Report of the Seventeenth Session of the IOTC Scientific Committee

Seychelles, 8–12 December 2014

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ACRONYMS

ACAP	Agreement on the Conservation of Albatrosses and Petrels
aFAD	Anchored fish aggregation device
ASPIC	A Stock-Production Model Incorporating Covariates
B	Biomass (total)
B_{MSY}	Biomass which produces 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
CE	Catch and effort
CI	Confidence interval
CMM	Conservation and Management Measure (of the IOTC; Resolutions and Recommendations)
CoC	Compliance Committee
CPCs	Contracting Parties and Cooperating Non-Contracting Parties
CPUE	catch per unit effort
current	Current period/time, i.e. $F_{current}$ means fishing mortality for the current assessment year
EEZ	Exclusive Economic Zone
ERA	ecological risk assessment
EU	European Union
F	Fishing mortality; F_{2010} is the fishing mortality estimated in the year 2010
FAD	Fish Aggretation device
FAO	Food and Agriculture Organization of the United Nations
FL	Fork length
F_{MSY}	Fishing mortality at MSY
GLM	Generalised liner model
HCR	Harvest control rule
HBF	Hooks between floats
HS	Harvest strategy
HSF	Harvest strategy framework
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
IO	Indian Ocean
IOTC	Indian Ocean Tuna Commission
IOSEA	Indian Ocean - South-East Asian Marine Turtle Memorandum
IPA	International Plan of Action
IPNLF	International Pole and Line Foundation
ISSF	International Seafood Sustainability Foundation
IUCN	International Union for the Conservation of Nature
IUU	Illegal, unregulated and unreported (fishing)
LJFL	Lower-jaw fork length
LRP	Limit reference point
LL	Longline
LSTLV	Large-scale tuna longline fishing vessel
M	Natural mortality
MEY	Maximum economic yield
MFCL	Multifan-CL
MOU	Memorandum of understanding
MP	Management procedure
MPA	Marine Protected Area
MSPEA	Maldives Seafood Processors and Exporters Association
MPF	Meeting Participation Fund
MSE	Management strategy evaluation
MSY	Maximum Sustainable Yield
n.a.	Not applicable
NGO	Non-governmental organization
NPOA	National plan of action
OFCF	Overseas Fishery Cooperation Foundation of Japan
OM	Operating model
OT	Oversears Territory
PS	Purse seine
PSA	Productivity Susceptibility Analysis
q	Catchability
RBC	Recommended biological catch
RFMO	Regional fisheries management organisation
ROS	Regional Observer Scheme

RTTP-IO	Regional Tuna Tagging Project of the Indian Ocean
SB	Spawning biomass (sometimes expressed as SSB)
SB_{MSY}	Spawning stock biomass which produces MSY
SC	Scientific committee
SCAF	Standing Committee on Administration and Finance
SE	Standard error
SWIOFC	South West Indian Ocean Fisheries Commission
SWIOFP	South West Indian Ocean Fisheries Project
SS3	Stock Synthesis III
SSB	Spawning stock biomass
TAC	Total allowable catch
TAE	Total allowable effort
Taiwan,China	Taiwan, Province of China
TCAC	Technical Committee on Allocation Criteria
tRFMO	tuna Regional Fishery Management Organization
TRP	Target reference point
TrRP	Trigger reference point
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNGA	United Nations General Assembly
VMS	Vessel Monitoring System
WP	Working Party of the IOTC
WPB	Working Party on Billfish
WPEB	Working Party on Ecosystems and Bycatch
WPDCS	Working Party on Data Collection and Statistics
WPFC	Working Party on Fishing Capacity
WPM	Working Party on Methods
WPNT	Working Party on Neritic Tunas
WPTmT	Working Party on Temperate Tunas
WPTT	Working Party on Tropical Tunas

STANDARDISATION OF IOTC WORKING PARTY AND SCIENTIFIC COMMITTEE REPORT TERMINOLOGY

SC16.07 (para. 23) The SC **ADOPTED** the reporting terminology contained in Appendix IV and **RECOMMENDED** that the Commission considers adopting the standardised IOTC Report terminology, to further improve the clarity of information sharing from, and among its subsidiary bodies.

HOW TO INTERPRET TERMINOLOGY CONTAINED IN THIS REPORT

Level 1: From a subsidiary body of the Commission to the next level in the structure of the Commission:

RECOMMENDED, RECOMMENDATION: Any conclusion or request for an action to be undertaken, from a subsidiary body of the Commission (Committee or Working Party), which is to be formally provided to the next level in the structure of the Commission for its consideration/endorsement (e.g. from a Working Party to the Scientific Committee; from a Committee to the Commission). The intention is that the higher body will consider the recommended action for endorsement under its own mandate, if the subsidiary body does not already have the required mandate. Ideally this should be task specific and contain a timeframe for completion.

Level 2: From a subsidiary body of the Commission to a CPC, the IOTC Secretariat, or other body (not the Commission) to carry out a specified task:

REQUESTED: This term should only be used by a subsidiary body of the Commission if it does not wish to have the request formally adopted/endorsed by the next level in the structure of the Commission. For example, if a Committee wishes to seek additional input from a CPC on a particular topic, but does not wish to formalise the request beyond the mandate of the Committee, it may request that a set action be undertaken. Ideally this should be task specific and contain a timeframe for the completion.

Level 3: General terms to be used for consistency:

AGREED: Any point of discussion from a meeting which the IOTC body considers to be an agreed course of action covered by its mandate, which has not already been dealt with under Level 1 or level 2 above; a general point of agreement among delegations/participants of a meeting which does not need to be considered/adopted by the next level in the Commission's structure.

NOTED/NOTING: Any point of discussion from a meeting which the IOTC body considers to be important enough to record in a meeting report for future reference.

Any other term: Any other term may be used in addition to the Level 3 terms to highlight to the reader of and IOTC report, the importance of the relevant paragraph. However, other terms used are considered for explanatory/informational purposes only and shall have no higher rating within the reporting terminology hierarchy than Level 3, described above (e.g. **CONSIDERED**; **URGED**; **ACKNOWLEDGED**).

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EXECUTIVE SUMMARY

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

Tuna – Highly migratory species

SC17.01 (para. 145) 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, and the combined Kobe plot for the three species assigned a stock status in 2014 (Fig. 4):

- Albacore (*Thunnus alalunga*) – Appendix XII
- Bigeye tuna (*Thunnus obesus*) – Appendix XIII
- Skipjack tuna (*Katsuwonus pelamis*) – Appendix XIV
- Yellowfin tuna (*Thunnus albacares*) – Appendix XV

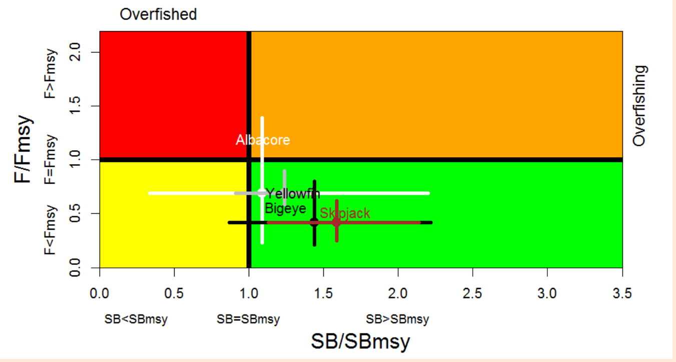


Fig. 4. Combined Kobe plot for bigeye tuna (black: 2013), skipjack tuna (brown: 2014), yellowfin tuna (grey: 2012) and albacore (white: 2014) showing the estimates of current stock size (SB) and current fishing mortality (F) in relation to the interim target spawning stock size and interim target fishing mortality. Cross bars illustrate the range of uncertainty from the model runs. Note that for skipjack tuna, the estimates are highly uncertain as F_{MSY} is poorly estimated, and as suggested for stock status advice it is better to use B_0 as a biomass reference point and C(t) relative to C_{MSY} as a fishing mortality reference point.

Billfish

SC17.02 (para. 147) The SC **RECOMMENDED** that the Commission note the management advice developed for each billfish species under the IOTC mandate, as provided in the Executive Summary for each species, and the combined Kobe plot for the three species assigned a stock status in 2014 (Fig. 5):

- Swordfish (*Xiphias gladius*) – Appendix XVI
- Black marlin (*Makaira indica*) – Appendix XVII
- Blue marlin (*Makaira nigricans*) – Appendix XVIII
- Striped marlin (*Tetrapturus audax*) – Appendix XIX
- Indo-Pacific sailfish (*Istiophorus platypterus*) – Appendix XX

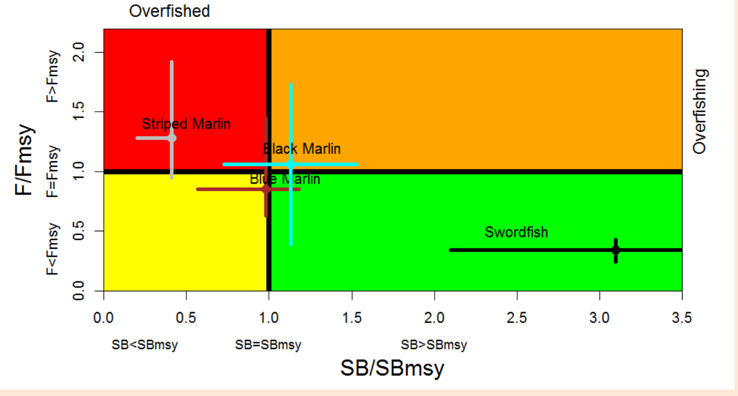


Fig. 5. Combined Kobe plot for swordfish (black: 2014), black marlin (light blue: 2014), blue marlin (brown: 2013) and striped marlin (grey: 2013) showing the estimates of current stock size (SB or B, species assessment dependent) and current fishing mortality (F) in relation to the interim target spawning stock size and interim target fishing mortality. Cross bars illustrate the range of uncertainty from the model runs.

Tuna and seerfish – Neritic species

SC17.03 (para. 148) The SC **RECOMMENDED** that the Commission note the management advice developed for each neritic tuna (and mackerel) species under the IOTC mandate, as provided in the Executive

Summary for each species, and the combined Kobe plot for the three species assigned a stock status in 2014 (Fig. 6):

- Bullet tuna (*Auxis rochei*) – Appendix XXI
- Frigate tuna (*Auxis thazard*) – Appendix XXII
- Kawakawa (*Euthynnus affinis*) – Appendix XXIII
- Longtail tuna (*Thunnus tonggol*) – Appendix XXIV
- Indo-Pacific king mackerel (*Scomberomorus guttatus*) – Appendix XXV
- Narrow-barred Spanish mackerel (*Scomberomorus commerson*) – Appendix XXVI

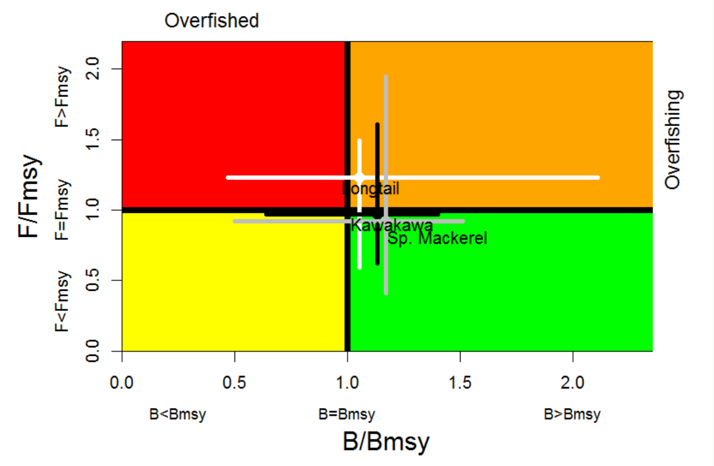


Fig. 6. Combined Kobe plot for kawakawa (black: 2014), longtail tuna (white: 2014) and narrow-barred Spanish mackerel (grey: 2014), showing the estimates of current stock size (B) and current fishing mortality (F) in relation to interim target spawning stock size and interim target fishing mortality. Cross bars illustrate the range of uncertainty from the model runs.

Status of Marine Turtles, Seabirds and Sharks in the Indian Ocean

Sharks

SC17.04 (para. 149) 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 shark (*Prionace glauca*) – Appendix XXVII
- Oceanic whitetip shark (*Carcharhinus longimanus*) – Appendix XXVIII
- Scalloped hammerhead shark (*Sphyrna lewini*) – Appendix XXIX
- Shortfin mako shark (*Isurus oxyrinchus*) – Appendix XXX
- Silky shark (*Carcharhinus falciformis*) – Appendix XXXI
- Bigeye thresher shark (*Alopias superciliosus*) – Appendix XXXII
- Pelagic thresher shark (*Alopias pelagicus*) – Appendix XXXIII

Marine turtles

SC17.05 (para. 150) 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 XXXIV

Seabirds

SC17.06 (para. 151) 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 XXXV

Shark fin to body weight ratio and wire leaders/traces

SC17.18 (para. 50) **NOTING** that the Commission, at its 18th Session considered a range of proposals on sharks which included matters relevant to the shark fin to body weight ratio and wire leaders/traces, the SC **RECALLED** its previous advice to the Commission as follows:

- 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.

- On the basis of information presented to the SC 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.

Fish aggregating devices

SC17.23 (para. 71) The SC **RECOMMENDED** that an ad hoc working group on FADs, drifting and anchored, be created to assess the consequences of the increasing number and technological developments of FADs in tuna fisheries and their ecosystems, in order to inform and advise on future FAD-related management options. This ad hoc working group would be of multi-sectorial nature, involving various stakeholders such as scientists, fishery managers, fishing industry representatives, administrators and fishers. The Terms of reference for this working group are provided at Appendix VIII.

Limit reference points

SC17.27 (para. 103) The SC **RECOMMENDED** the Commission consider an alternative approach to identify biomass limit reference points, such as those based on biomass depletion levels, when the MSY-based reference points are difficult to estimate. In cases where MSY-based reference points can be robustly estimated, limit reference points may be based around MSY.

SC17.28 (para. 104) The SC **RECOMMENDED** that in cases where MSY-based reference points cannot be robustly estimated, biomass limit reference points be set at 20% of unfished levels ($B_{LIM} = 0.2B_0$).

Target reference points

SC17.29 (para. 105) **NOTING** that the interim target reference points contained in Resolution 13/10 are also MSY-based and subject to the same difficulties with robust estimation, the SC **RECOMMENDED** that the Commission consider that stock biomass depletion levels equivalent to B_{MSY} are expected to lie in the range of 30% to 40% of unfished levels ($0.3B_0$ to $0.4B_0$), when MSY-based levels cannot be accurately estimated. The Commission may wish to consider a value of $0.4B_0$ or higher, if a precautionary buffer against reaching a biomass limit is desirable.

SC17.30 (para. 106) **NOTING** that the approach described in para. 105 is similar to what is currently taking place in other RFMOs such as WCPFC, the SC **RECOMMENDED** that the use of this type of reference point is adopted by the Commission. In considering target reference points, guidance will be required from the Commission on tolerable risks of exceeding limit reference points.

Fishing Mortality Equivalents

SC17.31 (para. 107) The SC **RECOMMENDED** that with respect to fishing mortality (F) reference points, for consistency between the definitions of overfished and overfishing, the Commission should consider using those F values that correspond to the biomass reference points. For example, given a biomass limit of $0.2B_0$, a consistent F limit reference point would be $F_{B20\%}$, the fishing mortality rate that reduces the biomass to 20% of unfished levels.

Skipjack tuna MSE update

SC17.32 (para. 110) The SC **NOTED** that the consultancy that has been used to develop the simulation tools and initial evaluations of some candidate Management Procedures has run to completion. Additional work is required to support the Commission's desire to implement management approaches that can achieve its objectives. In this regard, the SC **RECOMMENDED** that the Commission fully fund the work needed to support its requirement to achieve its objectives in particular facilitating the implementation of Resolution 12/01.

Review of the Draft, and Adoption of the Report of the 17th Session of the Scientific Committee

SC17.51 (para. 194) The SC **RECOMMENDED** that the Commission consider the additional science budget for 2015–16, (Appendix XLII) and the consolidated set of recommendations arising from SC17, provided at Appendix XLIII.

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	2012	2013	2014	Advice to the Commission
Temperate and tropical tuna stocks: These are the main stocks being targeted by industrial, and to a lesser extent, artisanal fisheries throughout the Indian Ocean, both on the high seas and in the EEZ of coastal states.								
Albacore *Thunnus alalunga*	Catch 2013: 38,297 t Average catch 2008–2013: 37,525 t MSY (1,000 t) (80% CI): 47.6 (26.7–78.8) F_{MSY} (80% CI): 0.31 (0.21–0.42) SB_{MSY} (1,000 t) (80% CI): 39.2 (25.4–50.7) F_{2012}/F_{MSY} (80% CI): 0.69 (0.23–1.39) SB_{2012}/SB_{MSY} (80% CI): 1.09 (0.34–2.20) SB_{2012}/SB_{1950} (80% CI): 0.21 (0.11–0.33)	2007						Catches have increased substantially since 2007, attributed to the Indonesian and Taiwan,China longline fisheries although there is substantial uncertainty remaining on the catch estimates. It is considered that recent catches are approaching MSY levels. Fishing mortality represented as F_{2012}/F_{MSY} is 0.69. Biomass is considered to be at or very near to the SB_{MSY} level (SB_{2012}/SB_{MSY} = 1.09). Considerable uncertainty remains in the assessments, indicating that a precautionary approach to the management of albacore should be applied by reducing fishing mortality or capping total catch levels to those taken in 2012 (34,000 t). Click here for full stock status summary: Appendix XII
Bigeye tuna *Thunnus obesus*	Catch in 2013: 109,343 t Average catch 2009–2013: 105,924 t MSY (1,000 t) (range): 132 (98–207) F_{MSY} (range): n.a. (n.a.–n.a.) SB_{MSY} (1,000 t) (range): 474 (295–677) F_{2012}/F_{MSY} (range): 0.42 (0.21–0.80) SB_{2012}/SB_{MSY} (range): 1.44 (0.87–2.22) SB_{2012}/SB_0 (range): 0.40 (0.27–0.54)	2008						No new stock assessment was carried out in 2014, thus, stock status is determined on the basis of the 2013 assessment and other indicators presented in 2014. All the runs (except 2 extremes) carried out in 2013 indicate the stock is above a biomass level that would produce MSY in the long term (i.e. $SB_{2012}/SB_{MSY} > 1$) and in all runs that current fishing mortality is below the MSY-based reference level (i.e. $F_{2012}/F_{MSY} < 1$). Current spawning stock biomass was estimated to be 40% of the unfished levels. Catches in 2013 (≈109,000 t) remain lower than the estimated MSY values from the 2013 stock assessments. The average catch over the previous five years (2009–13; ≈106,000 t) also remains below the estimated MSY. Click here for full stock status summary: Appendix XIII
Skipjack tuna *Katsuwonus pelamis*	Catch 2013: 424,580 t Average catch 2009–2013: 401,132 t MSY (1,000 t) (80% CI): 684 (550–849) F_{MSY} (80% CI): 0.65 (0.51–0.79) SB_{MSY} (1,000 t) (80% CI): 875 (708–1,075) C_{2013}/C_{MSY} (80% CI): 0.62 (0.49–0.75) SB_{2013}/SB_{MSY} (80% CI): 1.59 (1.13–2.14) SB_{2013}/SB_0 (80% CI): 0.58 (0.53–0.62)							The 2014 stock assessment model results did not differ substantively from the previous assessments. All the runs indicate the stock is above a biomass level that would produce MSY in the long term (i.e. $SB_{2013}/SB_{MSY} > 1$) and that the current proxy for fishing mortality is below the MSY-based reference level (i.e. $C_{current}/C_{MSY} < 1$). Current spawning stock biomass was estimated to be 57% of the unfished levels. Catches in 2014 (≈424,000 t) remain lower than the estimated MSY values from the 2014 stock assessments. The average catch over the previous five years (2009–13; ≈401,000 t) also remains below the estimated MSY. Click here for full stock status summary: Appendix XIV
Yellowfin tuna	Catch 2013: 402,084 t Average catch 2009–2013: 339,359 t	2008						No new stock assessment was carried out in 2014, thus, stock status is determined on the basis of the 2012 assessment and other indicators

Stock	Indicators	Prev[1]	2010	2011	2012	2013	2014	Advice to the Commission
Thunnus albacares	MSY (1,000 t) (80% CI): 344 (290–453) F_{MSY} (80% CI): n.a (n.a.–n.a.) SB_{MSY} (1,000 t) (80% CI): 881 (784–986) F_{curr}/F_{MSY} (80% CI): 0.69 (0.59–0.90) SB_{curr}/SB_{MSY} (80% CI): 1.24 (0.91–1.40) SB_{curr}/SB_0 (80% CI): 0.38 (0.28–0.38)							presented in 2014. Total catch has continued to increase with 400,292 t and 402,084 t landed in 2012 and 2013, respectively, well in excess of previous MSY estimates (≈17% above the MSY level of 344,000 t), in comparison to 327,453 t landed in 2011 and 299,713 t landed in 2010. Therefore it is difficult to know whether the stock is moving towards a state of being subject to overfishing. Click here for full stock status summary: Appendix XV
Billfish: These are the billfish stocks being exploited by industrial and artisanal fisheries throughout the Indian Ocean, both on the high seas and in the EEZ of coastal states. The marlins and sailfish are not usually targeted by most fleets, but are caught and retained as byproduct by the main industrial fisheries. They are important for localised small-scale and artisanal fisheries or as targets in recreational fisheries.								
Swordfish (whole Indian Ocean) *Xiphias gladius*	Catch 2013: 31,804 t Average catch 2009–2013: 26,510 t MSY (1,000 t) (80% CI): 39.40 (33.20–45.60) F_{MSY} (80% CI): 0.138 (0.137–0.138) SB_{MSY} (1,000 t) (80% CI): 61.4 (51.5–71.4) F_{2013}/F_{MSY} (80% CI): 0.34 (0.28–0.40) SB_{2013}/SB_{MSY} (80% CI): 3.10 (2.44–3.75) SB_{2013}/SB_{1950} (80% CI): 0.74 (0.58–0.89)	2007						The SS3 model, used for stock status advice indicated that MSY-based reference points were not exceeded for the Indian Ocean population as a whole ($F_{2013}/F_{MSY} < 1$; $SB_{2013}/SB_{MSY} > 1$). All other models applied to swordfish also indicated that the stock is above a biomass level that would produce MSY and current catches are below the MSY level. Spawning stock biomass in 2013 was estimated to be 58–89% of the unfished levels. Click here for full stock status summary: Appendix XVI
Swordfish (southwest Indian Ocean) *Xiphias gladius*	Catch 2013: 7,349 t Average catch 2009–2013: 7,265 t MSY (1,000 t) (80% CI): 9.86 (9.11–10.57) F_{MSY} (80% CI): 0.63 (0.59–0.70) B_{MSY} (1,000 t) (80% CI): 12.68 (12.52–12.78) F_{2013}/F_{MSY} (80% CI): 0.89 (0.61–1.14) B_{2013}/B_{MSY} (80% CI): 0.94 (0.68–1.23) B_{2013}/B_{1950} (80% CI): 0.16 (n.a.)							The assessments carried out in 2014 produced substantially conflicting results (ASIA, BBDM and ASPIC). The southwest Indian Ocean region has been subject to localised depletion over the past decade and biomass remains below the level that would produce MSY (B_{MSY}). In 2013, 7,349 t of swordfish catches were recorded from this region, which equals 110% of the recommended maximum catch of 6,678 t agreed to by the SC in 2011. If catches are maintained at 2013 levels, the probabilities of violating target reference points in 2016 are ≈ 81% for F_{MSY} and ≈ 40% for B_{MSY}. Click here for full stock status summary: Appendix XVI
Black marlin *Makaira indica*	Catch 2013: 14,400 t Average catch 2009–2013: 11,962 t MSY (1,000 t) (80% CI): 10.2 (7.6–13.8) F_{MSY} (80% CI): 0.25 (0.08–0.45) B_{MSY} (1,000 t) (80% CI): 37.8 (14.6–62.3) F_{2013}/F_{MSY} (80% CI): 1.06 (0.39–1.73) B_{2013}/B_{MSY} (80% CI): 1.13 (0.73–1.53) B_{2013}/B_{1950} (80% CI): 0.57 (0.37–0.76)							This is the second time that the WPB has applied a Stock Reduction Analysis technique to black marlin and further testing of how sensitive this technique is to model assumptions and available time series of catches needs to be undertaken. However, the WPB considers that the assessment is the best information currently available and as such, should be used to determine stock status, with the intention that alternative techniques be applied in 2015 to validate the results. Click here for full stock status summary: Appendix XVII
Blue marlin *Makaira nigricans*	Catch 2013: 13,834 t Average catch 2009–2013: 11,531 t MSY (1,000 t) (80% CI): 11.70 (8.02–12.40) F_{MSY} (80% CI): 0.49 (n.a.) B_{MSY} (1,000 t) (80% CI): 23.70 (n.a.) F_{2011}/F_{MSY} (80% CI): 0.85 (0.63–1.45) B_{2011}/B_{MSY} (80% CI): 0.98 (0.57–1.18) B_{2011}/B_{1950} (80% CI): 0.48 (n.a.)							No new assessment was undertaken in 2014. Thus, stock status is based on the previous assessment undertaken in 2013, as well as indicators available in 2014. In 2013, an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicated the stock is currently being exploited near maximum levels and that the stock is at the optimal biomass level. Two other approaches examined in 2013 came to similar conclusions, namely a Bayesian State Space model, and a data poor stock assessment method: Stock Reduction Analysis using only catch data. Total reported landings increased substantially in 2012 to 17,252 t, well above the MSY estimate of 11,690 t. In 2013 reported catches declined slightly to 13,843 t, still above the MSY

Stock	Indicators	Prev[1]	2010	2011	2012	2013	2014	Advice to the Commission
								level. Given the sharp increase in reported catches over the last two years, that are well above the MSY level, the stock is likely to have moved to a state of being subject to overfishing. Click here for full stock status summary: Appendix XVIII
Striped marlin *Tetrapturus audax*	Catch 2013: 4,429 t Average catch 2009–2013: 3,667 t MSY (1,000 t) (80% CI): 4.41 t (3.54–4.58) F_{MSY} (80% CI): 0.36 (n.a.) B_{MSY} (1,000 t) (80% CI): 12.43 t (n.a.) F_{2011}/F_{MSY} (80% CI): 1.28 (0.95–1.92) B_{2011}/B_{MSY} (80% CI): 0.416 (0.2–0.42) B_{2011}/B_0 (80% CI): 0.18 (n.a.)							No new assessment was undertaken in 2014. Thus, stock status is based on the previous assessment undertaken in 2013, as well as indicators available in 2014. In 2013 an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicated the stock is currently subject to overfishing and that biomass is below the level which would produce MSY. Two other approaches examined in 2013 came to similar conclusions, namely a Bayesian State Space model, and a Stock Reduction Analysis using only catch data. The ASPIC model indicated that the stock has been subject to overfishing for some years, and that as a result, the stock biomass is well below the B_{MSY} level and shows little signs of rebuilding despite the declining effort trend. In 2013 reported catches declined to 4,429 t, still above the MSY level. Click here for full stock status summary: Appendix XIX
Indo-Pacific Sailfish *Istiophorus platypterus*	Catch 2013: 29,750 t Average catch 2009–2013: 28,087 t MSY (1,000 t) (80% CI): 27.84 (24.70–35.00) F_{MSY} (80% CI): 0.27 (0.16–0.39) B_{MSY} (1,000 t) (80% CI): 95.2 (62.89–127.73) F_{2013}/F_{MSY} (80% CI): 1.19 (0.66–1.72) B_{2013}/B_{MSY} (80% CI): 1.12 (0.88–1.37) B_{2013}/B_0 (80% CI): 0.56 (0.44–0.69)							Data poor methods for stock assessment using Stock reduction analysis (SRA) techniques indicate that the stock is not overfished and close to or exceeding maximum sustainable yield levels. However, as this is the first time that the WPB used such a method on Indo-Pacific sailfish, further testing of how sensitive this technique is to model assumptions and available time series of catches needs to be undertaken before the WPB uses it to determine stock status. Click here for full stock status summary: Appendix XX
Neritic tunas and mackerel: These six species have become as important or more important as the three tropical tuna species (bigeye tuna, skipjack tuna and yellowfin tuna) to most IOTC coastal states with a total estimated catch of **623,242 t** being landed in 2013. They are caught primarily by coastal fisheries, including small-scale industrial and artisanal fisheries. They are almost always caught within the EEZs of coastal states. Historically, catches were often reported as aggregates of various species, making it difficult to obtain appropriate data for stock assessment analyses.								
Bullet tuna *Auxis rochei*	Catch 2013: 11,724 t Average catch 2009–2013: 10,598 t MSY (1,000 t) (80% CI): unknown F_{MSY} (80% CI): unknown B_{MSY} (1,000 t) (80% CI): unknown F_{2012}/F_{MSY} (80% CI): unknown B_{2012}/B_{MSY} (80% CI): unknown B_{2012}/B_0 (80% CI): unknown							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 status indicators can be used. Aspects of the fisheries for bullet tuna combined with the lack of data on which to base a more formal assessment, are a cause for considerable concern Stock status in relation to the Commission's B_{MSY} and F_{MSY} target reference points remains uncertain, indicating that a precautionary approach to the management of bullet tuna should be applied. Click here for full stock status summary: Appendix XXI
Frigate tuna *Auxis thazard*	Catch 2013: 88,974 t Average catch 2009–2013: 91,974 t MSY (1,000 t) (80% CI): unknown F_{MSY} (80% CI): unknown B_{MSY} (1,000 t) (80% CI): unknown F_{2012}/F_{MSY} (80% CI): unknown B_{2012}/B_{MSY} (80% CI): unknown B_{2012}/B_0 (80% CI): unknown							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 status indicators can be used. Aspects of the fisheries for frigate tuna combined with the lack of data on which to base a more formal assessment are a cause for considerable concern. Stock status in relation to the Commission's B_{MSY} and F_{MSY} target reference points remains uncertain, indicating that a precautionary approach to the management of frigate tuna should be applied. Click here for full stock status summary: Appendix XXII

Stock	Indicators	Prev[1]	2010	2011	2012	2013	2014	Advice to the Commission
Kawakawa *Euthynnus affinis*	Catch 2013: 168,954 t Average catch 2009–2013: 150,387 t MSY (1,000 t) (80% CI): 144 (113–167) F_{MSY} (80% CI): 0.51 (n.a.) B_{MSY} (1,000 t) (80% CI): 217 (168–152) F_{2012}/F_{MSY} (80% CI): 0.97 (0.62–1.61) B_{2012}/B_{MSY} (80% CI): 1.13 (0.64–1.4) B_{2012}/B_0 (80% CI): 0.57 (0.32–0.7)							Analysis using a Stock Reduction Analysis approach for a second year indicates that the stock is near optimal levels of F_{MSY}, and stock biomass is near the level that would produce MSY (B_{MSY}). Due to the quality of the data being used, the simplistic approach employed in 2014, combined with the rapid increase in kawakawa catch in recent years, measures need to be taken to slow the increase in catches in the IOTC area of competence. A separate analysis done on a sub-population (north-west Indian Ocean region) in 2014 indicated that that stock may be experiencing overfishing, although spawning biomass is likely to be above the level to produce MSY. Click for a full stock status summary: Appendix XXIII
Longtail tuna *Thunnus tonggol*	Catch 2012: 160,532 t Average catch 2009–2012: 139,971 t MSY (1,000 t) (80% CI): 120 (79–171) F_{MSY} (80% CI): 0.39 (0.27–0.51) B_{MSY} (1,000 t) (80% CI): 255 (173–377) F_{2012}/F_{MSY} (80% CI): 1.23 (0.47–2.11) B_{2012}/B_{MSY} (80% CI): 1.05 (0.59–1.49) B_{2012}/B_0 (80% CI): 0.53(0.30–0.75)							Stock Reduction Analysis techniques indicate that the stock is being exploited at a rate that exceed F_{MSY} in recent years. Whether a four quadrant stock structure of catches in the Indian Ocean or a one stock assumption is used in the analysis, the conclusions remain the same. Another analysis conducted on the northwest Indian Ocean with a Surplus Production Model (ASPIC) also indicates that the stock is subject to overfishing. More traditional methods of stock assessment need to be conducted by developing indices of abundance using catch and effort series from I.R. Iran and Indonesia. Click for a full stock status summary: Appendix XXIV
Indo-Pacific king mackerel *Scomberomorus guttatus*	Catch 2013: 44,363 t Average catch 2009–2013: 45,447 t MSY (1,000 t) (80% CI): unknown F_{MSY} (80% CI): unknown B_{MSY} (1,000 t) (80% CI): unknown F_{2012}/F_{MSY} (80% CI): unknown B_{2012}/B_{MSY} (80% CI): unknown B_{2012}/B_0 (80% CI): unknown							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. Aspects of the fisheries for Indo-Pacific king mackerel combined with the lack of data on which to base a more formal assessment are a cause for considerable concern. Stock status in relation to the Commission's B_{MSY} and F_{MSY} target reference points remains uncertain, indicating that a precautionary approach to the management of Indo-Pacific king mackerel should be applied. Click for a full stock status summary: Appendix XXV
Narrow-barred Spanish mackerel *Scomberomorus commerson*	Catch 2013: 148,695 t Average catch 2009–2013: 144,462 t MSY (1,000 t) (80% CI): 137(93–164) F_{MSY} (80% CI): 0.47 (0.41–1.95) B_{MSY} (1,000 t) (80% CI): 229 (132–265) F_{2012}/F_{MSY} (80% CI): 0.92 (0.41–1.95) B_{2012}/B_{MSY} (80% CI): 1.17 (0.50–1.51) B_{2012}/B_0 (80% CI): 0.59 (0.25–0.75)							Stock Reduction Analysis techniques indicate that the stock is being exploited at a rate that is near F_{MSY} in recent years, and the stock appears to be fully exploited. Northwest Indian Ocean (Gulf of Oman Sea countries) indicate that localised depletion may be occurring from an analysis done in 2013, and overfishing is occurring in this area, though the degree of connectivity with other areas remains unknown. Stock structure issues remain to be clarified. Click for a full stock status summary: Appendix XXVI

Sharks: Although sharks are not part of the 16 species directly under the IOTC mandate, sharks are frequently caught in association with fisheries targeting IOTC species. Some fleets are known to actively target both sharks and IOTC species simultaneously. As such, IOTC Contracting Parties 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 IOTC fisheries, although the list is not exhaustive.

