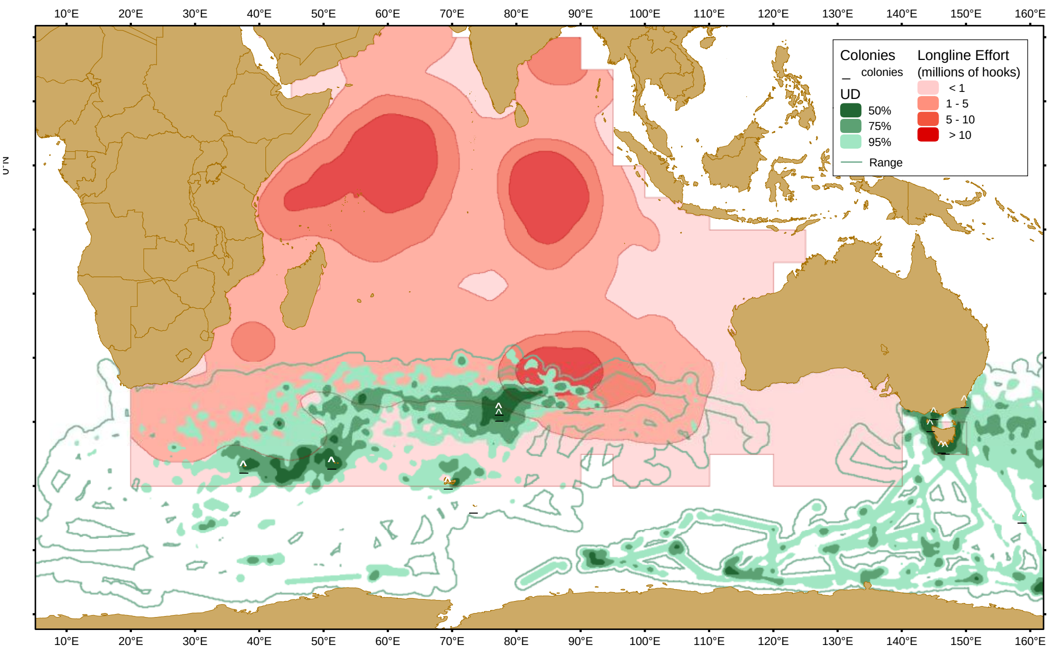

Fig. 1. Distribution of breeding albatrosses, petrels and shearwaters in the Indian Ocean (see Table 2 for a list of species included), and overlap with IOTC longline fishing effort for all gear types and fleets (average annual number of hooks set per 5° grid square from 2002 to 2005).

TABLE 2. Overlap between the distribution of breeding and non-breeding albatrosses, petrels and shearwaters and IOTC fishing effort* (Distributions derived from tracking data held in the Global Procellariiform Tracking Database.

Species/Population – Breeding	Global Population (%)	Overlap (%)
Amsterdam albatross (Amsterdam)	100	100
Antipodean (Gibson's) albatross		
Auckland Islands	59	1
Black-browed albatross		1
Iles Kerguelen	1	88
Macquarie Island	<1	1
Heard & McDonald	<1	
Iles Crozet	<1	
Buller's Albatross		2
Solander Islands	15	1
Snares Islands	27	2
Grey-headed albatross		7
Prince Edward Islands	7	70
Iles Crozet	6	
Iles Kerguelen	7	
Indian yellow-nosed albatross		
Ile Amsterdam	70	100
Ile St. Paul	<1	
Iles Crozet	12	
Iles Kerguelen	<1	
Prince Edward Island	17	
Light-mantled albatross	39	
Shy albatross		
Tasmania	100	67
Sooty albatross		
Iles Crozet	17	87
Ile Amsterdam	3	
Ile St. Paul	<1	
Iles Kerguelen	<1	
Prince Edward Island	21	
Wandering albatross		75
Iles Crozet	26	93
Iles Kerguelen	14	96

Prince Edward Islands	34	95
Northern giant petrel	26	
Southern giant petrel	9	
White-chinned Petrel		
Iles Crozet	?	60
Iles Kerguelen	?	
Prince Edward Island	?	
Short-tailed shearwater		
Australia	?	3
Species/Population – Non-breeding	**Global Population (%)**	**Overlap (%)**
Amsterdam albatross (Amsterdam)	100	98
Antipodean (Gibson's) albatross		9
Antipodes Islands	41	3
Auckland Islands	59	13
Black-browed albatross		
South Georgia (GLS data)	16	3
Heard & McDonald Islands	<1	
Iles Crozet	<1	
Iles Kerguelen	1	
Buller's albatross		13
Solander Islands	15	9
Snares Islands	27	15
Grey-headed albatross		
South Georgia (GLS data)	58	16
Iles Crozet	6	
Iles Kerguelen	7	
Prince Edward Island	7	
Indian yellow-nosed albatross		
Light-mantled albatross		
Northern royal albatross		3
Chatham Islands	99	3
Taiaroa Head	1	1
Shy albatross		
Tasmania	100	72
Sooty albatross		
Southern royal albatross		
Wandering albatross		59
White-capped albatross		
Northern giant petrel		
Southern giant petrel		
White-chinned petrel		
Westland petrel		
Short-tailed shearwater		

*Fishing data are based on the average annual number of hooks set per 5° grid square from 2002 to 2005. Overlap is expressed as the percentage of time spent in grid squares with longline effort, and is given for each breeding site as well the species' global population where sufficient data exists. Shaded squares represent species/colonies for which no tracking data were available).

Availability of information on the interactions between seabirds and fisheries for tuna and tuna-like species in the Indian Ocean

Bycatch data from onboard observer programs

Globally it is recognized that onboard observer programs are vital for collecting data on catches of non-target species, particularly those species which are discarded at sea. More specifically, observers need to observe hooks during setting and monitor hooks during the hauling process to adequately assess seabird bycatch and evaluate the effectiveness of mitigation measures in use. Levels of observer coverage significantly in excess of 5% are likely to be needed to accurately monitor seabird bycatch levels in IOTC fisheries.

The IOTC has implemented data collection measures using onboard observers to better understand the nature and extent of the interactions between fisheries for tuna and tuna-like species in the Indian Ocean and seabirds. Subsequently, IOTC members have implemented a number of national observer programmes that are providing information on the levels of seabird interactions. Observer data from all fleets and gears remains very low with only Australia and South Africa reporting levels of seabird interactions to date (Table 3). However, data from other sources and in other regions indicate that threats to seabirds are highest from longline gear.

TABLE 3. Members and Cooperating Non-Contracting Parties reporting of seabird interactions for the years 2008–2010 to the IOTC (to be updated before the 14th Session of the SC in December 2011).

CPC's	2008	2009	2010	Remarks
Australia	0	2	0	
Belize	0	0	0	Nil discards reported; no observers on board
China			0	Non-raised observer data
Taiwan,China				
Comoros	n.a.	n.a.	n.a.	No longline activity
European Union**				
Eritrea				
France (territories)	n.a.	n.a.	n.a.	No longline activity
Guinea				
India				Bycatch levels reported for research vessels
Indonesia			42	42 seabirds caught between 2005 and 2010 (non-raised observer data)
Iran, Islamic Republic of	n.a.	n.a.	n.a.	No longline activity
Japan			11	Non-raised observer data
Kenya				
Korea, Republic of		94	72	Non-raised observer data
Madagascar				
Malaysia				
Maldives, Republic of				No longline activity
Mauritius				
Oman, Sultanate of				
Pakistan	n.a.	n.a.	n.a.	No longline activity
Philippines	0	0	0	Nil discards reported; no observers on board
Seychelles				
Sierra Leone				
Sri Lanka				
Sudan				
Tanzania				
Thailand				
United Kingdom (BIOT)	n.a.	n.a.	n.a.	No longline activity
Vanuatu				
Mozambique*	n.a.	n.a.	n.a.	No longline activity
Senegal*	n.a.	n.a.	n.a.	No longline activity
South Africa*	157	467	162	

Green = CPC reported level of seabird interactions; Red = CPC did not report level of seabird interactions
*Cooperating non-Contracting Party
**Observer data was reported for the French purse-seine fleet for 2009 as well as for the La Réunion longline fleet. Moreover, the observer programme on-board the EU Purse-seine fleet has been discontinued because of piracy activities.

Longline

Observer data from longline fisheries occurring north of 20˚S is very sparse (Gauffier 2007). While seabird bycatch rates in tropical areas are generally assumed to be low, a number of threatened seabirds forage in these northern waters. Due to their small population sizes, bycatch at significant levels could be occurring but not, or almost never being observed.

Others gears

The impact of purse-seine fishing on tropical seabird species, including larids (gulls, terns and skimmers) and sulids (gannets and boobies), is generally considered to be low, but data remain sparse and there are anecdotal observations which suggest that these interactions might merit closer investigation. However, no observation of incidental catch of seabird in the purse-seine fishery has been made in the Indian Ocean since the beginning of the fishery 25 years ago. The scale and impacts of gillnet fishing impacts on seabirds in the IOTC convention area is unknown. Outside the convention area, gillnet fishing has been recorded as catching high numbers of diving seabird species, including shearwaters and cormorants (e.g. Berkenbusch and Abraham 2007). The large coastal gillnet fisheries in the northern part of the IOTC clearly merit closer investigation, and should be considered a priority, as should the impact of lost or discarded gillnets (ghost fishing) on seabirds.

Indirect impacts of fisheries

Many tropical seabird species forage in association with tunas, which drive prey to the surface and thereby bring them within reach of the seabirds. The depletion of tuna stocks could therefore have impacts on these dependent species. More widely, the potential 'cascade' effects of reduced shark and tuna abundances on the ecosystem is largely unknown. Although these kinds of impacts are difficult to predict, there are some examples that suggest meso-predator release has occurred in the Convention area (e.g. Romanov and Levesque 2009)

ASSESSMENT

A number of comprehensive assessments of the status of Indian Ocean seabirds are available, in addition to the IUCN threat status:

- Modelling work on Crozet wandering albatrosses and impact of longline fisheries in the IOTC zone (Tuck et al. 2011).
- ACAP Species assessment for: Amsterdam Albatross, Indian Yellow-nosed Albatross, Northern Royal Albatross, Southern Royal Albatross, Shy Albatross, Sooty Albatross, Wandering Albatross, Northern Giant Petrel, Southern Giant Petrel, Grey Petrel, Spectacled Petrel, White-chinned Petrel (http://www.acap.aq/acap-species).

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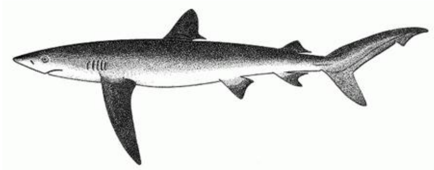
APPENDIX XXVII
EXECUTIVE SUMMARY: BLUE SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean Blue Shark
(*Prionace glauca*)

TABLE 1. IUCN threat status of blue shark (*Prionace glauca*) in the Indian Ocean

Common name	Scientific name	IUCN threat status[13]		
		Global status	**WIO**	**EIO**
Blue shark	*Prionace glauca*	Near Threatened	–	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
SOURCES: IUCN (2007, 2011)

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

The SC **RECOMMENDED** the following management advice for blue shark in the Indian Ocean noting that there remains considerable uncertainty about the relationship between abundance and the standardized CPUE series from the Japanese longline fleet, and about the total catches over the past decade.

Stock status. The current IUCN threat status of 'Near Threatened' applies to blue sharks globally (Table 1). There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment and limited basic fishery indicators currently available for blue shark in the Indian Ocean therefore the stock status is highly uncertain. Blue sharks are commonly taken by a range of fisheries in the Indian Ocean and in some areas they are fished in their nursery grounds. Because of their life history characteristics – they are relatively long lived (16–20 years), mature relatively late (at 4–6 years), and have relativity few offspring (25–50 pups every year), the blue shark is vulnerable to overfishing. Blue shark assessments in the Atlantic and Pacific oceans seem to indicate that blue shark stocks can sustain relatively high fishing pressure.

Outlook. Maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on blue shark will decline in these areas in the near future, and may result in localised depletion.

The Scientific Committee considered the following:

- The available evidence indicates risk to the stock status at current effort levels.
- The two primary sources of data that drive the assessment, total catches and CPUE are highly uncertain and should be investigated further as a priority.
- Noting that current reported catches (probably largely underestimated) are estimated at an average ~ 8,924 t over the last five years, ~ 9,416 t in 2010, maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE.
- The SC recommended that mechanisms are developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

[13] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Blue shark in the Indian Ocean are currently subject to a number of conservation and management measures adopted by the Commission:

- Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC* includes minimum reporting requirements for sharks, calls for full utilisation of sharks and includes a ratio of fin-to-body weight for shark fins retained onboard a vessel.
- Resolution 08/04 *Concerning the recording of catch by longline fishing vessels in the IOTC area* sets out the minimum logbook requirements for longline fishing vessels over 24 metres length and under 24 metres if they fish outside the EEZ of their flag State. As per this resolution, catch of all sharks must be recorded.
- Resolution 10/03 *Concerning the recording of catch by fishing vessels in the IOTC area* sets out minimum logbook requirements for all purse-seine vessels 24 metres length overall or greater and those under 24 metres if they fish outside the EEZs of their flag States. As per this resolution, catch and discard of all shark species should be recorded.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on blue shark interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010.

Extracts from Resolutions 09/06 and 11/04

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

3. CPCs shall take the necessary measures to require that their fishermen fully utilise their entire catches of sharks. Full utilisation is defined as retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing.

RESOLUTION 08/04 CONCERNING THE RECORDING OF CATCH BY LONGLINE FISHING VESSELS IN THE IOTC AREA

1. Each flag CPC shall ensure that all long line fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system. ….

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency

FISHERIES INDICATORS

General

Blue shark (*Prionace glauca*) is the most common shark in pelagic oceanic waters throughout the tropical and temperate oceans worldwide (Fig. 1). It has one of the widest ranges of all the shark species and may also be found close inshore. Adult blue sharks have no known predators; however, subadults and juveniles may be preyed upon by shortfin makos, white sharks, and adult blue sharks. Fishing is a major contributor to adult mortality. Table 2 outlines some of the key life history traits of blue shark in the Indian Ocean.

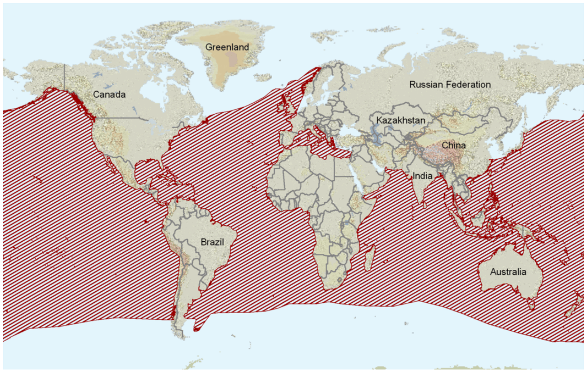


Fig. 1. The worldwide distribution of the blue shark (source: www.iucnredlist.org)

TABLE 2. Biology of Indian Ocean blue shark (*Prionace glauca*).

Parameter	Description
Range and stock structure	In the tropical Indian Ocean, the greatest abundance of blue sharks occurs at depths of 80 to 220 m, in temperatures ranging from 12 to 25°C. The distribution and movements of blue shark are strongly influenced by seasonal variations in water temperature, reproductive condition, and availability of prey. Long-distance movements have been observed for blue sharks, including transoceanic route from Australia to South Africa. The blue shark is often found in large single sex schools containing individuals of similar size. Subtropical and temperate waters appears to be nursery grounds south of 20°S, where small blue sharks dominate, but where all range of sizes from 55 to 311 cm FL are recorded. In contrast mature fish (FL > 185cm) dominate in the off-shore equatorial waters. Area of overlap with IOTC management area = high. No information is available on stock structure.
Longevity	Bomb radiocarbon dating of Indian Ocean blue sharks showed that males of 270 cm FL may attain 23 years of age. Preliminary data for Indian Ocean shows that male may reach 25 and females 21 years old. In the Atlantic Ocean, the oldest blue sharks reported were a 16 year old male and a 15 year old female. Longevity is estimated to be around 20 years of age in the Atlantic.
Maturity (50%)	Age: Sexual maturity is attained at about 5 years of age in both sexes. Size: not available for the Indian Ocean. In the Atlantic 182–218 cmTL for males; 173–221 cm TM for females.
Reproduction	Blue shark is a viviparous species, with a yolk-sac placenta. Once the eggs have been fertilised there is a gestation period of between 9 and 12 months. Litter size is quite variable, ranging from four to 135 pups and may be dependent on the size of the female. The average litter size observed from the Indian Ocean is 38, very similar to the one reported in the Atlantic Ocean, 37. Generation time is about 8-10 years. In Indian Ocean, between latitude 2 ºN and 6 ºS, pregnant females are present for most of the year. • Fecundity: relatively high (25-50) • Generation time: 8-10 years • Gestation Period: 9-12 months • Annual reproductive cycle
Size (length and weight)	Maximum size is around 380 cm FL. New-born pups are around 40 to 51 cm TL. Length–weight relationship for both sexes combined in the Indian Ocean is $TW=0.159*10^{-4} * FL^{2.84554}$.

SOURCES: Gubanov & Gigor'yev (1975); Pratt (1979); Anderson & Ahmed (1993); ICES (1997); Scomal & Natansen (2003); Mejuto et al. (2005); Mejuto & Garcia-Cortes (2006); IOTC 2007; Matsunaga (2007); Rabehagosoa et al. (2009); Romanov & Romanova (2009); Anon (2010), Romano & Campana (2011).

Fisheries

Blue sharks are often targeted by some semi-industrial and artisanal fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries and anecdotally in the purse seine fishery). However, in recent years longliners are occasionally targeting this species, due to an increase in its commercial value worldwide. The blue shark appears to have a similar distribution to swordfish. Typically, the fisheries take blue sharks between 180–240 cm FL or 30 to 52 kg. Males are slightly smaller than the females. In other Oceans, angling clubs are known to organise shark fishing competitions where blue sharks and mako sharks are targeted. Sport fisheries for oceanic sharks are apparently not so common in the Indian Ocean.

There is little information on the fisheries prior to the early 1970's, and some countries continue not to collect shark data while others do collect them but do not report it to IOTC. It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many catch records probably under-represent the actual catches of sharks because they do not account for discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights. FAO also compiles landings data on elasmobranchs, but the statistics are limited by the lack of species-specific data and data from the major fleets.

The practice of shark finning is considered to be regularly occurring and on the increase for this species (Clarke 2008; Clarke et al. 2006) and the bycatch/release injury rate is unknown but probably high.

Preliminary estimations of at-haulback mortality showed that 24.7% of the blue shark specimens captured in longline fisheries targeting swordfish are captured dead at time of haulback. Specimen size seems to be a significant factor, with larger specimens having a higher survival at-haulback (Coelho et al. 2011a).

TABLE 3. Estimated frequency of occurrence and bycatch mortality in the Indian Ocean pelagic fisheries.

Gears	PS	LL		BB/TROL/HAND	GILL	UNCL
		SWO	TUNA			
Frequency	rare	abundant		rare	unknown	unknown
Fishing Mortality	unknown	13 to 51 %	0 to 31%	unknown	unknown	unknown
Post release mortality	unknown	19%		unknown	unknown	unknown

SOURCES: Boggs (1992); Romanov (2002, 2008); Diaz & Serafy (2005); Ariz et al. (2006); Peterson et al. (2008); Romanov et al. (2008); Campana et al. (2009); Poisson et al. (2010)

Catch trends

The catch estimates for blue shark are highly uncertain as is their utility in terms of minimum catch estimates. Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, and Sri Lanka) while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories). For CPCs reporting longline data by species (i.e. Australia, Spain, Portugal, United Kingdom and South Africa), 74% of the catch of sharks by longliners, all targeting swordfish, were blue sharks.

TABLE 4. Catch estimates for blue shark in the Indian Ocean for 2009 and 2010.