Blue shark *Prionace glauca*	Reported catch 2013: Not elsewhere included (nei) sharks[2]: Average reported catch 2009–2013: Not elsewhere included (nei) sharks[2]: MSY (range):	23,197 t 46,728 t 24,447 t 49,318 t 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 below for a full stock status summary: ○ Blue sharks – Appendix XXVII ○ Oceanic whitetip sharks – Appendix XXVIII ○ Scalloped hammerhead sharks – Appendix XXIX ○ Shortfin mako sharks – Appendix XXX ○ Silky sharks – Appendix XXXI ○ Bigeye thresher sharks – Appendix XXXII ○ Pelagic thresher sharks – Appendix XXXIII
Oceanic whitetip shark *Carcharhinus longimanus*	Reported catch 2013: Not elsewhere included (nei) sharks[2]: Average reported catch 2009–2013: Not elsewhere included (nei) sharks[2]: MSY (range):	230 t 46,728 t 317 t 49,318 t unknown							
Scalloped hammerhead shark *Sphyrna lewini*	Reported catch 2013: Not elsewhere included (nei) sharks[2]: Average reported catch 2009–2013: Not elsewhere included (nei) sharks[2]: MSY (range):	128 t 46,728 t 91 t 49,318 t unknown							
Shortfin mako *Isurus oxyrinchus*	Reported catch 2013: Not elsewhere included (nei) sharks[2]: Average reported catch 2009–2013: Not elsewhere included (nei) sharks[2]: MSY (range):	1,572 t 46,728 t 1,364 t 49,318 t unknown							
Silky shark *Carcharhinus falciformis*	Reported catch 2013: Not elsewhere included (nei) sharks[2]: Average reported catch 2009–2013: Not elsewhere included (nei) sharks[2]: MSY (range):	3,573 t 46,728 t 3,843 t 49,318 t unknown							
Bigeye thresher shark *Alopias superciliosus*	Reported catch 2013: Not elsewhere included (nei) sharks[2]: Average reported catch 2009–2013: Not elsewhere included (nei) sharks[2]: MSY (range):	0 t 46,728 t 75 t 49,318 t unknown							
Pelagic thresher shark *Alopias pelagicus*	Reported catch 2013: Not elsewhere included (nei) sharks[2]: Average reported catch 2009–2013: Not elsewhere included (nei) sharks[2]: MSY (range):	0 t 46,728 t 75 t 49,318 t unknown							

[1] This indicates the last year taken into account for assessments carried out before 2010; [2]The point estimate is the median of the plausible models investigated in the 2013 SS3 assessment; [3] most recent years data 2010; [4] most recent years data 2011.

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 Session

1. The 17th Session of the Indian Ocean Tuna Commission's (IOTC) Scientific Committee (SC) was held in Seychelles, from 8 to 12 December 2014. A total of 62 individuals (75 in 2013) attended the Session, comprised of 53 delegates (60 in 2013) from 22 Contracting Parties (21 in 2013), 0 delegates from Cooperating Non-Contracting Parties (2 in 2013), and 9 observers, including 2 invited experts (12 observers in 2013). The list of participants is provided at Appendix I. The meeting was opened on 8 December 2014 by the Chair (Dr Tom Nishida – Japan).

2. Adoption of the Agenda and Arrangements for the Session

2. The SC **ADOPTED** the Agenda provided at Appendix II, with the inclusion of two new items under 'Other business,' the first from the European Union to include a new point on the Dialogue between scientists and managers; and the second an update on the GEF-ABNJ Project. The documents presented to the SC are listed in Appendix III.

3. The SC **NOTED** the request from Mauritius to remove agenda item 12, on the '*Evaluation of closed areas as management options*', however, the Chair indicated that as this was a direct request from the Commission, during its 18th Session, it needed to be retained.

4. The SC **NOTED** the following statement made by the Republic of Mauritius:

   "*The delegation of the Republic of Mauritius had earlier drawn the attention of the Committee to the fact that the Government of the Republic of Mauritius does not recognize the so-called "British Indian Ocean Territory". The Chagos Archipelago, including Diego Garcia, forms an integral part of the territory of the Republic of Mauritius under both Mauritian law and international law.*

   As also indicated earlier, Mauritius has initiated proceedings against the United Kingdom under the United Nations Convention on the Law of the Sea (UNCLOS) to challenge the legality of the 'marine protected area' ('MPA') which the United Kingdom has purported to establish around the Chagos Archipelago. The dispute is currently before the Arbitral Tribunal constituted under Annex VII to UNCLOS.

   Since the legality of the 'MPA' which the United Kingdom has purported to establish around the Chagos Archipelago is being challenged, it would not be appropriate for the Scientific Committee to undertake any analysis of that 'MPA'.

   Moreover, any consideration by the Working Party on Tropical Tunas of the impact of the 'MPA' purportedly established by the United Kingdom around the Chagos Archipelago cannot and should not be construed as implying that the United Kingdom has sovereignty or analogous rights over the Chagos Archipelago."

5. 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*."

3. Admission of Observers

6. The SC **NOTED** that at the 17th Session of the Commission, Members decided that its subsidiary bodies should be open to participation by observers from all those who have attended the current and/or previous sessions of the Commission. Applications by new Observers should continue to follow the procedure as outlined in Rule XIV of the IOTC Rules of Procedure (2014).

3.1 Food and Agriculture Organisation (FAO) of the United Nations

7. In accordance with Rule VI.1 and XIV.1 of the IOTC Rules of Procedure (2014), the SC **ADMITTED** the following as an observer to the 17th Session of the SC:
   - Food and Agriculture Organisation (FAO) of the United Nations

3.2 Intergovernmental Organisations (IGO)

8. In accordance with Rule VI.1 and XIV.4 of the IOTC Rules of Procedure (2014), the SC **ADMITTED** the following Inter-governmental organisations (IGO) as observers to the 17th Session of the SC:
   - Agreement on the Conservation of Albatrosses and Petrels (ACAP)

3.3 Non-governmental Organisations (NGO)

9. In accordance with Rule VI.1 and XIV.5 of the IOTC Rules of Procedure (2014), the SC **ADMITTED** the following Non-governmental organisations (IGO) as observers to the 17th Session of the SC:
   - Greenpeace International (GI)
   - International Seafood Sustainability Foundation (ISSF)
   - Marine Stewardship Council (MSC)
   - World Wide Fund for Nature (a.k.a World Wildlife Fund, WWF)

3.4 Invited experts

10. In accordance with Rules VI.1 and XIV.9 of the IOTC Rules of Procedure (2014), which state that the Commission may invite experts, in their individual capacity, to enhance and broaden the expertise of the SC and of its Working Parties, the SC **ADMITTED** the invited experts from Taiwan,China to the 17th Session of the SC.

4. Decisions of the Commission Related to the Work of the Scientific Committee

4.1 Outcomes of the 18th Session of the Commission

11. The SC **NOTED** paper IOTC–2014–SC17–03 which outlined the decisions and requests made by the Commission at its 18th Session, held from 1–5 June 2014, specifically relating to the IOTC science process, including the 7 Conservation and Management Measures (6 Resolutions and 1 Recommendations) adopted during the Session, as listed below:

Resolutions

- Resolution 14/01 *On the removal of obsolete Conservation and Management Measures*
- Resolution 14/02 *For the conservation and management of tropical tunas stocks in the IOTC area of competence*
- Resolution 14/03 *On enhancing the dialogue between fisheries scientists and managers*
- Resolution 14/04 *Concerning the IOTC record of vessels authorised to operate in the IOTC area of competence*
- Resolution 14/05 *Concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 14/06 *On establishing a programme for transhipment by large-scale fishing vessels*

Recommendations

- Recommendation 14/07 *To standardise the presentation of scientific information in the annual Scientific Committee report and in Working Party reports*

12. The SC **RECALLED** that Pursuant to Article IX.5 of the IOTC Agreement, India has in place an objection for the following Conservation and Management Measures adopted at the 17th Session of the Commission, **NOTING** that 13/02 has been superseded by Resolution 14/04, and 13/07 has been superseded by Resolution 14/05.
   - Resolution 13/02 *Concerning the IOTC record of vessels authorised to operate in the IOTC area of competence*
   - Resolution 13/03 *On the recording of catch and effort by fishing vessels in the IOTC area of competence*
   - Resolution 13/06 *On a scientific and management framework on the Conservation of sharks species caught in association with IOTC managed fisheries*
   - Resolution 13/07 *Concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*

13. The SC **NOTED** that at the 18th Session of the Commission, Members made several comments on the recommendations made by the Scientific Committee, which participants are asked to note (extracts from the S18 report):

1) *The Commission addressed the list of recommendations made by the SC16 (Appendix V) from its 2013 report (IOTC–2013–SC16–R) that related specifically to the Commission. The Commission ENDORSED the list of recommendations, taking into account the range of issues outlined in this Report (S18) and incorporated within adopted Conservation and Management Measures.* (S18 Report, para. 10)

Albacore

2) *The Commission AGREED that pending the results of the 2014 albacore stock assessment, it should take a precautionary approach to the management of albacore and consider, at its 19th Session, proposals for Conservation and Management Measure to reduce fishing pressure for albacore; including the consideration of zone-based management of fishing effort*. (S18 Report, para. 13)

Skipjack tuna

3) *NOTING that the SC expressed concerns on the ability of both the pole and line CPUE and the purse seine CPUE to reflect the dynamics of the stock, and given their major role in driving the current stock assessment results, the Commission REQUESTED that further investigation is carried out for both CPUE series.* (S18 Report, para. 14)

Striped marlin

4) *The Commission AGREED that it should take a precautionary approach to the management of striped marlin and consider, at its 19th Session, proposals for Conservation and Management Measures to reduce fishing pressure for striped marlin; including the consideration of zone-based management of fishing effort*. (S18 Report, para. 16)

5) *The Commission AGREED that all CPCs should take a precautionary approach and immediately reduce their impact on striped marlin in the IOTC area of competence*. (S18 Report, para. 17)

14. The SC **AGREED** to develop advice in response to each of the additional requests (detailed in the previous paragraph) made by the Commission, during the current Session.

4.2 Previous decisions of the Commission

15. The SC **NOTED** paper IOTC–2014–SC17–04 which outlined a number of Commission decisions, in the form of previous Resolutions that require a response from the SC in 2014, or for the SC to include the requested elements into its Program of Work, and **AGREED** to develop advice to the Commission in response to each request during the current Session.

5. Science Related Activities of the IOTC Secretariat in 2014

5.1 Report of the Secretariat – Activities in support of the IOTC science process in 2014

16. The SC **NOTED** paper IOTC–2014–SC17–05 which provided an overview of the work undertaken by the IOTC Secretariat in 2014, and thanked the Secretariat for the contributions to the science process in 2014, in particular via support to the working party and SC meetings, facilitation of the IOTC Meeting Participation Fund, improvements in the quality of some of the data sets being collected and submitted to the IOTC Secretariat, and through the facilitation of invited experts to raise the standard of IOTC meetings.

17. The SC **NOTED** that the issues on the use of the Meeting Participation Fund (MPF), raised by each of the IOTC Working Parties in 2014, would be discussed throughout the course of the current Session and summaried in Section 7.8.

18. The SC **REQUESTED** that the IOTC Secretariat, whenever meetings are held relating to the science or the science-management processes of the IOTC, with the funding support of IOTC, those meetings should be open to all CPCs. For meetings undertaken without the funding support of the IOTC, invitation and attendance would be entirely the choice of the organising body. However, the SC **REQUESTED** that the IOTC Secretariat informs all CPCs of such meetings and, where possible, report on the results of such meetings to all CPCs.

5.2 *Guidelines for the presentation of CPUE standardisations and stock assessment models*

19. The SC **NOTED** paper IOTC–2014–SC17–06 which requested that the SC revise the current '*Guidelines for the presentation of stock assessment models'*, noting that the Commission adopted Recommendation 14/07 *To standardise the presentation of scientific information in the annual Scientific Committee report and in Working Party reports*, at its 18th Session in 2014.

20. The SC **ADOPTED** revised '*Guidelines for the presentation of CPUE standardisations and stock assessment models: 2014*' for use by its working parties in 2015 and future years, as detailed in Appendix IV.

6. NATIONAL REPORTS FROM CPCS

21. The SC **NOTED** the 26 (28 in 2013, 26 in 2012) National Reports submitted to the IOTC Secretariat in 2014 by CPCs (Contracting Parties and Cooperating Non-Contracting Parties), the abstracts of which are provided at Appendix V. The following matters were raised in regard to the content of specific reports:
   - **Australia**: Nil comments.
   - **Belize**: The SC **EXPRESSED** its disappointment that Belize did not provide a National Report in 2014 and **REQUESTED** that the SC Chair, in conjunction with the Chair of the Commission, remind Belize to fulfil its reporting obligations to the IOTC.
   - **China**: The SC **NOTED** the lack of any reported marine turtle interactions and welcomed the plans to increase scientific observer coverage in the future as well as encouraging fishers to record interactions.
   - **Comoros**: Nil comments.
   - **Eritrea**: The SC **EXPRESSED** its disappointment that Eritrea did not provide a National Report in 2014 and **REQUESTED** that the SC Chair, in conjunction with the Chair of the Commission, remind Eritrea to fulfil its reporting obligations to the IOTC.
   - **European Union** (EU): The SC **NOTED** that in response to a question on how the information collected from the logbook system for support vessels, which has been in place since 2005, has been analysed, the EU indicated that data continues to be collected and analysed with 2013 data presented at WPTT16 (see paper IOTC–2014–WPTT16–19). Data on dFAD deployment have been collected since 2010 (the requirement to collect the information started in 2013).
   - **France (OT)**: Nil comments.
   - **Guinea**: The SC **EXPRESSED** its disappointment that Guinea did not provide a National Report in 2014 and **REQUESTED** that the SC Chair, in conjunction with the Chair of the Commission, remind the Guinea to fulfil its reporting obligations to the IOTC.
   - **India**: The SC **NOTED** that in response to a question on the reason of the sudden increases of reported catches for yellowfin in 2012 and 2013, India indicated that the reported catches are correct and due to improvements in the collection systems as well as the development of a new coastal longline/trolling fishery targeting yellowfin and skipjack tuna from around 2011.
   - **Indonesia**: Nil comments.
   - **Iran, Islamic Rep.**: The SC **NOTED** the reported bycatch interactions from the gillnet fleet, in particular marine turtles and mammals, was based on port sampling rather than the observer program. It was also **NOTED** that port sampling only reports retained bycatch, which would not record interactions or discards at sea. The SC **NOTED** that I.R. Iran is in the process of implementing an onboard scientific observer scheme, as required by IOTC Resolution 11/04. Thus, SC **ACKNOWLEGED** I.R. Iran's efforts to implement Resolution 11/04 and **ENCOURAGED** I.R. Iran to report back to the SC.
   - **Japan**: The SC **NOTED** that the current reported 5.7% observer coverage rate for the Japanese longline fleet is for the total number of operations, rather than by hooks. It was also questioned why only 1 marine turtle had been reported as being caught by the longline fleet for the 5.7% of operations observed, as this seemed to be very low and highly unlikely to represent the actual situation.
   - **Kenya**: Nil comments.
   - **Korea, Rep. of**: The SC **NOTED** that although no specific numbers were cited, indicated that 90% of purse seine sets by the Korean purse seine fleet are fish schools around dFADs. In addition, although the Rep. of Korea indicated that their recent observer coverage is considered to be as representative as possible, given current fleet dynamics, the SC **ENCOURAGED** the improvement of appropriate spatial stratification in the future.

- **Madagascar**: The SC **NOTED** that the National Report for Madagascar provides information on scientific observers onboard national vessels, which was appreciated and considered valuable information.
- **Malaysia**: The SC **NOTED** the discontinued operation of a number of longline vessels since 2012 due to changing economic circumstances including an increase in the price of fuel.
- **Maldives, Republic of**: The SC **COMMENDED** the Maldives for complying with the collection of catch and effot data from all fisheries at a 1 by 1 degree spatial scale required by the IOTC, and **ENCOURAGED** other CPCs to follow the example.
- **Mauritius**: The SC **NOTED** that the Report only presents data from one active purse seine vessel in 2013. However, it was highlighted that there were 8 purse seine vessels in the IOTC list of authorised vessels, flagged to Mauritius. Mauritius explained to the group that 7 new purse seine vessels were listed in the IOTC list of Authorised Vessels in 2014 and had commenced fishing operations in 2014 and those activities will be reported in the 2015 National Report.
- **Mozambique**: Nil comments.
- **Oman, Sultanate of**: National Report not presented orally as Oman was absent from the SC17 meeting.
- **Pakistan**: The SC **EXPRESSED** its disappointment that Pakistan did not provide a National Report in 2014 and **REQUESTED** that the SC Chair, in conjunction with the Chair of the Commission, remind Pakistan to fulfil its reporting obligations to the IOTC.
- **Philippines**: National Report not presented orally as the Philippines was absent from the SC17 meeting.
- **Seychelles, Republic of**: The SC **NOTED** that there is an absence of bycatch interactions reported by the Seychelles longline fleets. Seychelles has begun the implementation of its scientific observer scheme on its purse seine fleet and is planning on expanding such scheme to cover other industrial fleets in the near future which should improve this situation.
- **Sierra Leone**: The SC **EXPRESSED** its disappointment that Sierra Leone did not provide a National Report and **REQUESTED** that the SC Chair, in conjunction with the Chair of the Commission, remind Sierra Leone to fulfil its reporting obligations to the IOTC.
- **Somalia**: Nil comments.
- **Sri Lanka**: The SC **NOTED** the catch data presented to the WPTT16 are not consistent with the catches recorded in the IOTC database and that there may be some species identification issues with the reporting of tuna catches. The SC **REQUESTED** Sri Lanka contact the IOTC Secretariat in order to clarify this issue.
- **Sudan**: The SC **EXPRESSED** its disappointment that Sudan did not provide a National Report and **REQUESTED** that the SC Chair, in conjunction with the Chair of the Commission, remind Sudan to fulfil its reporting obligations to the IOTC.
- **Tanzania, United Republic of**: The SC **NOTED** the fleet consisted of two longline vessels in 2013, which reported fishing effort over a very large area. Tanzania should consider verifying this spatial effort pattern as it appears to be extensive.
- **Thailand**: The SC **NOTED** the difference in species composition of landings between 2011 and 2013, including the increase in landings of marlins and suggested these data are explored further.
- **United Kingdom (OT)**: The SC **NOTED** the implementation of a conservation management plan and the various research activities conducted. IUU fising activities continue to threaten the UK(OT) ecosystem and vessels have been apprehended by the UK(OT) with large shark catches found on board, suspected of illegally fishing within the UK(OT) EEZ. The SC **NOTED** the following additional statement made by the Republic of Mauritius: "*The Government of the Republic of Mauritius reaffirms that it 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 accession to independence. This excision was carried out in violation of international law and 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 the Republic of Mauritius under both Mauritian law and international law. The Republic of Mauritius is, however, being prevented from exercising its rights over the Chagos Archipelago because of the de facto and unlawful control of the United Kingdom over the Archipelago.

Moreover, the Government of the Republic of Mauritius does not recognize the existence of the 'marine protected area' ('MPA') which the United Kingdom has purported to establish around the Chagos Archipelago in breach of international law, including the provisions of the United Nations Convention on the Law of the Sea (UNCLOS). On 20 December 2010, the Republic of Mauritius initiated proceedings against the United Kingdom under Article 287 of, and Annex VII to, UNCLOS to challenge the legality of the 'MPA'. The dispute is currently before the Arbitral Tribunal constituted under Annex VII to UNCLOS.

In the light of the above, consideration of any documents which the United Kingdom has purported to submit to this Committee in respect of the Chagos Archipelago or which purport to refer to the Chagos Archipelago as the so-called "BIOT" or to the 'MPA' purportedly established by the United Kingdom around the Chagos Archipelago, as well as any action or decision that may be taken on the basis of such documents, cannot and should not be construed as implying that the United Kingdom has sovereignty or analogous rights over the Chagos Archipelago.

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**: National Report not presented orally as the Vanuatu was absent from the SC17 meeting.
- **Yemen**: The SC **EXPRESSED** its disappointment that Yemen did not provide a National Report and **REQUESTED** that the SC Chair, in conjunction with the Chair of the Commission, remind Yemen to fulfil its reporting obligations to the IOTC.
- **Djibouti**: The SC **EXPRESSED** its disappointment that Djibouti did not provide a National Report and **REQUESTED** that the SC Chair, in conjunction with the Chair of the Commission, remind Djibouti to fulfil its reporting obligations to the IOTC. The SC **NOTED** that Djibouti was granted Cooperating Non-Contracting Party status for the first time by the Commission at its 18th Session, and as such it was a requirement of the new status to comply with the National Report obligation.
- **Senegal**: The SC **EXPRESSED** its disappointment that Senegal did not provide a National Report and **REQUESTED** that the SC Chair, in conjunction with the Chair of the Commission, remind Senegal to fulfil its reporting obligations to the IOTC.
- **South Africa, Republic of**: National Report not presented orally as South Africa was absent from the SC17 meeting.

22. The SC **REMINDED** CPCs that the purpose of the National Reports is to provide relevant information to the SC on fishing activities of Contracting Parties (Members) and Cooperating Non-Contracting Parties (collectively termed CPCs) operating in the IOTC area of competence. The report should include all fishing activities for species under the IOTC mandate as well as sharks and other byproduct / bycatch species as required by the IOTC Agreement and decisions by the Commission.

23. The SC **REMINDED** CPCs that the submission of a National Report is mandatory, irrespective if a CPC intends on attending the annual meeting of the SC and shall be submitted no later than 15 days prior to the SC meeting. The National Report does not replace the need for submission of data according to the IOTC Mandatory Data Requirements listed in the relevant IOTC Resolution [currently 10/02].

24. **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 providing the reports by all CPCs, the SC **RECOMMENDED** that the Commission note that in 2014, 26 reports were provided by CPCs, down from 28 in 2013 (26 in 2012, 25 in 2011, 15 in 2010 and 14 in 2009) (Table 2).

25. The SC **AGREED** that spending ~ 25% of each annual Session on the presentation of National Reports by each CPC was not the best use of the SC's time, and as such, the SC also **AGREED** that for the next and future Sessions of the SC, National Reports would not be presented orally, but rather, that a single session (3 hours) be devoted to questions and answers on the reports submitted to the SC. Some flexibility would be retained if CPCs still wished to present brief updates on their activities related to the IOTC science Program of Work.

26. The SC **RECOMMENDED** that the Commission note the lack of compliance by several CPCs in 2014, that did not submit a National Report in 2014, noting that the Commission agreed that the submission of the reports to the SC is mandatory (Table 2).

TABLE 2. CPC submission of National Reports to the SC from 2005 to 2014.

CPC	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Australia	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Belize	n.a.	n.a.	Red	Red	Red	Red	Green	Green	Green	Red
China	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Comoros	Red	Red	Red	Red	Red	Green	Green	Green	Green	Green
Eritrea	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
European Union	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
France (OT)	Green hash	Green hash	Green hash	Green hash	Green hash	Green hash	Green	Green	Green	Green
Guinea	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
India	Red	Green	Green	Red	Green	Green	Green	Green	Green	Green
Indonesia	n.a.	n.a.	Red	Red	Red	Red	Green	Green	Green	Green
Iran, Islamic Rep. of	Red	Red	Red	Red	Red	Red	Green	Green	Green	Green
Japan	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Kenya	Red	Red	Green	Green	Green	Green	Green	Green	Green	Green
Korea, Republic of	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Madagascar	Red	Red	Red	Red	Green	Green	Green	Green	Green	Green
Malaysia	Red	Red	Red	Red	Red	Red	Green	Green	Green	Green
Maldives, Rep. of	n.a.	n.a.	n.a.	n.a.	Green	Green	Green	Green	Green	Green
Mauritius	Red	Red	Red	Green	Green	Green	Green	Green	Green	Green
Mozambique	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Green	Green	Green	Green
Oman, Sultanate of	Red	Red	Red	Red	Red	Red	Red	Green	Green	Green
Pakistan	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
Philippines	Red	Red	Red	Red	Red	Red	Red	Green	Green	Green
Seychelles, Rep. of	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Sierra Leone	n.a.	n.a.	n.a.	Red	Red	Red	Red	Red	Red	Red
Somalia	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Green
Sri Lanka	Red	Green	Green	Red	Red	Red	Green	Green	Green	Green
Sudan	Red	Red	Red	Red	Red	Red	Red	Green	Green	Red
Tanzania, United Republic of	n.a.	n.a.	Red	Red	Red	Red	Green	Red	Green	Green
Thailand	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
United Kingdom (OT)	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Vanuatu	Red	Red	Red	Red	Red	Red	Green	Red	Green	Green
Yemen	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Red	Red	Red
Djibouti*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Red
Senegal*	Red	Red	Red	Red	Red	Red	Green	Green	Green	Red
South Africa, Rep. of*	Green	Red	Green	Green	Green	Red	Green	Green	Green	Green

*Cooperating Non-Contracting Party in 2014. Green = submitted. Red = not submitted. Green hash = submitted as part of EU report, although needed to be separate. n.a. = not applicable (not a CPC in that year).

27. The SC **NOTED** the information provided by the Invited Experts from Taiwan,China which outlined fishing activities in the IOTC area of competence.

7. REPORTS OF THE 2014 IOTC WORKING PARTY MEETINGS

7.1 Report of the 4th Session of the Working Party on Neritic Tunas (WPNT04)

28. The SC **NOTED** the report of the 4th Session of the Working Party on Neritic Tunas (IOTC–2014–WPNT04–R), including the consolidated list of recommendations provided as an appendix to the report. The meeting was attended by 37 participants (45 in 2013, 35 in 2012; 28 in 2011), including 13 recipients of the MPF (11 in 2013, 10 in 2012; 9 in 2011).

7.1.1 Kawakawa – Maldives pole and line fishery catch rate standardisation: 2004–12

29. The SC **REQUESTED** that the Maldives undertake further investigation of the quality of the catch-and-effort data (i.e., the zero catch records, incidence of one day fishing per month records), and development of a criteria for identifying kawakawa targeted catch, in order to improve the quality of future abundance estimates. Results should be presented at the WPNT05 meeting.

7.1.2 Stock structure research

30. The SC **RECALLED** that in 2013, it had made an additional recommendation on stock structure research, targeted primarily at neritic tunas under the IOTC mandate. Subsequently, at the request of the EU (DG-MARE), a concept note was developed to examine if there is a population structure of neritic tunas throughout the Indian Ocean. The IOTC Secretariat proposed that the list of species be expanded from only neritic tunas, to other IOTC species, including billfish, tropical, temperate tunas and sharks. The concept note has since been approved by the EU who will contribute €1.3 million and require an additional 20% co-contribution (€260,000) from either the IOTC regular budget or in combination with collaborating Institutions. The project will encourage a collaborative approach to the extent feasible to meet the needs of the Commission. The need to work collaboratively with scientists in other oceans to assess stock structure as well as with scientists within the Indian Ocean region was highlighted.

7.2 Report of the 5th Session of the Working Party on Temperate Tunas (WPTmT05)

31. The SC **NOTED** the report of the 5th Session of the Working Party on Temperate Tunas (IOTC–2014–WPTmT05–R), including the consolidated list of recommendations provided as an appendix to the report. The meeting was attended by 27 participants (26 in 2012), including 3 recipients of the MPF (3 in 2012).

7.2.1 Review of the data available at the IOTC Secretariat for temperate tuna species

32. **NOTING** that in recent years many foreign vessels have been unloading catches of albacore in Mauritius, representing around 60% of the total albacore catch, the SC **REQUESTED** that the Chair of the WPTmT and the Chair of the SC contact Mauritius and indicate that they should be in attendance at all WPTmT meetings, given the high proportion of total albacore catch being landed in Mauritius, and that they should present information on its efforts to monitor albacore landings for catch and size (length) data, and to provide summaries of that data.

33. The SC **RECOGNISED** the value of the biological information for albacore being collected in Mauritius by port samplers and **REQUESTED** that the IOTC Secretariat provide additional support to Mauritius on how to collect and report this information. This should occur as soon as possible in 2015.

7.3 Report of the 12th Session of the Working Party on Billfish (WPB12)

34. The SC **NOTED** the report of the 12th Session of the Working Party on Billfish (IOTC–2014–WPB12–R), including the consolidated list of recommendations provided as an appendix to the report. The meeting was attended by 21 participants (24 in 2013; 23 in 2012; 27 in 2011) including 4 recipients of the MPF (10 in 2013; 5 in 2012; 5 in 2011).