Catch		2009	2010
Most recent catch	Blue shark	9,941	9,416 t
	nei-sharks	62,229 t	61,966
Mean catch over the last 5 years (2006–2010)	Blue shark		8,924 t
	nei-sharks		64,838 t

Note that the catches recorded for sharks are thought incomplete. The catches of sharks are usually not reported and when they are they might not represent the total catches of this species but simply those retained on board. It is also likely that the amounts recorded refer to weights of processed specimens, not to live weights. In 2010, seven countries reported catches of blue sharks in the IOTC region.

Nominal and standardised CPUE Trends

Statistics not available at the IOTC Secretariat by species.

Point estimates and values of the 95% confidence interval for the standardized Japanese longline CPUE of blue shark data were provided to IOTC.

There are no surveys specifically designed to assess shark catch rates in the Indian Ocean. Trends in localised areas might be possible in the future (for example, from the Kenyan recreational fishery). Historical research data shows overall decline in CPUE while mean weight of blue shark in this time series are relatively stable (Romanov et al. 2008).Trends in the Japanese CPUE series (Fig.1) suggest that the longline vulnerable biomass was more or less stable during 1994-2003 and subsequently decrease to 2010 (Hiraoka and Yokawa 2011). The nominal CPUEs of blue shark catches by the Portuguese longline fleet in the Indian Ocean showed variability between 1999-2010 and a general decreasing trend. However, the standardized series remained relatively stable with no apparently significant trends in the more recent years (2006-2010). This time series of standardized CPUEs is very short (5 years), it is part of an ongoing analysis, and should therefore be regarded as preliminary (Coelho et al. 2011b).

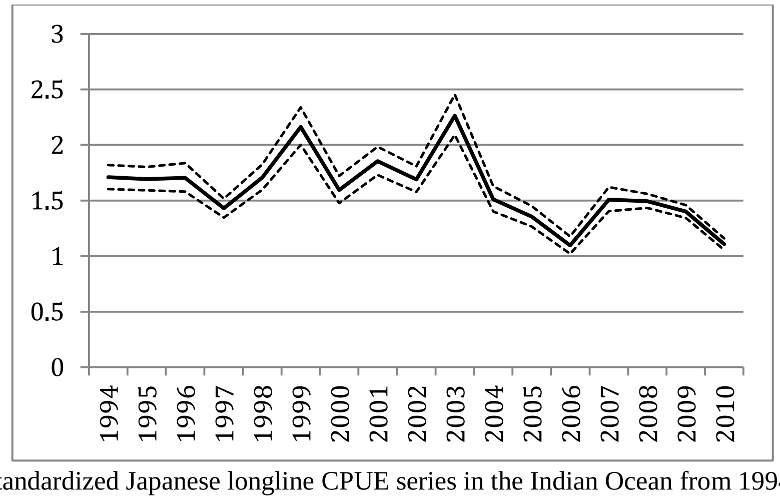


Fig. 1. Standardized Japanese longline CPUE series in the Indian Ocean from 1994 to 2010.

Average weight in the catch by fisheries

Data not available.

Number of squares fished

Catch and effort data not available.

STOCK ASSESSMENT

No quantitative stock assessment for blue shark has been undertaken by the IOTC Working Party on Ecosystems and Bycatch.

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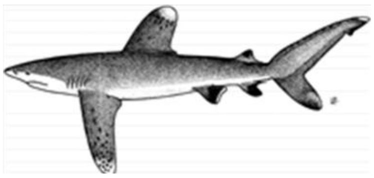
APPENDIX XXVIII
EXECUTIVE SUMMARY: OCEANIC WHITETIP SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean Oceanic Whitetip Shark (*Carcharhinus longimanus*)

TABLE 1. IUCN threat status of oceanic whitetip shark (*Carcharhinus longimanus*) in the Indian Ocean

Common name	Scientific name	IUCN threat status[14]		
		Global status	WIO	EIO
Oceanic whitetip shark	*Carcharhinus longimanus*	Vulnerable	–	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
SOURCES: IUCN (2007, 2011)

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

The SC **RECOMMENDED** the following management advice for oceanic whitetip sharks in the Indian Ocean, noting that there remains considerable uncertainty about the relationship between abundance and the standardized CPUE series from the Japanese longline fleet, and about the total catches over the past decade.

Stock status. The current IUCN threat status of 'Vulnerable' applies to oceanic whitetip sharks globally (Table 1). There is a paucity of information available on this species in the Indian Ocean and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment and limited basic fishery indicators currently available for oceanic whitetip sharks in the Indian Ocean therefore the stock status is highly uncertain. Oceanic whitetip sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived, mature at 4–5 years, and have relativity few offspring (<20 pups every two years), the oceanic whitetip shark is vulnerable to overfishing. Despite the lack of data, it is apparent from the information that is available that oceanic whitetip shark abundance has declined significantly over recent decades.

Outlook. Maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on oceanic whitetip sharks will decline in these areas in the near future, and may result in localised depletion.

The Scientific Committee considered the following:

- The available evidence indicates considerable risk to the stock status at current effort levels.
- The two primary sources of data that drive the assessment, total catches and CPUE are highly uncertain and should be investigated further as a priority.
- Noting that current catches (probably largely underestimated) are estimated at an average ~265 t over the last five years, ~450 t in 2010, maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE.
- The SC recommended that mechanisms are developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Oceanic whitetip sharks in the Indian Ocean are currently subject to a number of conservation and management measures adopted by the Commission:

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ratio of fin-to-body weight for shark fins retained onboard a vessel.

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- Resolution 11/04 *on a Regional Observer Scheme* requires data on blue shark interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010.

Extracts from Resolutions 09/06 and 11/04

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3. CPCs shall take the necessary measures to require that their fishermen fully utilise their entire catches of sharks. Full utilisation is defined as retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing.

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1. Each flag CPC shall ensure that all long line fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system. ….

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency

FISHERIES INDICATORS

General

Oceanic whitetip shark (*Carcharhinus longimanus*) was one of the most common large sharks in warm oceanic waters. It is typically found in the open ocean but also close to reefs and near oceanic islands (Fig. 1). Table 2 outlines some of the key life history traits of oceanic whitetip shark in the Indian Ocean.

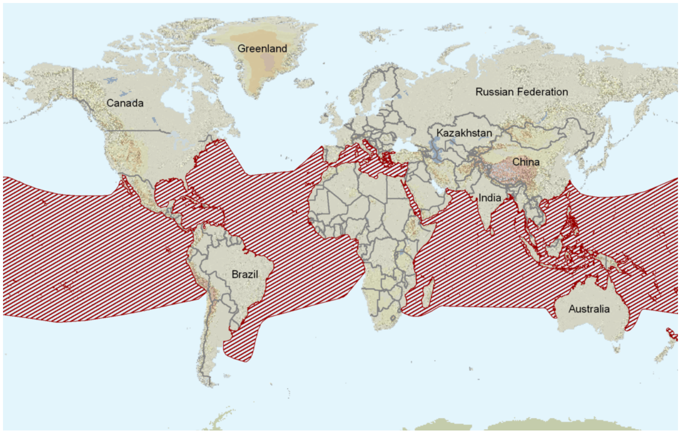

Fig. 1. The worldwide distribution of the oceanic whitetip shark (source: www.iucnredlist.org)

TABLE 2. Biology of Indian Ocean oceanic whitetip shark (*Carcharhinus longimanus*).

Parameter	Description
Range and stock structure	The population dynamics and stock structure of the oceanic whitetip shark in the Indian Ocean are not known. Area of overlap with IOTC management area = high.
Longevity	Maximum age observed was 11 years for the Central and Western Pacific and, 14 years for males and 17 years for females years for the South-Western Atlantic Ocean.
Maturity (50%)	Both males and females mature at around 6 to 7 years old or about 180–190 cm TL in the western South Atlantic Ocean and 4--5 years or 170–190 cm TL in the Central and western Pacific Ocean. Range of observed sizes-at-maturity was 160-196cm TL for males and 181-203cm TL for females.
Reproduction	Oceanic whitetip sharks are viviparous. Litter sizes range from 1-15 pups (mean=6.2) in the Pacific Ocean, with larger sharks producing more offspring. Each pup is approximately 60-65 cm at birth. In the south western Indian Ocean, oceanic whitetip sharks appear to mate and give birth in the early summer, with a gestation period which lasts about one year. The reproductive cycle is believed to be biennial. The locations of the nursery grounds are not well known but they are thought to be in oceanic areas. • Fecundity: medium (<20 pups) • Gestation Period: 12 months • Generation time: 11 years • Reproductive cycle is biennial
Size (length and weight)	Oceanic whitetip sharks are relatively large sharks and grow to up to 350 cm FL. Females grow larger than males. The maximum weight reported for this species is 167.4 kg. Length–weight relationship for both sexes combined in the Indian Ocean is TW=0.386*10-4 * FL2.75586.

SOURCES: Mejuto et al. (2005); Romanov & Romanova (2009); Coelho et al. (2009).

Fisheries

Oceanic whitetip sharks are targeted by some semi-industrial and artisanal fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries and purse seine fishery).

There is little information on the fisheries prior to the early 1970's, and some countries continue not to collect shark data while others do collect it but do not report it to IOTC. It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many catch records probably under-represent the actual catches of sharks because they do not account for discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights. FAO also compiles landings data on elasmobranchs, but the statistics are limited by the lack of species-specific data and data from the major fleets.

The practice of shark finning is considered to be regularly occurring for this species (Clarke 2008; Clarke et al. 2006) and the bycatch/release injury rate is unknown but probably high.

At-haulback mortality of oceanic whitetip sharks in the Atlantic ocean longline fishery targeting swordfish was estimated to be at 30.6% (Coelho et al., 2011).

TABLE 3. Estimated frequency of occurrence and bycatch mortality in the Indian Ocean pelagic fisheries.

Gears	PS	LL		BB/TROL/HAND	GILL	UNCL
		SWO	TUNA			
Frequency	common	common		common	common	unknown
Fishing Mortality	Study in progress	58%		unknown	unknown	unknown
Post release mortality	Study in progress			unknown	unknown	unknown

SOURCES: Romanov (2002, 2008); Ariz et al. (2006); Peterson et al. (2008); Romanov et al. (2008); Poisson et al. (2010)

Catch trends

The catch estimates for oceanic whitetip shark are highly uncertain as is their utility in terms of minimum catch estimates. Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, and Sri-Lanka) while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories). For CPCs reporting longline data by species (i.e. Australia, Spain, Portugal, United Kingdom and South Africa), 0.6% of the catch of sharks by longliners, all targeting swordfish, were oceanic whitetip sharks, and for CPCs reporting gillnet data by species (i.e. Sri Lanka), 7% of the catches of shark were oceanic whitetip sharks.

TABLE 4. Catch estimates for oceanic whitetip shark in the Indian Ocean for 2009 and 2010.

Catch		2009	2010
Most recent catch	Oceanic white tip shark	245 t	450 t
	nei-sharks	62,229 t	61,966 t
Mean catch over the last 5 years (2006–2010)	Oceanic white tip shark		265 t
	nei-sharks		64,838 t

Note that the catches recorded for sharks are thought incomplete. The catches of sharks are usually not reported and when they are they might not represent the total catches of this species but simply those retained on board. It is also likely that the amounts recorded refer to weights of processed specimens, not to live weights. In 2010, seven countries reported catches of oceanic whitetip sharks in the IOTC region.

Nominal and standardised CPUE Trends

Statistics not available at the IOTC Secretariat. Point estimates and 95% confidence interval for the standardized Japanese longline CPUE of oceanic whitetip shark data were not provided to the IOTC Secretariat.

Historical research data shows overall decline in CPUE and mean weight of oceanic whitetip shark (Romanov et al 2008). The authors of the paper presented at the WPEB07 (Semba and Yokawa 2011) stated that the early CPUE (2000-2002) were not reliable due to the data problems. Trends in the Japanese standardized CPUE series (2004-2009) suggest that the longline vulnerable biomass has clearly decreased (Semba and Yokawa 2011). Anecdotal reports suggest that oceanic white tips have become rare throughout much of the Indian Ocean during the past 20 years. Indian longline research surveys reported zero catches from the Arabia Sea during 2004–09 (John and Varghese 2009).

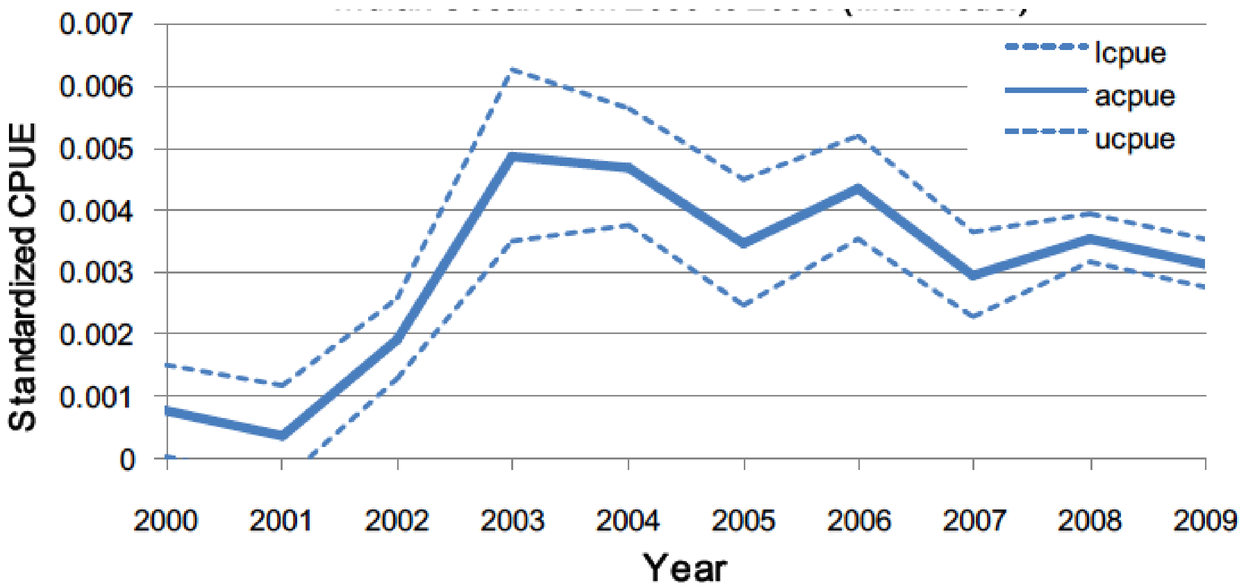

Fig. 1. Japanese longline CPUE series for oceanic whitetip shark in the Indian Ocean from 2000 to 2009.

Average weight in the catch by fisheries

Data not available.

Number of squares fished

Catch and effort data not available.

STOCK ASSESSMENT

No quantitative stock assessment for oceanic whitetip shark has been undertaken by the IOTC Working Party on Ecosystems and Bycatch.

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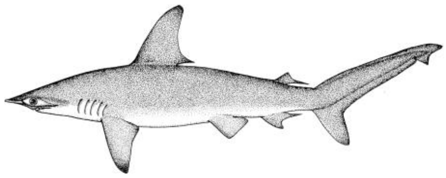
APPENDIX XXIX
EXECUTIVE SUMMARY: SCALLOPED HAMMERHEAD SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean Scalloped Hammerhead Shark (*Sphyrna lewini*)

TABLE 1. IUCN threat status of scalloped hammerhead shark (*Sphyrna lewini*) in the Indian Ocean.

Common name	Scientific name	IUCN threat status[15]		
		Global status	**WIO**	**EIO**
Scalloped hammerhead	*Sphyrna lewini*	Endangered	Endangered	Least concern

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
SOURCES: IUCN (2007, 2011)

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. The current IUCN threat status of 'Endangered' applies to blue sharks globally and specifically for the western Indian Ocean (Table 1). There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment or basic fishery indicators currently available for scalloped hammerhead shark in the Indian Ocean therefore the stock status is highly uncertain. Scalloped hammerhead sharks are commonly taken by a range of fisheries in the Indian Ocean. They are extremely vulnerable to gillnet fisheries. Furthermore, pups occupy shallow coastal nursery grounds, often heavily exploited by inshore fisheries. Because of their life history characteristics – they are relatively long lived (over 30 years), and have relativity few offspring (<31 pups each year), the scalloped hammerhead shark is vulnerable to overfishing.

Outlook. Maintaining or increasing effort will probably result in further declines in biomass and productivity. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on scalloped hammerhead shark will decline in these areas in the near future, and may result in localised depletion.

The Scientific Committee considered the following:

- The available evidence indicates considerable risk to the stock status at current effort levels.
- The primary source of data that drive the assessment (total catches) is highly uncertain and should be investigated further as a priority.
- Noting that current reported catches (probably largely underestimated) are estimated at an average ~16 t over the last five years, ~22 t in 2010, maintaining or increasing effort will probably result in further declines in biomass and productivity.
- The SC recommended that mechanisms are developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Scalloped hammerhead shark in the Indian Ocean are currently subject to a number of conservation and management measures adopted by the Commission:

- Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC* includes minimum reporting requirements for sharks, calls for full utilisation of sharks and includes a ratio of fin-to-body weight for shark fins retained onboard a vessel.
- Resolution 08/04 *Concerning the recording of catch by longline fishing vessels in the IOTC area* sets out the minimum logbook requirements for longline fishing vessels over 24 metres length and under 24 metres if they

[15] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

fish outside the EEZ of their flag State. As per this resolution, catch of all sharks must be recorded.

- Resolution 10/03 *Concerning the recording of catch by fishing vessels in the IOTC area* sets out minimum logbook requirements for all purse-seine vessels 24 metres length overall or greater and those under 24 metres if they fish outside the EEZs of their flag States. As per this resolution, catch and discard of all shark species should be recorded.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on blue shark interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010.

Extracts from Resolutions 09/06 and 11/04

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

3. CPCs shall take the necessary measures to require that their fishermen fully utilise their entire catches of sharks. Full utilisation is defined as retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing.

RESOLUTION 08/04 CONCERNING THE RECORDING OF CATCH BY LONGLINE FISHING VESSELS IN THE IOTC AREA

1. Each flag CPC shall ensure that all long line fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system. ….

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency

FISHERIES INDICATORS

General

Scalloped hammerhead shark (*Sphyrna lewini*) is widely distributed and common in warm temperate and tropical waters (Fig. 1). It is also found in estuarine and inshore waters. In some areas, the scalloped hammerhead shark forms large resident populations. In other areas, large schools of small-sized sharks are known to make seasonal migrations polewards. Scalloped hammerhead sharks feeds on pelagic fishes, rays and occasionally other sharks, squids, lobsters, shrimps and crabs. Table 2 outlines some of the key life history traits of scalloped hammerhead shark in the Indian Ocean.

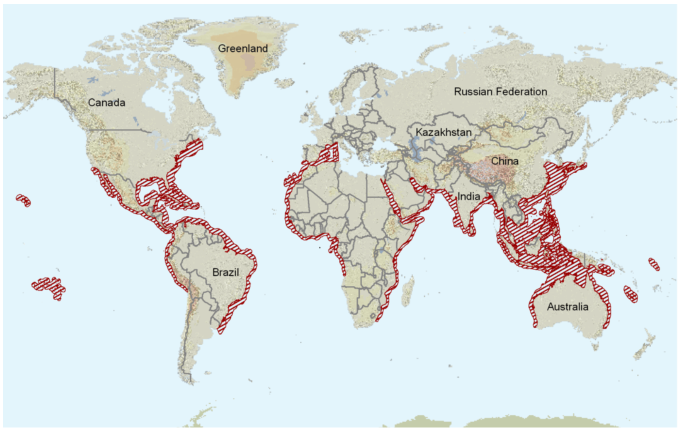


Fig. 1. The worldwide distribution of the scalloped hammerhead shark (source: www.iucnredlist.org)

TABLE 2. Biology of Indian Ocean scalloped hammerhead shark (*Sphyrna lewini*).