7.3.1 Recreational and sports fisheries for marlins and IP sailfish in the Indian Ocean

35. **NOTING** that in 2011, the Chair of the WPB, in collaboration with the IOTC Secretariat, participating billfish foundations and other interested parties, commenced a process to 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, the SC **REQUESTED** that the Chair and Vice-Chair of the WPB, work in collaboration with the IOTC Secretariat and the African Billfish Foundation to find a suitable funding source and lead investigator to undertake the project outlined in Appendix VI of the WPB12 Report. The aim of the project is to enhance data recovery from sports and other recreational fisheries in the western Indian Ocean region. The IOTC Secretariat shall circulate the concept note to potential funding bodies on behalf of the WPB. A similar concept note could be developed for other regions in the IOTC area of competence at a later date.

7.3.2 Shortbill spearfish

36. **NOTING** that one of the Indian Ocean billfish species (shortbill spearfish, *Tetrapturus angustirostris*) is currently not listed among the species managed by IOTC, and considering the ocean-wide distribution of this

species, its highly-migratory nature, and that it is a common bycatch in IOTC managed fisheries, the SC **RECOMMENDED** that the Commission include it in the list of species to be managed by the IOTC.

7.3.3 Swordfish

37. **NOTING** that the Commission has made the following request in recent years, the SC **AGREED** that there is no evidence of a separate genetic stock of swordfish in the southwest Indian Ocean, although this region has been subect to localised depletion over the past decade. As such, the Executive Summary for swordfish would reflect this advice to the Commission. Accordingly, until new evidence becomes available there is no need to conduct a separate stock assessment for this area. In the coming year, the EU co-financed stock structure project would again examine swordfish stock structure using alternative methods to those previously used. Given that the next stock assessment on swordfish is not planned until 2017, the results of this new work will be available before that time, to definitively resolve the matter.

*"The Commission **REQUESTED** that the southwest region continue to be analysed as a special resource, as it appears to be highly depleted compared to the Indian Ocean as a whole." (para. 29 of the S17 report).*

*"The Commission **ACKNOWLEDGED** that there is no current need to apply additional management measures to the southwest Indian Ocean, although the resource in this area should be carefully monitored." (para. 30 of the S17 report).*

7.4 Report of the 10th Session of the Working Party on Ecosystems and Bycatch (WPEB10)

38. The SC **NOTED** the report of the 10th Session of the Working Party on Ecosystems and Bycatch (IOTC–2014–WPEB10–R), including the consolidated list of recommendations provided as an appendix to the report. The meeting was attended by 37 participants (32 in 2013; 48 in 2012; 49 in 2011), including 5 recipients of the MPF (11 in 2013; 7 in 2012; 7 in 2011).

7.4.1 Evaluating benefits of retaining non-target species

39. The SC **NOTED** the request from the Commission (S18, para. 143), which states:

"*NOTING* *the comment from the authors of the proposal that the lack of data shall not prevent adoption of precautionary management measures, and that the measure is in line with UN Millennium Development Goals and provisions in the Ecosystem Approach to Fisheries (EAF) and may contribute to food security in some of the coastal countries of the IOTC, the Commission **REQUESTED** that the Scientific Committee review proposal IOTC–2014–S18–PropL Rev_1, and to make recommendations on the benefits of retaining non-targeted species catches, other than those prohibited via IOTC Resolutions, for consideration at the 19th Session of the Commission.*"

40. The SC **AGREED** that in the absence of relevant information to fulfill the Commission's request to provide advice on the benefits of retaining non-targeted species catches, other than those prohibited via IOTC Resolutions, that this work would be included in the 2015 WPEB Program of Work (see Appendix XXXVIII).

41. **NOTING** the lack of expertise and resources within the WPEB and the short timeframe to fulfill this task, the SC **RECOMMENDED** that a consultant be hired to conduct this work and present the results at the next WPEB meeting. The following tasks, necessary to address this issue, should be considered for the terms of reference, taking into account all species that are usually discarded on all major gears (i.e., purse seines, longlines and gillnets), and fisheries that take place on the high seas and in coastal countries EEZs:

    i) Estimate species-specific quantities of discards to assess the importance and potential of this new product supply, integrating data available at the IOTC Secretariat from the regional observer schemes;

    ii) Assess the species-specific percentage of discards that is captured dead versus alive, as well as the post-release mortality of species that are discarded alive, in order to estimate what will be the added fishing mortality to the populations, based on the best current information;

    iii) Assess the feasibility of full retention, taking into account the specificities of the fleets that operate with different gears and their fishing practices (e.g., transhipment, onboard storage capacity);

    iv) Assess the capacity of the landing port facilities to handle and process this catch;

v) Assess the socio-economic impacts of retaining non-target species, including the feasibility to market those species that are usually not retained by those gears;

vi) Assess the benefits in terms of improving the catch statistics through port-sampling programs;

vii) Evaluate the impacts of full retention on the conditions of work and data quality collected by onboard scientific observers, making sure that there is a strict distinction between scientific observer tasks and compliance issues.

42. The SC **NOTED** that a pilot project was recently started on full utilisation of non-targeted tuna bycatch from purse seine vessels in the Indian Ocean funded by ISSF, and is addressing some of these issues. It may be possible to gain information from this project in the future, **NOTING** that it is exclusively being developed for purse seine fisheries. The SC **ENCOURAGED** the authors of this project to report back to WPEB and SC when the results are available.

7.4.2 Sharks and rays

Review of data needs and way forward for the evaluation of shark stocks - catch data reconstruction

43. The SC **RECOMMENDED** that a short inter-sessional meeting is conducted with a small group of scientists to work mainly on blue shark catch data reconstruction to be used for stock assessment in 2015. Ideally, and to reduce costs, all participants should fund their own participation at a venue to be decided, or work electronically.

Review of new information on the status of sharks and rays

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

Shark Ecological Risk Assessment: review of current knowledge and potential management implications

45. The SC reiterated its **RECOMMENDATION** from 2013, that the Commission note the list of the 10 most vulnerable shark species to longline gear (Table 3) and purse seine gear (Table 4) in the Indian Ocean, as determined by a productivity susceptibility analysis, compared to the list of shark species/groups required to be recorded for each gear, contained in Resolution 13/03 o*n the recording of catch and effort by fishing vessels in the IOTC area of competence*. At the next revision to Resolution 13/03, the Commission may wish to add the missing species/groups of sharks and rays.

46. The SC reiterated its **RECOMMENDATION** from 2013, that, in line with Recommendation 12/15 on the best available science, the list of shark species (or groups of species) for longline gear under Resolution 13/03 (Table 3) should be supplemented with the silky shark (*Carcharhinus falciformis*), which was estimated to be at risk in longline fisheries by the ERA conducted in 2012 (ranked as the 4th most vulnerable species to longline gear). The SC **REQUESTED** the Commission to define the most appropriate means of collecting this additional information.

TABLE 3. List of the 10 most vulnerable shark species to longline gear compared to the list of shark species/groups required to be recorded in logbooks, as listed in Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*.

PSA vulnerability ranking	Most susceptible shark species to longline gear	FAO Code	Shark species currently listed in IOTC Resolution 13/03 for longline gear: mandatory recording	FAO Code
1	Shortfin mako (*Isurus oxyrinchus*)	SMA	Blue shark (*Prionace glauca*)	BSH
2	Bigeye thresher (*Alopias superciliosus*)	BTH	Mako sharks (*Isurus* spp.)	MAK
3	Pelagic thresher (*Alopias pelagicus*)	PTH	Porbeagle shark (*Lamna nasus*)	POR
4	Silky shark (*Carcharhinus falciformis*)	FAL	Hammerhead sharks (*Sphyrna* spp.)	SPN
5	Oceanic whitetip shark (*Carcharhinus longimanus*)	OCS	Other sharks	SKH

6	Smooth hammerhead (*Sphyrna zygaena*)	SPZ	Thresher sharks (*Alopias* spp.)	THR
7	Porbeagle (*Lamna nasus*)	POR	Oceanic whitetip shark (*Carcharhinus longimanus*)	OCS
8	Longfin mako (*Isurus paucus*)	LMA		
9	Great hammerhead (*Sphyrna mokarran*)	SPM		
10	Blue shark (*Prionace glauca*)	BSH		

47. The SC reiterated its **RECOMMENDATION** form 2013, that, in line with Recommendation 12/15 on the best available science, the list of shark species (or groups of species) for purse seine gear under Resolution 13/03 (Table 4) should be supplemented with the silky shark (*Carcharhinus falciformis*), mako sharks (*Isurus* spp.), hammerhead sharks (*Sphyrna* spp.), pelagic stingray (*Pteroplatytrygon violacea*), dusky shark (*Carcharhinus obscurus*), tiger shark (*Galeocerdo cuvier*), which were estimated to be at risk in purse seine fisheries by the ERA conducted in 2012. The SC **REQUESTED** the Commission to define the most appropriate means of collecting this additional information.

TABLE 4. List of the 10 most vulnerable shark species to purse seine gear compared to the list of shark species/groups required to be recorded in logbooks, as listed in Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*.

PSA vulnerability ranking	Most susceptible shark species to purse seine gear	FAO Code	Shark species listed in IOTC Resolution 13/03 for purse seine gear: Mandatory recording	FAO Code
1	Oceanic whitetip shark (*Carcharhinus longimanus*)	OCS	Whale sharks (*Rhincodon typus*)	RHN
2	Silky shark (*Carcharhinus falciformis*)	FAL	Thresher sharks (*Alopias* spp.)	THR
3	Shortfin mako (*Isurus oxyrinchus*)	SMA	Oceanic whitetip shark (*Carcharhinus longimanus*)	OCS
4	Great hammerhead (*Sphyrna mokarran*)	SPM		
5	Pelagic stingray (*Pteroplatytrygon violacea)*	PLS		
6	Scalloped hammerhead (*Sphyrna lewini*)	SPL		
7	Smooth hammerhead (*Sphyrna zygaena*)	SPZ		
8	Longfin mako (*Isurus paucus*)	LMA		
9	Dusky shark (*Carcharhinus obscurus*)	DUS		
10	Tiger shark (*Galeocerdo cuvier*)	TIG		

Best practice guidelines for the safe release and handling of encircled whale sharks

48. The SC reiterated its **RECOMMENDATION** from 2013, that the following *Guidelines for the safe release and handling of encircled whale* sharks, should be added as an additional page in the IOTC shark identification guides:

The methods listed below depend on the condition of the particular purse seine set, e.g. the size and orientation of the encircled animal, size of fish in the purse seine set and operation style.

- Cutting the net when the whale shark is at the surface and separated from the tuna and when the operation presents no danger for the crew;
- Standing the animal on the net and rolling it outside the bunt. A rope placed under the animal and attached to the float line could help rolling the whale shark out of the net;
- Brailing sharks (only for small individual less than 2–3 meters).

The crew should never:

- Pull up the shark by its tail;
- Tow the shark by its tail.

49. The SC reiterated its **RECOMMENDATION** from 2013, that the Commission allocates funds in its 2015 budget, to produce and print the IOTC best practice guidelines for the safe release and handling of encircled whale sharks, and for these to be incorporated into the existing IOTC "*Shark and ray identification in Indian Ocean pelagic fisheries*", identification cards.

Shark fin to body weight ratio and wire leaders/traces

50. **NOTING** that the Commission, at its 18th Session considered a range of proposals on sharks which included matters relevant to the shark fin to body weight ratio and wire leaders/traces, the SC **RECALLED** its previous advice to the Commission as follows:

- 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.
- On the basis of information presented to the SC 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.

7.4.3 Marine Turtles

Review of data available at the Secretariat for marine turtles

51. The SC **NOTED** that the lack of data from CPCs on interactions and mortalities of marine turtles in the Indian Ocean is a substantial concern, resulting in an inability of the WPEB to estimate levels of marine turtle bycatch. There is an urgent need to quantify the effects of fisheries for tuna and tuna-like species in the Indian Ocean on marine turtle species, and it is clear that little progress on obtaining and reporting data on interactions with marine turtles has been made. This data is necessary to allow the IOTC to respond and manage the adverse effects on marine turtles, and other bycatch species.

Review of Resolution 12/04 on the conservation of marine turtles

52. The SC reiterated its **RECOMMENDATION** from 2013, that at the next revision of IOTC Resolution 12/04 *on the conservation of marine turtles*, the measure is strengthened to ensure that where possible, CPCs report annually on the total estimated level of incidental catches of marine turtles, by species, as provided at Table 5.

TABLE 5. Marine turtle species reported as caught in fisheries within the IOTC area of competence.

Common name	Scientific name
Flatback turtle	*Natator depressus*
Green turtle	*Chelonia mydas*
Hawksbill turtle	*Eretmochelys imbricata*
Leatherback turtle	*Dermochelys coriacea*
Loggerhead turtle	*Caretta caretta*
Olive ridley turtle	*Lepidochelys olivacea*

7.4.4 Marine mammals

Development of technical advice for marine mammals

53. The SC reiterated its **RECOMMENDATION** from 2013, that depredation events be incorporated into Resolution 13/03 at its next revision, so that interactions may be quantified at a range of spatial scales. Depredation events should also be quantified by the regional observer scheme.

Best practice guidelines for the safe release and handling of encircled cetaceans

54. The SC reiterated its **RECOMMENDATION** from 2013, that the Commission allocates funds in its 2015 and 2016 budgets, to produce and print the IOTC best practice guidelines for the safe release and handling of encircled cetaceans. The guidelines could be incorporated into a set of IOTC cetacean identification cards: "*Cetacean identification for Indian Ocean fisheries*".

7.4.5 Indian Ocean Shark Year (multi-year research) Program (IO-ShYP)

55. The SC **NOTED** the report of the Indian Ocean Shark Year Program workshop (IO-ShYP01) (IOTC–2014–IOShYP01–R) which represents a further step to align the work of the WPEB with IOTC Conservation and Management Measures (CMMs), particularly to the recently adopted Resolution 13/06 *On a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries*. Moreover, the IO-ShYP aims to provide guidance to WPEB researchers, by prioritising issues related to data collection and research on species biology/ecology, fisheries and mitigation measures. Finally, by promoting cooperation and coordination among WPEB researchers, the IO-ShYP aims to improve the quality of the scientific advice on sharks provided to the Commission, and to better assess the impact on these species of the current CMMs.

56. The SC **AGREED** that the IO-ShYP shall remain a work in progress and may need to be modified/updated periodically based on progress and the information available. Funding should be sought from multiple sources, including those external to the IOTC (e.g. CPCs, WWF, GEF, Shark Alliance, PEW). For the IO-ShYP to be successfully implemented, it will require the active engagement of CPC scientists involved in IOTC work, industry and NGO's. The IO-ShYP will be incorporated into IOTC Science Program of Work, detailed in Section 14 below.

7.4.6 Status of development and implementation of National Plans of Action for seabirds and sharks, and implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations

57. The SC **NOTED** paper IOTC–2014–SC17–07 which provided the SC with the opportunity to consider, update and comment on the current status of development and implementation of national plans of action for seabirds and sharks, and implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations, by each IOTC CPC.

58. The SC **RECOMMENDED** that the Commission note the current status of development and implementation of National Plans of Action (NPOAs) for sharks and seabirds, and the implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations, by each CPC as provided at Appendix VI, recalling that the IPOA-Seabirds and IPOA-Sharks were adopted by the FAO in 1999 and 2000, respectively, and required the development of NPOAs. Despite the time that has elapsed since then, very few CPCs have developed NPOAs, or even carried out assessments to ascertain if the development of a Plan is warranted. Currently only 12 of the 35 IOTC CPCs have an NPOA-Sharks (8 more in development), while only 6 CPCs have an NPOA-Seabirds (2 more in development). A single CPC has determined than an NPOA-Sharks is not needed, and 5 have similarly determined than an NPOA-Seabirds is not needed. Currently only 6 of the 35 IOTC CPCs have implemented the FAO guidelines to reduce marine turtle mortality in fishing operations (2 more in progress), and one CPC (France (OT)) will implement a full NPOA in 2015.

Assessing the need for an NPOA

59. The SC **RECALLED** that the IPOA-SHARKS is a voluntary instrument that applies to all States engaged in shark fisheries. The text sets out a set of activities which implementing States are expected to carry out, including an assessment of whether a problem exists with respect to sharks, adopting a National Plan of Action for the conservation and management of sharks (NPOA-SHARKS), as well as procedures for national reviews and reporting requirements. The calendar years by when these actions preferably should have been taken, are indicated.

60. The SC **RECALLED** that the IPOA-SEABIRDS is a voluntary instrument that applies to all States engaged in longline fisheries. The text sets out a set of activities which implementing States are expected to carry out, including an assessment of whether a problem exists with respect to the incidental catch of seabirds in its longline fishery, adopting a National Plan of Action for reducing the incidental catch of seabirds in longline fisheries (NPOA-SEABIRDS) as well as procedures for national reviews and reporting requirements. The calendar years by when these actions preferably should have been taken, are indicated.

61. The SC **RECALLED** that searching for options to develop a process for assessing the need for an NPOA by CPCs, in particular for seabirds, was initiated by India and Sri Lanka at the WPEB09 meeting, as they had made a request to the IOTC to have their NPOA requirements for seabirds classified as '*Not applicable* (n.a.)'. Both of these CPCs have reported very few or no interactions with seabirds by their respective fisheries

targeting tuna and tuna-like species in the IOTC area of competence. The SC, in 2013 was unable to reach a conclusion on this matter, which was further discussed at the WPEB in 2014.

62. The SC **AGREED** that the process should require the following three elements 1) a scientifically-based approach to be taken; 2) to contain a requirement for the Precautionary approach, as adopted by the IOTC in Resolution 12/01 *On the implementation of the precautionary approach*; and 3) that the FAO guidelines concerning developments of NPOAs be followed.

63. The SC **ADOPTED** the process detailed in Appendix VII, for all CPCs to follow when requesting the IOTC Secretariat to apply a status of '*Not applicable* (n.a.)' for an NPOA, in the '*Table of progress in implementing NPOA-sharks, NPOA-seabirds and the FAO guidelines to reduce sea turtle mortality in fishing operations*'.

64. The SC **NOTED** the difficulties faced by the IOTC Secretariat when summarising and standardising information on reported seabird and marine turtle interactions across all CPCs given the number of sources and range in type of information reported. Given the increasing amount of information being reported, the SC therefore **REQUESTED** the WPEB discuss and develop new ideas to update and improve how these data are presented and summarised in the future.

IOTC NPOA portal

65. The SC **NOTED** the new NPOA portal on the IOTC website (http://iotc.org/science/status-of-national-plans-of-action-and-fao-guidelines) which provides details of the most recent updated table of progress in implementing NPOA-Sharks, NPOA-Seabirds and the FAO Guidelines to Reduce Sea Turtle Mortality in Fishing Operations. It also provides other information in support of CPCs wishing to develop their own NPOAs, such as the guidelines and NPOA documents from all CPCs who have submitted their NPOAs.

66. The SC **REQUESTED** that all CPCs without an NPOA-Sharks and/or NPOA-Seabirds expedite the development and implementation of a NPOA, and to report progress to the WPEB and SC in 2015, **NOTING** that NPOAs are a framework that should facilitate estimation of shark catches, seabird interactions, and development and implementation of appropriate management measures, which should also enhance the collection of bycatch data and compliance with IOTC Resolutions.

7.5 Report of the 16th Session of the Working Party on Tropical Tunas (WPTT16)

67. The SC **NOTED** the report of the 16th Session of the Working Party on Tropical Tunas (IOTC–2014–WPTT16–R), including the consolidated list of recommendations provided as an appendix to the report. The meeting was attended by 52 participants (46 in 2013; 47 in 2012; 49 in 2011), including 6 recipients of the MPF (10 in 2013; 8 in 2012; 13 in 2011).

7.5.1 Fish aggregating devices

68. The SC **NOTED** that the number of drifting FADs deployed by purse seine vessels has dramatically increased over the past 10 years which may reach around 10,000 monitored in 2013, for the EU and Seychelles purse seine fleets only). This figure does not include the FADs deployed by purse seine vessels of other fleets, such as Rep. of Korea (4 vessels), Sri Lanka (8 vessels) and Mauritius (6 vessels which entered the fleet in 2014). Efficient strategies have been developed to fish on drifting FADs (e.g. electronic buoys to track the FADs, some of these buoys being equipped with echo-sounders for acoustic estimation of biomass around it, the use of support vessels for the monitoring and technical maintenance of FADs and buoys). The use of FADs has increased the fishing efficiency of the fleets using FADs; however, the scientists are still unable to estimate with accuracy the magnitude of this increase, and the impact this has on the distribution and abundance of tuna and CPUE standardisation.

69. The SC **NOTED** the validity of FAD information collection requested in Resolution 13/08 to standardise the FAD CPUE. Moreover, some trends have appeared in the behaviour of tuna, especially skipjack tuna, that are now essentially caught on FADs as free schools have become very rare and with their average size getting smaller in the recent years; which may also be explained by the change of fleet behavious (i.e. focusing mostly on FAD fishing).

70. The SC **AGREED** that in such a context, it becomes necessary to estimate the fishing mortality associated to FAD fishing and the optimal number of FADs, in order to allow sustainable catches of tuna and minimise the risk in terms of ecological impacts, including bycatch. The SC further **NOTED** that the ICCAT Commission

agreed to create a working group to analyse the information collected in FAD Management Plans, started in recent years (IOTC Resolution 13/08), in order to assess the above mentioned questions.

71. The SC **RECOMMENDED** that an ad hoc working group on FADs, drifting and anchored, be created to assess the consequences of the increasing number and technological developments of FADs in tuna fisheries and their ecosystems, in order to inform and advise on future FAD-related management options. This ad hoc working group would be of multi-sectorial nature, involving various stakeholders such as scientists, fishery managers, fishing industry representatives, administrators and fishers. The Terms of reference for this working group are provided at Appendix VIII.

72. **NOTING** that the ICCAT and WCPFC have already approved at their 2014 sessions the establishment of such working groups, the SC **AGREED** that at least the ICCAT and IOTC working groups on FADs work jointly whenever possible. IOTC and ICCAT secretariats should liaise to check the possibility of this joint group, defining the most appropriate date and venue for a meeting in 2015. Presently, ICCAT has already scheduled the first meeting of its FAD working group in its 2015 Program of Work (early May 2015) which is not compatible with the agenda of the annual IOTC meeting, where the recommendation on the establishment of the FAD working group will be discussed and, if possible, adopted.

7.5.2 CPUE standardisations

73. **NOTING** the substantial work done in 2014 on CPUE standardisations since the workshop addressing this issue in 2013, but also that further work is required, the SC **ENDORSED** the workplan developed by Japan, Rep. of Korea and Taiwan,China for intersessional work, and for this to be carried out on the longline CPUE standardisation issues for bigeye tuna and yellowfin tuna (Appendix IX).

74. The SC **NOTED** the workplan developed for purse seine CPUE standardisation, and though a lower priority than the workplan developed for the longline CPUE standardisation, also **ENDORSED** it if funding were available to address this issue (Appendix X). However, this would be better evaluated after the results and progress of the FAD ad-hoc working group since it is essential for a purse seine standardisation process to include information on FADs.

7.5.3 Skipjack tuna

75. The SC **ENCOURAGED** the production of fishery indicators to assess population trends and that other indicators, such as the number of FADs deployed and active and/or environmental indicies, should also be examined in addition to existing fishery indicators for the Indian Ocean.

76. The SC **NOTED** that some fishery indicators (such as decrease on skipjack tuna catch per set rate and decline in free school CPUE) may indicate lower MSY reference points than the optimistic results of the skipjack tuna assessment. Accordingly, in 2014 the WPTT recommended using the lower range estimated MSY value. Although this was used during the assessment, due to time constraints, the tagging data was not used in a different stock assessment spatial structure. It was suggested to carry out a more comprehensive approach incorporating the tagging data in subsequent years.

77. The SC **NOTED** that the WPTT should focus on the ecological questions of the likely changes in the species composition of FAD skipjack tuna and yellowfin tuna catches over time.

78. The SC **NOTED** that spatial distribution of catch and effort and length frequency sampling in gillnets (especially in the eastern Indian Ocean) are incomplete which does not allow to proper configuration of gillnet catches in the stock assessment model (as they are currently aggregated into the 'Other' fleet category). The increase in the relative importance of the gillnet fishery for skipjack tuna, requires that those countries involved in skipjack tuna gillnet fisheries, as a matter of priority, collect the data as requested by IOTC.

7.6 Report of the 10th Session of the Working Party on Data Collection and Statistics (WPDCS10)

79. The SC **NOTED** the report of the 10th Session of the Working Party on Data Collection and Statistics (IOTC–2014–WPDCS10–R), including the consolidated list of recommendations provided as an appendix to the report. The meeting was attended by 30 participants (23 in 2013; 21 in 2011), including 1 recipient of the MPF (5 in 2013; 2 in 2011).

80. The SC **NOTED** that Indonesia had not been able to dispatch officers to the WPDCS due to an administrative issue and indicated that it will do its best to ensure participation of Indonesian officers to future meetings of the WPDCS.

7.6.1 General discussion on data issues

81. **NOTING** that some CPCs provide little or no feedback regarding clarification sought on the data issues identified by the IOTC Secretariat or the science Working Parties, following communications from the IOTC Secretariat or actions recommended by the Working Parties, the SC **AGREED** that when this occurs and the IOTC Secretariat has access to alternative information, the IOTC Secretariat shall continue attempts to compile best scientific estimates of catch for those fisheries, using the information available, and present those estimates to the Working Parties and Scientific Committee for further review and endorsement. In this regard the SC **ENDORSED** the data review process presented in Appendix V of the WPDCS10 Report.

82. The SC **RECALLED** that in 2013, it has requested that scientists from Taiwan,China assist India in the estimation of catches of IOTC species and sharks for India's longline fleet, in particular for the years 2006 and 2007. While India had indicated that it will not work with external institutions to revise catch estimates for its fishery, India had not provided revised catches for its longline fleet. In light of this, the SC **RECALLED** that it had previously endorsed the alternative catches estimated for this component and that these estimates are maintained until India provides a revised time-series for its fleet.

83. The SC **NOTED** that an update on the status of the IOTC tagging database and new tags recovered during 2013 to 2014 had been discussed at the WPDCS10 meeting. Recoveries from longline fisheries remain at very low levels: only one yellowfin tuna was recovered from longline vessels against the 17 yellowfin tuna recovered from purse seine vessels. Such poor rates of recovery from longline vessels may be due to various reasons, in particular a low reporting rate by longline vessel crew. This issue should be further explored by the WPDCS in 2015.

7.6.2 National statistical systems

84. The SC **NOTED** that, while I.R. Iran has implemented a logbook program for its drifting gillnet fisheries, to date no catch and effort data have been reported to the IOTC. I.R. Iran is yet to implement provisions of the Regional Observer Scheme, in particular boarding of observers on its industrial purse seine and drifting gillnet fleets, and provision of observer trip reports to the IOTC. In this regard the SC **REQUESTED** that I.R. Iran make the necessary arrangements to report catch-and-effort data to the IOTC, and size frequency data by IOTC grid, and implement provisions of the Regional Observer Scheme, and to seek assistance from the IOTC Secretariat with these tasks, where required.

85. The SC **NOTED** that to date Sri Lanka has not reported catch-and-effort data according to the standards or observer trip reports to the IOTC for its high seas fleet, which uses a combination of gillnets and longlines. In this regard the SC **REQUESTED** that Sri Lanka makes the necessary arrangements to report a complete set of catch-and-effort data to the IOTC, and implement provisions of the Regional Observer Scheme, and that the IOTC Secretariat continue assisting Sri Lanka with these tasks, where necessary.

7.6.3 Resolution 10/02 Mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties

86. The SC **RECOMMENDED** that the Commission makes the following amendments to IOTC Resolution 10/02:
    - Adopting the following definitions in order to clarify the type of fisheries, area and species covered by Resolution 10/02:
        - **Longline fisheries:** Fisheries undertaken by vessels in the IOTC Record of Authorized Vessels that use longline gear.
        - **Surface fisheries:** All fisheries undertaken by vessels in the IOTC Record of Authorized Vessels other than longline fisheries; in particular purse seine, pole-and-line, and gillnet fisheries.
        - **Coastal fisheries:** Fisheries other than longline or surface, as defined above, also called artisanal fisheries.
        - **IOTC area of competence**: as described in Annex A of the IOTC Agreement.

    - **Species:** refers to all species under the IOTC mandate as described in Annex B of the IOTC Agreement, and the most commonly caught elasmobranch species, as defined by the Commission in IOTC Resolution 13/03 or any subsequent revisions of this Resolution.
    - **Support vessels:** Any types of vessels that operate in support of the fishing activities of purse seine vessels.
- Specify the requirements for Nominal Catch data, including:
    - Changing the term Nominal by Total;
    - Change the time-period resolution of Total catch data from Year to Quarter, in order to be able to assess the seasonality of fisheries, in particular those that do not report catch-and-effort data;
    - Request separate reports for retained catches (in live weight) and discards (in live weight or number), as per the above Resolution.
- Specify the requirements for Catch and effort data, including:
    - Surface fisheries: Extend the requirements to report catch and effort data by type of fishing mode, drifting or anchored FADs, to fisheries other than the purse seine fisheries that use FADs; and ensure that the effort units reported are consistent with those requested in Resolution 13/03 or any subsequent revisions to such Resolution;
    - Coastal fisheries: Specify the time-period to be used to report this information, preferably Month.
- Harmonise the type of data resolution that is requested for coastal fisheries, in particular for catch-and-effort and size data; for data to be reported by month and landing area.
- Specify that Size Frequency data shall be reported according to the procedures described in the IOTC Guidelines for the Reporting of Fisheries Statistics (instead of those set out by the IOTC Scientific Committee, as recorded in the present Resolution).
- Specify the requirements for data on supply vessels, including:
    - Change the term Supply to Support (Support Vessels);
    - Indicate that data on the activities of support vessels shall be reported by the flag country of the vessels that receive the assistance of the support vessel (and not by the flag country or other parties);
    - Request the name of the purse seiners that receive assistance from each support vessel.

87. The SC **NOTED** that the WPDCS had deferred consideration of a proposal to move the deadline of data submission in IOTC Resolution 10/02 to a time earlier in the year. However, some CPCs may have difficulties to submit their statistics before the existing deadline and the deadline for data submissions should remain the same. The SC **ENCOURAGED** all CPCs to report their statistics as soon as they are available, where possible before the established deadline, to facilitate the work of the IOTC Working Parties. In addition, CPCs that do not report their statistics by the deadline should make the necessary arrangements to ensure that their statistics for their fisheries are produced and reported before the deadline.

7.6.4 Review of Estimates of Input Fishing Capacity

88. **NOTING** that while there are currently forms available for the reporting of fishing capacity in the IOTC area of competence, the majority of CPCs do not report this information for its coastal fisheries, the SC **RECOMMENDED** that the Commission consider making reporting mandatory if an estimate of total fishing capacity is required.

7.6.5 Resolution 11/04 On a regional observer scheme

89. The SC **RECALLED** the objectives of Resolution 11/04 on a regional observer scheme as follows:

> *"Para 1: The objective of the IOTC Observer Scheme shall be to collect verified catch data and other scientific data related to the fisheries for tuna and tuna-like species in the IOTC area of competence"*

90. **NOTING** that the objective of the Regional Observer Scheme contained in Resolution 11/04, and the rules contained in Resolution 12/02 *On data confidentiality policy and procedures* makes no reference to the data collected not being used for compliance purposes, the SC **RECOMMENDED** that at the next revision of Resolution 11/04, it be clearly stated that the data collected within the Regionl Observer Scheme shall not be used for compliance purposes.

7.6.6 *Review of length frequency data from longline fleets and likely impacts on the assessments*

91. The SC **AGREED** that further analysis was required to fully understand the recent changes in length composition reported by Taiwan,China – in particular whether there have been changes to the sampling protocols and selection of fish for sampling, and that the decline in the number of samples of small specimens of tropical tunas in particular may originate from high grading of catch onboard Taiwan,China longliners following the implementation of quotas on the Taiwan,China longline fleet in the Indian Ocean (i.e. only large specimens from the catch measured for length).

92. The SC **AGREED** that additional work is required by Japan, in collaboration with the IOTC Secretariat, to understand the lack of coherence in the historical time series between the size frequency data, and catch-and-effort and nominal catch reported by Japan longline vessels.

93. The SC **NOTED** that in both cases of the Japan and Taiwan,China size-frequency data, further analysis is a high priority, given the potential impact on stock assessments, and **RECALLED** the recommendation from the WPDCS for joint work on the documentation of procedures for the collection, processing and reporting of size frequency data continues, based on the terms of reference defined by the IOTC Secretariat, in particular:
    - Full description of the type of sampling platforms used (e.g. commercial boats, research boats, training boats, etc.), and collecting sources (e.g. fishermen, researchers, scientific observers, etc.)
    - Full description of the sampling protocols used, on each (e.g. full enumeration of every set, every other set, first 30 fish from each set sampled for size, etc.), by type of sampling platform and collecting source.
    - Type of measurements collected (e.g. gilled-and-gutted weight, fork length, etc.) and measurement tools used (calliper, measuring board, measuring tape, scale, etc.) by type of sampling platform, collecting source, and species.
    - Type of time-area stratification used for each species (e.g. quarter and defined area) and procedures used for the estimation of sampled weights in each stratum, including all equations used for the conversion of non-standard measurements into standard measurements, by species (e.g. deterministic conversion using a single length weight equation for all areas and time periods, etc.).
    - Description of any other procedures which involve the use of length frequency data (e.g. estimation of weights from the numbers reported in logbooks and substitution scheme in the case that lengths are not available in areas where there are catches and effort recorded, etc.).

7.6.7 *Data related: Capacity building activities*

94. The SC **NOTED** the indication from several CPCs, in particular Indonesia, Malaysia, Thailand, Sri Lanka and I.R. Iran, of their gratitude for the assistance that the IOTC-OFCF Project, the BOBLME, and the SmartFish Programme have provided over the years, in particular relating to capacity building in the area of data collection, management, and reporting. Further assistance may be required with the implementation of new requirements by the Commission, in particular the IOTC Regional Observer Scheme.

95. The SC **NOTED** the indication from OFCF, that the IOTC-OFCF Project will consider future assistance to coastal developing CPCs based on recommendations from the Commission or its subsidiary bodies or requests from individual CPCs, as per the funds available.

96. The SC **THANKED** the IOTC-OFCF Project for its continued support to the enhancement of data collection and processing systems in developing countries of the IOTC and **ENCOURAGED** the OFCF to extend support in the future.

97. The SC **NOTED** that, following a data mining mission by the IOTC-OFCF Project to Thailand in June 2014, Thailand confirmed that they will begin to report size-frequency samples for neritic tuna species collected from coastal purse seine vessels, according to the reporting standards of Resolution 10/02, and also work with the IOTC Secretariat to provide the historical time series of size-frequency data, collected by the Andaman Sea Fisheries Research and Development Center (AFRDEC).

7.7 *Report of the 5th Session of the Working Party on Methods (WPM05)*

98. The SC **NOTED** the report of the 5th Session of the Working Party on Methods (IOTC–2014–WPM05–R), including the consolidated list of recommendations provided as an appendix to the report. The meeting was attended by 28 participants (23 in 2013; 21 in 2011), including 1 recipient of the MPF (5 in 2013; 2 in 2011).

99. The SC **ACKNOWLEDGED** the work that has been carried out inter-sessionally by the WPM MSE informal working group on albacore and skipack tuna and thanked its members for the excellent progress achieved so far. The development of tools that would best allow interactively evaluating management procedures, including harvest control rules, and was considered an important but necessary step of the implementation requirements contained in Resolutions 12/01 and 14/03.

7.7.1 Albacore MSE update

100. The SC **NOTED** that a lot of progress was made towards management strategy evaluation (MSE) for the Indian Ocean albacore fishery. This work was primarily led by the WPM Chair and the informal MSE working group. An operating model (OM) was presented with some hypothetical Management Procedures (MP) to suggest alternative control rules could be evaluated using the approach developed by WPM for the Commission. Further refinements of the OM and MP's need to be conducted before final models would be evaluated by the Commission in 2016.

7.7.2 Resolution 13/10 On interim target and limit reference points and a decision framework

101. The SC **NOTED** that Resolution 13/10 *On interim target and limit reference points and a decision framework*, requires that the SC assess and further review the interim reference points and advise the Commission of its findings.

102. The SC **NOTED** the difficulties with accurately estimating the MSY-based interim reference points within Resolution 13/10 in cases where there is uncertainty in our knowledge of stock dynamics.

7.7.3 Limit reference points

103. The SC **RECOMMENDED** the Commission consider an alternative approach to identify biomass limit reference points, such as those based on biomass depletion levels, when the MSY-based reference points are difficult to estimate. In cases where MSY-based reference points can be robustly estimated, limit reference points may be based around MSY.

104. The SC **RECOMMENDED** that in cases where MSY-based reference points cannot be robustly estimated, biomass limit reference points be set at 20% of unfished levels ($B_{LIM} = 0.2B_0$)

7.7.4 Target reference points

105. **NOTING** that the interim target reference points contained in Resolution 13/10 are also MSY-based and subject to the same difficulties with robust estimation, the SC **RECOMMENDED** that the Commission consider that stock biomass depletion levels equivalent to B_{MSY} are expected to lie in the range of 30% to 40% of unfished levels ($0.3B_0$ to $0.4B_0$), when MSY-based levels cannot be accurately estimated. The Commission may wish to consider a value of $0.4B_0$ or higher, if a precautionary buffer against reaching a biomass limit is desirable.

106. **NOTING** that the approach described in para. 105 is similar to what is currently taking place in other RFMOs such as WCPFC, the SC **RECOMMENDED** that the use of this type of reference point is adopted by the Commission. In considering target reference points, guidance will be required from the Commission on tolerable risks of exceeding limit reference points.

7.7.5 Fishing Mortality Equivalents

107. The SC **RECOMMENDED** that with respect to fishing mortality (F) reference points, for consistency between the definitions of overfished and overfishing, the Commission should consider using those F values that correspond to the biomass reference points. For example, given a biomass limit of $0.2B_0$, a consistent F limit reference point would be $F_{B20\%,}$ the fishing mortality rate that reduces the biomass to 20% of unfished levels.

108. The SC **NOTED** that the interim limit reference points contained in Resolution 13/10 are not consistent with FAO and UNFSA guidelines, as in those agreements the fishing mortality rate which generates MSY (F_{MSY}) is considered as the limit reference point.

7.7.6 Skipjack tuna MSE update

109. The SC **NOTED** information paper IOTC–2014–SC17–INF01 which describes progress towards management strategy evaluation (MSE) for the Indian Ocean skipjack fishery. This work had been progressed by the Maldives in partial fulfilment of the conditions of its Marine Stewardship Council (MSC) certification of the

pole-and-line skipjack tuna fishery. The SC **ACKNOWLEDGED** the IPNLF and the Maldives' MSC client, MSPEA and WWF for their support in this work. The SC also **ACKNOWLEDGED** the support and technical guidance provided through an Advisory Committee funded by ISSF.

110. The SC **NOTED** that the consultancy that has been used to develop the simulation tools and initial evaluations of some candidate Management Procedures has run to completion. Additional work is required to support the Commission's desire to implement management approaches that can achieve its objectives. In this regard, the SC **RECOMMENDED** that the Commission fully fund the work needed to support its requirement to achieve its objectives in particular facilitating the implementation of Resolution 12/01.

7.7.7 Evaluation of current reference points and possible alternative reference points for management

111. The SC **AGREED** that reference points are markers against which management procedures are evaluated, and around which they may be designed rather than something to be evaluated themselves. The MSE process by itself will not result in new recommendations for limit reference points and, in the case of target reference points more specific guidance on tolerable risks will be required.

7.8 Summary discussion of matters common to Working Parties (capacity building activities – stock assessment course; connecting science and management, etc.)

7.8.1 Meeting participation fund

112. **NOTING** the various comments made by many of the developing CPCs in attendance at the meeting, that the IOTC MPF was crucial for the success of the WPNT, and that the benefits are clearly being seen in terms of increased active engagement at each meeting by recipients, as well as the rapidly increasing quality of the scientific papers being submitted, the SC **REQUESTED** that the funding of national scientists from developing Contractig Parties to attend the WPNT be considered a high priority.

113. The SC **NOTED** that participation by developing coastal state scientists to the WPNT has increased dramatically in recent years following the adoption and implementation of the IOTC Meeting Participation Fund 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*), now incorporated into the IOTC Rules of Procedure (2014), as well as though the hosting of the WPNT in developing coastal State Contracting Parties (Members) of the Commission.

114. The SC **NOTED** that the continued success of the WPNT, at least in the short term, appears heavily reliant on the provision of support via the MPF which was established primarily for the purposes of supporting scientists to attend and contribute to the work of the Scientific Committee and its Working Parties.

115. The SC **AGREED** that the MPF should be utilised so as to ensure that all developing Contracting Parties of the Commission are able to attend the WPNT meeting, as neritic tunas are very important resources for many of the coastal countries of the Indian Ocean. The papers presented to IOTC meetings by MPF recipients have continued to improve in quality as a direct result of improved attendance and participation by scientists from developing coastal states.

116. The SC **AGREED** that it will be beneficial to develop and implement a process to evaluate the effectiveness of the MPF against the Commission's science capacity building objectives and the following:
    - Improvement in the quality of data provided to the IOTC Secretariat by the CPC receiving MPF support;
    - Quality and relevance of the research papers submitted to the Working Parties.

117. The SC **NOTED** that the 2014 meetings of CoC11, SCAF11 and S18 in Colombo, Sri Lanka have accounted for significant expenditure against the MPF budget (USD $48,301). The total allocation for MPF in 2014 was USD 127,000 (US$60,000 from IOTC regular budget allocation and US$67,000 from the savings under the ICRU budgeting).

118. **NOTING** that the MPF was used to fund the participation of a reduced number of national scientists to the Working Parties in 2014, 49 national scientists to the Working Party meetings and the SC in 2014 (58 in 2013; 42 in 2012), all of which were required to submit and present a working paper at the meeting, the SC **RECOMMENDED** that the Commission consider the following:

- 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 now incorporated into the IOTC Rules of Procedure (2014), was established for the +purposes of supporting scientists and representatives from IOTC Contracting Parties who are developing States to attend and contribute to the work of the Commission, the Scientific Committee and its Working Parties.
- The Commission has made the following directives to the IOTC Secretariat:
  a) The Commission had directed the IOTC Secretariat (via Resolution 10/05 and now via the IOTC Rules of Procedure (2014)) to ensure that: (para. 88 of the S18 Report)
     i. the MPF be utilised, as a first priority, to support the participation of scientists from developing Contracting Parties in scientific meetings of the IOTC, including Working Parties, rather than non-science meetings.
     ii. the MPF will be allocated in such a way that no more than 25% of the expenditures of the Fund in one year is used to fund attendance to non-scientific meetings.
     iii. thus, 75% of the annual MPF shall be allocated to facilitating the attendance of developing Contracting Party scientists to the Scientific Committee and its Working Parties.
  b) The Commission had directed the IOTC Secretariat that any cost savings made on the annual IOTC budget, shall also be used to further supplement the $60,000 currently budgeted for the MPF.
- In accordance with para. 89 of the S18 Report, the IOTC Secretariat is actively seeking extra budgetary funding sources to supplement the MPF budget from individual Contracting Parties as well as other interested groups. However, the SC was informed by the IOTC Secretariat that other sources should actively be sought by interested candidates, including the UNFSA meeting fund, as well as through their own domestic budgetary processes.

119. The SC strongly **RECOMMENDED** that this fund be maintained into the future and increased back to its original allocation of $200,000 per year.

120. The SC **NOTED** the importance of the MPF in enabling scientists (including Chairpersons) to participate in Working Party meetings, and the significance of the support was reiterated by delegates from Thailand, Indonesia, Sri Lanka and India. The holding of the WPNT in developing coastal CPCs further increases participation in addition to the MPF.

121. The SC **AGREED** that prioritisation among working parties and participants should take place to manage the funds effectively. The development of appropriate management measures will be most effective with contributions from the Contracting Parties responsible for the highest catches relevant to the working group. Therefore, in terms of prioritising recipients of MPF, these funds should be targeted primarily at those fleets, followed by fleets with less important catches where possible.

122. The SC **REQUESTED** CPCs send a relevant scientist to consecutive Working Party meetings where possible, rather than having a different participant each year, to strengthen capacity and provide continuity.

123. The SC **RECOMMENDED** that the MPF rules of procedure be modified, so that a Draft working document, rather than an abstract, be submitted to the relevant Working Party MPF Selection Panel 45 days before the meeting, so that the Panel may review the full paper rather than just the abstract, and provide guidance on areas for improvement and the suitability of the application to receive funding using the MPF. The justification of this request is based upon the reduced funds available and the need to maximise benefits. The SC **AGREED** that until such time as the Commission revises the IOTC Rules of Procedure the MPF selection panels may choose to follow this proposal.

7.8.2 Capacity building activities

124. **NOTING** the request from the WPNT for further increasing the IOTC Capacity Building budget line in 2015 and 2016, the SC **ACKNOWLEDGED** the need for capacity building workshops/training to be carried out to support the collection, reporting and analysis of catch and effort data for neritic tuna and tuna-like species. The amount of funding being allocated to these capacity building activities and the difficulties in assessing the

impact in terms of improvements in the quality of data submissions and analyses is of high importance to the SC and should be incorporated into the Program of Work, discussed in Section 14 below.

125. The SC **AGREED** that capacitiy building activities can be considered successful in the short-term if the objectives of the activity have been met during the time in which support was provided. The assessment of whether longer-term objectives have been met involves assessing whether the activities have been maintained beyond the lifetime of the activity which can be highly variable among recipient CPCs. In cases where there has been no continuation or follow-up on the work undertaken, then this is taken into consideration for future requests which are subsequently given lower priority. Therefore CPCs which actively continue to support and build on these activities are prioritised in future.

126. The SC **AGREED** that, while external funding is helping the work of the Commission, funds allocated by the Commission to capacity building are still too low, considering the range of issues identified by the SC and its Working Parties, and **RECOMMENDED** that the Commission consider allocating more funds to these activities in the future.

127. The SC **RECOMMENDED** that the Commission further increase the IOTC Capacity Building budget line so that capacity building workshops/training can be carried out in 2015, 2016 and future years on the collection, reporting and analyses of catch and effort data for IOTC species, with a special focus on neritic tuna and tuna-like species. Where appropriate these training sessions shall include information that explains the entire IOTC process from data collection to analysis and how the information collected is used by the Commission to develop Conservation and Management Measures.

7.8.3 Tier approach for providing stock status advice

128. The SC **CONSIDERED** the proposal from the WPB to adopt a process to determine if a 'Tier' approach to providing stock status advice will likely enable the IOTC working parties to better communicate the levels of uncertainty present in the indicators used for monitoring the condition/status of IOTC stocks by categorising the types of assessments conducted, for the development of management advice/actions. Initial details of how a 'Tier' approach may be constructed are provided in Appendix XII of the WPB12 Report. The SC **REQUESTED** that the Chair of the WPM shall liaise with interested scientists to develop a revised proposal that includes the experience of other bodies, such as ICES, for consideration at the next SC meeting.

7.8.4 IOTC species identification cards

129. **NOTING** the recent online survey distributed by the IOTC Secretariat, the SC strongly **RECOMMENDED** that the IOTC Secretariat ensure that hard copies of the identification cards continue to be printed as many CPCs scientific observers, both on board and port, still do not have smart phone technology/hardware access and need to have hard copies on board. At this point in time, electronic formats, including 'applications or apps' are only suitable for larger scale vessels, and even in the case of EU purse seine vessels, the use of hard copies is relied upon due to on board fish processing and handling conditions, as well as weather conditions.

Tuna and tuna-like species

130. **NOTING** the excellent work undertaken by the IOTC Secretariat and other experts to develop and finalise the cards for the *Identification of tuna and tuna-like species in the Indian Ocean fisheries*, the SC **RECOMMENDED** that the cards be translated, in priority order to the following languages, according to the proportion of total catches of neritic tuna species reported by country, and that the IOTC Secretariat utilise funds from both the IOTC budget, as well as external funding sources to translate and print in hard copy, the identification cards. Funds were approved by the Commission in the 2014 budget for this purpose, however the IOTC Secretariat indicated the funds are yet to be received from Members. Number in brackets represents the recent proportion of the total neritic tuna catch in the IOTC area of competence:
   1) Bahasa-Indonesian (Indonesia 29%) and Malaysian (Malaysia 4%)
   2) Persian (Farsi-I.R. Iran 20%) and Arabic (Oman 3%)
   3) Hindi (India 18%) and Sinhala (Sri Lanka 5%)
   4) Urdu (Pakistan 7%)

Marine turtles, seabirds and sharks

131. The SC **REQUESTED** that the IOTC Secretariat facilitate the translation of the identification cards for marine turtles, seabirds and sharks into the following languages, in priority order: Farsi, Arabic, Spanish, Portuguese and Bahasa-Indonesian, and that the Commission allocate funds for this purpose.

132. **NOTING** that funds were approved by the Commission in the 2014 budget to translate and print hard copies of the marine turtle, seabird and shark identification cards, but this was only partially done as the IOTC Secretariat indicated the funds are yet to be received from Members, the SC **RECOMMENDED** that the translation and printing occur as soon as the necessary contributions are received.

Identification cards – general

133. The SC **AGREED** that IOTC CPCs should disseminate the identification cards to their observers and field samplers (Resolution 11/04), and as feasible, to their fishing fleets targeting tuna, tuna-like and shark species. This would allow accurate observer, sampling and logbook data on tuna and tuna-like species to be recorded and reported to the IOTC Secretariat as per IOTC requirements.

7.8.5 Glossary of scientific terms, acronyms and abbreviations

134. **RECALLING** that at its 15th Session in 2012, the SC adopted a glossary of scientific terms, acronyms and abbreviations for the most commonly used scientific terms in IOTC reports and Conservation and Management Measures (CMM), and that the glossary would remain a living document that the SC would modify incrementally in the future, the SC **AGREED** to add/modify the following terms/definitions, which would then be incorporated into the glossary and posted on the IOTC website in English and French:

- **Management objectives.** The social, economic, biological, ecosystem, and conservation goals specified for a given management unit (e.g. stock).
- **Management procedures.** A set of formal actions, usually consisting of data collection, stock assessment (or other indicators), and harvest control rules, able to iteratively and adaptively provide robust decisions to manage a fishery.
- **Management strategy evaluation (MSE).** Procedure whereby alternative management procedures' performance are tested and compared using stochastic simulations of stock and fishery dynamics aginst a set of management objectives.
- **Operating model.** Model simulation of stock and fishery dynamics, including sources of uncertainty, used in management strategy evaluation.

7.8.6 Chairs and Vice-Chairs of the SC and its subsidiary bodies

135. **NOTING** that the WPDCS had deferred the selection of a Vice-Chairperson of the WPDCS to the SC, the SC **CONSIDERED** candidates for the position of Vice-Chairperson of the WPDCS for the next biennium. Mr Stephen Ndegwa (Kenya) was nominated and elected as Vice-Chairperson of the WPDCS for the next biennium.

136. The SC **RECOMMENDED** that the Commission note and endorse the Chairs and Vice-Chairs for the SC and its subsidiary bodies for the coming years, as provided in Appendix XI.

8. Examination of the Effect of Piracy on Fleet Operations and Subsequent Catch and Effort Trends

137. The SC **NOTED** that the Commission, at its:

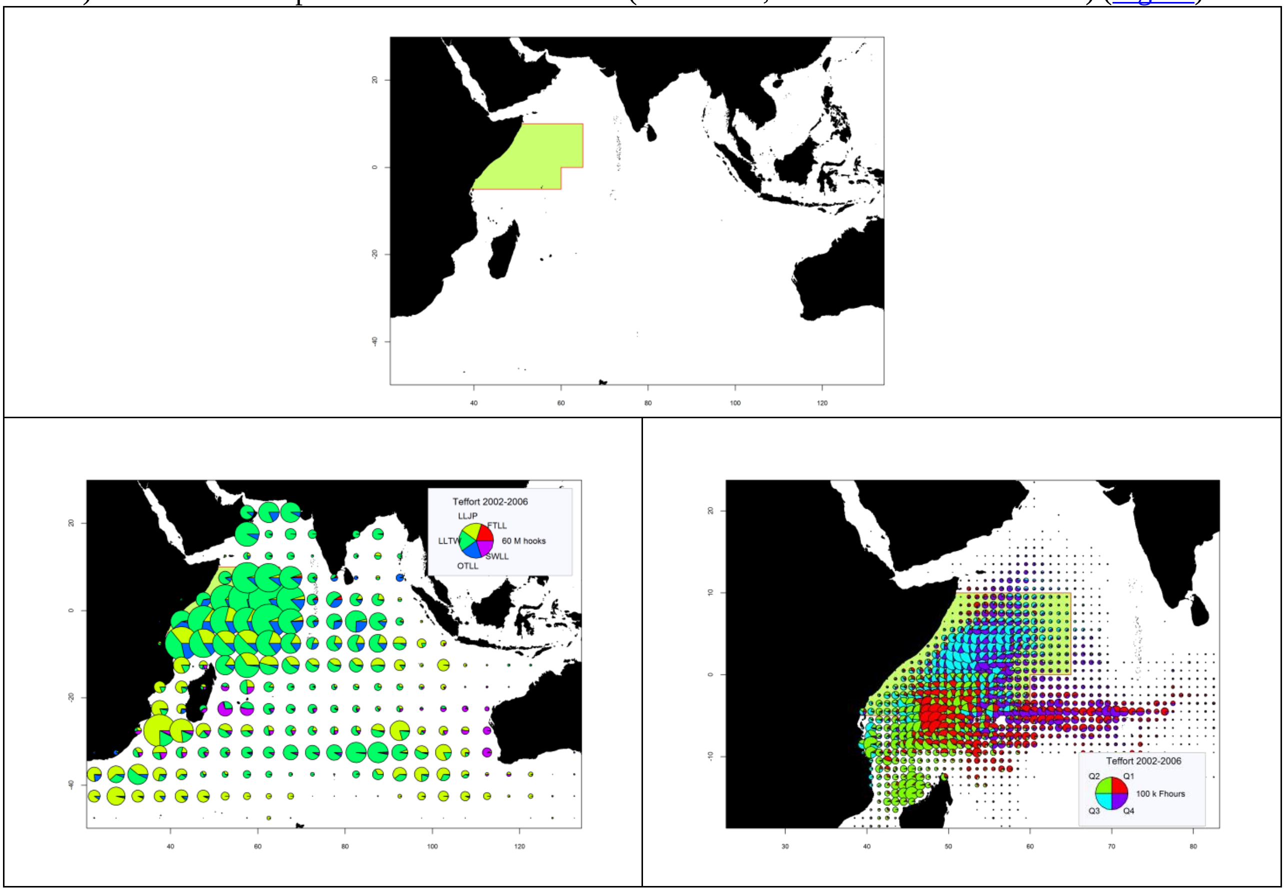
- 15th Session '*recognized that piracy activities in the western Indian Ocean, have had substantial negative consequences on the activities of some fleets, as well as the level of observer coverage in these areas. The Commission requests that the Scientific Committee assess the effect of piracy on fleet operations and subsequent catch and effort trends*' (para. 40 of the S15 report).
- 16th Session, further '*recognised the severe impact of piracy acts on humanitarian, commercial and fishing vessels off the coast of Somalia and noted that the range of the attacks extended towards almost all of the western Indian Ocean, notably toward Kenya and Seychelles, with attacks being reported in their respective EEZ.*' (para. 124 of the S16 report).

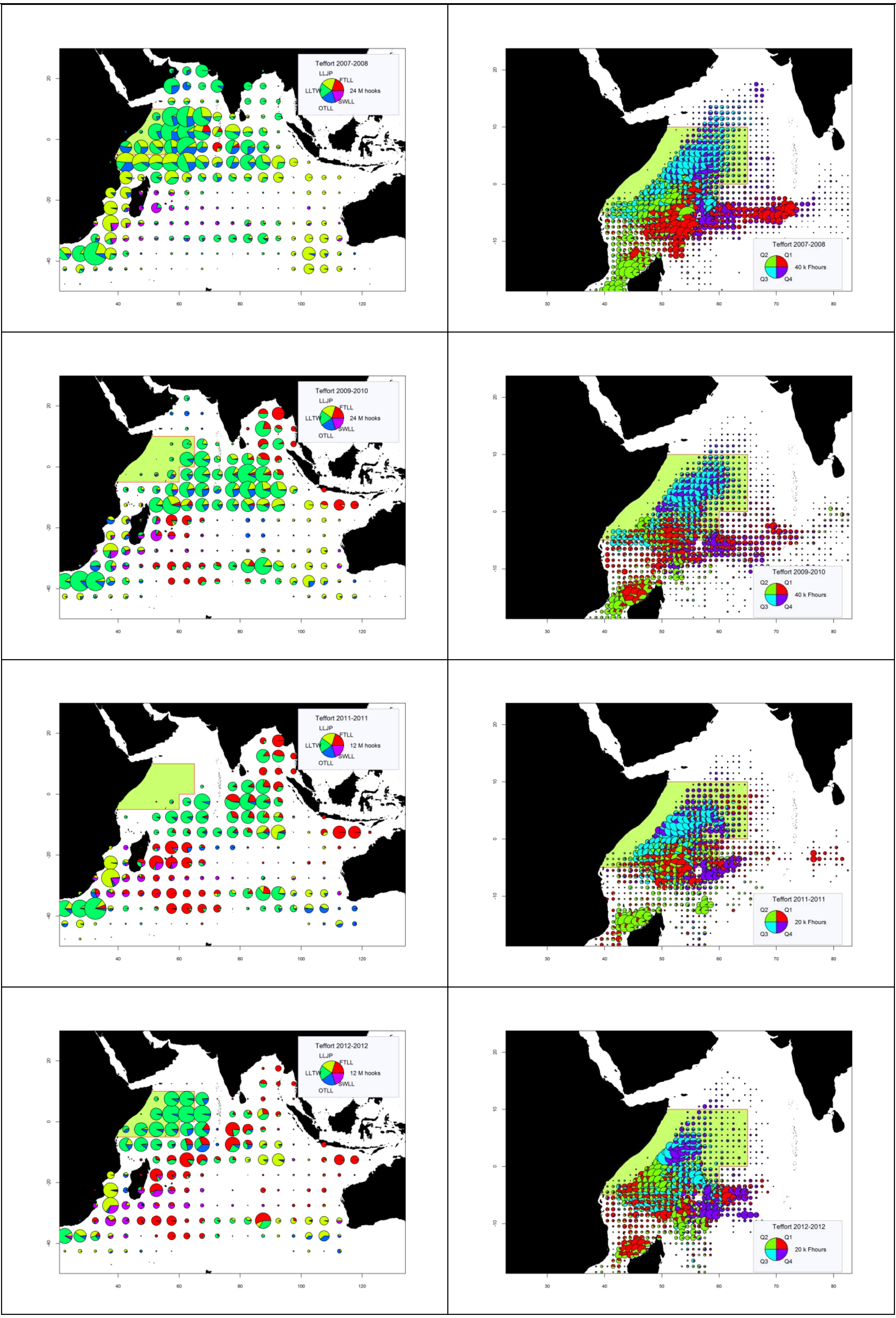
138. The SC **NOTED** some longline vessels have returned to their traditional fishing areas in the northwest Indian Ocean, due to security on board. Although no specific analysis of the impacts of piracy on any fisheries in the Indian Ocean were presented at IOTC Working Party meetings in 2014, many papers presented demonstrated clear impacts of piracy on fishing operations in the western Indian Ocean (Somali basin) and other areas as a result of relocated fishing effort (Fig. 1).

139. The SC **NOTED** that the reported increase in the catches of albacore in recent years by the longline fleets was most likely related to the increasing piracy activity in the western Indian Ocean which result in the displacement of longline vessels towards traditional albacore fishing ground in the southern Indian Ocean.

140. The SC **NOTED** that the relative number of active longline vessels in the IOTC area of competence declined substantially from 2008 until 2011 (Fig. 2a, b), as did the purse seine fleets, albeit to a lesser extent (Fig. 2c). The decline was likely due to the impact of piracy activities in the western Indian Ocean. The fishing effort by the purse seine fleets shifted east by at least 100 miles during 2008–11 compared to the historic distribution of effort (Fig. 1), although vessels remained in the area impacted by piracy due to the presence of onboard military personnel.

141. The SC **NOTED** that since 2011, there has been an increase in the number of active longline vessels in the Indian Ocean for Japan (68 in 2011, 72 in 2012 and also in 2013), China (15 in 2011, 36 in 2012 and also in 2013), Taiwan,China (132 in 2011, 138 in 2012 and 147 in 2013) and the Philippines (2 in 2011, 14 in 2012 and 9 in 2013) (Fig. 2a). Similarly, there has been an overall increase in the number of active purse seine vessels in the Indian Ocean for the European Union and assimilated fleets (34 in 2011, 37 in 2012 and 35 in 2013) and for all other purse seine fleets combined (23 in 2011, 31 in 2012 and 48 in 2013) (Fig. 2c).