Parameter	Description
Range and stock structure	The scalloped hammerhead shark is widely distributed and common in warm temperate and tropical waters down to 900 m. It is also found in estuarine and inshore waters. In some areas, the scalloped hammerhead shark forms large resident populations. In other areas, large schools of small-sized sharks are known to migrate seasonally polewards. Area of overlap with IOTC management area = high. There is no information available on stock structure.
Longevity	The maximum age for Atlantic Ocean scalloped hammerheads is estimated to be over 30 years with the largest individuals reaching over 310 cm TL. In the Eastern Indian Ocean, females are reported to reach 350 m TL
Maturity (50%)	Males in the eastern Indian Ocean mature at around 140-165 cm TL. Females mature at about 200 cm TL. In the northern Gulf of Mexico females are believed to mature at about 15 years and males at 9-10 years.
Reproduction	The scalloped hammerhead shark is viviparous with a yolk sac-placenta. Litters consist of 13-23 pups (mean=16.5). The reproductive cycle is annual and the gestation period is 9-10 months. The nursery areas are in shallow coastal waters. • Fecundity: medium (<31 pups) • Generation time: 17-21 years • Gestation Period: 9-10 months • Reproductive cycle is annual
Size (length and weight)	The maximum size for Atlantic Ocean scalloped hammerheads is estimated to be over 310 cm TL. In the Eastern Indian Ocean, females are reported to reach 350 m TL New-born pups are around 45-50 cm TL at birth in the eastern Indian Ocean.

SOURCES: Stevens and Lyle (1989); Jorgensen et al (2009)

Fisheries

Scalloped hammerhead sharks are often targeted by some semi-industrial, artisanal and recreational fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries and purse seine fishery). There is little information on the fisheries prior to the early 1970's, and some countries continue not to collect shark data while others do collect it but do not report it to IOTC. It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many catch records probably under-represent the actual catches of sharks because they do not account for discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights. FAO also compiles landings data on elasmobranchs, but the statistics are limited by the lack of species-specific data and data from the major fleets.

The practice of shark finning is considered to be regularly occurring and on the increase for this species (Clarke 2008; Clarke et al. 2006, Holmes et al. 2009) and the bycatch/release injury rate is unknown but probably high.

TABLE 3. Estimated frequency of occurrence and bycatch mortality in the Indian Ocean pelagic fisheries.

Gears	PS	LL		BB/TROL/HAND	GILL	UNCL
		SWO	TUNA			
Frequency	rare	common		absent	common	unknown
Fishing Mortality	unknown	unknown	unknown	unknown	unknown	unknown
Post release mortality	unknown	unknown	unknown	unknown	unknown	unknown

SOURCES: Romanov (2002, 2008); Dudley & Simpfendorfer (2006); Romanov et al. (2008)

Catch trends

The catch estimates for scalloped hammerhead are highly uncertain as is their utility in terms of minimum catch estimates. Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, and Sri-Lanka) while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories).

TABLE 4. Catch estimates for scalloped hammerhead shark* in the Indian Ocean for 2009 and 2010.

Catch		2009	2010
Most recent catch	Scalloped hammerhead shark	21 t	22 t
	nei-sharks	62,229 t	61,966 t
Mean catch over the last 5 years (2006–2010)	Scalloped hammerhead shark		16 t
	nei-sharks		64,838 t

* catches likely to be misidentified with the smooth hammerhead shark (*S. zygaena*) which is an oceanic species.

Note that the catches recorded for sharks are thought incomplete. The catches of sharks are usually not reported and when they are they might not represent the total catches of this species but simply those retained on board. It is also likely that the amounts recorded refer to weights of processed specimens, not to live weights. In 2010, seven countries reported catches of scalloped hammerhead sharks in the IOTC region.

Nominal and standardised CPUE Trends

Data not available at the IOTC Secretariat. However, Indian longline research surveys, in which scalloped hammerhead sharks contributed up to 6% of regional catch, demonstrate declining catch rates over the period 1984–2006 (John and Varghese 2009). CPUE in South African protective net shows steady decline from 1978.

Average weight in the catch by fisheries

Data not available.

Number of squares fished

Catch and effort data not available.

STOCK ASSESSMENT

No quantitative stock assessment for scalloped hammerhead shark has been undertaken by the IOTC Working Party on Ecosystems and Bycatch.

LITERATURE CITED

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Romanov E, Bach P, Romanova N, 2008. Preliminary estimates of bycatches in the western equatorial Indian Ocean in the traditional multifilament longline gears (1961-1989) IOTC Working Party on Ecosystems and Bycatch (WPEB) Bangkok, Thailand. 20-22 October, 2008. 18 p.

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APPENDIX XXX
EXECUTIVE SUMMARY: SHORTFIN MAKO SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi

Status of the Indian Ocean Shortfin Mako Shark (*Isurus oxyrinchus*)

TABLE 1. – IUCN threat status of shortfin mako shark (*Isurus oxyrinchus*) in the Indian Ocean

Common name	Scientific name	IUCN threat status[16]		
		Global status	WIO	EIO
Shortfin mako shark	*Isurus oxyrinchus*	Vulnerable	–	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
SOURCES: IUCN (2007, 2011)

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

The SC **RECOMMENDED** the following management advice for shortfin mako shark in the Indian Ocean, for the consideration of the Scientific Committee, noting that there remains considerable uncertainty about the relationship between abundance and the standardized CPUE series from the Japanese longline fleet, and about the total catches over the past decade.

Stock status. The current IUCN threat status of 'Vulnerable' applies to shortfin mako sharks globally (Table 1). Trends in the Japanese CPUE series suggest that the longline vulnerable biomass has declined from 1994 to 2003, and has been increasing since then. There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment or basic fishery indicators currently available for shortfin mako shark in the Indian Ocean therefore the stock status is highly uncertain. Shortfin mako sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (over 30 years), females mature at 18–21 years, and have relativity few offspring (<25 pups every two or three years), the shortfin mako shark is vulnerable to overfishing.

Outlook. Maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on shortfin mako shark will decline in these areas in the near future, and may result in localised depletion.

The Scientific Committee considered the following:

- The available evidence indicates considerable risk to the stock status at current effort levels.
- The two primary sources of data that drive the assessment, total catches and CPUE are highly uncertain and should be investigated further as a priority.
- Noting that current reported catches are estimated (probably largely underestimated) at an average ~990 t over the last five years, ~738 t in 2010, maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE.
- The SC recommended that mechanisms are developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Shortfin mako shark in the Indian Ocean are currently subject to a number of conservation and management measures adopted by the Commission:

- Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC* includes minimum reporting requirements for sharks, calls for full utilisation of sharks and includes a ratio of fin-to-body weight for shark fins retained onboard a vessel.

[16] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

- Resolution 08/04 *Concerning the recording of catch by longline fishing vessels in the IOTC area* sets out the minimum logbook requirements for longline fishing vessels over 24 metres length and under 24 metres if they fish outside the EEZ of their flag State. As per this resolution, catch of all sharks must be recorded.
- Resolution 10/03 *Concerning the recording of catch by fishing vessels in the IOTC area* sets out minimum logbook requirements for all purse-seine vessels 24 metres length overall or greater and those under 24 metres if they fish outside the EEZs of their flag States. As per this resolution, catch and discard of all shark species should be recorded.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on blue shark interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010.

Extracts from Resolutions 09/06 and 11/04

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

3. CPCs shall take the necessary measures to require that their fishermen fully utilise their entire catches of sharks. Full utilisation is defined as retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing.

RESOLUTION 08/04 CONCERNING THE RECORDING OF CATCH BY LONGLINE FISHING VESSELS IN THE IOTC AREA

1. Each flag CPC shall ensure that all long line fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system. ….

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency

FISHERIES INDICATORS

General

Shortfin mako shark (*Isurus oxyrinchus*) is widely distributed in tropical and temperate waters warmer than 16°C (Fig. 1) and is one of the fastest swimming shark species. It is known to leap out of the water when hooked and is often found in the same waters as swordfish. This species is at the top of the food chain, feeding on fast-moving fishes such as swordfish and tunas and occasionally on other sharks. Table 2 outlines some of the key life history traits of shortfin mako shark in the Indian Ocean.

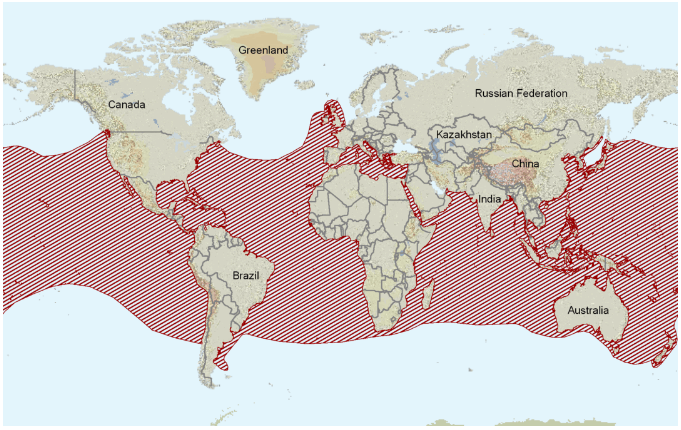

Fig. 1. The worldwide distribution of the shortfin mako shark (source: www.iucnredlist.org)

TABLE 2. Biology of Indian Ocean shortfin mako shark (*Isurus oxyrinchus*)

Parameter	Description
Range and stock structure	Widely distributed in tropical and temperate waters warmer than 16°C. Makos prefer epipelagic and littoral waters from the surface down to depths of 500 meters. Shortfin mako is not known to school. It has a tendency to follow warm water masses polewards in the summer. Tagging results from the North Atlantic Ocean showed that makos migrated over long distances and this suggests that there is a single well-mixed population in this area. Area of overlap with IOTC management area = high. No information is available on stock structure of shortfin mako sharks in the Indian Ocean.
Longevity	Maximum lifespans reported for this species are 32 years for females and 29 years for males in the western North Atlantic.
Maturity (50%)	Sexual maturity is estimated to be reached at 18-19 years or 290-300 m TL for females and 8 years or about 200 m TL for males in the western North Atlantic and 19-21 years or 207-290 m TL for females and 7-9 years or 180-190 m TL for males in the western South Pacific. In the western South Indian Ocean maturity was estimated at about 270 m TL for females and 190-210 m TL for males. The length at maturity of female shortfin mako sharks differs between the Northern and Southern hemispheres.
Reproduction	Female shortfin mako sharks are aplacental viviparous. Developing embryos feed on unfertilized eggs in the uterus during the gestation period, whose length is subject to debate but is believed to last 15-18 months. Litter size ranges from 4 to 25 pups (mean=12.5), with larger sharks producing more offspring. The nursery areas are apparently in deep tropical waters. The length of the reproductive cycle is up to three years. Generation time is estimated to be 14 years. • Fecundity: medium (<25 pups) • Generation time: 23 years • Gestation Period: 15-18 months • Reproductive cycle is biennial or triennial
Size (length and weight)	Maximum size of shortfin mako sharks in Northwest Atlantic Ocean is 4 m and 570 kg. In the Indian Ocean a female individual of 248 cm FL and 130 kg TW was aged as 18 years old. Length–weight relationship for both sexes combined in the Indian Ocean is TW=0.349*10-4 * FL2.76544. New-born pups are around 70 cm (TL).

SOURCES: Bass et al. (1973); Mejuto et al. (2005); Romanov & Romanova (2009)

Fisheries

Shortfin mako sharks are often targeted by some semi-industrial, artisanal and recreational fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries and anecdotally by the purse seine fishery). In other Oceans, due to its energetic displays and edibility, the shortfin mako shark is considered one of the great gamefish of the world. There is little information on the fisheries prior to the early 1970's, and some countries continue not to collect shark data while others do collect it but do not report it to IOTC. It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many catch records probably under-represent the actual catches of sharks because they do not account for discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights. FAO also compiles landings data on elasmobranchs, but the statistics are limited by the lack of species-specific data and data from the major fleets.

The practice of shark finning is considered to be regularly occurring for this species (Clarke et al. 2006; Clarke 2008) and the bycatch/release injury rate is unknown but probably high.

TABLE 3. Estimated frequency of occurrence and bycatch mortality in the Indian Ocean pelagic fisheries.

Gears	**PS**	**LL**		**BB/TROL/HAND**	**GILL**	**UNCL**
		SWO	**TUNA**			
Frequency	rare	common		rare–common	unknown	unknown
Fishing Mortality	unknown	13 to 51 %	0 to 31%	unknown	unknown	unknown
Post release mortality	unknown	19%		unknown	unknown	unknown

SOURCES: Romanov (2002, 2008); Ariz et al. (2006); Dudley & Simpfendorfer (2006); Peterson et al. (2008); Romanov et al. (2008)

Catch trends

The catch estimates for shortfin mako shark are highly uncertain as is their utility in terms of minimum catch estimates. Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, and Sri-Lanka while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories). For CPCs reporting longline data by species (i.e.

Australia, Spain, Portugal, United Kingdom and South Africa), 12% of the catch of sharks by longliners, all targeting swordfish, were shortfin mako sharks.

TABLE 4. Catch estimates for shortfin mako shark in the Indian Ocean for 2009 and 2010.

Catch		2009	2010
Most recent catch	Shortfin mako shark	561 t	738 t
	nei-sharks	62,229 t	61,966 t
Mean catch over the last 5 years (2006–2010)	Shortfin mako shark		990 t
	nei-sharks		64,838 t

Note that the catches recorded for sharks are thought incomplete. The catches of sharks are usually not reported and when they are they might not represent the total catches of this species but simply those retained on board. It is also likely that the amounts recorded refer to weights of processed specimens, not to live weights. In 2010, seven countries reported catches of blue sharks in the IOTC region.

Nominal and standardised CPUE Trends

Statistics not available at the IOTC Secretariat. Point estimates and 95% confidence interval for the standardized Japanese longline CPUE of shortfin mako shark data were not provided to the IOTC Secretariat.

Historical research data shows overall decline in CPUE and mean weight of mako sharks (Romanov et al. 2008). CPUE in South African protection net is fluctuating without any trend (Holmes et al. 2009). The CPUEs of shortfin mako catches by the Portuguese longline fleet in the Indian Ocean showed some significant variability between 1999-2010, but no noticeable trends. The standardized series for the more recent years (2006-2010) also did not show significant trends. It should be noted that this time series of standardized CPUEs is very short (5 years), part of an ongoing analysis, and should therefore be regarded as preliminary (Coelho et al. 2011b).

The Japanese CPUE series (Fig. 1) suggest that the longline vulnerable biomass largely fluctuated during 1994-2010 (Kimoto et al. 2011) and there are no apparent trends.

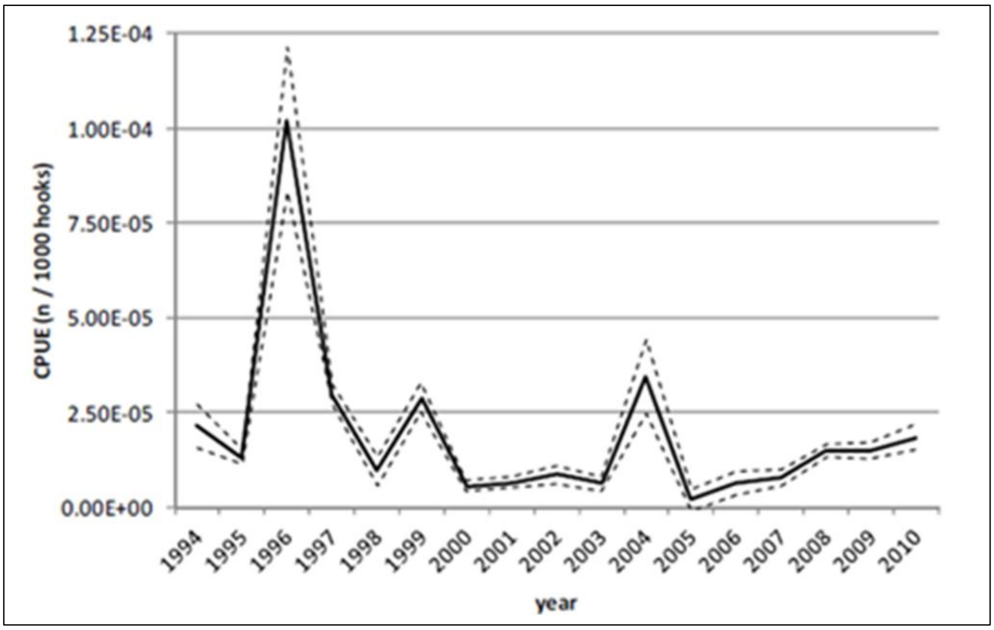

Fig. 1. Standardized Japanese longline CPUE series in the Indian Ocean from 1994 to 2010 for shortfin mako shark.

Average weight in the catch by fisheries

Data not available.

Number of squares fished

Catch and effort data not available.

STOCK ASSESSMENT

No quantitative stock assessment for shortfin mako has been undertaken by the IOTC Working Party on Ecosystems and Bycatch.

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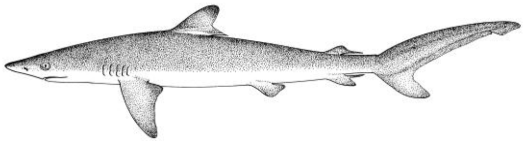
APPENDIX XXXI
EXECUTIVE SUMMARY: SILKY SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean Silky Shark
(*Carcharhinus falciformis*)

TABLE 1. IUCN threat status of silky shark (*Carcharhinus falciformis*) in the Indian Ocean

Common name	Scientific name	IUCN threat status[17]		
		Global status	WIO	EIO
Silky shark	*Carcharhinus falciformis*	Near Threatened	Near Threatened	Near Threatened

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
SOURCES: IUCN (2007, 2011)

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. The current IUCN threat status of 'Near Threatened' applies to silky sharks in the western and eastern Indian Ocean and globally (Table 1). There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment or basic fishery indicators currently available for silky shark in the Indian Ocean therefore the stock status is highly uncertain. Silky sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (over 20 years), mature relatively late (at 6–12 years), and have relativity few offspring (<20 pups every two years), the silky shark is vulnerable to overfishing. Despite the lack of data, it is clear from the information that is available that silky shark abundance has declined significantly over recent decades.

Outlook. Maintaining or increasing effort will probably result in declines in biomass, productivity and CPUE. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on silky shark will decline in these areas in the near future, and may result in localised depletion.

The Scientific Committee considered the following:

- The available evidence indicates considerable risk to the stock status at current effort levels.
- Total catches are highly uncertain and should be investigated further as a priority.
- Noting that current reported catches (probably largely underestimated) are estimated at an average ~ 670 t over the last five years, ~1, 153 t in 2010, maintaining or increasing effort will probably result in further declines in biomass.
- The SC recommended that mechanisms are developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Silky shark in the Indian Ocean are currently subject to a number of conservation and management measures adopted by the Commission:

- Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC* includes minimum reporting requirements for sharks, calls for full utilisation of sharks and includes a ratio of fin-to-body weight for shark fins retained onboard a vessel.
- Resolution 08/04 *Concerning the recording of catch by longline fishing vessels in the IOTC area* sets out the minimum logbook requirements for longline fishing vessels over 24 metres length and under 24 metres if they fish outside the EEZ of their flag State. As per this resolution, catch of all sharks must be recorded.

[17] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

- Resolution 10/03 *Concerning the recording of catch by fishing vessels in the IOTC area* sets out minimum logbook requirements for all purse-seine vessels 24 metres length overall or greater and those under 24 metres if they fish outside the EEZs of their flag States. As per this resolution, catch and discard of all shark species should be recorded.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on blue shark interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010.

Extracts from Resolutions 09/06 and 11/04

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

3. CPCs shall take the necessary measures to require that their fishermen fully utilise their entire catches of sharks. Full utilisation is defined as retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing.

RESOLUTION 08/04 CONCERNING THE RECORDING OF CATCH BY LONGLINE FISHING VESSELS IN THE IOTC AREA

1. Each flag CPC shall ensure that all long line fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system. ….

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency

FISHERIES INDICATORS

General

Silky sharks (*Carcharhinus falciformis*) are one of the most abundant large sharks inhabiting warm tropical and subtropical waters throughout the world (Fig. 1). Table 2 outlines some of the key life history traits of silky shark in the Indian Ocean.