Teffort 2007-2008
LLJP
FTLL
24 M hooks
SWLL
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Q2
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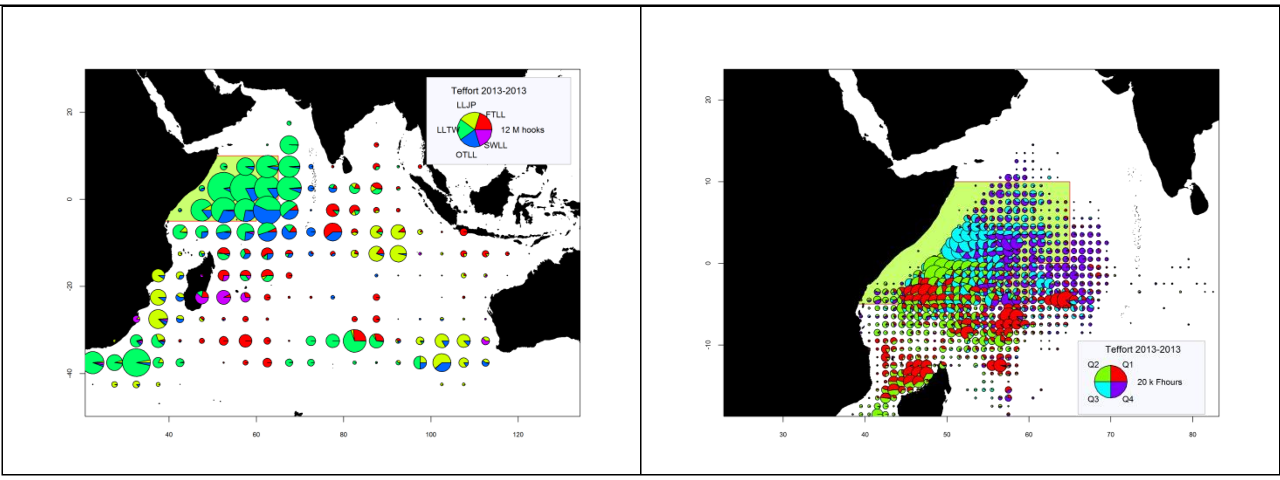
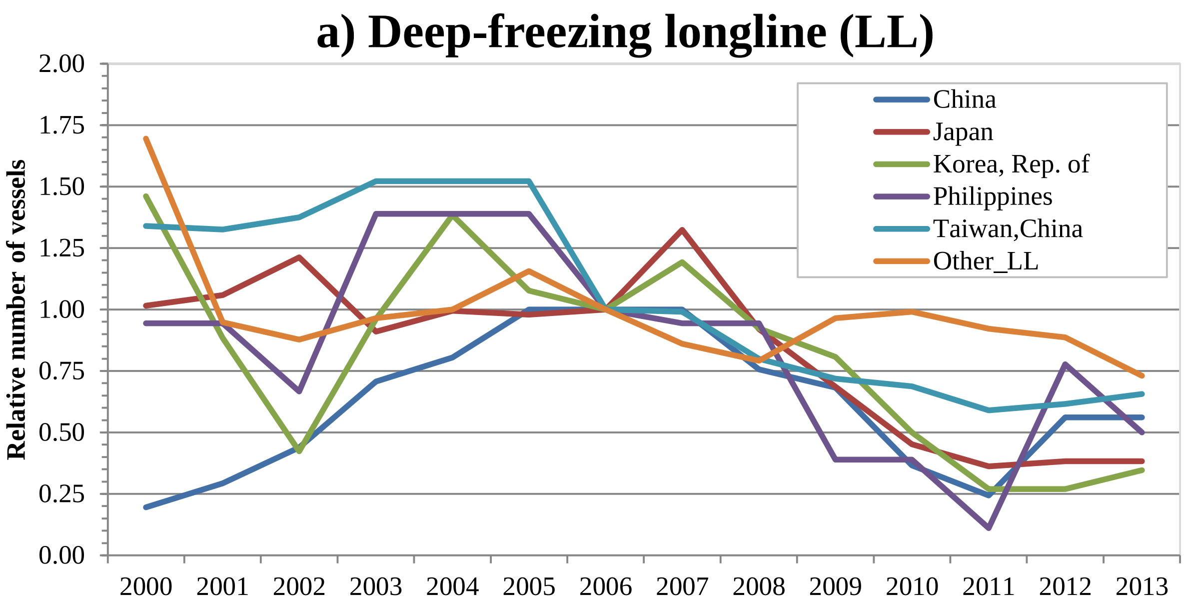
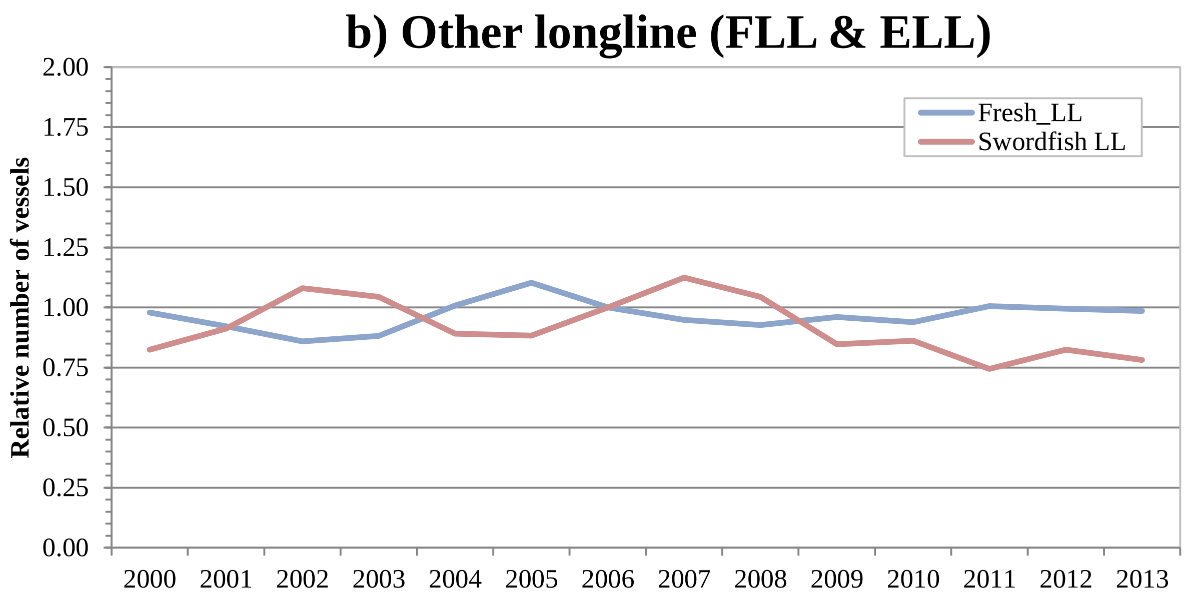


Fig. 1. Longline: The geographical distribution of fishing effort for longline (5 x 5 degrees; millions of hooks – left column) as reported for the longline fleets of Japan (LLJP), Taiwan,China (LLTW), fresh-tuna longline (FTLL), other longline (OTLL), and longline directed at swordfish (SWLL) in the IOTC area of competence (Data as of September 2014), for 2002–06, 2007–08, 2009–10, 2011, 2012 and 2013. Longline effort: 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). Purse seine: The geographical distribution of fishing effort for purse seine (1 x 1 degrees; hours fished – right column) in the IOTC area of competence (data as of September 2014), for 2002–06, 2007–08, 2009–10, 2011, 2012 and 2013. The area shaded in green is where piracy activities are considered highest. The area shaded in green is where piracy activities are considered highest.





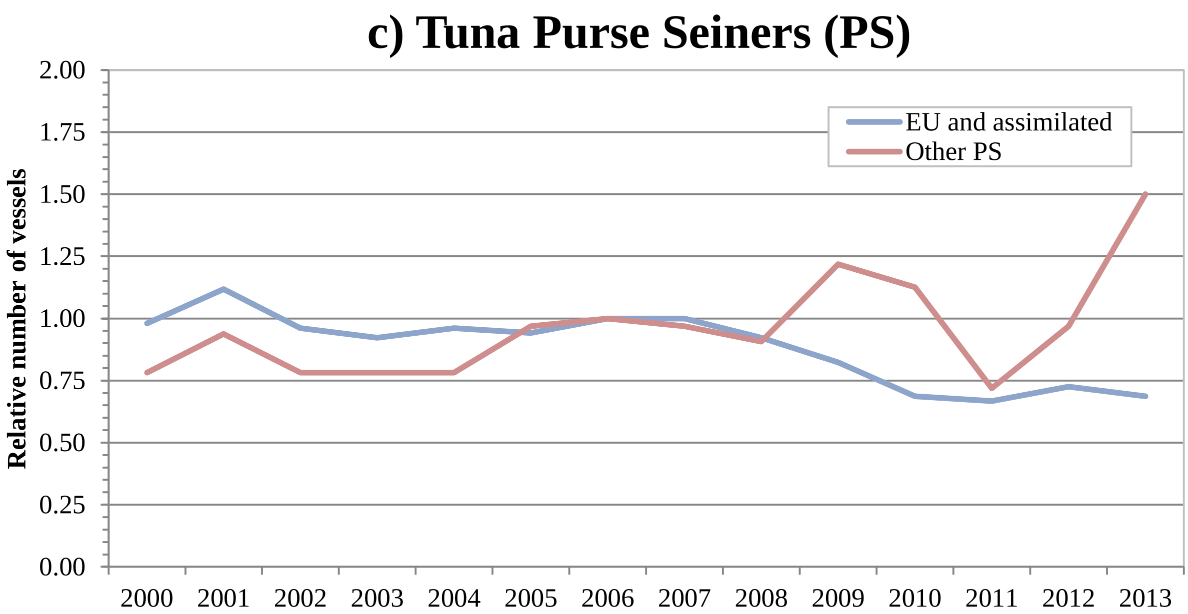
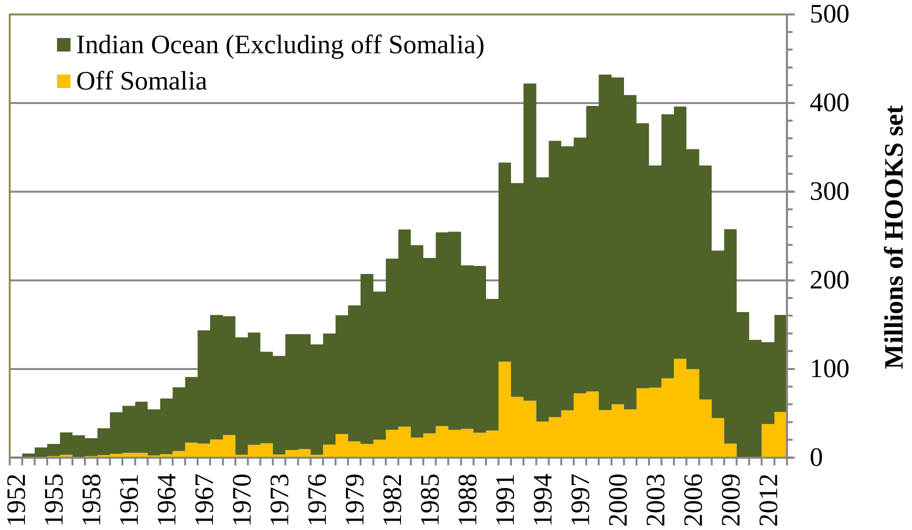


Fig. 2. The change in the relative number of some active a) deep freezing longline (numbers have been scaled to the number of active vessels in 2006), b) other longline and c) purse seine (PS) fleets since 2000 in the Indian Ocean.

142. The SC **RECALLED** that in the first half of 2011, 11 longline vessels from Taiwan,China, moved to the Atlantic Ocean and 2 to the Pacific Ocean. However, in the second half of 2011, 5 longline vessels returned from the Atlantic Ocean, and 1 longline vessel returned from the Pacific Ocean. The departure of the vessels from the Indian Ocean is reflected in the total effort deployed throughout not only the western Indian Ocean impacted by piracy, but also the entire Indian Ocean (Fig. 3a for longline and Fig. 3b for purse seine). In 2012, the trend was reversed, with a total of 15 longline vessels being transferred from the Atlantic Ocean back to the Indian Ocean, resulting in an overall increase in longline effort, particularly in the western Indian Ocean (Fig. 3a). Similarly, 6 longline vessels from Taiwan,China have been transferred from the Pacific Ocean back to the Indian Ocean in 2012. Although total levels of effort for the Taiwan,China longline fleet in the Indian Ocean remained low in 2012, effort levels in waters off Somalia increased markedly (Figs. 1 and 3a).

143. The SC **AGREED** that given the reports that both longline and purse seine vessels from some fleets have moved back into the western Indian Ocean in 2012 and 2013, this should be closely monitored and reported at the SC and the working party meetings in 2015.



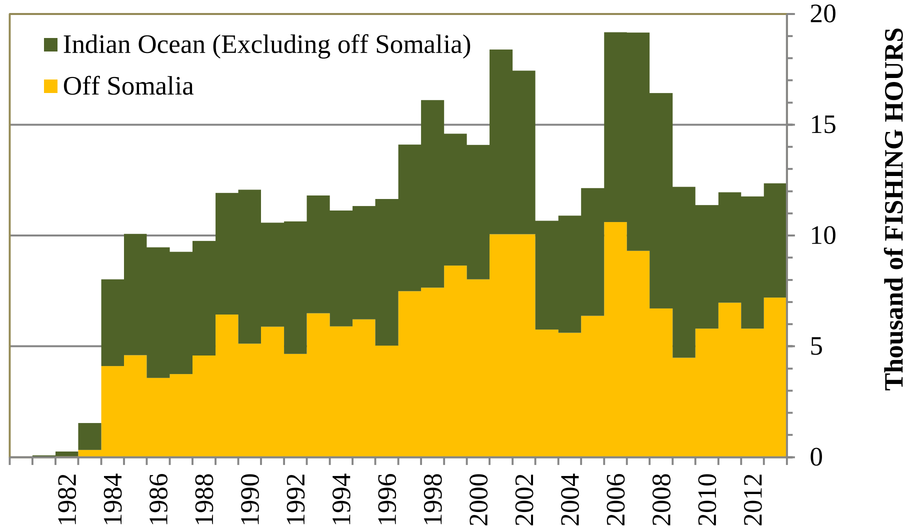


Fig. 3. Changes in total effort for top) longline (number of hooks set in millions), and bottom) purse seine (number of hours fished in thousands) vessels by year and geographical area: off the Somalia coastline (area shown in the insert of Fig. 1) and for the rest of the Indian Ocean based on catch and effort data reported to the IOTC Secretariat.

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

144. **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.

9.1 Tuna – Highly migratory species

145. 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, and the combined Kobe plot for the three species assigned a stock status in 2014 (Fig. 4):
   - Albacore (*Thunnus alalunga*) – Appendix XII
   - Bigeye tuna (*Thunnus obesus*) – Appendix XIII
   - Skipjack tuna (*Katsuwonus pelamis*) – Appendix XIV
   - Yellowfin tuna (*Thunnus albacares*) – Appendix XV

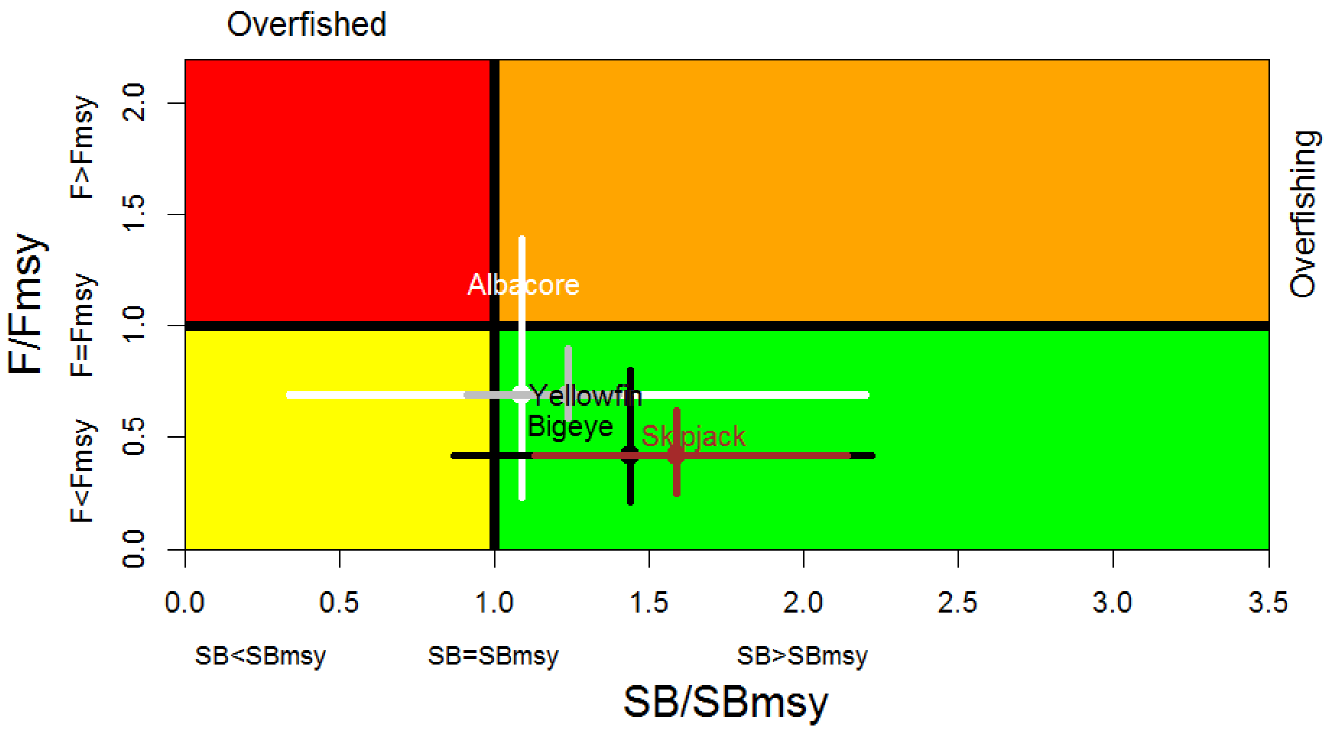


Fig. 4. Combined Kobe plot for bigeye tuna (black: 2013), skipjack tuna (brown: 2014), yellowfin tuna (grey: 2012) and albacore (white: 2014) showing the estimates of current stock size (SB) and current fishing mortality (F) in relation to the interim target spawning stock size and interim target fishing mortality. Cross bars illustrate the range of uncertainty from the model runs. Note that for skipjack tuna, the estimates are highly uncertain as FMSY is poorly estimated, and as suggested for stock status advice it is better to use B_0 as a biomass reference point and C(t) relative to CMSY as a fishing mortality reference point.

146. The SC **NOTED** paper IOTC–2014–SC17–ES05 which provided an overview of the biology, stock status and management of southern bluefin tuna (*Thunnus maccoyii*), and thanked CCSBT for providing it.

9.2 Billfish

147. The SC **RECOMMENDED** that the Commission note the management advice developed for each billfish species under the IOTC mandate, as provided in the Executive Summary for each species, and the combined Kobe plot for the three species assigned a stock status in 2014 (Fig. 5):
   - Swordfish (*Xiphias gladius*) – Appendix XVI
   - Black marlin (*Makaira indica*) – Appendix XVII

- Blue marlin (*Makaira nigricans*) – Appendix XVIII
- Striped marlin (*Tetrapturus audax*) – Appendix XIX
- Indo-Pacific sailfish (*Istiophorus platypterus*) – Appendix XX

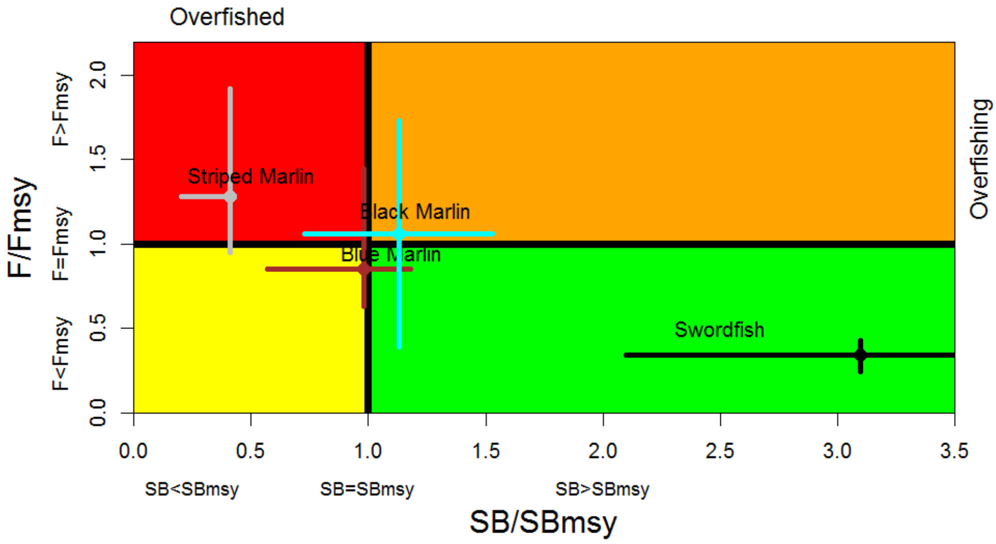


Fig. 5. Combined Kobe plot for swordfish (black: 2014), black marlin (light blue: 2014), blue marlin (brown: 2013) and striped marlin (grey: 2013) showing the estimates of current stock size (SB or B, species assessment dependent) and current fishing mortality (F) in relation to the interim target spawning stock size and interim target fishing mortality. Cross bars illustrate the range of uncertainty from the model runs.

9.3 Tuna and seerfish – Neritic species

148. The SC **RECOMMENDED** that the Commission note the management advice developed for each neritic tuna (and mackerel) species under the IOTC mandate, as provided in the Executive Summary for each species, and the combined Kobe plot for the three species assigned a stock status in 2014 (Fig. 6):
    - Bullet tuna (*Auxis rochei*) – Appendix XXI
    - Frigate tuna (*Auxis thazard*) – Appendix XXII
    - Kawakawa (*Euthynnus affinis*) – Appendix XXIII
    - Longtail tuna (*Thunnus tonggol*) – Appendix XXIV
    - Indo-Pacific king mackerel (*Scomberomorus guttatus*) – Appendix XXV
    - Narrow-barred Spanish mackerel (*Scomberomorus commerson*) – Appendix XXVI

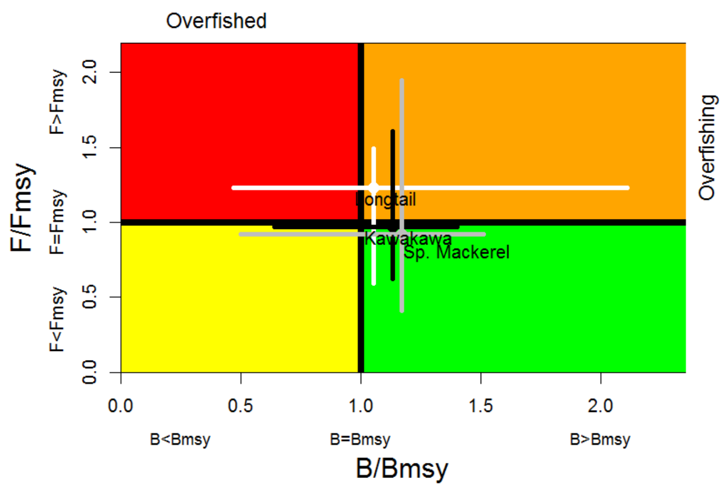


Fig. 6. Combined Kobe plot for kawakawa (black: 2014), longtail tuna (white: 2014) and narrow-barred Spanish mackerel (grey: 2014), showing the estimates of current stock size (B) and current fishing mortality (F) in relation to interim target spawning stock size and interim target fishing mortality. Cross bars illustrate the range of uncertainty from the model runs.

10. Status of Marine Turtles, Seabirds and Sharks in the Indian Ocean

10.1 Sharks

149. 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 shark (*Prionace glauca*) – Appendix XXVII
    - Oceanic whitetip shark (*Carcharhinus longimanus*) – Appendix XXVIII
    - Scalloped hammerhead shark (*Sphyrna lewini*) – Appendix XXIX
    - Shortfin mako shark (*Isurus oxyrinchus*) – Appendix XXX
    - Silky shark (*Carcharhinus falciformis*) – Appendix XXXI
    - Bigeye thresher shark (*Alopias superciliosus*) – Appendix XXXII
    - Pelagic thresher shark (*Alopias pelagicus*) – Appendix XXXIII

10.2 Marine turtles

150. 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 XXXIV

10.3 Seabirds

151. 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 XXXV

11. Implementation of the Regional Observer Scheme

152. The SC **NOTED** paper IOTC–2014–SC17–08 Rev_2 which provided an update on the status of implementation and reporting to the IOTC Secretariat of the Regional Observer Scheme (ROS) set out by Resolution 09/04 *on a Regional Observer Scheme*, superseded by Resolution 11/04 *on a Regional Observer Scheme* at the 15th Session of the Commission (S15) in 2011 (provided in Appendix XXXVI).

153. The SC **NOTED** that as of 21st November 2014, fourteen CPCs (Australia, China, Comoros, EU(France and Portugal), Indonesia, Japan, Kenya, Rep. of Korea, Madagascar, Maldives, Mauritius, Mozambique, Seychelles and South Africa) have submitted a list of observers and have been allocated an IOTC observer registration number.

154. The SC **NOTED** that as of 21st November 2014, one hundred and seventy two (172) observer trip reports have been submitted to the IOTC Secretariat by Australia, China, EU(France and Portugal), Japan, Rep. of Korea, Madagascar, Mozambique and South Africa. The levels of coverage estimated for all combined fleets and CPCs are still very low and, especially for longline fleets, they are well below the minimal levels recommended by the Commission (around 0.24% of the number of hooks set covered by observers in 2013).

155. The SC **REQUESTED** that all IOTC CPCs urgently submit, and keep up-to-date, their list of accredited observers to the IOTC Secretariat and 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)

156. The SC **NOTED** that the timely submission of observer trip reports to the IOTC Secretariat is necessary to ensure that the SC 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 IOTC scientists to better assess the impacts of fisheries for tuna and tuna-like species on bycatch species.

157. The SC **EXPRESSED** its strong concern regarding the low level of 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. Such a low level of implementation and reporting is detrimental to the work of the SC, in particular regarding the estimation of incidental catches of non-targeted species, as requested by the Commission. Capacity building activities are planned for 2015 in I.R. Iran, Pakistan and Sri Lanka in support of the Regional Observer Scheme to assist CPCs with implementation and development of their national programmes.

158. The SC **AGREED** that, in addition to the implementation of the ROS which is likely to take time, the collection of scientific data by all other means available including self-sampling (collection of data by trained crew) such as that carried out for the small-scale components of the EU,France longline fleet and electronic monitoring (sensors and video cameras) be encouraged and developed, and for CPCs to report on progress at the next WPEB meeting. This is particularly important for fleets which are not achieving the target level of coverage of human observers due to factors such as the small size of vessels, such as the gillnet fleets.

11.1 Proposed revisions to Resolution 11/04 on a regional observer scheme

159. **RECALLING** the objectives of Resolution 11/04 *on a regional observer scheme* as follows: "Para 1: The objective of the IOTC Observer Scheme shall be to collect verified catch data and other scientific data related to the fisheries for tuna and tuna-like species in the IOTC area of competence" and **NOTING** that the objective of the ROS contained in Resolution 11/04, and the rules contained in Resolution 12/02 *On data confidentiality policy and procedures* makes no reference to the data collected not being used for compliance purposes, the SC **RECOMMENDED** that at the next revision of Resolution 11/04, it be clearly stated that the data collected shall not be used for compliance purposes.

11.2 Observer trip reporting template

160. **RECALLING** the 15th Session of the Commission, where it was stated that the observer reporting template and manual "*will be reviewed and revised as necessary*", the SC **NOTED** the revisions to the observer reporting templates proposed by the WPEB10 and the WPDCS10 to improve the quality of the data submissions for scientific purposes such as stock assessments and other such scientific work as requested by the IOTC Scientific Committee.

161. **NOTING** that improving the quality of data submissions is a process that evolves and develops over time, the SC **ADOPTED** the revised observer templates as interim reporting templates for immediate use by CPCs where ready and for preliminary use by CPCs where further time is required for review. The SC **AGREED** that the IOTC Secretariat will make these templates available in 2015 and update the guidance in the manual accordingly. Following implementation in interim format, the SC **AGREED** that these will be reviewed and modified further as appropriate in 2015.

162. The SC **NOTED** that this is consistent with Resolution 11/04 which states "…*the IOTC Scientific Committee will elaborate an observer working manual, a template to be used for reporting (including minimum data fields) and a training program*".

163. The SC **CONGRATULATED** Japan for submitting observer data in electronic format (rather than in pdf and word documents) and **ENCOURAGED** other CPCs to do the same to facilitate data management and timely use of data.

11.3 Electronic Monitoring

164. The SC **NOTED** that electronic monitoring systems are meant to complement onboard scientific observers work but not to replace observers, as some of the tasks of observers cannot be carried out with electronic monitoring.

165. The SC **AGREED** that standards for such systems for purse seine and other gear types would need to be developed, and **NOTED** that ICCAT is working towards the adoption of minimum standards for Electronic Monitoring Systems for purse seine vessels given that, according to recent analyses conducted, they can provide very useful information on fishing trips and be a complement to port sampling and human observer programs for tropical tuna purse seine fisheries. Since there are several vendors and multiple possible system configurations, these standards would aim to standardise the implementation of Electronic Monitoring systems and to ensure that the systems can result in collecting useful information for fisheries monitoring. ISSF's technical report 2014-08 "*Updated guidance on Electronic Monitoring Systems for tropical tuna purse seine*

fisheries" could be used as a starting point for this objective. There is a clear need to determine best practices for the integration of information from EMS, human observer, and port sampling programs.

166. **NOTING** that electronic monitoring (including video) has been trialled and successfully implemented in many fisheries worldwide (e.g. Australia, European Union, USA, New Zealand), with the aim of supplementing scientific observers on board vessels; and given the current difficulties cited as reasons for not deploying scientific observers under the IOTC Regional Observer Scheme (ROS) on board large-scale gillnet vessels operating in the Indian Ocean; the SC **RECOMMENDED** that the Commission considers assigning the IOTC Secretariat, in consultation with interested IOTC scientisits, to develop a project on electronic monitoring in the IOTC area of competence. This would allow an evalution of the efficacy of electronic monitoring in the collection of information on catch, discards and fishing effort as a means to supplement scientific observer coverage for large-scale gillnet vessels. The trial will include an evaluation of the main challenges of using electronic monitoring data such as the accurate identification of IOTC and bycatch species, weight and size of catches and the time taken to process the footage and extract the required data. The concept note/proposal shall also include a clear indication that the IOTC data confidentiality policy (Resolution 12/02) will need to be modified to ensure any data/information collected is for the sole purpose of scientific analysis and not for compliance purposes. The concept note should include a detailed budget and be communicated to a range of potential funding organisations.

12. EVALUATION OF CLOSED AREAS AS MANAGEMENT OPTIONS

167. The SC **NOTED** the following statement by Mauritius:
"*Any consideration by the Scientific Committee of the impact of the 'MPA' purportedly established by the United Kingdom around the Chagos Archipelago cannot and should not be construed as implying that the United Kingdom has sovereignty or analogous rights over the Chagos Archipelago*".

168. The SC **NOTED** that the Commission, at its 18th Session, requested the following:
"*NOTING that the objective of Resolution 12/13 was 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 populations, the Commission REQUESTED that the SC (via the WPTT in 2014) undertake an analysis of the combined impacts of the two closed areas in the Indian Ocean (contained in Resolution 12/13 and the UK(OT) MPA), with the objective of determining the utility of closed areas in managing highly migratory species.*" (S18, Para. 23)

169. **NOTING** that Resolution 12/13 *for the conservation and management of tropical tunas stocks in the IOTC area of competence*, was superseded by Resolution 14/02, and that the new Resolution no longer contains requirements for time area closures, the SC **AGREED** that there was no need to undertake an analysis or discussion of the request detailed in the S18 Report, para. 23 in respect of the IOTC closure. In consideration of the combined impacts of the two closed areas in the Indian Ocean the SC **NOTED** that it was necessary to consider the impact of the closures on both the fish stocks, and their effect on the dynamics of the fishing fleets.

170. The SC reiterated its previous **RECOMMENDATION** with respect to bigeye tuna, skipjack tuna and yellowfin tuna stocks, that the Commission note that the previous IOTC closure is likely to be ineffective, as fishing effort will be redirected to other fishing grounds in the Indian Ocean and it considered that this recommendation also related to the wider network of closures including UK(OT) MPA. Papers IOTC–2013–SC16–INF11 and IOTC–2011–SC14–40, which examined the effect of IOTC closure and the effect of the UK(OT) MPA as well as a partial Maldives closure on the status of yellowfin tuna, concluded that if displacement of effort occurred to areas outside the closures then there would be no effect. An effect was only observed if it was assumed that all effort that would have occurred in those areas was entirely removed from the fishery. Thus any positive impacts of closed areas would likely be offset by effort reallocation.

171. **NOTING** that new research was presented at WPTT16 which looked at the impact of closed area management on purse seine (FAD and free school) fleet dynamics (see papers IOTC–2014–WPTT16–14; IOTC–2014–WPTT16–17), the SC **AGREED** that more work on fleet dynamics including FAD use would be beneficial to predict the outcomes of management interventions such as closed areas. Similarly, whilst it was agreed that current closed areas have negligible impact on stock status, the potential to utilise this management tool should

be retained for the future subject to further understanding of the impacts of closures on stock status and fleet dynamics.

172. The SC **RECOMMENDED** that the Commission specify the level of reduction or the long term management objectives to be achieved with any time area closure/s and/or alternative measures which it adopts in the future, as these will, in turn, guide and facilitate the analysis by the SC and its subsidiary bodies.

13. Progress on the Implementation of the Recommendations of the Performance Review Panel

173. The SC **NOTED** paper IOTC–2014–SC17–09 which provided an update on progress regarding Resolution 09/01 *on the performance review follow–up*. The second Performance Review was delayed and will commence in 2015.

174. 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 XXXVII.

14. Program of work and schedule of Working Party and Scientific Committee meetings

14.1 Program of Work (2015–2019) and assessment schedule

175. The SC **NOTED** paper IOTC–2014–SC17–10 which outlined the proposed research priorities for each of the Working Parties, with the aim of developing an IOTC Science Program of Work for 2015 to 2019.

176. The SC **REMINDED** the IOTC Secretariat that any projects recommended by the SC in 2013, and which were subsequently endorsed by the Commission and funded for implementation in 2014 and/or 2015 budget, should occur in 2015, if not already completed.

177. The SC **NOTED** the proposed Program of Work and priorities for each of the Working Parties and **AGREED** to a consolidated Program of Work as outlined in Appendix XXXVIII. The Chairs and Vice-Chairs of each working party shall ensure that the efforts of their working party is focused on the core areas contained within the appendix, taking into account any new research priorities identified by the Commission at its next Session.

178. The SC **REQUESTED** that during the 2015 Working Party meetings, each group not only develop a Draft Program of Work for the next five years containing low, medium and high priority projects, but that all High Priority projects are ranked. The intention is that the SC would then be able to review the rankings and develop a consolidated list of the highest priority projects to meet the needs of the Commission. Where possible, budget estimates should be determined, as well as the identification of potential funding sources.

179. The SC **AGREED** that identifying research priorities among its Working Partes (Appendix XXXVIII) will assist individual CPCs and the IOTC Secretariat to identify funding sources for the implementation of priority research projects. Accordingly, and in the interest of transparency, the SC **REQUESTED** the IOTC Secretariat to follow the following consultative process involving the SC and Working Party Chairs and Vice-Chairs and the IOTC Secretariat:

- **Step 1:** Working Parties to identify research needs (based on the needs of the Commission), rank them by order of priority, provide cost estimates and list potential funding sources;
- **Step 2:** The SC and Working Party Chair and Vice-Chair, in liason with the IOTC Secretariat should develop a consolidated document taking into account the different Working Party research needs and priorities, with the objective of ranking the research needs among all Working Parties;
- **Step 3:** The Chair of the SC shall present these to the SC, to be discussed and endorsed as the consolidated research priorities for the IOTC Science process;
- **Step 4:** The IOTC Secretariat, in consultation with the Chair and Vice-Chair of the SC and Chair and Vice-Chair or relevant Working Parties, shall identify funding possibilities to undertake the consolidated research priorities;

- **Step 5:** Once the funding sources have been committed to a particular research priority, the panel mentioned above in Step 2 shall develop terms of reference of the 'Expression of Interest' (including tasks, timelines and deliverables) and the selection procedure/criteria;
- **Step 6:** IOTC Secretariat to advertise a call for 'Expression of Interest' among the IOTC Commissioner's and Science contact lists, and via the IOTC website;
- **Step 7:** The Chair of the SC, Chair(s) and Vice-Chair(s) of the WP(s) concerned, in liaison with the IOTC Secretariat shall determine the most appropriate project proposal, based on the criteria defined in Step 5 and in line with the financial rules of the Commission and FAO. Potential contracted candidate will be contacted by the IOTC Secretariat to confirm availability.

14.2 Assessment schedule

180. The SC **ADOPTED** a revised assessment schedule, ecological risk assessment and other core projects for 2015–19, for the tuna and tuna-like species under the IOTC mandate, as well as the current list of key shark species of interest, as outlined in Appendix XXXIX.

14.3 Invited Experts

181. The SC **RECOMMENDED** that at least one 'Invited Expert' be brought to each of the science Working Parties in 2015 and in each subsequent year, so as to further increase the capacity of the Working Paties to undertake the work detailed in the Program of Work (Appendix XL). The IOTC regular budget shall include travel funds (flights, DSA) for this purpose. The Invited Expert for each meeting will continue to be selected based on the process adopted by the Scientific Committtee and provided at Appendix XL.

14.4 Consultants

182. The SC **AGREED** that the hiring of stock assessment consultants to assist in building capacity among the various Working Parties, by supplementing the skill set available within the IOTC Secretariat and CPCs to develop stock assessment approaches for the various stocks. An indicative budget is provided at Table 6. The Consultant for each meeting will be selected based on the process adopted by the Scientific Committtee and provided at Appendix XL.

183. **NOTING** the highly beneficial and relevant work done by IOTC stock assessment consultants in 2014 and in previous years, the SC **RECOMMENDED** that engagement by consultants be continued for each coming year based on the Program of Work (Appendix XXXVIII), to supplement the skill set available within the IOTC Secretariat and CPCs. An indicative budget is provided at Table 6.

TABLE 6. Estimated budget required to hire a consultant to carry out stock assessments on tuna and tuna-like species under the IOTC mandate, sharks frequently caught by IOTC fisheries, and capacity building, in 2015 and 2016.

Description	Unit price	Units required	2015 Total (US$)	2016 Total (US$)	Priority
WPNT					
Neritic tuna data poor stock assessment and capacity building (fees)	450	15	6,750	6,750	Low
Neritic tuna data poor stock assessment and capacity building (travel)	5,000	1	5,000	5,000	Low
WPB					
Billfish data poor stock assessment (fees)	450	15	6,750	6,750	Med
Billfish data poor stock assessment (travel)	5,000	1	5,000	5,000	Med
WPEB					
Shark stock assessment (fees)	450	20	9,000	9,000	High
Shark stock assessment (travel)	5,000	1	5,000	5,000	High
Evaluation of the discards ban proposal	450	35	Nil	15,750	Med
WPTT					
Tropical tuna stock assessment (fees)	450	35	15,750	15,750	High
Tropical tuna stock assessment (travel)	5,000	1	5,000	5,000	High

WPTmT					
Temperate tuna stock assessment (fees)	450	35	Nil	15,750	High
Temperate tuna stock assessment (travel)	5,000	1	Nil	5,000	High
WPM					
External peer review of the albacore MSE	450	10	4,500	Nil	Med
External peer review of the skipjack tuna MSE	450	10	4,500	Nil	Med
TOTAL			**67,250**	**94,754**	

14.5 Schedule of meetings for 2015 and 2016

184. The SC **NOTED** paper IOTC–2014–SC17–11 Rev_1 which outlined the proposed schedule for IOTC Working Parties and SC meetings for 2015 and 2016.

185. The SC **RECOMMENDED** that the Commission endorse the schedule of Working Party and Scientific Committee meetings for 2015 and 2016 provided at Appendix XLI.

15. Other Business

15.1 Discussion of the Science to Management dialogue

186. The SC **NOTED** that Resolution 14/03 *on enhancing the dialogue between fisheries scientists and managers* established a process with the objective to enhance communication and foster mutual understanding between fisheries managers and scientists, by establishing a forum to exchange views and to support the development and effective implementation of management strategies.

187. **NOTING** that Resolution 14/03 established clear objectives, terms of reference and a meeting schedule to develop the general framework to guide establishment, review and update of management objectives and strategies, the SC **REQUESTED** that roles and the responsibilities of both fisheries managers and scientists (SC), and possible interactions and feedback, are developed and clarified within this framework.

188. The SC **NOTED** that Resolution 14/03 *on enhancing the dialogue between fisheries scientists and managers* stated that the scientific advice is a corner stone for effective management of IOTC stocks. However, given the limited time allocated to the presentation of the Scientific Committee Report during the last IOTC Commission meeting, the SC **CONSIDERED** that this precludes the achievement of the objectives established in the above mentioned Resolution.

189. **NOTING** that the time allocated to the Scientific Committee report presentations in other tuna RFMOs, such as ICCAT, is substantially longer, the SC **REQUESTED** the Chair of the Commission consider allocating more time for the presentation of the Scientific Committee report, with the aim of ensuring better explanation of the work conducted and the provision of the management advice as requested by the Commission.

190. The SC **NOTED** the substantial progress being made by the Working Party on Methods to develop management strategy evaluation frameworks, and that for this work to progress there is a need for clear guidance to the SC on fishery management objectives and on tolerable risks associated with breaching the limits. In this regard, the SC **RECOMMENDED** that these issues be given a high priority for broad discussion by the CPCs during the Science and Management Dialogue Workshops under Resolution 14/03 and that the Chair of the Commission consider inclusion of their discussion in the Commission meeting.

15.2 GEF-ABNJ Project update

191. The SC **NOTED** the update from FAO on the progress of its ABNJ Tuna Project which is one of four projects of the Common Oceans Program, supported the Global Environment Facility, and with 19 partners including all tuna RFMOs, as well as governments, NGOs and private sector organisations. Structured in three basic components, the Project aims at facilitating and accelerating existing initiatives from the tuna RFMOs and supporting the sharing of experiences amongst the tuna RFMOs in areas of common interest.

192. The SC **NOTED** that:
- the first component supports the full implementation of the precautionary approach at the RFMO level, according to the guidelines of international instruments. Support is given in the form of capacity building and facilitating the management strategy evaluation through dialogues between the scientific community and officials from member States, as it was the case of IOTC workshops in April and May. The Project is also

promoting and supporting the preparation of long-term plans for the implementation of the ecosystem approach in fisheries in each RFMO.

- the second component focuses on the reduction of IUU fishing through a number of strategies, and the development of the CLAV is one of the key contributions by IOTC Secretariat to the Project.
- the third component of the Project addresses the ecosystem impacts of tuna fisheries, including estimation and possible mitigation of bycatch in the gillnet fisheries in the northern Indian Ocean, an activity lead by WWF.

193. The SC **NOTED** that there is also pilot work to develop consistent management plans for sharks in the Pacific, and sharing of information on bycatch management measures and practices in tuna fisheries available through a global Bycatch Management Information System (BMIS). In addition, on-the-water pilots in collaboration with BirdLife and ISSF are foreseen to test mitigation techniques for by-catch of small tuna and sharks in purse-seiners or incidental seabird mortality in longline fleets.

16. Review of the Draft, and Adoption of the Report of the 17th Session of the Scientific Committee

194. The SC **RECOMMENDED** that the Commission consider the additional science budget for 2015–16, (Appendix XLII) and the consolidated set of recommendations arising from SC17, provided at Appendix XLIII.

195. The SC **ADOPTED** the report of the 17th Session of the Scientific Committee (IOTC–2014–SC17–R) on 12 December 2014.

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APPENDIX II
AGENDA FOR THE SEVENTEENTH SESSION OF THE SCIENTIFIC COMMITTEE

Date: 8–12 December 2014
Location: Eden Bleu Hotel, Eden Island, Seychelles
Time: 09:00 – 17:00 daily
Chair: Dr. Tsutomu Nishida; **Vice-Chair:** Mr. Jan Robinson

1. **OPENING OF THE SESSION** (Chair)
2. **ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION** (Chair)
3. **ADMISSION OF OBSERVERS** (Chair)
4. **DECISIONS OF THE COMMISSION RELATED TO THE WORK OF THE SCIENTIFIC COMMITTEE** (IOTC Secretariat)
   - 4.1 Outcomes of the 18th Session of the Commission
   - 4.2 Previous decisions of the Commission
5. **SCIENCE RELATED ACTIVITES OF THE IOTC SECRETARIAT IN 2014** (IOTC Secretariat)
   - 5.1 Report of the Secretariat – Activities in support of the IOTC science process in 2014
   - 5.2 Revised: Guidelines for the presentation of CPUE standardisations and stock assessment models
6. **NATIONAL REPORTS FROM CPCs** (CPCs)
7. **REPORTS OF THE 2014 IOTC WORKING PARTY MEETINGS**
   - 7.1 IOTC–2014–WPNT04–R Report of the 4th Session of the Working Party on Neritic Tunas
   - 7.2 IOTC–2014–WPTmT05–R Report of the 5th Session of the Working Party on Temperate Tunas
   - 7.3 IOTC–2014–WPB12–R Report of the 12th Session of the Working Party on Billfish
   - 7.4 IOTC–2014–WPEB10–R Report of the 10th Session of the Working Party on Ecosystems and Bycatch
     - IO-ShYP: Shark year program
   - 7.5 IOTC–2014–WPTT16–R Report of the 16th Session of the Working Party on Tropical Tunas
   - 7.6 IOTC–2014–WPDCS10–R Report of the 10th Session of the Working Party on Data Collection and Statistics
   - 7.7 IOTC–2014–WPM05–R Report of the 5th Session of the Working Party on Methods
   - 7.8 Summary discussion of matters common to Working Parties (capacity building activities – stock assessment course; connecting science and management, etc.)
8. **EXAMINATION OF THE EFFECTS OF PIRACY ON FLEET OPERATIONS AND SUBSEQUENT CATCH AND EFFORT TRENDS** (Chair)
9. **STATUS OF TUNA AND TUNA-LIKE RESOURCES IN THE INDIAN OCEAN** (Chair)
   - 9.1 Tuna – Highly migratory species
   - 9.2 Tuna and mackerel – Neritic species
   - 9.3 Billfish
10. **STATUS OF SHARKS, MARINE TURTLES AND SEABIRDS IN THE INDIAN OCEAN** (Chair)
    - 10.1 Sharks
    - 10.2 Marine turtles
    - 10.3 Seabirds
11. **IMPLEMENTATION OF THE REGIONAL OBSERVER SCHEME** (IOTC Secretariat)
12. **EVALUATION OF CLOSED AREAS AS MANAGEMENT OPTIONS** (Chair)
    S18, Para. 23: *NOTING that the objective of Resolution 12/13 was 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 populations, the Commission REQUESTED that the SC (via the WPTT in 2014) undertake an analysis of the combined impacts of the two closed areas in the Indian Ocean (contained in Resolution 12/13 and the UK(OT) MPA), with the objective of determining the utility of closed areas in managing highly migratory species.

13. PROGRESS ON THE IMPLEMENTATION OF THE RECOMMENDATIONS OF THE PERFORMANCE REVIEW PANEL (IOTC Secretariat)

14. PROGRAM OF WORK AND SCHEDULE OF WORKING PARTY AND SCIENTIFIC COMMITTEE MEETINGS (IOTC Secretariat)

14.1 Program of Work (2015–2019) and assessment schedule

14.2 Schedule of meetings for 2015 and 2016

15. OTHER BUSINESS (Chair)

15.1 Discussion of the Science to Management dialogue

15.2 GEF-ABNJ Project update

16. REVIEW OF THE DRAFT, AND ADOPTION OF THE REPORT OF THE 17th SESSION OF THE SCIENTIFIC COMMITTEE (Chair)

APPENDIX III
LIST OF DOCUMENTS

Document	Title	Availability
IOTC–2014–SC17–01a	Agenda of the 17th Session of the Scientific Committee	✓ (9 September 2014) ✓ (6 December 2014)
IOTC–2014–SC17–01b	Draft: Annotated agenda of the 17th Session of the Scientific Committee	✓ (23 November 2014) ✓ (6 December 2014)
IOTC–2014–SC17–02	Draft: List of documents of the 17th Session of the Scientific Committee	✓ (11 November 2014) ✓ (7 December 2014)
IOTC–2014–SC17–03	Outcomes of the 18th Session of the Commission (IOTC Secretariat)	✓ (11 November 2014)
IOTC–2014–SC17–04	Previous decisions of the Commission (IOTC Secretariat)	✓ (11 November 2014)
IOTC–2014–SC17–05 Rev_1	Report of the Secretariat – Activities in support of the IOTC science process in 2014 (IOTC Secretariat)	✓ (23 November 2014) ✓ (28 November 2014)
IOTC–2014–SC17–06	Revised: Guidelines for the presentation of CPUE standardisations and stock assessment models (IOTC Secretariat)	✓ (23 November 2014)
IOTC–2014–SC17–07	Status of development and implementation of national plans of action for seabirds and sharks, and implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations (IOTC Secretariat)	✓ (11 November 2014)
IOTC–2014–SC17–08 Rev_2	Update on the implementation of the regional observer scheme (IOTC Secretariat)	✓ (23 November 2014) ✓ (24 November 2014) ✓ (8 December 2014)
IOTC–2014–SC17–09	2014: Update on progress regarding Resolution 09/01 – on the performance review follow–up (IOTC Secretariat)	✓ (23 November 2014)
IOTC–2014–SC17–10	Revision of the program of work (2015–19) for the IOTC science process (IOTC Secretariat)	✓ (23 November 2014)
IOTC–2014–SC17–11 Rev_1	Proposed schedule of Working Party and Scientific Committee meetings for 2015 and 2016 (IOTC Secretariat)	✓ (23 November 2014) ✓ (6 December 2014)
Executive Summaries		
IOTC–2014–SC17–ES01 Rev_3	Status of the Indian Ocean Albacore (ALB: *Thunnus alalunga*) resource	✓ (17 November 2014) ✓ (8 December 2014) ✓ (11 December 2014)
IOTC–2014–SC17–ES02	Status of the Indian Ocean bigeye tuna (BET: *Thunnus obesus*) resource	✓ (24 November 2014)
IOTC–2014–SC17–ES03 Rev_1	Status of the Indian Ocean skipjack tuna (SKJ: *Katsuwonus pelamis*) resource	✓ (24 November 2014) ✓ (11 December 2014)
IOTC–2014–SC17–ES04 Rev_1	Status of the Indian Ocean yellowfin tuna (YFT: *Thunnus albacares*) resource	✓ (24 November 2014) ✓ (11 December 2014)
IOTC–2014–SC17–ES05	Report on biology, stock status and management of southern bluefin tuna: 2013 (from CCSBT)	✓ (23 November 2014)
IOTC–2014–SC17–ES06	Status of the Indian Ocean bullet tuna (BLT: *Auxis rochei*) resource	✓ (17 November 2014)
IOTC–2014–SC17–ES07	Status of the Indian Ocean frigate tuna (FRI: *Auxis thazard*) resource	✓ (17 November 2014)
IOTC–2014–SC17–ES08 Rev_1	Status of the Indian Ocean kawakawa (KAW: *Euthynnus affinis*) resource	✓ (17 November 2014) ✓ (11 December 2014)
IOTC–2014–SC17–ES09 Rev_1	Status of the Indian Ocean longtail tuna (LOT: *Thunnus tonggol*) resource	✓ (17 November 2014) ✓ (11 December 2014)
IOTC–2014–SC17–ES10	Status of the Indian Ocean Indo-Pacific king mackerel (GUT: *Scomberomorus guttatus*) resource	✓ (17 November 2014)
IOTC–2014–SC17–ES11 Rev_1	Status of the Indian Ocean narrow-barred Spanish mackerel (COM: *Scomberomorus commerson*) resource	✓ (17 November 2014) ✓ (11 December 2014)
IOTC–2014–SC17–ES12 Rev_1	Status of the Indian Ocean black marlin (BLM: *Makaira indica*) resource	✓ (21 November 2014) ✓ (11 December 2014)
IOTC–2014–SC17–ES13 Rev_1	Status of the Indian Ocean blue marlin (BUM: *Makaira nigricans*) resource	✓ (21 November 2014) ✓ (11 December 2014)

Document	Title	Availability
IOTC–2014–SC17–ES14	Status of the Indian Ocean striped marlin (MLS: *Tetrapturus audax*) resource	✓ (21 November 2014)
IOTC–2014–SC17–ES15 Rev_1	Status of the Indian Ocean Indo-Pacific sailfish (SFA: *Istiophorus platypterus*) resource	✓ (21 November 2014) ✓ (6 December 2014)
IOTC–2014–SC17–ES16	Status of the Indian Ocean swordfish (SWO: *Xiphias gladius*) resource	✓ (21 November 2014)
IOTC–2014–SC17–ES17	Status of the Indian Ocean blue shark (BSH: *Prionace glauca*)	✓ (17 November 2014)
IOTC–2014–SC17–ES18	Status of the Indian Ocean oceanic whitetip shark (OCS: *Carcharhinus longimanus*)	✓ (17 November 2014)
IOTC–2014–SC17–ES19	Status of the Indian Ocean scalloped hammerhead shark (SPL: *Sphyrna lewini*)	✓ (17 November 2014)
IOTC–2014–SC17–ES20	Status of the Indian Ocean shortfin mako shark (SMA: *Isurus oxyrinchus*)	✓ (17 November 2014)
IOTC–2014–SC17–ES21	Status of the Indian Ocean silky shark (FAL: *Carcharhinus falciformis*)	✓ (17 November 2014)
IOTC–2014–SC17–ES22	Status of the Indian Ocean bigeye thresher shark (BTH: *Alopias superciliosus*)	✓ (17 November 2014)
IOTC–2014–SC17–ES23	Status of the Indian Ocean pelagic thresher shark (PTH: *Alopias pelagicus*)	✓ (17 November 2014)
IOTC–2014–SC17–ES24 Rev_1	Status of marine turtles in the Indian Ocean	✓ (17 November 2014) ✓ (8 December 2014)
IOTC–2014–SC17–ES25 Rev_2	Status of seabirds in the Indian Ocean	✓ (17 November 2014) ✓ (8 December 2014)
Working Party Reports		
IOTC–2014–WPNT04–R	Report of the 4th Session of the Working Party on Neritic Tunas	✓ (3 September 2014)
IOTC–2014–WPTmT05–R	Report of the 5th Session of the Working Party on Temperate Tunas	✓ (3 September 2014)
IOTC–2014–WPEB10–R	Report of the 10th Session of the Working Party on Ecosystems and Bycatch	✓ (7 November 2014)
IOTC–2014–WPB12–R	Report of the 12th Session of the Working Party on Billfish	✓ (7 November 2014)
IOTC–2014–WPTT16–R	Report of the 16th Session of the Working Party on Tropical Tunas	✓ (24 November 2014)
IOTC–2014–WPDCS10–R	Report of the 10th Session of the Working Party on Data collection and Statistics	✓ (5 December 2014)
IOTC–2014–WPM05–R Rev_1	Report of the 5th Session of the Working Party on Methods	✓ (7 December 2014) ✓ (9 December 2014)
National Reports		
IOTC–2014–SC17–NR01	Australia	✓ (4 November 2014)
IOTC–2014–SC17–NR02	Belize	Due: 23 November 2014
IOTC–2014–SC17–NR03 Rev_1	China	✓ (18 November 2014) ✓ (23 November 2014)
IOTC–2014–SC17–NR04	Comoros	✓ (22 November 2014)
IOTC–2014–SC17–NR05	Eritrea	Due: 23 November 2014
IOTC–2014–SC17–NR06	European Union	✓ (26 November 2014)
IOTC–2014–SC17–NR07	France (OT)	✓ (24 November 2014)
IOTC–2014–SC17–NR08	Guinea	Due: 23 November 2014
IOTC–2014–SC17–NR09	India	✓ (5 December 2014)
IOTC–2014–SC17–NR10	Indonesia	✓ (5 December 2014)
IOTC–2014–SC17–NR11	Iran, Islamic Republic of	✓ (22 November 2014)
IOTC–2014–SC17–NR12	Japan	✓ (29 November 2014)
IOTC–2014–SC17–NR13	Kenya	✓ (18 November 2014)
IOTC–2014–SC17–NR14	Korea, Republic of	✓ (24 November 2014)

Document	Title	Availability
IOTC–2014–SC17–NR15	Madagascar	✓ (28 November 2014)
IOTC–2014–SC17–NR16	Malaysia	✓ (4 November 2014)
IOTC–2014–SC17–NR17	Maldives, Republic of	✓ (23 November 2014)
IOTC–2014–SC17–NR18	Mauritius	✓ (20 November 2014)
IOTC–2014–SC17–NR19	Mozambique	✓ (26 November 2014)
IOTC–2014–SC17–NR20	Oman, Sultanate of	✓ (24 November 2014)
IOTC–2014–SC17–NR21	Pakistan	Due: 23 November 2014
IOTC–2014–SC17–NR22	Philippines	✓ (21 November 2014)
IOTC–2014–SC17–NR23	Seychelles, Republic of	✓ (5 December 2014)
IOTC–2014–SC17–NR24	Sierra Leone	Due: 23 November 2014
IOTC–2014–SC17–NR25	Somalia	✓ (28 October 2014)
IOTC–2014–SC17–NR26	Sri Lanka	✓ (22 November 2014)
IOTC–2014–SC17–NR27	Sudan	Due: 23 November 2014
IOTC–2014–SC17–NR28	Tanzania	✓ (19 November 2014)
IOTC–2014–SC17–NR29 Rev_1	Thailand	✓ (29 October 2014) ✓ (11 December 2014)
IOTC–2014–SC17–NR30	United Kingdom (OT)	✓ (6 November 2014)
IOTC–2014–SC17–NR31	Vanuatu	✓ (1 December 2014)
IOTC–2014–SC17–NR32	Yemen	Due: 23 November 2014
Cooperating Non-Contracting Parties		
IOTC–2014–SC17–NR33	Djibouti	Due: 23 November 2014
IOTC–2014–SC17–NR34	Senegal	Due: 23 November 2014
IOTC–2014–SC17–NR35	South Africa, Republic of	✓ (1 December 2014)
Information papers		
IOTC–2014–SC17–INF01	Management strategy evaluation for the Indian Ocean skipjack tuna fishery (Bentley N & Adam MS)	✓ (24 November 2014)

APPENDIX IV
GUIDELINES FOR THE PRESENTATION OF CPUE STANDARDISATIONS AND STOCK ASSESSMENT MODELS

These guidelines attempt to ensure greater transparency and facilitate peer-review of models employed in the provision of advice on the status of the stocks. Scientists presenting stock assessment model runs should provide to the IOTC Secretariat a copy of all input and output files, for all runs presented, and of the executable file or files used within 10 days of the end of each meeting. These will be archived for future testing and replication. Scientists are encouraged to freely share the source code of the methods used. The IOTC Stock assessment expert/s will support CPC's in meeting these guidelines.

While this is not an all encompassing list, these documents should describe:

1) The available catch data and mention, if necessary, data sources or observations not included in the analysis.
2) Available indices of abundance used.
3) Available tag data used
4) Assumptions made on parameter values used as constants.
5) Parameters estimated and priors specified if used in parameter estimation.
6) Population trajectories and dynamics with respect to reference points.
7) Residual diagnostics on both CPUE derived indices (e.g. qq plots, observed versus fitted values, fitted versus residuals scatter plots).
8) Residual plots of model versus observed CPUE, and observed versus actual catch compositions should be presented.
9) When referring to datasets provided by the Secretariat, the date, coverage and precise database should be mentioned.
10) Data sources not previously seen by a Working Party may need a separate document presenting them. This includes standardized CPUE series or other data sources processed prior to use.
11) The population dynamics that are modelled and the techniques used should be clearly presented including a description of the partition, annual cycle, and other relevant population processes.
12) Alternative scenarios and retrospective analyses should ideally be carried and, if included, a description of the motivation for the selection of base and alternative cases should be added, giving detail of how the alternative case assumptions differ from those of the base case.
13) The description of any retrospective analyses should cover the assumptions involved and results obtained.
14) Projections should be similarly documented as detailed below.

Documentation requirement and guidelines

While these guidelines are basic good practices to include in the assessments and background data that go into the assessments (including CPUEs), they are not meant to preclude CPC's from presenting data or assessment models.

Software inspection and archival

- Input and output files of all alternative runs or scenarios presented should be made available during the meeting for inspection by interested members and for later archiving by the IOTC Secretariat. Ideally, these should be stored together with a copy of the software used in the analysis. When this is not possible due to licensing issues, a complete reference of the versions of both software and operating system employed should be made. Similarly, confidential inputs need not be provided but they should be documented and identified.
- Software used should ideally be open sourced using an appropriate license, or at least be made available to interested parties for inspection under a limited license. If closed source software is used, this should be clearly justified and sufficient tests as to its validity and reliability, under similar circumstances as those under which it will be used in IOTC-related work, should be carried out and its results made available. Even if the software is not available/open sourced, an executable should be part of the documentation so anyone could run the model.
- Comprehensive testing, including testing of the influence of various assumptions, is greatly encouraged in all cases.

Observations

- Describe the available data and mention, if necessary, data sources or observations not included in the analysis. When referring to datasets provided by the IOTC Secretariat, indicate the date, coverage (years, fleets, areas), and precise database (e.g. Nominal Catch, Catch and Effort).
- Data sources not previously seen by a Working Party might need their own document presenting them. This includes standardised CPUE series or other data sources processed prior to use.

Standardised CPUE indices of abundance

- Description of data pre-processing (e.g. treatment of outliers, selection of core areas if applicable).
- Efforts should be made to describe temporal and spatial patterns in the data, identifying gaps or sudden operational changes that that lead to an unbalanced design.
- Software and specific function calls.
- Standard diagnostic plots (e.g. residuals, leverage plots, qq plots, observed versus fitted values, fitted versus residuals scatter plots).
- Parameter values, including error estimates for the final model used.
- For complicated models, a stepwise progression from simpler models should be documented to help identify confounding, and a distinction between statistical significance and practical significance.
- Efforts should be made to circulate these analyses well in advance of the relevant working party to allow discussion, and timely implementation in the stock assessment analyses.

Population dynamics

- Describe the population dynamics that are modelled and the techniques used including a description of the partition (age/length/sex groups, maturity, spatial structure, movement dynamics, if necessary), annual cycle (time steps, growth assumptions, natural and fishing mortality functions, recruitment, and sequence of those), and relevant population processes. Fixed parameters should be identified and documented. Emphasis should be placed in describing the formal statistical methods applied, including modelling methods, and form, limits and assumptions of both free and derived parameters.

Statistical methods

- Describe of the formal statistical methods, including
    1. Software name, version number, bibliographic references and source
    2. Maximum likelihood or objective function
    3. Bootstrap assumptions and MCMC algorithm, if used.
- Describe the free parameters used by the model, including
    1. Name and description of the parameter
    2. Details of the estimation bounds/functional relationships with other parameters
    3. Details of the prior assumed (if any), and source of the prior
    4. Weightings for likelihood terms
    5. Adjustment of variance by scaling/adding process error
    6. Penalties
- Describe the derived parameters used by the model, including
    1. Name, description and definitions of derived parameters (be precise with those that have alternative definitions, e.g., B_0, MSY, B_{MSY})
    2. Details of any bounds/functional relationships with other parameters.
    3. Details of any priors assumed (including source).

Scenarios and retrospective analyses

- Alternative scenarios and retrospective analyses should be carried when possible and, if included, a description of the motivation for the selection of base and alternative cases should be added, giving detail of how the alternative case assumptions differ from those of the base case. Description of any retrospective analyses, should cover the assumptions involved and results obtained. Projections should be similarly documented.

Standards for assessment outputs:

Management quantities:

As **AGREED** by the IOTC Scientific Committee, assessments shall be presented with the minimum set of management quantities, where possible. Examples (Example 1) indicating the derived management quantities with uncertainty are shown below.

EXAMPLE 1: Key management quantities from the XXXX assessment for aggregate Indian Ocean, using a base case with xxxx details xxxx. CI values are 80% from the base case run; and from the ASPIC assessment for the southwest Indian Ocean. n.a. = not available.