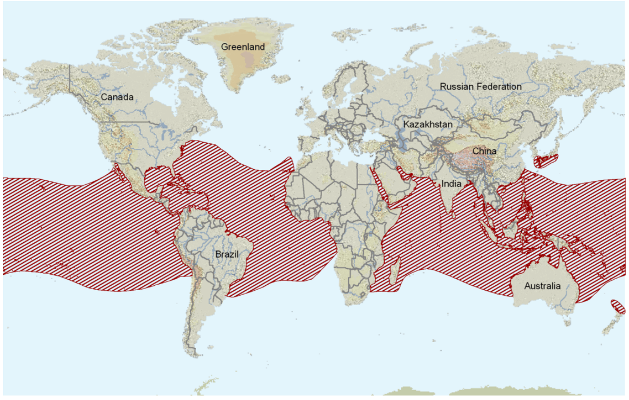


Fig. 1. The worldwide distribution of the silky shark (source: www.iucnredlist.org)

TABLE 2. Biology of Indian Ocean Silky sharks (*Carcharhinus falciformis*).

Parameter	Description
Range and stock structure	Essentially pelagic, the silky shark is distributed from slopes to the open ocean. It also ranges to inshore areas and near the edges of continental shelves and over deepwater reefs. It also demonstrates strong fidelity to seamounts and natural or man-made objects (like FADs) floating at the sea surface. Silky sharks live down to 500 m. Typically, smaller individuals are found in coastal waters. Small silky sharks are also commonly associated with schools of tuna, particularly under floating objects. Large silky sharks associate with free-swimming tuna schools. Silky sharks often form mixed-sex schools containing similar sized individuals. Area of overlap with IOTC management area = high. No information is available on stock structure.
Longevity	20+ years for males; 22+ years for females in the southern Gulf of Mexico and maximum size is over 300 cm long. Generation time was estimated to be between 11 and 16 years in the Gulf of Mexico years.
Maturity (50%)	The age of sexual maturity is variable. In the Atlantic Ocean, off Mexico, silky sharks mature at 10-12+ years. By contrast in the Pacific Ocean, males mature at around 5-6 years and females mature at around 6-7 years. Size: 239 cm TL for males; 216 cm Tl for females.

Reproduction	The silky shark is a placental viviparous species with a gestation period of around 12 months. Females give birth possibly every two years. The number of pups per litter ranges from 9-14 in the Eastern Indian Ocean, and 2-11 in the Pacific Ocean. • Fecundity: medium (<20 pups) • Generation time: 11-16 years • Gestation period: 12 months • Reproductive cycle is biennial
Size (length and weight)	Maximum size is over 300 cm long FL. New-born pups are around 75-80 cm TL or less at birth. Reported as 56–63 cm TL in the Maldives. 78–87 cm TL in South Afrrica. Length–weight relationship for both sexes combined in the Indian Ocean is TW=0.160*10-4 * FL2.91497.

SOURCES: Strasburg (1958); Bass et al. (1973); Stevens (1984); Anderson & Ahmed (1993); Mejuto et al (2005); Matsunaga (2007); Romanov & Romanova (2009)

Fisheries

Silky sharks are often targeted by some semi-industrial, artisanal and recreational fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries and purse seine fishery). Sri Lanka has had a large fishery for silky shark for over 40 years.

There is little information on the fisheries prior to the early 1970’s, and some countries continue not to collect shark data while others do collect it but do not report it to IOTC. It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many catch records probably under-represent the actual catches of sharks because they do not account for discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights. FAO also compiles landings data on elasmobranchs, but the statistics are limited by the lack of species-specific data and data from the major fleets.

The practice of shark finning is considered to be regularly occurring and on the increase for this species (Clarke 2008; Clarke et al. 2006) and the bycatch/release injury rate is unknown but probably high.

TABLE 3. Estimated frequency of occurrence and bycatch mortality in the Indian Ocean pelagic fisheries.

Gears	PS	LL		BB/TROL/HAND	GILL	UNCL
		SWO	TUNA			
Frequency	common	abundant		common	abundant	abundant
Fishing Mortality	study in progress	study in progress	study in progress	unknown	unknown	unknown
Post release mortality	study in progress	unknown	unknown	unknown	unknown	unknown

SOURCES: Romanov (2002, 2008); Ariz et al. (2006); Peterson et al. (2008); Romanov et al. (2008)

Catch trends

The catch estimates for silky shark are highly uncertain as is their utility in terms of minimum catch estimates. Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, and Sri Lanka) while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories). For CPCs reporting longline data by species (i.e. Australia, Spain, Portugal, United Kingdom and South Africa), 1.5% of the catch of sharks by longliners, all targeting swordfish, were silky sharks, and for CPCs reporting gillnet data by species (i.e. Sri Lanka), 22% of the catches of shark were silky sharks.

TABLE 4. Catch estimates for silky shark in the Indian Ocean for 2009 and 2010.

Catch		2009	2010
Most recent catch	Silky shark	543 t	1,153 t
	nei-sharks	62,229 t	61,966 t
Mean catch over the last 5 years (2006–2010)	Silky shark		670 t
	nei-sharks		64,838 t

Note that the catches recorded for sharks are thought incomplete. The catches of sharks are usually not reported and when they are they might not represent the total catches of this species but simply those retained on board. It is also likely that the amounts recorded refer to weights of processed specimens, not to live weights. In 2010, seven countries reported catches of silky sharks in the IOTC region.

Nominal and standardised CPUE Trends

Data not available at the IOTC Secretariat. However, Maldivian shark fishermen report significant declines in silky shark abundance over past 20 years (Anderson 2009). In addition, Indian longline research surveys, in which silky sharks contributed 7% of catch, demonstrate declining catch rates over the period 1984–2006 (John & Varghese 2009). No long-term data for purse-seine CPUE are available, however there is anecdotal evidences of five-fold decrease of silky shark catches per set between 1980s and 2005s.

Average weight in the catch by fisheries

Data not available.

Number of squares fished

Catch and effort data not available.

STOCK ASSESSMENT

No quantitative stock assessment for silky shark has been undertaken by the IOTC Working Party on Ecosystems and Bycatch.

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Petersen S, Nel D, Ryan P and Underhill L, 2008. Understanding and mitigating vulnerable bycatch in southern African trawl and longline fisheries. 225 p. WWF South Africa Report Series.

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APPENDIX XXXII
EXECUTIVE SUMMARY: BIGEYE THRESHER SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi

Status of the Indian Ocean Bigeye Thresher Shark (*Alopias superciliosus*)

TABLE 1. IUCN threat status. of bigeye thresher shark (*Alopias superciliosus*) in the Indian Ocean

Common name	Scientific name	IUCN threat status[18]		
		Global status	WIO	EIO
Bigeye thresher shark	*Alopias superciliosus*	Vulnerable	–	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
SOURCES: IUCN (2007, 2011)

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

The SC **RECOMMENDED** the following management advice for bigeye thresher shark in the Indian Ocean, noting that there remains considerable uncertainty in the stock status due to lack of information necessary for assessment or to for the development of other indicators of the stock.

Stock status. The current IUCN threat status of 'Vulnerable' applies to bigeye thresher shark globally (Table 1). There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment and limited basic fishery indicators currently available for bigeye thresher shark in the Indian Ocean therefore the stock status is highly uncertain. Bigeye thresher sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (+20 years), mature at 9-13 years, and have few offspring (2-4 pups every year), the bigeye thresher shark is vulnerable to overfishing.

Outlook. Current longline fishing effort is directed to other species, however bigeye thresher sharks is a common bycatch these fisheries. Hooking mortality is apparently very high, therefore IOTC regulation 10/12 prohibiting retaining of any part of thresher sharks onboard and promoting life release of thresher shark are apparently ineffective for species conservation. Maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE. However there are few data to estimated CPUE trends, in view of IOTC regulation 10/12 and reluctance of fishing fleet to report information on discards/non-retained catch. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into other areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on bigeye thresher shark will decline in these areas in the near future, which may result in localised depletion.

The Scientific Committee considered the following:

- The available evidence indicates considerable risk to the status of the IO stock at current effort levels.
- Two important sources of data that inform the assessment, total catches and CPUE are highly uncertain and should be investigated further as a priority.
- Noting that current catches (probably largely underestimated) are estimated at an average ~4 t over the last five years, ~5 t in 2010, maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE.
- The SC recommended that mechanisms are developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.
- The SC agreed that three options should be considered for amendment of Resolution 08/04 concerning the recording of the catch by longline fishing vessels in the IOTC area in order to improve data collection and statistics on sharks that would allow the development of stock status indicators.

[18] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Bigeye thresher shark in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission:

- Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC* includes minimum reporting requirements for sharks, calls for full utilisation of sharks and includes a ratio of fin-to-body weight for shark fins retained onboard a vessel (although for thresher sharks this has been largely superseded by Resolution 10/12 as it is prohibited to retain any part).
- Resolution 08/04 *Concerning the recording of catch by longline fishing vessels in the IOTC area* sets out the minimum logbook requirements for longline fishing vessels over 24 metres length and under 24 metres if they fish outside the EEZ of their flag State. As per this resolution, catch of all sharks (retained and discarded) must be recorded.
- Resolution 10/03 *Concerning the recording of catch by fishing vessels in the IOTC area* sets out minimum logbook requirements for all purse-seine vessels 24 metres length overall or greater and those under 24 metres if they fish outside the EEZs of their flag States. As per this resolution, catch and discard of all shark species should be recorded.
- Resolution 10/12 *On the Conservation of Thresher Sharks (Family Alopiidae) caught in Association with Fisheries in the IOTC Area of Competence* prohibiting Fishing Vessels flying the flag of IOTC Members and Cooperating non-Contracting Parties (CPCs) from retaining on board, transhipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family Alopiidae.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on bigeye thresher shark interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010.

Extracts from Resolutions 09/06 and 11/04

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

3. CPCs shall take the necessary measures to require that their fishermen fully utilise their entire catches of sharks. Full utilisation is defined as retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing.[19]

RESOLUTION 08/04 CONCERNING THE RECORDING OF CATCH BY LONGLINE FISHING VESSELS IN THE IOTC AREA

1. Each flag CPC shall ensure that all long line fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system. ….

RESOLUTION 10/12 ON THE CONSERVATION OF THRESHER SHARKS (FAMILY ALOPIIDAE) CAUGHT IN ASSOCIATION WITH FISHERIES IN THE IOTC AREA OF COMPETENCE

1. Fishing Vessels flying the flag of an IOTC Member and Cooperating non-Contracting Parties (CPCs) are prohibited from retaining on board, transshipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family Alopiidae.
2. CPCs shall require vessels flying their flag to promptly release unharmed, to the extent practicable, thresher sharks when brought along side for taking on board the vessel.
3. CPCs shall encourage their fishermen to record incidental catches as well as live releases. These data will be then kept at the IOTC secretariat.

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency

FISHERIES INDICATORS

General

Bigeye thresher shark (*Alopias superciliosus*) is found in pelagic coastal and oceanic waters throughout the tropical and temperate oceans worldwide (Fig. 1). Found in coastal waters over the continental shelves, sometimes close inshore in shallow waters, and on the high seas in the epipelagic zone far from land; also caught near the bottom in deep water on

[19] This is not applicable to Alopiidae in view of Resolution 10/12 *On the conservation of thresher sharks (Family Alopiidae) caught in association with fisheries in the IOTC area of competence*.

the continental slopes (Compagno 2001). It can be found near the surface, and has even been recorded in the intertidal, but it is commonest below 100m depth, occurs regularly to at least 500 m deep and has been recorded to 723 m deep (Nakano et al. 2003, Compagno 2001). No predation on bigeye thresher sharks has been reported to date; however it may be preyed upon by makos, white sharks, and killer whales. Fishing is the major contributor to adult mortality. This species used its long tail to attack prey (Compagno 2001; Aalbers et al. 2010). Table 2 outlines some of the key life history traits of bigeye thresher shark in the Indian Ocean.

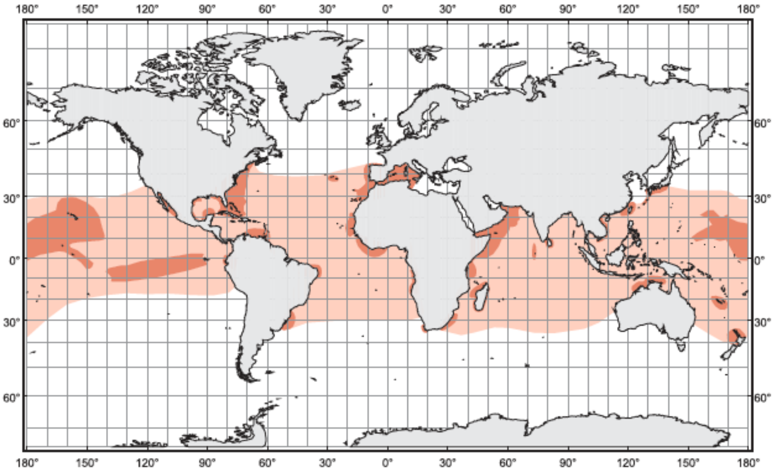

Fig. 1. The worldwide distribution of the bigeye thresher shark (source: FAO).

TABLE 2. Biology of Indian Ocean bigeye thresher shark (*Alopias superciliosus*).

Parameter	**Description**
Range and stock structure	In the tropical Indian Ocean, the greatest abundance of bigeye thresher shark occurs at depths of 50 to 300 m, in temperatures ranging from 8 to 25°C. It is considered a highly migratory species, however, no published information on horizontal movements of bigeye thresher shark is known for the Indian Ocean. This species exhibits a prominent diurnal pattern in vertical distribution spending daytime at the depth between 200 and 700 m depth and migrating to the upper layers at night. Bigeye thresher shark is a solitary fish however it is often caught in the same areas and habitats as pelagic thresher sharks *Alopias pelagicus*. Area of overlap with IOTC management area = high. No information is available on stock structure.
Longevity	No ageing studies is known for the Indian Ocean. In the Pacific Ocean (China, Taiwan Province) the oldest bigeye thresher sharks reported were a 19 year old male and a 20 year old female for fish ~ 370 cm TL. Taking into consideration that maximum length is exceed 400 cm longevity is apparently around 25-30 years. In the Eastern Atlantic Ocean, the maximum ages reported in a recent life history study were 22 years for females and 17 years for males (Fernandez-Carvalho et al., in press).
Maturity (50%)	Age: Sexual maturity is attained at 12-13 years (females), 9-10 years (males). Size: Males mature at 270-300 cm total length (TL) and females at 332-355 cm TL. Size at 50% maturity from the eastern Atlantic Ocean was estimated at 206 cm FL for females (95% CI: 199-213 cm FL), and 160 cm FL for males (95% CI: 156-164 cm FL) (Fernandez-Carvalho et al., 2011).
Reproduction	Bigeye thresher shark is an aplacental viviparous with oophagy species. • Fecundity: very low (2-4) • Generation time: around 15 years (due to oophagy) • Gestation Period: 12 months • Reproductive cycle: unknown Of the thresher sharks, the Bigeye Thresher has the lowest rate of annual increase, estimated at 1.6% under sustainable exploitation (Smith et al. 2008), or 0.002-0.009 (Cortés 2008, Dulvy et al. 2008).
Size (length and weight)	Maximum size is around 461 cm TL. New-born pups are around 64-140 cm TL. Length–weight relationship for both sexes combined in the Indian Ocean is $TW=0.155*10^{-4}*FL^{2.97883}$

SOURCES: Compagno (2001); Chen *et* al. (1997); Lui et al. (1998); Nakano et al (2003), Weng, Block (2004); Amorim et al. (2007); Stevens et al. (2010); Romanov (2011) pers. comm.

Fisheries

Bigeye thresher shark are often targeted by some recreational, semi-industrial and artisanal fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries). Typically, the fisheries take bigeye thresher sharks between 140-210 cm FL or 40 to 120 kg (Romanov, 2011 pers. comm.). In Australia thresher sharks used to be a target of sport fishermen. Sport fisheries for oceanic sharks are apparently not so common in other Indian Ocean countries.

There is little information on the fisheries prior to the early 1970's. Some countries still fail to collect shark data while others do collect it but fail to report to IOTC. It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many existing catch records probably under-represent the actual catches of sharks because they do not account for discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights. FAO also compiles landings data on elasmobranchs, but their statistics are limited by the lack of species-specific data and data from the major fleets. Thresher sharks were marketed both locally and in European markets until at least up until early 2011 despite the 2010 IOTC regulation. The practice of shark finning is considered to be regularly occurring and on the increase for this species (Clarke 2008; Clarke et al. 2006). The post-release mortality is unknown but probably high. In longline fisheries bigeye thresher sharks are often hooked by the tail (Compagno, 2001; Romanov, 2011 pers. comm.) and die soon afterward. Therefore they are discarded dead if not retained. In most cases discarded sharks are not recorded in fisheries logbooks. Therefore the current IOTC regulation measures (notably Resolution 10/12) appear to have limited conservation effect while contributing to further loss of fisheries data. Other types of conservation efforts such as protected areas should be considered for this species group by the WPEB, taking into account a detailed analysis of catch distribution and 'hotspots' of abundance derived from research data.

TABLE 3. Estimated frequency of occurrence and bycatch mortality in the Indian Ocean pelagic fisheries.

Gears	PS	LL		BB/TROL/HAND	GILL	UNCL
		SWO	TUNA			
Frequency	absent	Common		rare	unknown	unknown
Fishing Mortality	no	high	high	unknown	unknown	unknown
Post release mortality	N/A	unknown	unknown	unknown	unknown	unknown

SOURCES: Boggs (1992); Anderson & Ahmed (1993); Romanov (2002, 2008); Ariz et al., 2006; Peterson et al. (2008); Romanov et al. (2008).

Catch trends

The catch estimates for bigeye thresher shark are highly uncertain, as is their utility in terms of minimum catch estimates. Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, and Sri-Lanka) while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories).

TABLE 4. Catch estimates for bigeye thresher shark in the Indian Ocean for 2009 and 2010.

Catch		2009	2010
Most recent catch	bigeye thresher	5 t	5 t
	nei-sharks	62,229 t	61,966
Mean catch over the last 5 years (2006–2010)	bigeye thresher		4 t
	nei-sharks		64,838 t

Note that reported shark catches are incomplete. The catches of sharks are usually not reported and when they are they might not represent the total catches of this species but simply those retained on board. It is also likely that the amounts recorded refer to weights of processed specimens, not to live weights. In 2010, seven countries reported catches of bigeye thresher sharks in the IOTC region.

Nominal and standardised CPUE trends

Data not available at the IOTC Secretariat. There are no surveys specifically designed to assess shark catch rates in the Indian Ocean. Historical research data shows overall decline both in CPUE and mean weight of thresher sharks (Romanov, 2011, pers. comm.).

Average weight in the catch by fisheries

Data not available.

Number of squares fished

Catch and effort data not available.

STOCK ASSESSMENT

No quantitative stock assessment for bigeye thresher shark has been undertaken by the IOTC Working Party on Ecosystems and Bycatch.

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APPENDIX XXXIII
EXECUTIVE SUMMARY: PELAGIC THRESHER SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi

Status of the Indian Ocean Pelagic Thresher Shark (*Alopias pelagicus*)

TABLE 1. IUCN threat status of pelagic thresher shark (*Alopias pelagicus*) in the Indian Ocean

Common name	**Scientific name**	**IUCN threat status[20]**		
		Global status	**WIO**	**EIO**
Pelagic thresher shark	*Alopias pelagicus*	Vulnerable	–	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
SOURCES: IUCN (2007, 2011)

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

The SC **RECOMMENDED** the following management advice for pelagic thresher shark in the Indian Ocean, noting that there remains considerable uncertainty in the stock status due to lack of information necessary for assessment or to for the development of other indicators of the stock.

Stock status. The current IUCN threat status of 'Vulnerable' applies to pelagic thresher shark globally (Table 1). There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment and limited basic fishery indicators currently available for pelagic thresher shark in the Indian Ocean therefore the stock status is highly uncertain. Pelagic thresher sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (+ 20 years), mature at 8-9 years, and have few offspring (2 pups every year), the pelagic thresher shark is vulnerable to overfishing.

Outlook. Current longline fishing effort is directed to other species, however pelagic thresher sharks is a common bycatch these fisheries. Hooking mortality is apparently very high, therefore IOTC regulation 10/12 prohibiting retaining of any part of thresher sharks onboard and promoting life release of thresher shark are apparently ineffective for species conservation. Maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE. However there are few data to estimated CPUE trends, in view of IOTC regulation 10/12 and reluctance of fishing fleet to report information on discards/non-retained catch. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into other areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on pelagic thresher shark will decline in these areas in the near future, which may result in localised depletion.

The Scientific Committee considered the following:

- The available evidence indicates considerable risk to the status of the IO stock at current effort levels.
- Two important sources of data that inform the assessment, total catches and CPUE are highly uncertain and should be investigated further as a priority.
- Noting that current catches (probably largely underestimated) are estimated at 2 t in 2010, maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE.
- The SC recommended that mechanisms are developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.
- The SC agreed three options should be considered for amendment of Resolution 08/04 concerning the recording of the catch by longline fishing vessels in the IOTC area in order to improve data collection and statistics on sharks that would allow the development of stock status indicators.

[20] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Ecosystems and Bycatch and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Pelagic thresher shark in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission:

- Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC* includes minimum reporting requirements for sharks, calls for full utilisation of sharks and includes a ratio of fin-to-body weight for shark fins retained onboard a vessel (although for thresher sharks this has been largely superseded by Resolution 10/12).
- Resolution 08/04 *Concerning the recording of catch by longline fishing vessels in the IOTC area* sets out the minimum logbook requirements for longline fishing vessels over 24 metres length and under 24 metres if they fish outside the EEZ of their flag State. As per this resolution, catch of all sharks (retained and discarded) must be recorded.
- Resolution 10/03 *Concerning the recording of catch by fishing vessels in the IOTC area* sets out minimum logbook requirements for all purse-seine vessels 24 metres length overall or greater and those under 24 metres if they fish outside the EEZs of their flag States. As per this resolution, catch and discard of all shark species should be recorded.
- Resolution 10/12 *On the Conservation of Thresher Sharks (Family Alopiidae) caught in Association with Fisheries in the IOTC Area of Competence* prohibiting to Fishing Vessels flying the flag of IOTC Member and Cooperating non-Contracting Parties (CPCs) from retaining on board, transhipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family Alopiidae.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on pelagic thresher shark interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010.

Extracts from Resolutions 09/06 and 11/04

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

3. CPCs shall take the necessary measures to require that their fishermen fully utilise their entire catches of sharks. Full utilisation is defined as retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing. [21]

RESOLUTION 08/04 CONCERNING THE RECORDING OF CATCH BY LONGLINE FISHING VESSELS IN THE IOTC AREA

4. Each flag CPC shall ensure that all long line fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system. ….

RESOLUTION 10/12 ON THE CONSERVATION OF THRESHER SHARKS (FAMILY ALOPIIDAE) CAUGHT IN ASSOCIATION WITH FISHERIES IN THE IOTC AREA OF COMPETENCE

2. Fishing Vessels flying the flag of an IOTC Member and Cooperating non-Contracting Parties (CPCs) are prohibited from retaining on board, transshipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family Alopiidae.
5. CPCs shall require vessels flying their flag to promptly release unharmed, to the extent practicable, thresher sharks when brought along side for taking on board the vessel.
6. CPCs shall encourage their fishermen to record incidental catches as well as live releases. These data will be then kept at the IOTC secretariat.

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

10. Observers shall:

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency

FISHERIES INDICATORS

General

Pelagic thresher shark (*Alopias pelagicus*) is a common shark in pelagic coastal and oceanic waters throughout the tropical Indo-Pacific (Fig. 1). This species is commonly confused with common thresher shark (*Alopias vulpinus*), which is mostly temperate species and often recorded under wrong name. Apparently most of tropical records of

[21] This is not applicable to Alopiidae in view of Resolution 10/12 *On the conservation of thresher sharks (Family Alopiidae) caught in association with fisheries in the IOTC area of competence*.

common thresher sharks in the Indo-Pacific are misidentified pelagic threshers. Due to identification confusions actual distribution and biology of pelagic and common thresher sharks are poorly known. It is probably highly migratory and is epipelagic from the surface to at least 300 m depth (Compagno 2001, Romanov 2011 pers. comm.). It aggregates around seamounts and continental slopes (Compagno 2001). No predation on pelagic thresher sharks has been reported to date; however being smalles species among thresher sharks it may be preyed upon by bigger species such as tiger shark, makos, white sharks, and killer whales. Fishing is a major contributor to adult mortality. This species used its long tail to attack prey (Compagno 2001; Aalbers et al. 2010). Table 2 outlines some of the key life history traits of pelagic thresher shark in the Indian Ocean.

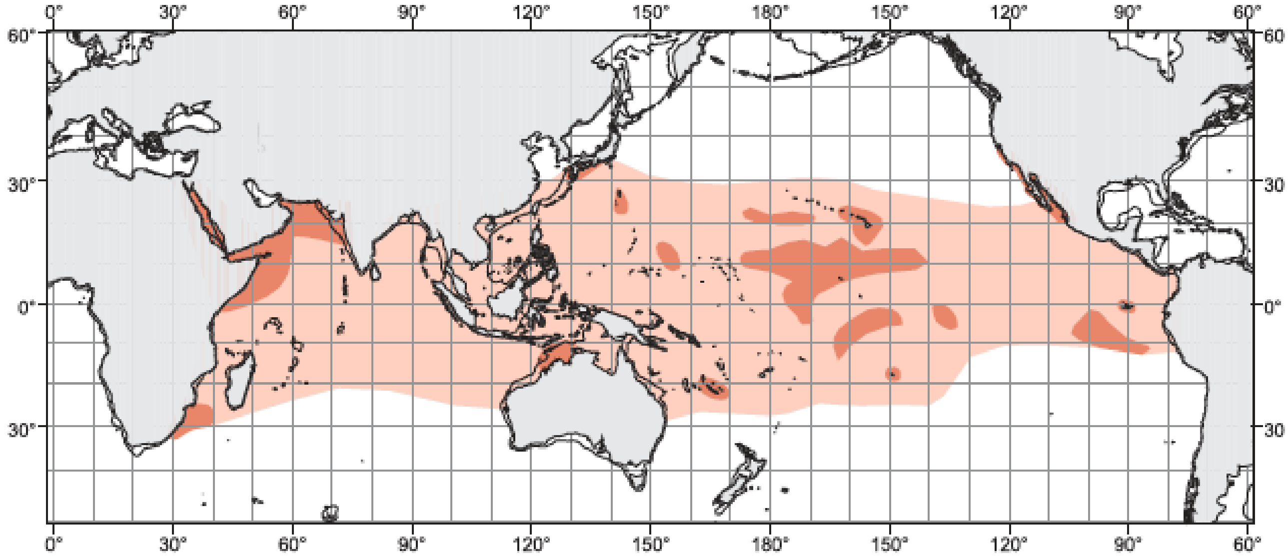

Fig. 1. The worldwide distribution of the pelagic thresher shark (source: FAO).

TABLE 2. Biology of Indian Ocean pelagic thresher shark (*Alopias pelagicus*).

Parameter	Description
Range and stock structure	In the tropical Indian Ocean, the greatest abundance of pelagic thresher shark occurs at depths of 50 to 300 m, in temperatures ranging from 8 to 25°C. It is considered as highly migratory species however no published information on horizontal movements of pelagic thresher shark is known for the Indian Ocean. Apparently pelagic thresher shark is a solitary fish however it is often aggregated around seamounts or over continental slopes. Area of overlap with IOTC management area = high. No information is available on stock structure.
Longevity	No ageing studies is known for the Indian Ocean, In the Pacific Ocean (China, Taiwan Province) the oldest pelagic thresher sharks reported were a 20 year old male (170 cm SL) and a 28 year old female for fish ~ 188 cm SL.
Maturity (50%)	Age: Sexual maturity is attained at 8-9 years (females), 7-8 years (males). Size: Males mature at 140-145 cm standard length (SL) and females at 145-150 cm TL.
Reproduction	Pelagic thresher shark is an ovoviviparous species, without a placental attachment. • Fecundity: very low (2) • Generation time: 8-10 years • Gestation period: <12 months • Reproductive cycle: unknown Its potential annual rate of population increase under sustainable fishing is thought to be very low and has been estimated at or 0.033 (Dulvy et al. 2008)
Size (length and weight)	Maximum size is around 365 cm TL. New-born pups are around 158-190 cm TL. Length–weight relationship for both sexes combined in the Indian Ocean is $TW=0.001*10^{-4}*FL^{2.15243}$

SOURCES: Compagno (2001); Lui et al. (1998); Reardon et al. (2004); Romanov (2011) pers. comm.

Fisheries

Pelagic thresher shark are often targeted by some recreational, semi-industrial and artisanal fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries). Typically, the fisheries take pelagic thresher sharks between 120-190 cm FL or 20 to 90 kg (Romanov 2011 pers. comm.). In Australia thresher sharks used to be a target of sport fishermen. Sport fisheries for oceanic sharks are apparently not so common in other Indian Ocean countries.

There is little information on the fisheries prior to the early 1970's. Some countries still fail to collect shark data while others do collect it but fail to report to IOTC. It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many existing catch records probably under-represent the actual catches of sharks because they do not account for discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights. FAO also compiles landings data on elasmobranchs, but their statistics are limited by the lack of species-specific data and data from the major fleets. Thresher sharks were marketed both locally and in European markets until at least up until early 2011 despite the 2010 IOTC regulation. The practice of shark finning is considered to be regularly occurring and on the increase for this species (Clarke 2008; Clarke et al. 2006). The bycatch/release mortality rate is unknown but probably high. In longline fisheries pelagic thresher sharks are often hooked by the tail (Compagno, 2001; Romanov, 2011 pers. comm.) and die soon afterward. Therefore they are discarded dead if not retained. In most cases discarded sharks are not recorded in fisheries logbooks. Therefore the current IOTC regulation measures (notably Resolution 10/12) appear to have limited conservation effect while contributing to further loss of fisheries data. Other types of conservation efforts such as protected areas should be considered for this species group by the WPEB, taking into account a detailed analysis of catch distribution and 'hotspots' of abundance derived from research data. Extremely common misidentification of this species with common thresher shark aggravate situation with data collection.

TABLE 3. Estimated frequency of occurrence and bycatch mortality in the Indian Ocean pelagic fisheries.

Gears	PS	LL		BB/TROL/HAND	GILL	UNCL
		SWO	TUNA			
Frequency	absent	Common		rare	unknown	unknown
Fishing Mortality	no	high	high	unknown	unknown	unknown
Post release mortality	N/A	unknown	unknown	unknown	unknown	unknown

SOURCES: Boggs (1992); Romanov (2002, 2008); Romanov (2011) pers. comm.

Catch trends

The catch estimates for pelagic thresher shark are highly uncertain as is their utility in terms of minimum catch estimates. Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, and Sri-Lanka) while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories).

TABLE 4. Catch estimates for pelagic thresher shark in the Indian Ocean for 2009 and 2010.

Catch		2009	2010
Most recent catch	pelagic thresher	2 t	2 t
	nei-sharks	62,229 t	61,966
Mean catch over the last 5 years (2006–2010)	pelagic thresher		*No data reported prior to 2009*
	nei-sharks		64,838 t

Note that reported shark catches are incomplete. The catches of sharks are usually not reported and when they are they might not represent the total catches of this species but simply those retained on board. It is also likely that the amounts recorded refer to weights of processed specimens, not to live weights. In 2010, none of CPCs reported catches of pelagic thresher sharks in the IOTC region.

Nominal and standardised CPUE Trends

Data not available at the IOTC Secretariat. There are no surveys specifically designed to assess shark catch rates in the Indian Ocean. Historical research data shows overall decline both in CPUE and mean weight of thresher sharks (Romanov, 2011, pers. comm.).

Average weight in the catch by fisheries

Data not available.

Number of squares fished

Catch and effort data not available.

STOCK ASSESSMENT

No quantitative stock assessment for pelagic thresher shark has been undertaken by the IOTC Working Party on Ecosystems and Bycatch.

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APPENDIX XXXIV
UPDATE ON THE IMPLEMENTATION OF THE IOTC REGIONAL OBSERVER SCHEME

CPCs	Active Vessels LOA≥24m or High Seas vessels[22]				Progress	List of accredited observers submitted	Observer Trip Reports submitted
	LL	PS	GN	BB			
MEMBERS							
Australia	4	9			Australia has implemented an observer programme that complies with the IOTC Regional Observer Scheme.	YES: 21	YES: 3
Belize	5				No information received by the Secretariat.	No	No
China	20				China has an observer programme.	No	YES: 1
–Taiwan,China	562				No information received by the Secretariat.	YES: 54	No
Comoros					Comoros does not have vessel more than 24m on which observer should be placed. 2 observers were trained under the IOC Regional Monitoring Project, and 5 by SWIOFP.	YES: 7	N/A
Eritrea					No information received by the Secretariat.	No	No
European Union	47	21			EU has an observer programme on-board its purse-seine fleets, however the programme is limited due to the piracy activity in the western Indian Ocean. EU has or is developing observer programmes on-board its longline fleets, i.e. La Réunion, Spanish and Portuguese fleets.	Partial: EU,France: 7 EU,Portugal: 3	YES: 1
France (OT)		5			No information received by the Secretariat.	YES: 15	No
Guinea	3				No information received by the Secretariat.	No	No
India	53				India has not developed any observer programme so far.	No	No
Indonesia	996				Indonesia has an observer programme based in Benoa, Bali with 5 trained observers. The number of observers should double in 2012.	No	No
Iran, Isl. Rep. of		8	863		No information received by the Secretariat.	No	No
Japan	83	1			Japan has started its observer programme on the 1st of July 2010, and 14 observers are currently being deployed in the Indian Ocean.	YES: 14	YES: 6
Kenya	1				Kenya is developing an observer programme and 5 observers have been trained under the SWIOFP training.	No	No
Korea, Rep. of	13				Korea has an observer programme since 2002 with 3 observers being deployed in the Indian Ocean giving a14.5% coverage of the fishing operation in 2009.	No	No
Madagascar	3				Madagascar is developing an observer programme. Five and three observers have been trained respectively under the SWIOFP and the IOC projects.	YES: 8	No
Malaysia	41	1			No information received by the Secretariat.	No	No
Maldives, Rep. of				459	Maldives vessels are monitored by field samplers at landing sites. Have in excess of 250 vessels larger than 24m.	No	No
Mauritius	4				Mauritius is developing an observer programme, and, 5 and 3 observers have been trained respectively under the SWIOFP and the IOC projects.	No	No
Oman, Sul. of	48				No information received by the Secretariat.	No	No
Pakistan			10		No information received by the Secretariat.	No	No

[22] The number of active vessels is given for 2010.

Philippines	7				No information received by the Secretariat.	**No**	**No**
Seychelles, Republic of	35	9			Seychelles is developing an observer programme. Four and three observers have been trained respectively under the SWIOFP and the IOC projects.	**YES: 7**	**No**
Sierra Leone					No information received by the Secretariat.	**No**	**No**
Sri Lanka			3346		Sri Lanka has not started the implementation of an observer programme.	**No**	**No**
Sudan					No information received by the Secretariat.	**No**	**No**
Tanzania, United Rep.of	3				No information received by the Secretariat.	**No**	**No**
Thailand	2	4			Thailand has not developed an observer programme so far.	**No**	**No**
United Kingdom					UK does not have any active vessels in the Indian Ocean.	N/A	N/A
Vanuatu	4				No information received by the Secretariat.	**No**	**No**
COOPERATING NON-CONTRACTING PARTIES							
Mozambique					No information received by the Secretariat.	**No**	**No**
Senegal	3				No information received by the Secretariat.	**No**	**No**
South Africa, Republic of	23				No information received by the Secretariat.	**No**	**No**

APPENDIX XXXV
DRAFT PROPOSAL FOR MINIMUM REQUIREMENTS FOR CATCH AND EFFORT DATA

Record once per trip (or month for daily operation), unless gear configuration changes

1.1 REPORT INFORMATION

1) Date of the submission of logbook
2) Name of reporting person

1.2 VESSEL INFORMATION

1) Vessel name and/or registration number
2) IOTC number, where available
3) Call sign: if call sign is not available, other unique identifying code such as registration or fishing license number should be used
4) Vessel size: gross tonnage and/or overall length (meters)

1.3 CRUISE INFORMATION

For multiday fishing operations record the

1) Departure date and port
2) Arrival date and port

1.4 OTHER REQUIRED INFORMATION

Longline (Gear Configuration):

1) Average branch line length (meters): straight length in meters between snap and hook (Figure 1)
2) Average float line length (meters): straight length in meters from the float to the snap
3) Average length between branch (meters): straight length of main line in meters between successive branch lines
4) Main line material classified into four categories:
    a. Thick rope (Cremona rope)
    b. Thin rope (PE or other materials)
    c. Nylon braided
    d. Nylon monofilament

Purse Seine
Gear configuration:

1) Length and height of the purse seine net
2) Stretched mesh size

Search information:

1) Days searched
2) Spotter plane used (Yes/No)
3) Supply vessel (Yes/No)

Gillnet (Gear Configuration):

1) Minimum and maximum fishing depth of assembled net (meters): record the maximum and minimum of the depth range fished
2) Mesh size of net (millimetres): record the mesh size used during the trip
3) Height of assembled net (meters): height on assembled net in meters
4) Netting material: e.g. nylon braid, nylon monofilament, etc.
5) Total length of net lost and not recovered (meters): record the total length lost during the trip

Pole and line (Gear configuration)

1) Number of poles onboard
2) Number of fishermen

Record once per set/shot/operation

2.1 OPERATION

For longline:

1) Date of set (YYYY/MM/DD)
2) Position in latitude and longitude: either at noon (GMT) position or position of start of gear, area code of operation (e.g. Seychelles EEZ, High seas, etc.) may be optionally used
3) GMT (24 hr) of starting setting the gear
4) Sea surface temperature at noon with one decimal point, if available (XX.X^{o}C)
5) Number of hooks between floats: if there are different hooks counts between floats in a single set then record the most representative (average) number
6) Total number of hooks used in the set
7) Number of light-sticks used in the set
8) Type of bait used in the set

For purse seine:

1) Date of event (YYYY/MM/DD)
2) Type of event: **fishing set** or **deployment of a new FAD**
3) Position in latitude and longitude and time of event, or if no event during the day, at noon (GMT)
4) If fishing set: specify if the set was successful, nil, well, type of school (FAD association, specify the type (e.g. object, beacon, whale shark, whale, etc.) and/or free swimming school)
5) Sea surface temperature at noon with one decimal point, if available (XX.X^{o}C)

For gillnet:

1) Date of set (YYYY/MM/DD): record the date for each set of day at sea (for days without sets)
2) Total length of net (meters): length floatline used for each set in meters
3) Start fishing time: record the UCT time (24 hr) when starting each set

4) Start and end position in latitude and longitude: record start and end latitude and longitude that represent the area that your gear is set between. Record the latitude and longitude at noon for days with no set.
5) Depth at which net is set (meters): approximate depth at which the gillnet is set

For Pole and Line:

1) Date of activity: record the day. Each day should be recorded separately.
2) Position: record the latitude and longitude at noon
3) Number of fishing gears used: Record the number of fishing poles used during the day
4) Start fishing time (record the UTC time (24 hr) immediately after bait fishing is complete and the vessel heads to the ocean for fishing. For multiple days, the time at which search starts should be recorded) and end fishing time (record the UTC time (24 hr) immediately after fishing is complete from the last school. On multiple days this is the time fishing stopped from the last school.
5) Type of school: FAD associated and/or free school

2.2 CATCH

1) Catch weight (kg) or number by species per set/shot/fishing event for each of the species and form of processing in section 2.3:
   a. For longline by number and weight;
   b. For purse seine by weight;
   c. For gillnet by weight;
   d. For pole and line by weight or number

2.3 SPECIES

TABLE 1. List of elasmobranchs species to be recorded in the logbook for longline, purse seine and gillnet fishing vessels.