Management Quantity	**Aggregate Indian Ocean**
YYYY catch estimate (most recent)	xx,xxx t
Mean catch from YYYY–YYYY (5-yrs)	xx,xxx t
MSY (80% CI)	xx,xxx (xx,xxx–xx,xxx)
Data period used in assessment	YYYY–YYYY
F_{MSY} (80% CI)	x.xx (x.xx–x.xx)
SB_{MSY} (80% CI)	x.xx (x.xx–x.xx)
$F_{current}/F_{MSY}$ (80% CI)	x.xx (x.xx–x.xx)
$B_{current}/B_{MSY}$ (80% CI)	x.xx (x.xx–x.xx)
$SB_{current}/SB_{MSY}$ (80% CI)	x.xx (x.xx–x.xx)
$B_{current}/B_0$ (80% CI)	x.xx (x.xx–x.xx)
$SB_{current}/SB_0$ (80% CI)	x.xx (x.xx–x.xx)
$B_{current}/B_{0,\,F=0}$ (80% CI)	x.xx (x.xx–x.xx)
$SB_{current}/SB_{0,\,F=0}$ (80% CI)	x.xx (x.xx–x.xx)

Kobe II Strategy Matrix

The Commission has requested that Kobe II management strategy matrices be provided for all stock assessments by the species Working Parties, and for these to be included in the report of the SC:

S16: "*The Commission **NOTED** the provision by the SC of the Kobe II strategy matrix for bigeye tuna, skipjack tuna, yellowfin tuna and swordfish (IO and SWIO) and recognized that it is a useful and necessary tool for management. The Commission **REQUESTS** that such matrices shall be provided for all stock assessments by the species Working Parties, and for these to be included in the report of the SC in 2012 and all future reports*." (para. 33 of the S16 report).

Target reference points: Initial projections should be at a coarse level, i.e. current catch levels, ± 10%, ± 20%, ± 30% and ± 40% (see example 2 below). However, once these initial projections have been run, finer scale projections (e.g. ± 5%) should be undertaken and included in the assessment paper that are related to possible management actions being investigated.

Limit reference points: Initial projections for limit reference points should be at a coarse level, i.e. current catch levels, ± 10%, ± 20%, ± 30% and ± 40% (see example 2 below). However, once these initial projections have been run, finer scale projections (e.g. ± 5%) should be undertaken and included in the assessment paper that are related to possible management actions being investigated.

EXAMPLE 2: Species: Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based reference points for nine constant catch projections (average catch level from YYYY–YYYY (xx,xxx t), ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from YYYY–YYYY) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60% (catch t)	**70%** (catch t)	**80%** (catch t)	**90%** (catch t)	**100%** (catch t)	**110%** (catch t)	**120%** (catch t)	**130%** (catch t)	**140%** (catch t)
$B_{2016} < B_{MSY}$	9	13	19	28	40	53	65	82	86
$F_{2016} > F_{MSY}$	3	6	30	56	81	91	98	99	100
$B_{2023} < B_{MSY}$	0	0	1	3	14	41	87	100	100

$F_{2023} > F_{MSY}$	0	0	5	67	92	98	99	100	100
Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from YYYY–YYYY) and probability (%) of violating MSY-based limit reference points (B_{lim} = 0.4 B_{MSY}; F_{Lim} = 1.4 F_{MSY})**								
	60% (catch t)	**70%** (catch t)	**80%** (catch t)	**90%** (catch t)	**100%** (catch t)	**110%** (catch t)	**120%** (catch t)	**130%** (catch t)	**140%** (catch t)
$B_{2016} < B_{Lim}$	4	6	8	14	20	23	40	45	65
$F_{2016} > F_{Lim}$	3	6	15	15	20	33	45	67	100
$B_{2023} < B_{Lim}$	0	0	0	6	24	26	49	74	100
$F_{2023} > F_{Lim}$	0	0	0	10	22	45	67	96	100

KOBE Plots

1) A KOBE plot must be provided with each stock assessment paper as requested by the Commission Some description describing the axes used (derived quantity, B_{MSY}, SB_{MSY}, F_{MSY}, C_{MSY}, etc). The plot trajectory should be described in recent years (Example 3).
2) Target and limit reference points should also be plotted.

As requested by the Commission and detailed in IOTC Recommendation 12/14 (para. 1):

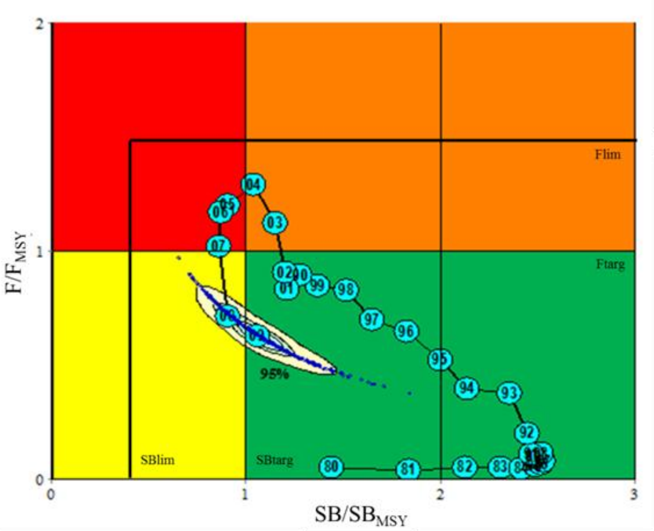
Para 1: *When assessing stock status and providing recommendations to the Commission, the Scientific Committee should apply the following interim target and limit reference points for the species of tuna and tuna-like species listed in* ***Table 1****.* B_{MSY} *refers to the biomass level for the stock that would produce the Maximum Sustainable Yield;* F_{MSY} *refers to the level of fishing mortality that produces the Maximum Sustainable Yield.*

Table 1. Interim target and limit reference points.

Stock	Target Reference Point	Limit Reference Point
Albacore tuna	B_{MSY}; F_{MSY}	40% of B_{MSY}; 40% above F_{MSY}
Bigeye tuna	B_{MSY}; F_{MSY}	50% of B_{MSY}; 30% above F_{MSY}
Skipjack tuna	B_{MSY}; F_{MSY}	40% of B_{MSY}; 50% above F_{MSY}
Yellowfin tuna	B_{MSY}; F_{MSY}	40% of B_{MSY}; 40% above F_{MSY}
Swordfish	B_{MSY}; F_{MSY}	40% of B_{MSY}; 40% above F_{MSY}

If a stock assessment is undertaken for a species other than those listed in IOTC Recommendation 12/14 (shown above) then the following default interim target and limit reference points shall be shown on the Kobe plot:

Stock	Target Reference Point	Limit Reference Point
Other IOTC species	B_{MSY}; F_{MSY}	50% of B_{MSY}; 20% above F_{MSY}



EXAMPLE 3: Species: Model Aggregated Indian Ocean assessment Kobe plot (95% Confidence surfaces shown around YYYY estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each

year YYYY–YYYY. Target (Ftarg and SBtarg) and limit (Flim and SBlim) reference points are shown to be 0.4 and 1.4 of SB_{MSY} and F_{MSY} respectively.

Deadlines for availability of data for stock assessments need to be adhered to:

As **AGREED** by the Scientific Committee in 2011:

1) 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.
2) 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.

Issues related to Data Quality and stock status advice

In addition the following statements will be made with regard to data quality:

The assessment was based on TRADITIONAL/DATA POOR stock assessment based approaches. This statement will clarify the following:

TRADITIONAL: Approaches using standard catch per unit effort (CPUE) data and age-length information with possible additional tagging data.

DATA POOR: Using catch based methods using depletion based assumption type models like Stock Reduction Analysis (SRA).

Note, in cases where stock status advice is made using **only** a data poor approach, a clarification that the methods used to determine stock status use data poor techniques and this should not have the same status as the traditional (data rich approaches).

EXAMPLE 4: Differentiation in stock status advice from Data poor versus traditional approaches

* Data poor stock assessment only. Status should be interpreted with caution due to the high levels of uncertainty. Further testing of how sensitive this technique is to model assumptions and available time series of catches, as well as the trialling of an alternative stock assessment approach needs to be undertaken before stock status can be used for management action; n.a. = not available

Stock Status Advice with multiple runs analysed

In cases where stock status advice would be based on numerous runs analysed, the weight of each run needs to be incorporated in reporting the final results. Some minimal criteria on the overall set of runs examined needs to be incorporated. The following advice could be given:

1) Either a statement quantifying the probability (number of runs/overall runs analysed with weights to each scenario) of being in the green quadrant, red quadrant, yellow quadrant or orange quadrant.
OR
2) A table in same format as Kobe showing these probabilities of being in each quadrant (shown below, Example 5)

EXAMPLE 5: Percentage of times the stock status is in respective quadrant of the Kobe plot (shown below)

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)	**5%**	**25%**
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)	**10%**	**60%**
Not assessed/Uncertain		

Biological Data (in an Appendix or part of the executive summary):

A reference to biological data needs to be made and this will be in the executive summary following the stock status as an appendix/part of the information that goes along with the stock status. An example of this is shown below:

EXAMPLE 6 (which goes into information in executive summary as either in Appendix or in the main body): Model parameters agreed to by the WPTmT for use in base case stock assessment.

Biological parameters	Value for assessments
Stock structure	Single
Sex ratio	1:1
Age (longevity)	15+ years
Natural mortality	M=0.2207 (/year) constant over ages[1] (or M=0.4 for immature and 0.22 for mature fish). Hybrid approach was recommended of M-0.4 for juveniles that declines to M=0.22 for adult (age 5). M. Pacific values of M=0.3 were also appropriate for examining.
Growth formula	$L(t)=124.10\ [1-e^{-0.164\ (t+2.2390)}]$; Well et al (2013) (N. Pacific)[2] Chen et al. (2012) Sex based growth curve
Weight-length allometry	$W=aL^b$ $a=1.3718 \times 10^{-5}$, b=3.0973 common to sex[3]
Maturity	Age (0-15):0, 0, 0, 0, 0.09, 0.47, 0.75, 0.88, 0.94, 0.97, 0.99, 0.99, 1, 1, 1 Farley et al (2012) (S. Pacific)
Fecundity	Proportional to the spawning biomass
Stock-recruitment	B&H, h=0.7, sigma_R=0.6 (alternative h=0.8, and 0.8 are also appropriate)
Other parameters	
Fisheries	7 (Jpn LL N & S, Twn LL N & S, DN, PS, Other)
Abundance indices	JPN, TWN,CHN, KOR (combined if available)
Selectivity	Fishery specific. Dome-shaped double-normal

[1] Lee and Liu 1992; [2] Well et. al. 2013 (Chen et. al. 2012 was also appropriate and sex specific); [3] Penny 1994

APPENDIX V
NATIONAL REPORT ABSTRACTS (2014)

Australia (IOTC–2014–SC17–NR01)
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) Area of Competence. In 2013, four Australian longliners from the Western Tuna and Billfish Fishery and zero longliners from the Eastern Tuna and Billfish Fishery operated in the IOTC Area of Competence. They caught 14.6 t of albacore (*Thunnus alalunga*), 90.6 t of bigeye tuna (*Thunnus obesus*), 40.5 t of yellowfin tuna (*Thunnus albacares*), 203.5 t of swordfish (*Xiphias gladius*) and 2.0 t of striped marlin (*Tetrapturus audax*). These catches represent approximately 11 per cent of the peak catches taken by Australian vessels fishing in the IOTC Area of Competence in 2001, for these five species combined. In addition, Australian vessels using minor line methods took a small amount of catch. 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 4495 t in 2013. A small amount of skipjack tuna (*Katsuwonus pelamis*) was caught by purse seine fishing (0.5 t). In 2013, approximately 1 t of shark was landed by the Australian longline fleet operating in the IOTC Area of Competence and 5893 sharks were discarded/released. There was no observer coverage in the IOTC Area of Competence in the 2013 calendar year. Observers were deployed in late 2012 and early 2014 so that observer coverage requirements were fulfilled for the 2012–13 and 2013–14 financial years.

Belize (IOTC–2014–SC17–NR02)
National Report not provided.

China (IOTC–2014–SC17–NR03 Rev_1)
Deep-frozen longline and ice fresh-longline are the only two fishing gears used by Chinese vessels to catch tuna and tuna-like species in the IOTC waters. The number of active deep-frozen longline vessels increased from 10 in 2011 to 31 in 2013, while the number of ice-fresh longline vessels kept at five. Chinese longline fleet caught 5233 MT of tropical tunas (BET and YFT) in 2013, which is higher than the catch in 2012(2943 MT). The albacore tuna catch in 2013 was 1011 MT, which is lower than the catch in 2012 (1835 MT). Implementation of both the logbook and observer programs is going on for the Chinese longline fleet in the Indian Ocean. Catch and effort data collection of bycatch species have been improved. One scientific observer was dispatched in 2013 and the trip report has been submitted.

Comoros (IOTC–2014–SC17–NR04)
Fishing in Comoros is exclusively artisanal, and operated on 3-9 m motorized or non-motorized wooden or fiberglass, non-decked vessels. Comorian fisheries exploit mainly pelagic species (*Thunnus albacares, Katsuwonus pelamis, Thunnus alalunga, Istiophorus platypterus, Thunnus obesus, Euthynnus affinis*) and contribute entirely to the population's diet, while providing 55% of total jobs in the agricultural sector, i.e. about 8,000 fishermen. Troll line, drop line and a few nets targeting small pelagic species are the main fishing gears used. A trip lasts between one and seven days. Since February 2011, Comoros have implemented a data collection system at landing sites. The production for 2012 was estimated by this survey at 7,916 tones for all species combined, and around 4,584 tones of tunas for a total of 5,623 fishing crafts. There is no industrial fishing at national level. This fishing activity is operated by a foreign fleet under a Fishing Agreement. None of the catch of this fleet is unloaded nor transshipped within the country.

Eritrea (IOTC–2014–SC17–NR05)
National Report not provided.

European Union (IOTC–2014–SC17–NR06)
The fleet of the European Union operating in the waters of the Indian Ocean is composed of two main segments. The first is an offshore segment comprised of purse seine vessels targeting three tropical tuna species, of longline vessels targeting mainly swordfish with important bycatch of some species of pelagic sharks and of tuna-like species in the case of the longliners from La Réunion. The second is a coastal segment, comprised of vessels less than 12m long using longline and troll or handline and capturing large pelagic species and associated species using, for some of them, anchored fish aggregating devices as auxiliary fishing devices. In accordance with IOTC Resolution 10/02, Member flag States (Spain, France, Portugal and the UK) have submitted scientific data characterizing the activity of the fleet of the European Union which has, in 2013, fished in the IOTC area of competence, allowing the IOTC Scientific Committee to conduct its work. This report was difficult to compile, in relation to the issue of the Mayotte fleet.

Indeed, the report pertains to the year 2013, but the Mayotte fleet has moved under the mandate of the EU on January 1st, 2014. The authors have compiled the report from UE,France as follows:

- for statistics, they considered only the UE,France-flagged vessels; those registered in Mayotte are included in the France (territories) report;
- the data coming from the purse seiners observer programmes are included in both the UE,France and the France (territories) reports.

Catch data and interactions with seabirds and turtles as well as information on the EU artisanal fleet (Mayotte excluded) are also included in the national reports annexed to this report from the EU.

France (OT) (IOTC–2014–SC17–NR07)
The French Overseas Territories in the Indian Ocean include Mayotte –a Department since March 31st, 2011– and the Scattered islands that are attached to the administration of the French Southern and Antarctic Lands (TAAF). In January 2010, Mayotte established a marine park (MP) with a Management Board, which maritime boundaries are those of Mayotte's EEZ. A second marine park was established on February 22nd, 2012 (Decree No. 2012-245 of February 22nd, 2012): the MP of the Glorieuses, which is under the responsibility of the Scattered islands, and extends over the entire Glorieuses EEZ. The total catches in the Indian Ocean of the 5 French purse seiners registered in Mayotte amounted in 2013 to 26,000 tonnes, a 10% decrease compared to 2012 (29,000t) in spite of a similar total fishing effort. The observer program introduced in 2005 and discontinued in 2009 for security reasons, following the increase of Somali piracy, resumed in 2011 and continued in 2013, especially on the large purse seiners of the fleet, through a collaboration established with the TAAF. The global coverage rate is 13,6%. The coastal fishing fleet of Mayotte is composed of a large number of canoes and small boats –operating mainly handline fishing, trolling and net fishing– and of four small longliners (pelagic drifting longline) targeting mainly tuna and swordfish. Catches by longliners in the waters of Mayotte are increasing and estimated at 52 tonnes in 2011 and 67 tonnes in 2012. The implementation of a fisheries information system to collect, compile and process data from this fleet is planned for the end of 2014. – *see paper for full abstract*

Guinea (IOTC–2014–SC17–NR08)
National Report not provided.

India (IOTC–2014–SC17–NR09)
In India, fishing is an age-old practice, besides providing protein rich food and employment to more than 6 million fishermen, this sector provides export earnings of about 30,213.26 crores of rupees to the country. Marine fish landings of the country have increased from a modest of 0.5 million tonnes during 1950 to 3.44 million tonnes during 2013-14 (MOA, 2014). Major share of the fish landings in India, where a multi species, multi gear fishery exists is from the coastal fishery (Sajeevan and Nair, 2006). Neritic Tuna form a significant share of pelagic fishery and oceanic fishery is mainly consists of Tuna and Tuna like fishes. Tuna fishery in India consists of both targeted longliners and multipurpose coastal fishing fleets. India's tuna fishing fleet includes traditional, motorized and mechanised boats operating various traditional gears, small pole and line boats, small longliners and industrial longliners. Except the Industrial tuna long liners and pole and line boats other fishing fleets are aimed at multi species fishery. Tuna and allied resources also caught by these fleets as by-catch. The total production of tunas and tuna-like fishes, including neritic and oceanic tunas, billfishes and seerfishes during the year 2013 was192,777 tonnes against a total production of 179,625 tonnes during the year 2012(Premchand et al., 2013). An increase in the tuna landings by the oceanic fishery and decrease in the landings of coastal fishery sector was noticed during the year under report. Yellow Fin Tuna with 56.67% by weight to the total catch dominated the catches recorded in the oceanic resource survey conducted by the Fishery Survey of India in the EEZ indicates the abundance of the target fish in the Indian EEZ. 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). – *see paper for full abstract*

Indonesia (IOTC–2014–SC17–NR10)
For fisheries management purpose, Indonesian waters are divided into eleven Fisheries Management Areas (FMA). Three of them located within the IOTC area of competence, namely Fisheries management Areas (FMAs) 572 (Indian Ocean – West Sumatera), FMA 573 (South of Java – East Nusa Tenggara) and 571 (Malacca Strait and Andaman Sea). Because of the fish resources in the shore areas are indicated in overexploited so that some fishermen conducted the fishing in the offshore waters especially for catching large pelagic fishes such as tuna, skipjack, marlins etc. For fishing these resources, the fishers usually use tuna long line, purse seine and hand line. Long line is the main fishing gear type operated in those FMAs, was 1,282 vessels in 2014. The national catch of four main tuna species in 2013 was estimated 185,742 ton which composed of yellowfin tuna (61,380 t); bigeye tuna (34,259 t), skipjack tuna (90,103 t) and albacore (6,095 t). Port sampling and scientific observer programs are still continuing and conducted by

Research Institute for Tuna fisheries (RITF) Benoa. Recently ministerial regulation of MMAF no 01year 2013 concerning observer onboard for fishing and carrier vessel was issued, furthermore Database Sharing Systems for Fisheries Management which integrate a number of databases, including the licensing, logbook and VMS databaseshas recently launched by the Minister of Marine Affairs and Fisheries on 19 November 2013 in Jakarta.

Iran, Islamic Republic of (IOTC–2014–SC17–NR11)
Islamic Republic of Iran with vast resources in terms of 5800 km coastline (including coastal areas of the Persian Gulf Islands), 2700 km Length of continental coastline and 196000 km2 Shelf areas has the opportunity to access High Seas through Strait of Hurmoz. The long Iranian coastline about193 port and landing places with over 140 thousand fishermen which are involved is fishing activities and 11500 fishing crafts consist of fishing boat, dhows and vessel which are engaged in fishing in the coastal and offshore waters. Gillnet and purse seine are two main fishing methods used by Iranian vessels to target large pelagic species (especially tuna and tuna-like) in the IOTC area competency and also some of small boats used trolling in coastal fisheries. The total production of large pelagic fishes during 2013 was 239600 Mt which 210000Mt belongs to tuna and tuna-like fishes in the Indian Ocean areas. Those catch consist of Big eye tuna 1649Mt,Yellowfin tuna 32403 Mt, Longtail tuna 66572Mt, Skipjack 33327Mt, Frigate tuna 6827Mt, Kawakawa 28764Mt, Indo-pacific king mackerel 5752Mt, Narrow- barred Spanish mackerel 20021Mt and Billfish 14280Mt. 95.3% of catch comes from Gillnet gear, while around 2.5% of catch belong to Purse seiners and 2.2% comes from Trolling vessels. Iran has taken various actions to implement the Scientific Committee recommendations and IOTC Resolutions. One of the notable approaches in our country in the field of tuna fishery is how to fulfill the IOTC regulations and adapting it with national implementing condition and complying with the IOTC approvals. Some of actions taken by Iran are improving data collection system by completing of AMAR software to meet IOTC demanded outputs with a suitable reporting for tuna fishery and bycatch during 2013. It is noteworthy to say that we could identify and include billfish and sharks catch by purse seiners and gillnet fleets in our data base and reported to the IOTC Secretariat.

Japan (IOTC–2014–SC17–NR12)
This Japanese national report describes following 8 issues in recent five years (2010-2014), 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 program”, “port sampling program” and “unloading and transshipment”, (6) national research programs and (7) Implementation of Scientific Committee recommendations & resolutions of the IOTC relevant to the Scientific Committee and (8) working documents.

Kenya (IOTC–2014–SC17–NR13)
The Kenyan tuna fishing fleet structure consists of an artisanal commercial segment and recreational fleets which all combined target and impact species under the IOTC mandate. The commercial artisanal fishing fleet is composed of a multi-gear and multi- species fleet operating in the territorial waters. The local boats are broadly categorized as outrigger boats or dhows which come with variants depending on the construction designs. It is estimated that 850 artisanal vessels are engaged in the fishing for tuna and tuna like species in 2013 within the coastal waters. The Main gears used are artisanal long line hooks, gillnets, monofilament nets and artisanal trolling lines. . Catches from artisanl tuna fisheries increased from 201 to 314 tons. Other important species landed were sailfish 140 tons, and Spanish mackerel 168 tons respectively .Catches for tuna are not distinguished to distinct species groups because of identification problems with the data collectors. Recreational fisheries are an important component of the Kenyan fishing fleet landing about 138 tons in 2014. The main target species being marlins, sailfish (Istiophiridae), swordfish (Xiiphidae) and tuna (Scombridae).Other species caught include small pelagic species such as barracuda, Spanish mackerel, Wahoo and sharks are landed. The artisanal fisheries and recreational fishing fleets have interactions with sharks where sharks are caught and the carcass is retained and fully utilised in artisanal fisheries and recreational trolling line fisheries have a voluntary shark release policy for sharks.

Korea, Republic of (IOTC–2014–SC17–NR14)

Korea has two type of fishing gears which are lonline fishery and purse seine fishery in the Indian Ocean. Korean tuna longline fishery in the Indian Ocean commenced in 1957. The number of active vessels in 2013 was 9 for longline fishery and 4 for purse seine fishery. With this fishing capacity, Korean tuna longline fishery caught 2,437 mt in 2013, which was 7% lower than that of 2012. The fishing efforts in 2013 were 5,430 thousand hooks and distributed higher in the western and eastern areas around 20°S-40°S, while the fishing efforts averaged for 5 recent years (2009-2013) were 6,396 thousand hooks and distributed in the tropical areas around 20°N-20°S as well as in the western and eastern areas around 20°S-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 tuna became important in catch. Korean tuna purse seine fishery in the Indian Ocean commenced in 2012 and recorded about 12 thousand mt in 2013. In 2013, 4 purse seine vessels operated mainly in the western and central tropical areas around 5°N-10°S to fish skipjack tuna and yellowfin tuna. The fishing efforts in 2013 were 724 sets, which mainly distributed in the tropical areas around 50°E-70°E. In 2013, 2 scientific observers for longline fishery and 1 scientific observer for purse seine fishery were dispatched on board for implementing observer program and scientific data collection, which carried out 10.1% and 6.2% of observer coverage in terms of the number of hooks and sets, respectively.

Madagascar (IOTC–2014–SC17–NR15)
National tuna fishing is operated mainly by small longliners under 24m LOA. The number of vessels in this fishery has gradually increased in the eastern part of Malagasy waters since its development in 2007. In 2013, there were 8 such vessels with a license to fish tuna and tuna-like species. Since 2010, they have been operating on the eastern side of Madagascar. It should be noted that these vessels make relatively short trips in order to maintain tuna and tuna-like species fresh on ice. In terms of production, the unloaded catch reported by the three companies licensed to fish tuna and tuna-like species has slightly decreased over the last three years, in spite of the increase in the number of fishing vessels. So far, there is no explanation to this situation, given that many uncertainties are still to be clarified, especially since logbook collection at unloading sites hasn't been implemented yet. The only geographical data available come from the VMS (Vessel Monitoring System) and the observer program. Fishing vessels licensed to catch demersal fish can also incidentally interact with some IOTC species, in particular neritic species. These are handline, longline and multipurpose vessels operating in the benthic area of the western and eastern part of Madagascar's EEZ (Exclusive Economic Zone). The traditional tuna fishery is still largely unknown in Madagascar. Joint efforts by the fisheries administration and its partners have recently been developed to highlight the ins and outs of this fishery.

Malaysia (IOTC–2014–SC17–NR16)
In 2013 tuna catches contributed about 4% of total marine finfish in Malaysia. For neritic tuna, in the west coast of Peninsular Malaysia, two species dominated the catches, longtail and kawakawa and they were mainly caught by purse seine and trawl nets. The landing of neritic tuna in 2013 from the west coast of Peninsular Malaysia (Malacca Straits) showed a decrease in catches by 34% from 2012, where kawakawa showed 44.3% of the reduction in catches and records catch in 2012 and 2013 were from 23,738 tons and 17,635 tons respectively. The catch of oceanic tuna in 2013 also decreased significantly by 143% from 978.8 tons in 2012 to 402 tons in 2013. Albacore showed most apparent reduction from 681.8 tons in 2012 to only 107.5 tons in 2013. The fleet which only consisted of 5 fishing vessels and one carrier, unloaded and exported the catches at the Port Louis, Mauritius. Albacore tuna formed nearly 70% of the catches in the form of frozen tuna. On observer program, it will only be implemented accordingly when the size of Malaysian fleet increase to 20 units. However, for domestic vessels operating beyond 30 nm offshore, there are plan by the DoF to implement observer on board and logbook system. The revised NPOA-Sharks is already complete and gazetted and will be published by end of 2014. On sea turtle, 2 sanctuary and information centres have regularly implementing awareness program for student and fishermen communities. Hatching program at these centres managed to release over 65,000 baby turtles back to the sea. There are several research programs on sea turtle been carried out at different areas in Malaysian waters and the ongoing projects are c-hook and satellite tracking.

Maldives (IOTC–2014–SC17–NR17)
The Maldivian tuna fishery comprises of four components; pole-and-line, handline, longlining and trolling. The most important is the traditional liveabait pole-and-line fishery. The fishery was certified by the Marine Stewardship Council (MSC) in November 2012. The main target species is skipjack tuna (*Katsuwonus pelamis*), but small amounts (~15-17%) of juvenile yellowfin tuna (*Thunnus albacares*) are also caught in the fishery of which about 5-10% is bigeye tuna (Thunnus obesus). Handline fishery is still expanding and targets surface dwelling large yellowfin tuna (> 70 cm FL). A Maldivian longline fishery is being developed following the termination of the licensing scheme for foreign longliners in 2010. Trolling fishery is minor and targets mainly neritic species of kawakawa (Euthynnus affinis) and frigate tuna (Auxis thazard), but occasionally also catches skipjack and yellowfin tuna. Catches of skipjack registered an increases in 2013 following declining catches from an all-time high of around 140,000 t in 2006. Recent catches have been of the order of 60,000 – 75,000 t, still much less recorded catch in 2006. Caches of

yellowfin are increasing, due to the growing handline fishery. No specialized vessel is required for handline fishing hence many pole-and-line vessels now carry both sets of gears and switch target fishery and gear depending on fishing opportunities. Many also practice multi- day switching them opportunistically. Most recent catches of the yellowfin are around 50,000 t and about 60% of the catch is from handline fishery. The national data collection was based on an enumeration system, which is now replaced by a modern logbook data collection system. A web-enabled database will become online by the end of this year to allow compilation and processing of catch and effort data. The web-enabled database will also be used to record tuna purchases by the exporters. The database when fully functional will help maintain records of active fishing vessel and fishing licenses. – *see paper for full abstract*

Mauritius (IOTC–2014–SC17–NR18)
Mauritius is an important hub in this part of the Indian Ocean for tuna fishing vessels, particularly for longliners. In addition, Mauritius benefits from a large EEZ (1.9 Million km2) and it attracts a considerable number of Asian and European fishing vessels which take up fishing licences. In 2013, 94 foreign longliners and 37 purse seiners were issued licences to fish for tuna and tuna-like species in the EEZ of Mauritius. During 2013, there was a total of 831 calls of .fishing vessels at Port Louis out of which 744 calls were for unloading and transhipment of tuna fishing vessels. 52,668 tonnes of tuna were transshipped. The Mauritian tuna longline fleet consisted of 3 semi-industrial longline fishing vessels less than 24 Metres in length. These vessels landed 68 tonnes of chilled fish with a total effort of 648,640 hooks. These vessels target swordfish (41.7%) but also landed by-catch comprising yellowfin (*Thunnus albacares*, 16.6%), bigeye (*Thunnus obesus*, 25.3%), albacore (*Thunnus alalunga*, 9.1 %) tunas, and billfishes (3%). No encounter with seabirds and marine turtles were noted. The fishing areas were spread between latitudes 16°S and 20°S and longitudes 56°E and 61°E. A small amount (0.68 tonne) of shortfin mako shark (Isurus oxyrhinchus) was landed by the longliners. However, 2624 tonnes of sharks consisting mainly of blue shark (*Prionace glauca*, 79%) followed by shortfin mako shark (16.9%) were landed for transhipment by foreign longliners during 2013. One Mauritius-flagged purse seiner started operations in the September 2013. The fishing areas were spread between latitudes 0o to 8o S and longitudes 35oE and 69oE. The total catch landed by the purse seiner was 855 tonnes with an effort of 77 sets. The majority of the catch comprised of skipjack tuna (55.7 %), followed by yellowfin tuna (41.2%) and bigeye tuna (3.2%).