For longline:

IOTC species

Southern bluefin tuna (*Thunnus maccoyii*)
Albacore (*Thunnus alalunga*)
Bigeye tuna (*Thunnus obesus*)
Yellowfin tuna (*Thunnus albacares*)
Skipjack tuna (*Katsuwonus pelamis*)
Swordfish (*Xiphias gladius*)
Striped marlin (*Tetrapturus audax*)
Indo-Pacific blue marlin (*Makaira mazara*)
Black marlin (*Makaira indica*)
Indo-Pacific sailfish (*Istiophorus platypterus*)

Other species

Shortbill spearfish (*Tetrapturus angustirostris*)
Blue Shark (*Prionace glauca*)
Mako Sharks (*Isurus* spp.)
Porbeagle (Lamna nasus)
Oceanic Whitetip Shark (*Carcharhinus longimanus*)
Hammerhead Sharks (Sphyrnidae)
Other bony fish
Other sharks

Optional species to be recorded

Thresher Sharks (*Alopias* spp.)
Tiger shark (*Galeocerdo cuvier)*
Crocodile shark (*Pseudocarcharias kamoharai*)
Great white shark (*Carcharodon carcharias*)
Mantas and devils rays (Mobulidae)
Pelagic stingray (*Pteroplatytrygon violacea*)
Other requiem sharks (*Carcharhinus spp.*)
Other sharks
Other rays

For purse seine:

IOTC species	***Optional species to be recorded***
Albacore (*Thunnus alalunga*)	Oceanic whitetip shark (*Carcharhinus longimanus*)
Bigeye tuna (*Thunnus obesus*)	Silky shark (*Carcharhinus falciformis*)
Yellowfin tuna (*Thunnus albacares*)	Whale shark (*Rhincodon typus*)
Skipjack tuna (*Katsuwonus pelamis*)	Mantas and devils rays (Mobulidae)
Other IOTC species	Other sharks
	Other rays
	Other bony fish

For gillnet:

IOTC species

Albacore (*Thunnus alalunga*)
Bigeye tuna (*Thunnus obesus*)
Yellowfin tuna (*Thunnus albacares*)
Skipjack tuna (*Katsuwonus pelamis*)
Longtail tuna (Thunnus tonggol)
Frigate and bullet tuna (*Auxis spp.*)
Kawakawa (*Euthynnus affinis*)
Narrow-barred Spanish mackerel (*Scomberomorus commerson*)
Indo-Pacific king mackerel (*Scomberomorus guttatus*)
Swordfish (*Xiphias gladius*)
Indo-Pacific sailfish (*Istiophorus platypterus*)
Marlins (*Tetrapturus* spp.; *Makaira* spp.)
Other IOTC species

Other species

Shortbill spearfish (*Tetrapturus angustirostris*)
Blue Shark (*Prionace glauca*)
Mako Sharks (*Isurus* spp.)
Porbeagle (Lamna nasus)
Oceanic Whitetip Shark (*Carcharhinus longimanus*)
Hammerhead Sharks (Sphyrnidae)
Other bony fish
Other sharks

Optional species to be recorded

Thresher Sharks (*Alopias* spp.)
Tiger shark (*Galeocerdo cuvier)*
Crocodile shark (*Pseudocarcharias kamoharai*)
Great white shark (*Carcharodon carcharias*)
Mantas and devils rays (Mobulidae)
Pelagic stingray (*Pteroplatytrygon violacea*)
Other requiem sharks (*Carcharhinus spp.*)
Other sharks
Other rays

For pole-and-line:

IOTC species	***Optional species to be recorded***
Albacore (*Thunnus alalunga*)	Other bony fish
Bigeye tuna (*Thunnus obesus*)	Sharks
Yellowfin tuna (*Thunnus albacares*)	Rays
Skipjack tuna (*Katsuwonus pelamis*)	
Frigate and bullet tuna (*Auxis spp.*)	
Kawakawa (*Euthynnus affinis*)	
Longtail tuna (Thunnus tonggol)	
Narrow-barred Spanish mackerel (*Scomberomorus commerson*)	
Other IOTC species	

2.4 REMARKS

1) Discard of tuna, tuna-like fish and sharks to be recorded by species in weight (kg) or number for all gears should be recorded in the remarks[23]
2) Any interactions with whale sharks (*Rhincodon typus*), marine mammals, marine turtles and seabirds should be recorded in the remarks
3) Other information is also written in the remarks

Note: The species included in the logbooks are regarded as minimum requirement. Optionally other frequently caught shark and/or fish species should be added as required across different areas and fisheries.

HANDLINE

All logbook information shall be recorded by day; where more than one fishing event is recorded for the same day, it is advisable to record each fishing event separately

Record once in one cruise, or month where daily operation

1-1 INFORMATION OF REPORT

1) Fishing day (or Date of submission of the logbook, where multiple fishing days).
2) Name of reporting person

1-2 VESSEL INFORMATION

3) Vessel name and registration number
4) IOTC number, where available
5) Fishing License number
6) Licensed gears and species
7) Vessel size: Gross tonnage (in MT) and/or length overall (in m)

1-3 CRUISE INFORMATION

1) Departure date and port
2) Arrival date and port

HANDLINE

2-1 OPERATION

1) Date of fishing

Record the date of fishing. Each fishing day should be recorded separately.

2) Number of fishermen

Record the number of fishermen on the boat by fishing day (fishing event)

3) Number of Fishing Gear

Record the number of fishing gear used during the day (fishing event). If the exact number is not available a range may be used i) less than 5 lines, ii) 6-10 lines; iii) more than 11 lines.

4) Start Fishing Time

Record the UCT time (24 hr) corresponding to the time the boat heads to ocean for fishing. Where fishing occurs on multiple days the time at which searching starts should be recorded.

5) End Fishing Time

Record the UCT time (24 hr) immediately after fishing is complete. This is the time in which the captain decides to head home. On multiple days this is the time fishing stopped.

[23] Recall the Recommendation 10/13 *On the Implementation of a Ban on Discards of Skipjack Tuna, Yellowfin Tuna, Bigeye Tuna and Non Targeted Species Caught by Purse Seiners*

6) Type of school (Anchored or drifting FAD, marine mammal, free, other)

Record the type of school, i.e. anchored FAD, drifting FAD, marine mammal associated, other.

7) Position of the catch

Record the latitude and longitude at the start of each fishing event; record the latitude and longitude at noon for non-fishing days, where not in port.

Where information is recorded by day, record the 1° x 1° area(s) where fishing took place.

8) Bait

Record the type of bait used (e.g. fish, squid), where applicable

2-2 CATCH

Catch in number and weight (kg) by species

1) Catch number and Weight

For each species shown in section 2-3 caught and retained, record the number and estimated live weight (kg), per fishing day (fishing event).

2) Discard number and Weight

For each species shown in section 2-3 caught and not retained record the number and estimated live weight (kg) discarded, per fishing day (fishing event).

2-3 SPECIES

Common name	**Scientific name**
Yellowfin tuna	*Thunnus albacares*
Bigeye tuna	*Thunnus obesus*
Skipjack tuna	*Katsuwonus pelamis*
Indo-Pacific sailfish	*Istiophorus platypterus*
Black marlin	*Makaira indica*
Other billfish	
Longtail tuna	*Thunnus tonggol*
Kawakawa	*Euthynnus affinis*
Frigate tuna/Bullet tuna	*Auxis spp.*
Narrow-barred Spanish mackerel	*Scomberomorus commerson*
Indo-Pacific king mackerel	*Scomberomorus guttatus*
Sharks	
Other fishes	

2-4 REMARKS

1) Discard of tuna, tuna-like fish should be recorded in the remarks, to species level where possible.
2) Other relevant information is also written in the remarks.
Note: These species included in the logbook are regarded as minimum requirement. Optionally other species should be added as species may differ depending on the area fished and type of fishery.

TROLLING VESSELS

All logbook information shall be recorded by day; where more than one fishing event is recorded for the same day, it is advisable to record each fishing event separately

Record once in one cruise

1-1 INFORMATION OF REPORT

8) Date of the submission of logbook.
9) Name of reporting person

1-2 VESSEL INFORMATION

10) Vessel name and registration number
11) IOTC number, where available
12) Fishing License number
13) Licensed gears and species
14) Vessel size: Gross tonnage (in MT) and/or length overall (in m)

1-3 CRUISE INFORMATION

3) Departure date and port
4) Arrival date and port

TROLLING VESSELS

2-1 OPERATION

1) Date of fishing

Record the date of fishing. Each fishing day should be recorded separately.

2) Number of fishermen

Record the number of fishermen on the boat by fishing day (fishing event)

3) Number of Fishing Gear

Record the number of lines and hooks used during the day (fishing event). If the exact number is not available a range may be used i) less than 5 lines, ii) 6-10 lines; iii) more than 11 lines.

4) Time Fishing

Record the total number of hours fishing during the day (fishing event).

5) Number and type of school (Anchored or drifting FAD, marine mammal, free, other) fished

Record the number and type of school fished (i.e. anchored FAD, drifting FAD, marine mammal associated or free) fished during the day.

6) Position of the catch

Record the latitude and longitude when fishing starts; record the latitude and longitude at noon for non-fishing days, where not in port.

Where information is recorded by day, record the 1° x 1° area(s) where fishing took place.

7) Bait

Record the type of bait/lures used, where applicable

2-2 CATCH

Catch in number or weight (kg) by species

1) Number or Weight of fish retained

For each species shown in section 2-3 caught and retained, record the number or estimated live weight (kg), per fishing day (fishing event).

2-3 SPECIES

Common name	**Scientific name**
Yellowfin tuna	*Thunnus albacares*
Bigeye tuna	*Thunnus obesus*
Skipjack tuna	*Katsuwonus pelamis*
Albacore	*Thunnus alalunga*
Swordfish	*Xiphias gladius*
Indo-Pacific blue marlin	*Makaira mazara*
Black marlin	*Makaira indica*
Striped marlin	*Tetrapturus audax*
Indo-Pacific sailfish	*Istiophorus platypterus*
Other billfish	
Longtail tuna	*Thunnus tonggol*
Kawakawa	*Euthynnus affinis*
Frigate tuna/Bullet tuna	*Auxis spp.*
Narrow-barred Spanish mackerel	*Scomberomorus commerson*
Indo-Pacific king mackerel	*Scomberomorus guttatus*
Sharks	
Other fishes	

2-4 REMARKS

1) Discard of tuna, tuna-like fish should be recorded in the remarks, to species level where possible in number or live weight.

2) Other relevant information is also written in the remarks.

Note: These species included in the logbook are regarded as minimum requirement. Optionally other species should be added as species may differ depending on the area fished and type of fishery.

APPENDIX XXXVI
UPDATE ON PROGRESS REGARDING RESOLUTION 09/01 – ON THE PERFORMANCE REVIEW FOLLOW–UP

(NOTE: NUMBERING AND RECOMMENDATIONS AS PER APPENDIX I OF RESOLUTION 09/01)

ON CONSERVATION AND MANAGEMENT	RESPONSIBILITY	UPDATE/STATUS	WORKPLAN/TIMELINE	PRIORITY
Data collection and sharing				
The Panel identified a poor level of compliance by many IOTC Members. with their obligations, notably those related to the statistical requirements on artisanal fisheries and sharks, and recommends that:				
3. The timing of data reporting be modified to ensure that the most recent data are available to the working parties and the Scientific Committee.	*Scientific Committee*	**Completed**: Currently CPCs are required to submit information on their flag vessels by 30th June every year. The timeline for coastal CPCs who license foreign vessels has been brought forward to 15th February every year.The timing of the Working Party will be reviewed annually to ensure that assessments can be completed and results reported to the Scientific Committee each year.	Review annually at IOTC WP and SC meetings.	Medium.
5. The scheduling of meetings of the working parties and Scientific Committee be investigated based on the experience of other RFMOs. This should bear in mind the optimal delivery of scientific advice to the Commission.	*Scientific Committee*	**Completed**: Given the large number of meetings of other RFMOs, it is becoming increasingly difficult to find a schedule of meetings that would be better than the one currently in practice. However, the Working Parties and the Scientific Committee will annually review the timing of the Working Parties.	Review annually at IOTC WP and SC meetings.	Low.
6. The Commission task the Scientific Committee with exploring alternative means of communicating data to improve timeliness of data provision.	*Scientific Committee*	**Partially completed**: The Secretariat encourages members to utilise electronic means to expedite reporting. A study was commissioned for 2011 to determine the feasibility of reporting near real–time for various fleets. Outcome: Real time reporting not currently possible for most CPCs	Review annually at IOTC WP and SC meetings. Within the best delays	Medium.

10. There is a need to improve the quality and quantity of the data collected and reported by the Members, including the information necessary for implementing the ecosystem approach. The most immediate emphasis should be placed on catch, effort and size frequency. The Panel also recommends that:	*Scientific Committee*	**Ongoing**: See below recommendation 11.		
12. A regional scientific observer programme to enhance data collection (also for non–target species) and ensure a unified approach be established, building on the experience of other RFMOs, Regional standards on data collection, data exchanged and training should be developed.	*Scientific Committee*	**Completed**: Resolution 11/04 (superseding Res.09/04 and Res. 10/04) provides CPCs with the necessary framework for putting in place national scientific observer programmes. The Regional Observers Scheme commenced July 1st 2010, and is based on national implementation. The Secretariat coordinated the preparation of standards for data requirements, training and forms.	Review annually at IOTC WP and SC meetings.	High.
15. The Secretariat's capacity for data dissemination and quality assurance be enhanced, including through the employment of a fisheries statistician.	*Standing Committee on Administration and Finance via Scientific Committee* *Commission*	**Partially completed**: The existing post of Data Analyst was converted to a Fisheries Statistician to join the Data Section of the Secretariat. A new Fisheries Officer (data/stats) has been selected and will join the Secretariat in early 2012.	Staffing needs to be assessed annually at IOTC meetings.	Medium.
16. A statistical working party be established to provide a more efficient way to identify and solve the technical statistical questions.	*Scientific Committee*	**Completed**: The Working Party on Data Collection and Statistics resumed its annual meeting in 2009.	Annual meeting.	High.
21. Innovative or alternative means of data collection (e.g. port sampling) should be explored and, as appropriate, implemented.	*Scientific Committee*	**Ongoing**: The Secretariat has been implementing sampling programmes since 1999. The IOTC–OFCF Programme has supported sampling programmes and other means of data collection since 2002. The SC recommended the continuation of the IOTC-OFCF project.	Review annually at IOTC WP and SC meetings.	Medium.

Quality and provision of scientific advice				
23. For species with little data available, the Scientific Committee should be tasked with making use of more qualitative scientific methods that are less data intensive.	*Scientific Committee*	**In progress**: The species Working Parties have been using informal analyses of stock status indicators when data are considered insufficient to conduct full assessments for some time. However, a formal system that reviews those qualitative indicators and provides a recommendation on the current status, based on the weight–of–evidence has yet to be developed.	To be considered at the WPM and others. Review annually at IOTC WP and SC meetings.	High.
25. Confidentiality provisions and issues of accessibility to data by the scientists concerned needs to be clearly delineated, and/or amended, so that analysis can be replicated.	*Scientific Committee*	**Ongoing**: Input, output and executable files for the assessment of major stocks are archived with the Secretariat to allow replication of analyses. Access to operational data under cooperative arrangements, and those subject to confidentiality rules is still limited. In some cases the Secretariat is bound by the domestic data confidentiality rules of Members and Cooperating non–Contracting Parties. The SC recommended to include observer data under the confidentiality policy of IOTC.	Review annually at IOTC WP and SC meetings.	Medium.
27. To enhance the quality of scientific advice and the technical soundness of the papers being considered by the Scientific Committee and its working parties, and to encourage publication of IOTC scientific papers in relevant journals, future consideration should be given to the establishment of a scientific editorial board within the Scientific Committee	*Scientific Committee*	**Partially completed**: Guidelines for the presentation of stock assessment papers were revised and agreed to by the Scientific Committee in 2010. An editorial board should select working party papers to be submitted for publication to a Peer Reviewed journal.	Review annually at IOTC WP and SC meetings. Creation of an Editorial board and prior arrangement with an International Journal by 2013.	Medium.
29. Ongoing peer review by external experts should be incorporated as standard business practice of working parties and the Scientific Committee.	*Scientific Committee*	**Pending**: External experts (Invited Experts) are regularly invited to provide additional expertise at Working Party meetings, although this does not constitute a formal process of peer review. The Scientific Committee in 2010, agreed that once stock assessment models were considered robust, that peer review would be advantageous and funds will be requested to undertake peer reviews of stock assessments. The Scientific Committee will review the processes for Invited Experts, Consultants and Peer review at its 14th Session in 2011.	Review annually at IOTC WP and SC meetings.	Medium.

30. New guidelines for the presentation of more user friendly scientific reports in terms of stock assessments should be developed. In this respect, Kobe plots are considered to be the most desirable method of graphical presentation, especially to non–technical audience.	*Scientific Committee*	**Ongoing**: All recent stock assessment results have been presented using the Kobe plot, and the species Working Parties are progressing in presenting the Kobe matrix. The 2010 and 2011Scientific Committee report includes Kobe Matrices for all stock assessments. The format of the Working Party reports and the resultant Executive Summaries has been revised to improve readability and content.	Review annually at IOTC WP and SC meetings.	Medium.
Adoption of conservation and management measures				
35. IOTC should consider developing a framework to take action in the face of uncertainty in scientific advice.	*Scientific Committee and Commission*	**In progress**: The Scientific Committee has agreed that the development of a Management Strategy Evaluation process be initiated to provide better advice that would incorporate explicit consideration of uncertainty. The 2012 meeting of the Working Party on Methods will focus on this process.	Intersessional start of the MSE process by correspondence, as of Jan.2012 Progress at 2012 WPM annual meeting.	High.
Capacity management				
42. IOTC should establish a stronger policy on fishing capacity to prevent or eliminate excess fishing capacity.	*Working Party on Fishing Capacity* *Scientific Committee* *Commission*	**Ongoing**: The Commission has since 2003 adopted a series of Resolutions (03/01, 06/05, 07/05 and 09/02) with the objective of addressing the issue of fishing capacity. However, to date these resolutions have not resulted in a strong control on fishing capacity, and the concern remains that overcapacity might result from this lack of control. The Secretariat is actively involved in developing the global vessels record for vessels fishing for tuna and tuna–like species that would contribute to the assessment of existing fishing capacity.	See Recommendation 33, which has been agreed as the priority path in this regard.	Medium.

APPENDIX XXXVII
RULES OF PROCEDURE FOR THE SELECTION OF INVITED EXPERTS TO ATTEND IOTC WORKING PARTY MEETINGS

Definition of an Invited expert

The role of an Invited Expert and the guiding principles for their selection are as follows (noting that Invited Experts are **NOT** consultants, as they are **unpaid**, other than for return **economy** airfares and DSA to attend a meeting):

Duties: (i) if possible/willing, to carry out tasks identified by the Working Party (WP) (to be identified separately for each meeting); (ii) as applicable, attend and contribute to discussions at any preparatory sessions (e.g. any pre-assessment workshops, noting that ideally, these may need to be carried out several months in advance of a WP meeting), and at the WP meeting;

Capacity: The invited expert must have recognized experience and skill in the subjects for which they are tasked;

Independence: The invited expert's advice on matters relating to tasks defined by the WP should be based on the principles of independence, impartiality and transparency. Therefore, the invited expert shall be invited in their personal capacity without representing any CPCs and/or stakeholder. Participation of experts based in IOTC developing coastal states shall be encouraged. Invited Experts should not be:

- directly involved with current IOTC stock assessments or CPUE standardisations.
- from a CPC where a scientist is presenting a stock assessment or CPUE standardization.

Confidentiality: Invited Experts shall not divulge any information, including data considered confidential by the Commission, as defined in IOTC Resolution 98/02.

Process for Selection

Process and timeline for the selection of an Invited Expert.

STEP	Action Item	Responsibility	Due date
1	Chair of the Working Party (WP) (Vice-Chair if Chair not available) to distribute an email to the IOTC Science contact list (consisting of the combined WP and SC mailing list/s), calling for Invited Expert nominations. The call for nomination will include a summary of the priority areas for contribution (identified during the previous WP meeting, in combination with requests from the SC and Commission), specific details to be provided by potential candidates (e.g. one page CV), and the selection timeline.	Chair of the WP (or Vice-Chair)	No later than 90 days prior to the commencement of the WP meeting or any other preparatory sessions as identified by the WP.
2	Deadline for nominations: two weeks from the call for nominations. Nominations should be made via return email to the IOTC Science contact list.	IOTC Science contact list	14 days after the call for nominations by the Chair (Step 1 above)
3	Selection panel, **consisting of the Chair and Vice-Chair of the Working Party, in consultation with the Chair of the Scientific Committee** to determine the most appropriate Invited Expert/s for the meeting, taking into consideration budgetary constraints, as advised by the Executive Secretary or his/her delegate. Potential Invited Expert to be contacted by the Chair to confirm availability.	Selection panel	Within 5 days of the deadline for comments on candidates from participants
4	Chair of the Working Party (or Vice-Chair) to advise the IOTC Science contact list of the successful Invited Expert/s, and request the Secretariat to commence the travel process. The IOTC Secretariat will also inform the IOTC Commissioner's contact list of the selected Invited Expert/s for each meeting.	Chair of WP or alternate & Secretariat	Within 2 days of the selection meeting.
5	Working Party meeting.	Participants	–

Appendix XXXVIII
Consolidated set of Recommendations of the Fourteenth Session of the Scientific Committee (12–17 December, 2011) to the Commission

STATUS OF TUNA AND TUNA-LIKE RESOURCES IN THE INDIAN OCEAN

Tuna – Highly migratory species

SC14.01 (para. 129) The SC **RECOMMENDED** that the Commission note the management advice developed for each tropical and temperate tuna species as provided in the Executive Summary for each species.

- Albacore (*Thunnus alalunga*) – Appendix X
- Bigeye tuna (*Thunnus obesus*) – Appendix XI
- Skipjack tuna (*Katsuwonus pelamis*) – Appendix XII
- Yellowfin tuna (*Thunnus albacares*) – Appendix XIII

Tuna and mackerel – Neritic species

SC14.02 (para. 132) The SC **RECOMMENDED** that the Commission note the management advice developed for each neritic tuna species as provided in the Executive Summary for each species:

- Longtail tuna (*Thunnus tonggol*) – Appendix XIV
- Narrow-barred Spanish mackerel (*Scomberomorus commerson*) – Appendix XV
- Bullet tuna (*Auxis rochei*) – Appendix XVI
- Frigate tuna (*Auxis thazard*) – Appendix XVII
- Kawakawa (*Euthynnus affinis*) – Appendix XVIII
- Indo-Pacific king mackerel (*Scomberomorus guttatus*) – Appendix XIX

Billfish

SC14.03 (para. 133) The SC **RECOMMENDED** that the Commission note the management advice developed for each billfish species as provided in the Executive Summary for each species:

- Swordfish (*Xiphias gladius*) – Appendix XX
- Black marlin (*Makaira indica*) – Appendix XXI
- Indo-Pacific blue marlin (*Makaira mazara*) – Appendix XXII
- Striped marlin (*Tetrapturus audax*) – Appendix XXIII
- Indo-Pacific sailfish (*Istiophorus platypterus*) – Appendix XXIV

Status of Marine Turtles, Seabirds and Sharks in the Indian Ocean

Marine turtles

SC14.04 (para. 134) The SC **RECOMMENDED** that the Commission note the management advice developed for marine turtles, as provided in the Executive Summary encompassing all six species found in the Indian Ocean:

- Marine turtles – Appendix XXV

Seabirds

SC14.05 (para. 135) The SC **RECOMMENDED** that the Commission note the management advice developed for seabirds, as provided in the Executive Summary encompassing all species commonly interacting with IOTC fisheries for tuna and tuna-like species:

- Seabirds – Appendix XXVI

Sharks

SC14.06 (para. 136) The SC **RECOMMENDED** that the Commission note the management advice developed for a subset of shark species commonly caught in IOTC fisheries for tuna and tuna-like species:

- Blue sharks (*Prionace glauca*) – Appendix XXVII
- Oceanic whitetip sharks (*Carcharhinus longimanus*) – Appendix XXVIII
- Scalloped hammerhead sharks (*Sphyrna lewini*) – Appendix XXIX
- Shortfin mako sharks (*Isurus oxyrinchus*) – Appendix XXX
- Silky sharks (*Carcharhinus falciformis*) – Appendix XXXI
- Bigeye thresher sharks (*Alopias superciliosus*) – Appendix XXXII
- Pelagic thresher sharks (*Alopias pelagicus*) – Appendix XXXIII

GENERAL RECOMMENDATIONS TO THE COMMISSION

Activities of the IOTC Secretariat in 2011

SC14.07 (para. 11) The SC **RECOMMENDED** that while the recruitment process for a new stock assessment expert at the IOTC Secretariat is being finalised, the Secretariat hire an individual/s to fill the staffing gap. This was considered to be particularly important given the upcoming tagging symposium in late 2012.

National Reports from CPCs

SC14.08 (para. 13) Noting that the Commission, at its 15th Session, expressed concern regarding the limited submission of National Reports to the SC, and stressed the importance of proving the reports by all CPCs, the SC **RECOMMENDED** that the Commission note that in 2011, 25 reports were provided by CPCs, up from 15 in 2010 and 14 in 2009 (Table 2). The SC stressed the importance of the submission of National Reports by all CPCs and urged those CPCs who did not met their reporting obligations in this regard (7), to provide a National Report to the SC in 2012.

Status of development and implementation of Nation Plans of Action for seabirds and sharks

SC14.09 (para. 18) The SC **NOTED** the current status of development and implementation of Nation Plans of Action for sharks and **RECOMMENDED** that all CPCs without an NPOA-Sharks expedite the development and implementation of their NPOA-Sharks, and to report progress to the WPEB in 2012, recalling that NPOA-Sharks are a framework that should facilitate estimation of shark catches, and development and implementation of appropriate management measures, which should also enhance the collection of bycatch data and compliance with IOTC Resolutions.

Report of the Third Session of the Working Party on Temperate Tunas

SC14.10 (para. 32) Noting the request by the Commission at its 15th Session for a new assessment of albacore to be undertaken in 2011 (para. 37 of the S15 report), the SC **RECOMMENDED** that the Commission note that although a new assessment was undertaken in 2011, there remains considerable uncertainty about the relationship between abundance and the standardized CPUE series, and about the total catches over the past decade and that the WPTmT has limited confidence in the assessment undertaken. Thus, there is an urgent need to carry out a revised stock assessment for the albacore resource in the Indian Ocean in 2012, and the Commission should consider allocating funds for this purpose, noting that individual CPCs are finding it difficult to justify expending the necessary resources to undertake stock assessments.

Status of catch statistics

SC14.11 (para. 57) The SC **RECOMMENDED** that the Commission note the status of catch statistics for the main species of sharks, by major fisheries (gears), for the period 1950–2010, as provided in Appendix VI:Tables a–c. Although some CPCs have reported more detailed data on sharks in recent years, including time-area catches and effort, and length frequency data for the main commercial shark species, the SC expressed strong **CONCERN** that the information on retained catches and discards of sharks contained in the IOTC database remains very incomplete.

SC14.12 (para. 59) Noting that despite the mandatory reporting requirements detailed in Resolutions 05/05, 08/04, 09/06, 10/02, 10/03, and 10/06, bycatch data remain largely unreported by CPCs and the SC **RECOMMENDED** that the Compliance Committee and the Commission address this non-compliance by taking steps to develop mechanisms which would ensure that CPCs fulfil their bycatch reporting obligations.

SC14.13 (para. 60) The SC **RECOMMENDED** that the current IOTC Resolution 08/04 concerning the recording of catch by longline fishing vessels in the IOTC area, Resolution 10/03 concerning the recording of catch by fishing vessels in the IOTC area and Resolution 10/02 mandatory statistical requirements for IOTC members and cooperating non-contracting parties be amended in order to include a clear list of shark and marine turtle species or group of species, that should be recorded and reported to the IOTC Secretariat as per the IOTC requirements for target species.

SC14.14 (para. 61) Noting that there is extensive literature available on pelagic shark fisheries and interactions with fisheries targeting tuna and tuna-like species, in countries having fisheries for sharks, and in the databases of governmental or non-governmental organizations, the SC **AGREED** on the need for a major data mining exercise in order to compile data from as many sources as possible and attempt to rebuild historical catch series of the most commonly caught shark species. In this regard, the WPEB **RECOMMENDED** that the Scientific Committee considers presenting a proposal to the Commission for this activity, including a budget.

On Resolution 98/02 Data confidentiality policy and procedures

SC14.15 (para. 62) Noting that CPCs have begun to submit observer trip reports and observer data to the IOTC Secretariat, and that confidentially rules contained apply to these data (Cf. Resolution 11/04, para. 12), the SC **RECOMMENDED** that Resolution 98/02 be amended in order to clearly incorporate observer data in the data confidentiality policy of the IOTC.

Species identification cards – Sharks, seabirds and marine turtles

SC14.16 (para. 66) The SC **RECOMMENDED** that the Commission agree to allocate additional funds from the IOTC accumulated funds, or other sources, be allocated to print and distribute the identification cards for sharks, seabirds and marine turtles to developing coastal states.

Sharks – ERA

SC14.17 (para. 67) Noting the general lack of catch data on sharks, the SC strongly **RECOMMENDED** that an (Ecological Risk Assessment) ERA is conducted for sharks caught in fisheries targeting tuna and tuna-like species in the Indian Ocean before the next session of the WPEB. In order to do so, the SC **RECOMMENDED** that the Commission allocate specific funds for such an analysis. Should a Fishery Officer be recruited at the IOTC Secretariat, he/she may be in a position to coordinate this task.

Sharks – Wire leaders/traces

SC14.18 (para. 68) On the basis of information presented to the SC in 2011 and in previous years, the SC **RECOGNISED** that the use of wire leaders/traces in longline fisheries may imply targeting of sharks. The SC therefore **RECOMMENDED** to the Commission that if it wishes to reduce catch rates of sharks by longliners it should prohibit the use of wire leaders/traces.

Sharks – Resolution 05/05 *concerning the conservation of sharks caught in association with fisheries managed by IOTC*

Fin to body weight ratio

SC14.19 (para. 69) The SC **ADVISED** the Commission to consider, that the best way to encourage full utilisation of sharks, to ensure accurate catch statistics, and to facilitate the collection of biological information, is to revise the IOTC Resolution 05/05 *concerning the conservation of sharks caught in association with fisheries managed by IOTC* such that all sharks must be landed with fins attached (naturally or by other means) to their respective carcass. However, the SC **NOTED** that such an action would have practical implementation and safety issues for some fleets and may degrade the quality of the product in some cases. The SC **RECOMMENDED** all CPCs to obtain and maintain the best possible data for IOTC fisheries impacting upon sharks, including improved species identification.

Sharks – Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC'S)*

SC14.20 (para. 70) Noting that the collection and reporting of data on sharks as per the IOTC Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPCs)* is very poor at the moment, the SC **RECOMMENDED** that Resolution 10/02 is reinforced by including specific requirements in the provision of nominal catch data for a list of most commonly caught shark species (Table 3). The SC **NOTED** that nominal catch data can be derived from logbook data, observer data or port sampling scheme. Furthermore, the Resolution should be strengthened by amending the provision of catch-and-effort and size data to be applicable to sharks species as well as other bycatch, noting that these data can be derived from logbook or observer data.

Table 3. List of the most commonly caught elasmobranch species.

Common name	Species	Code
Manta and devil rays	Mobulidae	MAN
Whale shark	*Rhincodon typus*	RHN
Thresher sharks	*Alopias spp.*	THR
Mako sharks	*Isurus spp.*	MAK

Silky shark	*Carcharhinus falciformis*	FAL
Oceanic whitetip shark	*Carcharhinus longimanus*	OCS
Blue shark	*Prionace glauca*	BSH
Hammerhead shark	Sphyrnidae	SPY
Other Sharks and rays	–	SKH

Sharks – On Resolution 10/12 on the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence

SC14.21 (para. 71) Noting that Resolution 10/12 *on the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence* prohibits the retention of any part or whole carcass of thresher sharks and that the collection of biological samples on dead individuals would increase the scientific knowledge of these species, the SC **RECOMMENDED** that Resolution 10/12 be amended in order to allow observers to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs) from thresher sharks that are dead at haulback.

Seabirds

SC14.22 (para. 79) The SC **RECOMMENDED** that the specifications for the design and deployment of bird scaring lines be amended in order to take into account different specifications depending on the size of the longline fishing vessel, as follows:

Bird-scaring line design

1. The bird-scaring line shall be a minimum aerial extent of 100 m in length for vessels that exceed 35 m in length and of 75 m in length for vessel less or equal to 35 m in length. If the bird-scaring line is less than 150 m in length, it will include an object towed at the seaward end to create tension to maximise aerial coverage. The section above water shall be a strong fine line of a conspicuous colour such as red or orange.

Deployment of bird scaring lines

1. The bird scaring line shall be deployed before longlines enter into the water.
2. The vessels exceeding 35 m in length should deploy two lines with an aerial extent of 100 m minimum. The vessels that are less or equal to 35 m in length could deploy a single line with an aerial extent of 75 m minimum. To achieve this coverage the line shall be suspended from a point a minimum of 5 metres above the water at the stern on the windward side of the point where the branch line enters the water.

SC14.23 (para. 81) The SC **RECOMMENDED** that Resolution 10/06 be strengthened in order to make the reporting of seabird interactions mandatory for vessels fishing for species under the IOTC mandate.

SC14.24 (para. 82) The SC **RECOMMENDED** that any amendment to Resolution 10/06 should allow sufficient time for orderly implementation, to allow training and redevelopment of gears and operations.

SC14.25 (para. 83) The SC **RECOMMENDED** that the Commission consider revising Resolution 10/06 *On Reducing the Incidental Bycatch of Seabirds in Longline Fisheries*, noting the technical specifications and other considerations outlined and agreed to by the SC in paragraphs 73 to 82 of the report of the SC14.

SC14.26 (para. 84) The SC **AGREED** that seabird identification can be very difficult, even for trained scientific observers, and **RECOMMENDED** that observers take photographs of seabirds caught by fishing vessels and submit them to seabird experts, or to the IOTC Secretariat, for confirmation of identification.

SC14.27 (para. 85) As a matter of consistency and to increase the reporting of seabird interactions, the SC **RECOMMENDED** that the recording of interactions with seabirds (as a group) be included in the minimum requirements for logbooks or through observer programmes for all fleets.

SC14.28 (para. 86) The SC further **RECOMMENDED** the Commission consider that more research is conducted on the identification of hot spots of interactions of seabirds with fishing vessels.

Marine turtles

SC14.29 (para. 88) Noting the general lack of data on incidental catch of marine turtles, the SC **RECOMMENDED** that an ERA be conducted for marine turtles caught in fisheries targeting tuna and tuna-like species in the Indian Ocean before the session of the WPEB where marine turtles will be a priority. In order to do so, the SC **RECOMMENDED** that the Commission allocate specific funds for such an analysis.

SC14.30 (para. 89) Noting that reporting of interactions with marine turtles is already mandatory through Resolution 09/06 which states "*CPCs shall collect (including through logbooks and observer programs) and provide to the Scientific Committee all data on their vessels' interactions with marine turtles in fisheries targeting the species covered by the IOTC Agreement"* (Res.09/06, para.2), and in order to increase the reporting of interactions, the SC **RECOMMENDED** that the recording of marine turtles caught as bycatch is included in the minimum requirements of logbooks or through observer programmes for all fleets fishing in the IOTC area.

SC14.31 (para. 91) The SC **RECOMMENDED** that current IOTC Resolution 09/06 *on Marine Turtles* be strengthened to ensure that CPCs report annually on the level of incidental catches of marine turtles by species.

SC14.32 (para. 92) Noting that paragraph 4 of Resolution 09/06 *on Marine Turtles* currently refers to "hard shelled turtles", which could be read to exclude leatherback turtles, and noting the Scientific Committee's previous recommendation to the Commission that the resolution should apply to leatherback turtles, the SC **RECOMMENDED** that the Commission revise Resolution 09/06 *on marine turtles* so that the term "hard-shelled" be deleted and replaced by "marine" to ensure application to all marine turtle species.

Redundant/obsolete Conservation and Management Measures (Resolutions and Recommendations)

SC14.33 (para. 93) The SC **RECOMMENDED** that the Commission revoke the following Conservation and Management Measures, noting that they have either been superseded by a new Resolution adopted by the Commission, but were not specifically revoked (Recommendation 05/09 and 05/08), or the CMM was to carry out a specific scientific task which is now complete (Resolution 00/02):

- Recommendation 05/09 *On incidental mortality of seabirds*
- Recommendation 05/08 *On sea turtles and Resolution 09/06 On marine turtles*
- Resolution 00/02 *On a survey of predation of longline caught fish*.

Report of the First Session of the Working Party on Neritic Tunas

SC14.34 (para. 97) The SC **AGREED** that there was an urgent need to carry out stock assessments for neritic tunas in the Indian Ocean, however at present the data held at the IOTC Secretariat would be insufficient to undertake this task. As such, the SC **RECOMMENDED** that the Commission consider allocating appropriate funds to further increase the capacity of coastal states to collect, report and analyse catch data on neritic tuna and tuna-like species in the Indian Ocean.

IOTC Observer Trip Report Template

SC14.35 (para. 99) Noting that in 2010, the SC requested that the WPDCS discuss collection and reporting by observers of the data items below:

- Information on the type and numbers of branch lines and wire leaders used (longline)
- Information on the number and type of electronic equipment used on board
- Area resolution (1 degree square at present)
- Information on the state of the sea and weather conditions
- Information on depredation
- Information on lost fishing gear
- Information on the number of hooks used by type and size.

and noting the difficulties that some observers may have in collecting and reporting of the data items that are requested in the observer trip report template (seven items listed above), and further noting that collecting this information may compromise access to other basic data on board longline vessels, the SC **RECOMMENDED** that the Commission allow for some flexibility in the collection and reporting of these data, until such a time where the CPCs concerned are in a position to collect and provide this information.

SC14.36 (para. 100) Noting that the use of monofilament leaders may allow sharks to escape by biting through the line (removing the hook), in contrast to wire leaders which are not prone to 'bite-off', the SC **RECOMMENDED** that, where possible for fleets that have not already prohibited the use of wire leaders, the number of 'bite-off' per leader type is added to the longline hauling information recorded by the observer (currently in the IOTC observer form FORM 4-LL – Fishing Event Longline).

SC14.37 (para. 101) Noting that the current observer trip reporting template includes summaries of catch and bycatch by 1° square as required in Resolution 11/04, and that there is no summary of the effort exerted during the trip at the same scale, the SC **RECOMMENDED** that a new table is added to the observer trip reporting template that would ensure effort during the trip is recorded, as follows:

Year	Month	Square (1°x1°)	Effort deployed
			Longline: number of hooks deployed Purse seine on free-schools: number of fishing sets Purse seine on associated schools: number of fishing sets, and number of new FADs deployed Gillnet: number of panels deployed Pole-and-line: number of fishing days Handline: number of fishing days Troll-line: number of fishing days

SC14.38 (para. 102) The SC **RECOMMENDED** that the observer trip report is submitted in an electronic format, where possible, noting that the forms/tables in the observer trip report template are for illustrative purposes and that the complete information required could be reported in a different format.

SC14.39 (para. 103) Noting that at present, the observer reporting template includes obligatory reporting of information concerning waste management on board the fishing vessel (International Convention for the Prevention of Pollution from Ships – MARPOL), the SC **RECOMMENDED** that the reporting of this information be made optional, as most fishing vessels are already bound by this international regulation.

SC14.40 (para. 104) Noting that the reporting of transhipment events have to be reported through the IOTC Transhipment Programme, and that the IOTC Transhipment Programme applies only where transhipments involve a fishing vessel with LOA 24 m or greater and carrier vessels, pointing out that transhipments between fishing vessels, in particular, fresh-tuna longliners, are very common, the SC **AGREED** that in order to avoid duplication, observers under the IOTC Regional Observer Scheme can refrain from reporting Transhipments when those events are recorded by observers under the IOTC Transhipment Programme, **RECOMMENDING** that this is incorporated into the observer report.

Activities under the IOTC-OFCF Project

SC14.41 (para. 107) Acknowledging the value of projects such as the IOTC-OFCF in the region, the SC **NOTED** with thanks the support offered by the IOTC-OFCF project since 2002, and strongly **RECOMMENDED** that the activities carried out under the IOTC-OFCF project, including the IOTC-OFCF project itself, continue after the project ends in March 2013.

Meeting participation fund

SC14.42 (para. 108) The SC **NOTED** that the increased attendance by national scientists from developing CPCs to IOTC Working Parties in 2011 was partly due to the IOTC Meeting Participation Fund (MPF), adopted by the Commission in 2010 (Resolution 10/05 *on the establishment of a Meeting Participation Fund for developing IOTC Members and non-Contracting Cooperating Parties*), and **RECOMMENDED** that the Commission maintain this fund into the future.

SC14.43 (para. 109) The SC **RECOMMENDED** that the Commission consider the problems encountered by potential MPF recipients in 2011. Specifically, there were a number of officially funded recipients who could not attend the various IOTC meetings at the last moment due to internal/domestic administrative processes (including but not limited to South Africa, I.R. Iran). In some cases this resulted in loss of the Commission's MPF funds due to late cancellations.

Dedicated workshop on CPUE standardisation

SC14.44 (para. 110) Noting the combined recommendations from the WPB, WPTmT and WPTT to hold a dedicated workshop on CPUE standardization in 2012, the SC **RECOMMENDED** that a dedicated, informal workshop on CPUE standardization, including issues of interest for other IOTC species, should be carried out before the next round of stock assessments in 2013, and that where possible it should include a range of invited experts, including those working on CPUE standardisation in other ocean/RFMOs, in conjunction with scientists from Japan, Republic of Korea and Taiwan,China, and supported by the IOTC Secretariat. The SC **NOTED** the CPUE workshop organised by ISSF and scheduled to be held late March 2012 in Hawai'i, USA, and urged national scientists working on purse seine CPUE standardisations to attend where possible.

Increased workload and staffing at the IOTC Secretariat

SC14.45 (para. 114) The SC **RECOMMENDED** that an additional Fishery Officer (P3 or P4) be hired, or consultants contracted, to handle a range of issues related to bycatch, including those from the Commission relating to ecosystems and bycatch issues (see para. 113).

Examination of the Effect of Piracy on Fleet Operations and Subsequent Catch and Effort Trends

SC14.46 (para. 127) In response to the request of the Commission (para. 40 of the S15 report), the SC **RECOMMENDED** that given the lack of quantitative analysis of the effects of piracy on fleet operations and subsequent catch and effort trends, and the potential impacts of piracy on fisheries in other areas of the Indian Ocean through the relocation of longliners to other fishing grounds, specific analysis should be carried out and presented at the next WPTT meeting by the CPCs most affected by these activities, including Japan, Republic of Korea and Taiwan,China.

Implementation of the Regional Observer Scheme

SC14.47 (para. 139) The SC **RECOMMENDED** that all IOTC CPCs urgently implement the requirements of Resolution 11/04 on a Regional Observer Scheme, which states that: "The observer shall, within 30 days of completion of each trip, provide a report to the CPCs of the vessel. The CPCs shall send within 150 days at the latest each report, as far as continuous flow of report from observer placed on the longline fleet is ensured, which is recommended to be provided with 1°x1° format to the Executive Secretary, who shall make the report available to the Scientific Committee upon request. In a case where the vessel is fishing in the EEZ of a coastal state, the report shall equally be submitted to that Coastal State." (para. 11), **NOTING** that the timely submission of observer trip reports to the Secretariat is necessary to ensure that the Scientific Committee is able to carry out the tasks assigned to it by the Commission, including the analysis of accurate and high resolution data, in particular for bycatch, which would allow the scientists to better assess the impacts of fisheries for tuna and tuna-like species on bycatch species.

SC14.48 (para. 143) The SC **AGREED** that such a low level of implementation and reporting is detrimental to its work, in particular regarding the estimation of incidental catches of non-targeted species, as requested by the Commission and **RECOMMENDED** the Commission to consider how to address the lack of implementation of observer programmes by CPCs for their fleets and reporting to the IOTC Secretariat as per the provision of Resolution 11/04 *on a Regional Observer Scheme*, noting the update provided in Appendix XXXIV.

Implementation of the Precautionary approach and Management strategy Evaluation

SC14.49 (para. 146) Noting that the development of an MSE process will require management objectives to be specified, the SC **RECOMMENDED** that the Commission provide clear guidance in this regard, noting that the adoption of the Precautionary Approach, as defined in the Fish Stocks Agreement, may be the first step.

SC14.50 (para. 149) The SC **RECOMMENDED** that interim target and limit reference points be adopted and a list of possible provisional values for the major species is listed in Table 5. These values should be replaced as soon as the MSE process is completed. Provisional target reference points would be based on the MSY level of the indicators, and on different multipliers for the limit reference points.

Table 5. Interim target and limit reference points.

Stock	Target Reference Point	Limit Reference Point
Albacore	B_{MSY}; F_{MSY}	0.4*B_{MSY}; 1.4*F_{MSY}
Bigeye tuna	B_{MSY}; F_{MSY}	0.5*B_{MSY}; 1.3*F_{MSY}
Skipjack tuna	B_{MSY}; F_{MSY}	0.4*B_{MSY}; 1.5*F_{MSY}
Yellowfin tuna	B_{MSY}; F_{MSY}	0.4*B_{MSY}; 1.4*F_{MSY}
Swordfish	B_{MSY}; F_{MSY}	0.4*B_{MSY}; 1.4*F_{MSY}

SC14.51 (para. 157) The SC **ENDORSED** the roadmap presented for the implementation of MSE in the Indian Ocean in IOTC–2011–SC14–36 and **RECOMMENDED** the Commission agree to initiate a consultative process among managers, stakeholders and scientists to begin discussions about the implementation of MSE in IOTC.

Data Provision Needs – by gear

SC14.52 (para. 169) The SC **RECOMMENDED** that the minimum recording requirements for handline and trolling provided in Appendix XXXV be incorporated into the revised proposal for minimum recording requirements as detailed in para. 170.

SC14.53 (para. 170) The SC **RECOMMENDED** that IOTC Recommendation 11/06 be modified to include the elements as provided in Appendix XXXV, noting that the lists of species to be recorded, as detailed in section 2.3 of Annex II, and makes collection of these data mandatory.

SC14.54 (para. 171) The SC **RECOGNISED** that not all CPCs attended the SC meeting and that some of these CPCs, especially coastal states, may have difficulties implementing new minimum data requirements immediately. The SC therefore **RECOMMENDED** that the Commission adopt a flexible approach to any further resolutions on minimum data requirements, e.g. through staged implementation over a period of two years.

Outlook on Time-Area Closures

SC14.55 (para. 173) Noting that the request contained in Resolution 10/01 does not specify the expected objective to be achieved with the current or alternative time area closures, and that the SC and WPTT were not clear about the intended objectives of the time-area closure taking into account recent reduction of effort as well as recent likely recovery of the yellowfin tuna population, the SC **RECOMMENDED** that the Commission specify clear objectives as to what are the management objectives to be achieved with this and/or alternative measures. This will, in turn, guide and facilitate the analysis of the SC, via the WPTT in 2012 and future years.

SC14.56 (para. 174) Noting the lack of research examining time-area closures in the Indian Ocean by the WPTT in 2011, as well as the slow progress made in addressing the Commission request, the SC **RECOMMENDED** that the SC Chair begins a consultative process with the Commission in order to obtain clear guidance from the Commission about the management objectives intended with the current or any alternative closure. This will allow the SC to address the Commission request more thoroughly.

Evaluation of the IOTC time-area closure

SC14.57 (para. 178) The SC **RECOMMENDED** that the Commission note that the current closure is likely to be ineffective, as fishing effort will be redirected to other fishing grounds in the Indian Ocean. The positive impacts of the moratorium within the closed area would likely be offset by effort reallocation. For example, the WPTmT noted that longline fishing effort has been redistributed to traditional albacore fishing grounds in recent years, thereby further increasing fishing pressure on this stock.

SC14.58 (para. 179) Noting that the objective of Resolution 10/01 is to decrease the overall pressure on the main targeted stocks in the Indian Ocean, in particular yellowfin tuna and bigeye tuna, and also to evaluate the impact of the current time/area closure and any alternative scenarios on tropical tuna population, the SC **RECOMMENDED** that the Commission specify the level of reduction or the long term management objectives to be achieved with the current or alternative time area closures, as these are not contained within the Resolution 10/01.

Alternative Management Measures; Impacts of the Purse-Seine Fishery; Juvenile Tuna Catches

SC14.59 (para. 186) The SC **RECOMMENDED** that the Commission note that:

- most of the evidence provided to date has indicated that the resource in the southwest Indian Ocean has been overfished in the past decade and biomass remains below the level that would produce MSY (B_{MSY}), however recent declines in catch and effort have brought fishing mortality rates to levels below F_{MSY}. There is a risk of reversing the rebuilding trend if there is any increase in catch in this region. Thus, catches in the southwest Indian Ocean should be maintained at levels at or below those observed in 2009 (6,600 t), until there is clear evidence of recovery and biomass exceeds B_{MSY}.
- the southwest region should continue to be analysed as a special resource, as it appears to

be highly depleted compared to the Indian Ocean as a whole. However the difference in depletion does not appear to be as extreme as analyses in previous years have suggested. A review of the spatial assumptions should be conducted following the final results of the Indian Ocean Swordfish Stock Structure (IOSSS) project and the analysis of tagging experiments undertaken by SWIOFP.

- that there is no current need to apply additional management measures to the southwest Indian Ocean, although the resource in the area should be carefully monitored.
- that the Working Party on Methods will be progressing Management Strategy Evaluation over the coming year that will aid in addressing the Commission's request, which was considered as the appropriate mechanism for this work.

SC14.60 (para. 190) The SC **NOTED** however, that the fishery statistics available for many fleets, in particular for coastal fisheries, are not accurate enough for a comprehensive analysis as has been repeatedly noted in previous WPTT and SC reports. In particular, the SC **RECOMMENDED** that all CPCs catching yellowfin tuna should undertake scientific sampling of their yellowfin tuna catches to better identify the proportion of bigeye tuna catches. Therefore, the SC **RECOMMENDED** the countries engaged in those fisheries to take immediate actions to reverse the situation of fishery statistics reporting to the IOTC Secretariat.

SC14.61 (para. 192) The SC **ADVISED** the Commission that the Western and Central Pacific Fisheries Commission has implemented since 2009 a FAD closure for the conservation of yellowfin tuna and bigeye tuna juveniles which has been very effective. The SC **RECOMMENDED** further investigation of the feasibility and impacts of such a measure, as well as other measures, in the context of Indian Ocean fisheries and stocks.

Progress in Implementation of the Recommendations of the Performance Review Panel

SC14.62 (para. 195) The SC **RECOMMENDED** that the Commission note the updates on progress regarding Resolution 09/01 – on the performance review follow–up, as provided at Appendix XXXVI.

Schedule and Priorities of Working Party and Scientific Committee Meetings for 2012 and Tentatively for 2013

SC14.63 (para. 197) The SC **RECOMMENDED** that the Commission endorse the schedule of Working Party and Scientific Committee meetings for 2012, and tentatively for 2013 (Table 8).

Table 8. Schedule of Working Party and Scientific Committee meetings for 2012, and tentatively for 2013.

Meeting	2012		2013 (tentative)	
	Date	Location	Date	Location
Working Party on Temperate Tunas	3–5 July (3d)	TBD (China?)	Early Aug (3d)	TBD (ICCAT SAA)
Working Party on Billfish	11–15 Sept (5d)	Cape town, South Africa – TBD	10–14 Sept (5d)	Bali, Indonesia
Working Party on Ecosystems and Bycatch	17–19 Sept (3d)	Cape town, South Africa – TBD	16–18 Sept (5d)	Bali, Indonesia
Working Party on Methods	22–23 Oct (2d)	Port Louis, Mauritius	18–19 Oct (2d)	TBD
Working Party on Tropical Tunas	24–29 Oct (6d)	Port Louis, Mauritius	21–26 Oct (6d)	TBD
Working Party on Neritic Tunas	Pending (3d)	Penang, Malaysia	Pending (3d)	TBD
Working Party on Data Collection and Statistics	nil	nil	5–6 Dec	TBD
Scientific Committee	10–15 Dec (6d)	Victoria, Seychelles	9–14 Dec (6d)	TBD

Requests from the Commission

SC14.64 (para. 222) Noting that each year the Commission makes a number of requests to the SC without clearly identifying the task to be undertaken, its priority against other tasks previously or simultaneously assigned to the SC and without assigning a budget to fund the request made, the SC **RECOMMENDED** that these matters be addressed by the Commission at its next session.

Election of a Chairperson and Vice-Chairperson for the Next Biennium

SC14.65 (para. 232) The SC **RECOMMENDED** that the Commission note the new Chair, Dr. Tom

Nishida (Japan) and Vice-Chair, Mr. Jan Robinson (Seychelles), of the SC for the next biennium, as well as the Chairs and Vice-Chairs of each of the Working Parties as provided in Appendix VII.

Review of the Draft, and Adoption of the Report of the Fourteenth Session of the Scientific Committee

SC14.66 (para. 233) The SC **RECOMMENDED** that the Commission consider the consolidated set of recommendations arising from SC14, provided at Appendix XXXVIII.

RESEARCH RECOMMENDATIONS AND PRIORITIES

Working Party on Billfish (WPB) – Research Recommendations and Priorities

SC14.67 (para. 201) The SC **RECOMMENDED** that marlins and sailfish undergo CPUE analysis in 2012, with striped marlin taking priority over other species.

SC14.68 (para. 202) The SC **RECOMMENDED** that as a matter of priority, striped marlin be the subject of CPUE analysis in 2011, and that CPUE series be compared among fleets where possible.

SC14.69 (para. 203) The SC **AGREED** that there was no urgent need to carry out stock assessments for the swordfish resources in the Indian Ocean in 2012, and **RECOMMENDED** that efforts over the coming year be focused on the other billfish species, in particular on striped marlin.

SC14.70 (para. 204) The SC **RECOMMENDED** the following core areas as priorities for research over the coming year;

- Swordfish stock structure and migratory range – using genetics
- Swordfish stock structure and movement rates – using tagging techniques
- Billfish species growth rates
- Size data analyses
- Stock status indicators – exploration of indicators from available data
- CPUE standardization – swordfish, marlins and sailfish
- Stock assessment – Istiophorids
- Depredation – focus on the southwest

Working Party on Temperate Tunas (WPTmT)

Stock assessment

SC14.71 (para. 206) The SC **AGREED** that there was an urgent need to carry out revised stock assessments for the albacore resource in the Indian Ocean in 2012, and **RECOMMENDED** that the Commission consider approving funds for this purpose.

Stock structure

SC14.72 (para. 207) Noting that at present very little is known about the population structure and migratory range of albacore in the Indian Ocean, other than the possible connectivity with the southern Atlantic, the SC **RECOMMENDED** that a research project addressing the albacore stock structure, migratory range and movement rates in the Indian Ocean be considered at its 2012 annual meeting as this project is assigned a high priority.

Additional core topics for research

SC14.73 (para. 208) The SC **RECOMMENDED** that the following core topic areas as priorities for research over the coming year:

- Size data analyses
- Growth rates and ageing studies
- Stock status indicators – exploration of indicators from available data
- Collaborate with SPC-OFP to examine their current simulation approach to determine priority research areas.

Working Party on Tropical Tunas (WPTT)

CPUE standardisation

SC14.74 (para. 211) The SC **RECOMMENDED** that if possible, the IOTC Secretariat and Maldivian scientists continue the joint effort to standardize the Maldivian pole-and-line CPUE in preparation for assessment in 2012.

SC14.75 (para. 212) The SC **RECOMMENDED** that standardization of purse seine CPUE be made where possible using the operational data on the fishery, and that participants working on CPUE for the main fleets, attend the CPUE standardization workshop being organized by ISSF in Honolulu, Hawaii in 2012.

Stock assessment

SC14.76 (para. 213) Noting the difficulty of carrying out stock assessments for three tropical tuna species in a single year, the SC **RECOMMENDED** to a revised assessment schedule on a two- or three-year cycle for the three tropical tuna species as outlined in Table 9. Following the uncertainty remaining in the yellowfin tuna assessment the SC **AGREED** that priories for stock assessments in 2012 would be yellowfin tuna (Multifan-CL and SS3, Yield per recruit and possibly others) with an update of fishery indicators for the other two species.

Table 9. New schedule proposed for tropical tuna species stock assessment.

Species/Assessment year	2012	2013	2014	2015	2016	2017
Yellowfin tuna	Full	Update	Update	Full	Update	Update
Skipjack tuna	Update	Full	Update	Update	Full	Update
Bigeye tuna	Update	Update	Full	Update	Update	Full

Note: the schedule may be change depending on the situation of the stock from various sources such as fishery indicators, Commission requests, etc.

Additional topics for research

SC14.77 (para. 214) The SC **RECOMMENDED** the following core topic areas as priorities for research over the coming year in order of priority: update of the Brownie-Peterson method for the 3 tropical tuna species (possible issue for the 2012 IO Tuna Tagging Symposium).

- An updated yellowfin tuna growth curve (work in progress to be presented to 2012 Tuna Tagging Symposium).
- Multi-gear yield per recruit.

Working Party on Ecosystems and Bycatch (WPEB

SC14.78 (para. 215) The SC **AGREED** that sharks should be the priority for the next meeting of the WPEB in 2012, and seabirds, marine turtle, marine mammals and other bycatch should be reassessed as priorities at the next session of the SC. Thus, the SC **RECOMMENDED** the following core topic areas as priorities for research over the coming year.

- **Ecological Risk Assessment**
  - i. All sharks
- **CPUE analyses**
  - i. Oceanic whitetip shark
  - ii. Other sharks
- **Stock status analyses**
  - i. Oceanic whitetip shark
  - ii. Other sharks
- **Capacity building**
  - i. Scientific assistance to CPCs and specific fleets considered to have the highest risk to bycatch species (e.g. gillnet fleets and longline fleets).

Working Party on Neritic Tunas (WPNT)

Stock structure

SC14.79 (para. 216) Noting that at present very little is known about the population structure and migratory range of most neritic tunas in the Indian Ocean, the SC **RECOMMENDED** a research plan that includes two separate research lines; i) genetic research to determine the connectivity of neritic tunas throughout their distributions, and ii) tagging research to better understand the movement dynamics, possible spawning locations, and post-release mortality of neritic tunas from various fisheries in the Indian Ocean. These should be considered high priority research projects for 2012 and 2013.

Biological information

SC14.80 (para. 217) The SC **RECOMMENDED** that quantitative biological studies are required to determine maturity-at-age and fecundity-at-age relationships, and age and growth for all neritic tunas throughout their range.

CPUE standardisation

SC14.81 (para. 219) The SC **RECOMMENDED** that where feasible, support should be provided by the IOTC Secretariat and other CPCs, to aid in the development of standardised CPUE series for each neritic tuna species.

Stock assessment

SC14.82 (para. 221) The SC **AGREED** that there was an urgent need to carry out stock assessments for neritic tunas in the Indian Ocean, however at present the data held at the IOTC Secretariat would be insufficient to undertake this task. As such, the SC **RECOMMENDED** that the Commission consider allocating appropriate funds to further increase the capacity of coastal states to collect, report and analyse catch data on neritic tunas.