Mozambique (IOTC–2014–SC17–NR19)
The main tuna industrial fishery in Mozambique is operated by foreign distant water fishing fleets. Between 2005 and 2010, to this industry, the Ministry of Fisheries has issued annually, an average of 125 licenses (44 purse seiner and 81 long liners). From 2011 to date, the number of foreign vessels licensed to fish for Tuna in Mozambique EEZ from 12 nautical miles offshore has been decreasing. Purse seiner fishing occurs mainly between the parallels 10o 32' and 20o south while the long-liner fishing occurs between 20o and 26o 52' south with particular intensity below parallel 25o south. The recent official information, reports an annual catch ranging from 1,000 tons to 17,500 tons, with annual average between 5,000 to 7,000 tons. However, recent statistics particularly deposited on IOTC indicate that the real catch from Mozambican waters is close to 20,000 tons per year. This scenario clearly indicates some mistakes in reporting the catches which was explained by the wrong line border limit leading to miss reporting of Mozambican catches until June 2012. Apart from the more accurate and better structured information stated above, Mozambique has one industrial longliner which operated for two years 2011 and 2012, targeting tuna and tuna-like species. The artisanal, sport and recreational fisheries coming from very long time, along the coast with some impact in the tuna and tuna-like species. The semi-industrial linefishery exits prior to 1990 and impacts on Spanish mackerel. The average catch of the two years of operation of the industrial longliner vessel was 240 tons and the picture from the artisanal, semi-industrial linefishery, sport and recreational fisheries together, appoint to 1765 tons in 2013. The estimates from artisanal, sport and recreational fisheries can be considered incomplete taking into account that gathering of data on catch from these fisheries is actually a challenge for…. – *see paper for full abstract*

Oman (IOTC–2014–SC17–NR20)
The total production of the Omani fishery sector amounted to around 206,000 Tons in 2013, with a slight increase of approximately 7.7% compared to 2012. Tuna species, considered as highly valuable products for Omani consumers, have experienced tremendous fluctuations in their total annual production and decreasing from 5501T in 2012 to 2172T in 2013. This fluctuation of coastal tuna activities finds probably its origin, among others, in the modification of environmental factors, predator- prey relationship, spawning problems (Dr. Al Qu mi, 2011) and the actual reduction of the industrial pelagic fleet. In the industrial fleet ,the number of vessels decreased from 10 vessels in 2011 to 5 vessels in 2013. This reduction in the industrial fishing capacity was initiated by the national Authorities for the purpose of restructuring the industrial fishing sector to improve its competitiveness and efficiency. Artisanal and coastal fleets have, however, increased massively in the number of vessels and fishermen. For the monitoring aspects of the Tuna fishery, the Omani Government has introduced the logbook data collection scheme, the Vessel Monitoring System (VMS) and Port Sampling Program (PSP), observer programme (underdevelopment) and a scheme to enhance

the quality of data gathered in order to manage and sustain efficiently the Omani fisheries. At the same time, the Government started to run and monitor several other projects for other marine species such as sea birds and marine turtles but are still in their starting stages.

Pakistan (IOTC–2014–SC17–NR21)
National Report not provided.

Philippines (IOTC–2014–SC17–NR22)
The Philippine fleet authorized to conduct fishing activities in the Indian Ocean is composed of both purse seine and longline fishing vessels. However, for the year 2013, the active fishing vessels are only longline fishing vessels. The number and list of active vessels were submitted to the IOTC in compliance to Resolution 10/08 on February 10, 2014. These are Jetmark No. 101, San Carlos No. 18, Sun Warm No. 8, Castro No. 168, Jetmark No. 102, Jetmark No. 726, Boada No. 5, Castro No. 668, and Marigold 2. Philippine tuna fishing fleet. Tuna fisherfolks uses various types of fishing boats ranging from traditional dugout which are propelled by wooden paddles to large steel hulled vessels which are fully equipped with modern fishing equipment for long distance fishing. Traditional boats represent the municipal fishing sector with vessels less than 3 GT in size. Their management and regulation are in accordance to the jurisdiction of the Local Government Units (LGUs) though national legislation also govern their operations. The latter comprises the commercial sector with vessels (> 3GT) which are required to fish outside municipal waters [beyond 15km off the shoreline] and are required to secure commercial fishing vessel and gear license (CFVGL) from the Bureau of Fisheries and Aquatic Resources which is subject to renewal every three (3) years. With the implementation of RA 9379 or the Handline Fishing Law, this gives a separate category for the handline vessels which were formerly considered under the municipal fishing vessels.

Seychelles (IOTC–2014–SC17–NR23)
The Seychelles purse seine fleet which consisted of eight purse seiners for the previous 3 years, was reduced to 7 vessels in 2013 whilst the number of supply vessels increased from 3 to 4. In general nominal effort has been on a downward trend over the past 5 years, and it further declined by 324 days (15%) in 2013, which can be attributed to the drop in the number of purse seine vessel. The total annual catch reported by the purse seine fleet decreased by 33% between 2010 and 2012. However despite the drop in fishing effort the total annual catch increased by 13% from 50, 938 MT in 2012 to 57,324 MT in 2013. Catch rate increased by 7.81 MT/Fishing day to reach 31.69MT/Fishing day in 2013 compared to 23.88 MT/Fishing day in 2012. Even though yellowfin tuna was the dominant species caught making up 46% of the total catch in 2013, it experienced a slight decline of 4% from 2012, whilst skipjack tuna catch increased by 32 %. Two more fishing vessels joined the Seychelles Industrial longline fleet in 2013 making a total of 32 vessels. The total catch reported by the industrial longline fleet for 2013 is estimated at 10,565 MT representing a 28% drop in catches, despite an 18% increase in fishing effort when compared to 2012. In term of species composition, bigeye tuna remained as the dominant species caught by this fleet for the past seven years, accounting for an average of 56% of the total catch, even though catches of this species decreased by 46% in 2013 when compared to 2012. The estimated catch rate decreased from 0.77 MT/1000 hooks in 2012, to reach 0.47 MT/1000 hooks which is at similar level to catch rate reported prior to 2012. – *see paper for full abstract*

Sierra Leone (IOTC–2014–SC17–NR24)
National Report not provided.

Somalia (IOTC–2014–SC17–NR25)
Somalia

Somalia is recovering from 22 years of civil war that left the countries without any working institution. Somalia is now rebuilding its administration and since August 2012, the Federal Government of Somalia was established in Mogadishu. Fishing grounds in front of Somalia are well known by tuna fishermen and have been traditionally fished by longliners and purse seiners. However, since 2007, activities in the region has been drastically declining due to the increasing piracy activities of the coastal of Somalia. Since the Federal government is in place, and with the help of the International Community, piracy has been declining, and fishing vessels are returning in the North West Indian Ocean. Somalia is committed to fully participate to the regional management of tuna and tuna-like species, and became the 32nd Member of IOTC on the 22nd May 2014. Somalia does not currently have a fishing fleet targeting tuna and tuna-like species, except a small artisanal coastal fleet. The newly established Federal Ministry of Fisheries and Marine Resources has not yet developed sampling programme and data collection systems for this fleet, however, it is working with funding agencies to develop such systems in the near future, which would allow Somalia to submit fisheries statistics to IOTC. Somalia has not yet licensed any foreign fishing vessels to fish for tuna and tuna-like species in its EEZ. However, a licensing system is being developed at the moment, and licenses could be issued soon.

In parallel, Somalia is working to develop Monitoring Control and Surveillance tools to monitor and control its EEZ. Somalia will work to increase its compliance with IOTC Conservation and Management Measures and fully participate to the IOTC process.

Sri Lanka (IOTC–2014–SC17–NR26)
The total catch of IOTC species in Sri Lanka for the year 2013, was 108,458 t, which shows a 1.2% increased than that of 2012. The Skipjack tuna (Katsuwonus pelamis) dominated the catch, and amounted to 52% (54,730t) while yellowfin tuna (Thunnus albacares) was the second most species representing 23% (23,991t) of the catch. A 5% drop of yellowfin tuna catch was noted than that of 2012. The bigeye tuna (Thunnus obsesus), catch was relatively low and accounted for 1.5% of the total catch. The billfish catch was 12% of the total IOTC sp. and 5% of it represented sword fish (Xiphias gladius). Three neritic tuna species; kawakawa (Euthennus affinis), bullet tuna (Auxis rochei) and frigate tuna (Auxis thazard) represented 11% of the catch. The by-catch was 3% of the total IOTC species and the main species caught were sharks and rays. The total shark catch was 1804t showing 0.7% reduction than that of 2012. Out of the 2463 authorized vessels, 2241 vessels were actively operated in the high seas in year 2013. More than 98% of these fishing vessels were between 10.2 - 15m LOA and fishing was manually operated. The gears used were mainly long line, gill net, gill net long line combination and ring net. Sri Lanka introduced 8 purse seiners in the latter part of 2013. Data collection and reporting system have been underwent several advancement. Log book has been progressively implemented while VMS and the on-board observer program were being in the process of testing and implementation will be in 2014. NPOA- IUU of Sri Lanka was prepared and published. The legal provision for high seas fishing was established under Fisheries and Aquatic Resources Act No. 35 of 2013. Capacity building program for enumerators and awareness for fishers to improve the data collection, reporting, legal systems have been continuously carried out during the year 2013.

Sudan (IOTC–2014–SC17–NR27)
National Report not provided.

Tanzania, United Republic of (IOTC–2014–SC17–NR27)
Presently the national fleet of Tanzania is mainly artisanal characterized by multi-species, multi-gear and multi-cultural fisheries. Most of the fishing takes place within 6 nm 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 hooks and 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. Furthermore two commercial Tanzania flagged longline vessels have been active in the EEZ of contracting parties as well as the high seas. Statistics from the Fisheries Departments (from both Zanzibar and the main land Tanzania) for the year 2013 for artisanal fishery indicates 4672, 2188, 5519 and 5753 tonnes of tuna, kingfish, Indian mackerel and sharks and rays were caught respectively. From the flagged vessels operating on IOTC area of competence, total catch for tuna and tuna like species was about 347 thousands tones. Recreational fishing data are missing and the available catch data from artisanal fishery is missing geographic position, type of gear and effort information. Log sheet data started to be collected since 2002 from all licensed vessels fishing in Tanzania EEZ and a Vessel Monitoring System (mainly for licensed vessels and flagged vessels) has been working since 2009. There has been neither Observer nor Port sampling programmes because Tanzanian Ports does not have facilities for handling commercial deep sea fishing vessels. No transhipment at sea is allowed within the EEZ of Tanzania. Currently, there is no major research programme for tuna and tuna like species. The only existing programmes are from universities and individuals from research institutes. Most of these programmes are focusing on identifying and marking potential fishing grounds on the EEZ, the target being reducing fishing pressure on shallow water habitats.

Thailand (IOTC–2014–SC17–NR29 Rev_1)
Neritic tuna and king mackerel species in the Andaman Sea Coast, Thailand comprise 7 species (*Thunnus tonggol*, *Euthynnus affinis*, *Auxis thazard*, *A. rochie*, *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 37,037 tons in 1998 to 8,670 tons in 2010. The production was quite stable around 11,889 and increase to 22,218 in 2011. 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. During 2009 to 2013, fishing operations were recorded 2,073 fishing days. The highest total catch was in 2010 with 607.69 tons followed by 2012, 2011, 2013 and 2009 respectively (470.41, 373.44, 307.74 and 295.22 tons). The highest CPUE was found in 2010 with 13.62 fish/1,000 hooks followed by 2012 and 2013, respectively (10.83 and 10.16 fish/1,000 hooks). Bigeye tuna and yellowfin tuna caught by number (and weight) were 24,126 fish (1,120.61 tons) and 10,531 fish (374.47 tons), respectively. The average percentage composition by number of the bigeye tuna

and yellowfin tuna were 45.17% and 19.72% and by weight 54.54% and 18.23%, respectively. The composition of bigeye tuna by fishing zones during 2009-2013 was the highest catch in the East Coast of Somalia (15,571 fish and 690.85 tons) and the lowest catch in Arabian Sea (86 fish and 3.70 tons). The composition of yellowfin tuna by zone during 2009-2013 was also the highest catch in the the East Coast of Somalia (5,527 fish and 190.62 tons) and the lowest catch in the Arabian Sea (84 fish and 3.07 tons). *- See paper for full abstract*

United Kingdom (OT) (IOTC–2014–SC17–NR30)
UK (OT) waters have been a Marine Protected Area (MPA) since April 2010. Diego Garcia and its territorial waters are excluded from the MPA and include a recreational fishery. UK (OT) does not operate a flag registry and has no commercial tuna fleet or fishing port. The United Kingdom (OT) National Report summarises fishing in its recreational fishery in 2013 and provides details of research activities undertaken within the MPA to date. The recreational fishery landed 11.92t of tuna and tuna like species on Diego Garcia in 2013. Principle target tuna species of the industrial fisheries (yellowfin, bigeye and skipjack tunas) contributed 31% of the total catch of tuna and tuna like species of the recreational fishery. Length frequency data were recorded for a sample of 248 yellowfin tuna from this fishery. The mean length was 80.6cm. Sharks caught in the recreational fishery are released alive. IUU fishing remains the greatest threat to the UK(OT) ecosystem and fisheries but a range of other threats exist including invasive and pest species, climate change, coastal change, disease, and pollution. During 2014 the UK(OT) Authority published its Interim conservation Management Framework setting out plans for environmental research, including those relevant to the pelagic ecosystem and IOTC fisheries. In 2014 Recommendations of the Scientific Committee and those translated into Resolutions of the Commission have been implemented as appropriate by the UK(OT) Authorities and are reported.

Vanuatu (IOTC–2014–SC17–NR31)
Vanuatu did not have any vessels operating in the Indian Ocean in 2013, thus this report for 2014, is for 2012. There was only longline fishery operated by Vanuatu in 2012 in the Indian Ocean. 2 longliners targeted the 2 major tuna species, yellowfin tuna and bigeye tuna with albacore tuna, shark, blue marlin and sword fish as the by-catch. Total catch of 2012 was estimated to be 347.584 mt, comprising of 146.280 mt for yellowfin, 90.862 mt for bigeye tuna, 6.421 mt for albacore tuna, 107 mt for shark, 8 mt for striped marlin, 28.741-mt forblue marlin and 43.763 mt for sword fish. These data were compiled from the logsheets that submitted by the vessels to the Vanuatu Department of Fisheries.

Yemen (IOTC–2014–SC17–NR32)
National Report not provided.

Djbouti (IOTC–2014–SC17–NR33)
National Report not provided.

Senegal (IOTC–2014–SC17–NR34)
National Report not provided.

South Africa, Republic of (IOTC–2014–SC17–NR35)
South Africa has two commercial fishing sectors which either target or catch tuna and tuna-like species as bycatch in the Indian Ocean, the swordfish/tuna longline and the pole and line/ rod and reel sector. The pole sector, which operates mainly in the Atlantic Ocean from September – May each year, only occasionally crosses over into the Indian Ocean in search of yellowfin tuna. In 2013, no tuna pole vessels fished in the Indian Ocean and instead targeted yellowfin available inshore in the Atlantic Ocean, or opted to fish for albacore on the Atlantic high seas. The South African flagged longline vessels have traditionally used swordfish (*Xiphias gladius*) targeting methods in the Indian and Atlantic Oceans, whilst the Japanese foreign flagged vessels target tropical tunas (yellowfin, *Thunnus albacares* and bigeye tuna, *Thunnus obesus*) with effort focused in the Indian Ocean. Although the local South African fleet targets swordfish, their catch comprises of only 50-60% swordfish, the remainder being tropical tunas and sharks (blue and mako sharks). Catches of albacore (bycatch in the longline sector), bigeye tuna, shortfin mako (*Isurus oxyrinchus*) and blue shark (*Prionace glauca*) remained relatively stable in 2013 compared to previous years. The southern bluefin tuna (*Thunnus maccoyii*) catches however decreased. South Africa's quota from CCSBT is minimal (40t) making this a non-target. It is concerning that swordfish catches remained low in the South West Indian Ocean. New vessels are encouraged to target swordfish yet the situation has not improved. Yellowfin tuna catches increased from 522t to 907t in 2013, an increase that is mirrored by the tuna pole sector operating in the Atlantic Ocean over the same time period. The necessity to conduct research into the stock origin and intermixing of tuna and swordfish populations at the boundary between the Atlantic and Indian Oceans is a research priority in South Africa.

APPENDIX VI
STATUS OF DEVELOPMENT AND IMPLEMENTATION OF NATIONAL PLANS OF ACTION (NPOA) FOR SHARKS AND SEABIRDS AND IMPLEMENTATION OF THE FAO GUIDELINES TO REDUCE MARINE TURTLE MORTALITY IN FISHING OPERATIONS: 2014

CPC	Sharks	Date of Implementation	Seabirds	Date of implementation	Marine turtles	Date of implementation	Comments
MEMBERS							
Australia		1st: April 2004 2nd: July 2012		1st: 1998 2nd: 2006 3rd: 2014		2003	**Sharks:** 2nd NPOA-Sharks (Shark-plan 2) was released in July 2012, along with an operational strategy for implementation: http://www.daff.gov.au/fisheries/environment/sharks/sharkplan2 **Seabirds:** Has implemented a Threat Abatement Plan [TAP] for the Incidental Catch (or Bycatch) of Seabirds During Oceanic Longline Fishing Operations since 1998. The present TAP took effect from 2014 and largely fulfills the role of an NPOA in terms of longline fisheries. http://www.antarctica.gov.au/__data/assets/pdf_file/0017/21509/Threat-Abatement-Plan-2014.pdf Australia is developing an NPOA to address the potential risk posed to seabirds by other fishing methods, including longline fishing in state and territory waters, which are not covered by the current threat abatement plan. **Marine turtles:** Australia's current marine turtle bycatch management and mitigation measures fulfill Australia's obligations under the FAO-Sea turtles Guidelines.
Belize							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
China		–		–			**Sharks:** Development has not begun. **Seabirds:** Development has not begun. **Marine turtles:** No information received by the Secretariat.
–Taiwan,China		1st: May 2006 2nd: May 2012		1st: May 2006 2nd: Jul 2014			**Sharks:** No revision currently planned. **Seabirds:** No revision currently planned. **Marine turtles:** Domestic laws introduced in 2013. Available on request.
Comoros		–		–			**Sharks:** Development has not begun. **Seabirds:** Development has not begun. **Marine turtles:** No information received by the Secretariat.
Eritrea							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
European Union		5 Feb 2009		16-Nov-2012		2007	**Sharks:** Approved on 05-Feb-2009 and it is currently being implemented. **Seabirds:** The EU adopted on Friday 16 November an Action Plan to address the problem of incidental catches of seabirds in fishing gears. **Marine turtles**: European Union Council Regulation (EC) No 520/2007 of 7 May 2007 lay down technical measures for the conservation of marine turtles including articles and provisions to reduce marine turtle bycatch. The regulation urges Member States to do their utmost to reduce the impact of fishing on sea turtles, in particular by applying the measures provided for in

							paragraphs 2, 3 and 4 of the resolution.
France (territories)		5 Feb 2009		2009, 2011		Pending: 2015	**Sharks:** Approved on 05-Feb-2009. **Seabirds:** Implemented in 2009 and 2011. 2009 for Barrau's petrel and 2011 for Amsterdam albatross. **Marine turtles:** To be implemented in 2015 for the five species of marine turtles that are present in the southwest Indian Ocean.
Guinea							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
India			n.a. (provisional)				**Sharks:** Currently being drafted with the assistance of BOBP-IGO **Seabirds:** India has determined that seabird interactions are not a problem for their fleets. However, a formal evaluation has not yet taken place which the WPEB and SC have approved. **Marine turtles:** No information received by the Secretariat.
Indonesia		–		–			**Sharks:** NPOA guidelines developed and released for public comment among stakeholders in 2010 (funded by ACIAR Australia—DGCF). Training commenced 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. **Marine turtles:** No information received by the Secretariat.
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. i.e. no longline vessels. **Marine turtles:** No information received by the Secretariat.
Japan		03-Dec-2009		03-Dec-2009			**Sharks:** NPOA–Shark assessment implementation report submitted to COFI in July 2012 **Seabirds:** NPOA–Seabird implementation report submitted to COFI in July 2012. **Marine turtles:** No information received by the Secretariat.
Kenya			n.a.	–			**Sharks:** A National Plan of Action for sharks is being developed and shall put in place a framework to ensure the conservation and management of sharks and their long-term sustainable use in Kenya. A shark assessment Report shall be developed by the end of the 2015 calendar year. **Seabirds:** Kenya does not have any flagged longline vessels on its registry. There is no evidence of any gear seabird interaction with the current fishing fleet. Kenya does not therefore consider developing NPOA seabirds as necessary for the time being. **Marine turtles:** The Kenyan fisheries law prohibits retention and landing of turtles caught incidentally in fishing operations. Public awareness efforts are conducted for artisanal gillnet and artisanal longline fishing fleets on the mitigations measures that enhance marine turtle conservation.
Korea, Republic of		08-Aug-11		–		–	**Sharks:** Currently being implemented. **Seabirds:** Drafted in January 2014 and on standby for approval by the minister. **Marine turtles:** All Rep. of Korea vessels fully implement Res 12/04.

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. **Marine turtles:** No information received by the Secretariat.
Malaysia		2008	n.a.	–		2008	**Sharks:** A review of the NPOA-Shark (2008) is in the final stages, with stakeholder consultation due to be completed in September 2013. A revised NPOA-Sharks is expected to be published by the end of 2013. **Seabirds:** Malaysia has carried out a review and determined that an NPOA-Seabirds is not necessary as no longline vessels flagged to Malaysia fish south of 20 degrees south. **Marine turtles:** A NPOA For Conservation and Management of Sea Turtles had been published in 2008.
Maldives, Republic of		–	n.a.	–			**Sharks:** Maldives has developed the NPOA-Sharks with the assistance of Bay of Bengal Large Marine Ecosystem (BoBLME) Project. A stakeholder consultation for the NPOA-Sharks was held in April of 2014. The NPOA-Sharks is in the finalization process and is expected to be published in November of 2014. The longline logbooks ensure the collection of shark bycatch data to genus level. Maldives would be reporting on shark bycatch to the appropriate technical Working Party meetings of IOTC. **Seabirds:** Article 12 of IPOA states that if a 'problem exists' CPCs adopt an NPOA. IOTC Resolution 05/09 suggests CPCs to report on seabirds to the IOTC Scientific Committee if the issue is appropriate'. Maldives considers that seabirds are not an issue in the Maldives fisheries, both in the pole-and-line fishery and in the longline fishery. The new longline fishing regulations has provision on mitigation measures on seabird bycatch. **Marine turtles:** Longline regulation has provisions to reduce marine turtle bycatch. The regulation urges longline vessels to have dehookers for removal of hook and a line cutter on board, to release the caught marine turtles as prescribed in Resolution 12/04.
Mauritius							**Sharks:** Mauritius does not issue national or foreign fishing licence to vessels targeting sharks in its Exclusive Economic Zone. However, sharks are usually landed as bycatch. Mauritius will work in consultation with the IOTC Secretariat to prepare a simplified NPOA-sharks for Mauritius. **Seabirds:** Mauritius does not have national vessels operating beyond 25^0S. However, fishing companies have been requested to implement all mitigation measures as provided in the IOTC Resolutions. **Marine turtles:** Mauritius does not have national boats operating outside its EEZ. Moreover, marine turtles are protected by the national law. Fishing companies have been **requested** to carry line cutters and de-hookers in order to facilitate the appropriate handling and prompt release of marine turtles caught or entangled.
Mozambique		–		–			**Sharks**: Drafting of new legislation is in progress which considers the issues of shark conservation in licensing requirements. The SWIOFish project within the framework of the implementation of the Linefish Management Plan is going to finance the NPOA shark from 2015. Moreover, Mozambique has developed in 2014, the Terms and Conditions of Licensing for tuna fishing to

							be attached to fishing license. These contain all the measures for the conservation and management of tuna fisheries and include the aspects related to conservation of sharks, seabirds and marine turtles. **Seabirds**: Mozambique is regularly briefing the Masters of their fishing vessels on the mandatory requirement to report any seabird interaction with longliner fleet. **Marine turtles**: see above.
Oman, Sultanate of							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
Pakistan							**Sharks:** Sharks are landed with the fins attached and each and every part of the body of sharks are utilised. A workshop on "Conservation and Management of Sharks was conducted on 15th September 2014. As per recommendations of the workshop, there is still a need for collection and synthesis of more compatible data to prepare Shark Assessment Report (SAR) / draft NPOA. PLAN: (i) October, 2014 to March 2015: Collection and synthesis of additional data. (ii) April, 2015 to June 2015: Preparation of SAR and draft NPOA. Circulation of draft NPOA to concerned stakeholders for comments. (iii) July, 2015 to September 2015: Holding workshop, presentations of draft NPOA / comments, recommendations and adoption of NPOA. **Seabirds:** Pakistan considers that seabird interactions are not a problem for Pakistani fishing fleet as our tuna fishing operations do not include longline vessels. **Marine turtles:** Pakistan has already framed Regulations regarding the prohibition of catching and retaining marine turtles. As regards to the reduction of marine turtle bycatch by gillnetters; presently Marine Fisheries Department (MFD) in collaboration with International Union for Conservation of Nature (IUCN) Pakistan, is undertaking an assessment. Stakeholder Coordination Committee Meeting was conducted on 10th September 2014. The "Turtle Assessment Report (TAR)" will be finalized by February 2015 and necessary guidelines / action plan will be finalized by June 2015. As per clause-5 (c) of Pakistan Fish Inspection & Quality Control Act, 1997, "Aquatic turtles, tortoises, snakes, mammals including dugongs, dolphins, porpoises and whales etc" are totally forbidden for export and domestic consumption.
Philippines		Sept. 2009		–			**Sharks:** Under periodic review. **Seabirds:** Development has not begun. No seabird interactions recorded. **Marine turtles:** No information received by the Secretariat.
Seychelles, Republic of		Apr-2007		–			**Sharks:** NPOA-sharks to currently being reviewed and a report will be provided for the next WPEB. **Seabirds:** Development has not begun. The industrial longline fleet of Seychelles has been instructed to conform with the requirements of Res. 12/06. **Marine turtles:** No plan developed as the moment.
Sierra Leone							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
Somalia							**Sharks:** Somalia is currently revising its fisheries legislation (current one being from 1985) and will consider the development of NPOAs as part of this

							revision process. **Seabirds:** See above. **Marine turtles:** See above.
Sri Lanka			n.a. (provisional)				**Sharks:** An NPOA-sharks has been finalized and is currently being implemented. **Seabirds:** Sri Lanka has determined that seabird interactions are not a problem for their fleets. However a formal review has not yet taken place which the WPEB and SC have approved. **Marine turtles:** Marine turtles are legally protected in Sri Lanka. In the longline fishery only circle hooks are used (J-hooks are banned). Gillnets longer than 2.5 km are now prohibited in domestic legislation on the high-seas. Reporting of bycath is facilitated via logbooks reserving a separated box.
Sudan							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** 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. **Marine turtles:** No information received by the Secretariat.
Thailand		23-Nov-2005		–			**Sharks:** Second NPOA-sharks currently being drafted. **Seabirds:** Development has not begun. **Marine turtles:** Not yet implemented.
United Kingdom	n.a.	–	n.a.	–		–	British Indian Ocean Territory (Chagos Archipelago) waters are a Marine Protected Area closed to fishing except recreational fishing in the 3nm territorial waters around Diego Garcia. Separate NPOAs have not been developed within this context. **Sharks/Seabirds:** For sharks, UK is the 24th signatory to the Convention on Migratory Species 'Memorandum of Understanding on the Conservation of Migratory Sharks' which extends the agreement to UK Overseas Territories including British Indian Ocean Territories; Section 7 (10) (e) of the *Fisheries (Conservation and Management) Ordinance* refers to recreational fishing and requires sharks to be released alive. No seabirds are caught in the recreational fishery. **Marine turtles:** No marine turtles are captured in the recreational fishery. A monitoring programme is taking place to assess the marine turtle population in UK (OT).
Vanuatu		Aug 2014					**Sharks:** Commenced in August 2014. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
Yemen							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
COOPERATING NON-CONTRACTING PARTIES							
Djibouti							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.

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. **Marine turtles:** No information received by the Secretariat.
South Africa, Republic of		–		2008			**Sharks:** The gazetting of the draft NPOA-sharks for public comment has been approved by the Minister of the Department of Agriculture, Forestry and Fisheries (6 July 2012). **Seabirds:** Published in August 2008 and fully implemented. The NPOA-seabirds has been earmarked for review. **Marine turtles:** No information received by the Secretariat.

Colour key	
Completed	
Drafting being finalised	
Drafting commenced	
Not begun	

APPENDIX VII
PROCESS FOR ASSESSING THE NEED FOR AN NPOA

The the IPOA-SHARKS is a voluntary instrument that applies to all States engaged in shark fisheries. The text sets out a set of activities which implementing States are expected to carry out, including an assessment of whether a problem exists with respect to sharks, adopting a National Plan of Action for the conservation and management of sharks (NPOA-SHARKS), as well as procedures for national reviews and reporting requirements. The calendar years by when these actions preferably should have been taken, are indicated.

The IPOA-SEABIRDS is a voluntary instrument that applies to all States engaged in longline fisheries. The text sets out a set of activities which implementing States are expected to carry out, including an assessment of whether a problem exists with respect to the incidental catch of seabirds in its longline fishery, adopting a National Plan of Action for reducing the incidental catch of seabirds in longline fisheries (NPOA-SEABIRDS) as well as procedures for national reviews and reporting requirements. The calendar years by when these actions preferably should have been taken, are indicated.

The process should require the following three elements 1) a scientifically-based approach to be taken; 2) to contain a requirement for the Precautionary approach, as adopted by the IOTC in Resolution 12/01 *On the implementation of the precautionary approach*; and 3) that the FAO guidelines concerning developments of NPOAs, which consider NPOAs-Seabirds as a voluntary initiative by each CPC.

The following process should be followed by CPCs when requesting the IOTC Secretariat apply a status of '*Not applicable (n.a.)*' for an NPOA, in the '*Table of progress in implementing NPOA-sharks, NPOA-seabirds and the FAO guidelines to reduce sea turtle mortality in fishing operations*', available on the IOTC website: http://iotc.org/science/table-progress-implementing-npoa-sharks-npoa-seabirds-and-fao-guidelines-reduce-sea-turtle-mortality

- Each CPC requesting a status of '*Not applicable (n.a.)*' for the development of an NPOA shall present the following to the WPEB:

  i. List of species of seabirds/sharks recorded in the area of fishing activities of the CPC;

  ii. Evidence (scientific surveys/research) that clearly indicate the level of interactions of seabirds/sharks with gears used in the CPCs fisheries targeting tuna and tuna-like species in the IOTC area of competence; such surveys should cover all seasons with multiple trips to ensure that relatively rare events such as seabird bycatch can be detected, and similarly should include a high degree of spatial coverage of fishing effort by gear type; where fishing effort overlaps with marine Important Bird and Biodiversity Areas (available at: http://54.247.127.44/marineIBAs/default.html), those areas should be prioritised for survey effort.

  iii. Application to WPEB to consider a recommendation to the Scientific Committee to apply a status of '*not applicable (n.a.)*' for the CPCs fisheries as having non-detrimental interactions with seabirds/sharks in the IOTC area of competence, and thus, an NPOA is not required at that point in time.

  iv. A plan of periodic review of the need for an NPOA by the CPC, including the calendar years when periodic review should be undertaken.

- The WPEB shall review (at its annual session) applications detailed in paragraph 1, and provide its advice to the Scientific Committee on whether it should 1) approve or reject the application; or 2) request additional supporting information from the CPC.

- The SC should consider the advice from the WPEB and either 1) accept or reject the advice relevant to the application; or 2) request additional supporting information from the CPC be provided to the WPEB for its consideration.

APPENDIX VIII
TERMS OF REFERENCE FOR AN AD HOC WORKING GROUP ON FISH AGGREGATING DEVICES (FADS)

1) The objectives of the ad hoc working group on Fish Aggregating devices (FADs) would be the following:
   - To collect and compile information about past and present numbers of buoys and FADs, changes in FAD-related technology and activities of supply vessels;
   - To review the requirements of collection of data on FADs established in Res 13/08 in order to assess the necessity for revision;
   - To assess the effect of FAD's density and spatial distribution on the behavior, distribution and species composition of the tuna schools;
   - To assess the developments in FAD-related technology notably with regards to:
     - changes in catchability due to technological improvement ;
     - using FAD and buoys marking and identification as a tool for monitoring, tracking and control of FADs.
     - reducing FAD's ecological impacts through improved design, such as non-entangling FADs and biodegradable material.
   - To evaluate ways to improve the use of information related to FADs in the process of stock assessment, particularly in the standardization of catch per unit effort, and in ecological risk assessment for non-target species;
   - Through an active exchange of views, to identify management options, including the regulation of deployment limits and characteristics of FADs, and activities of support vessels;
   - To assess the consequences of these management options, in conjunction with other fleets fishing mortality components, on IOTC-managed species and on the pelagic ecosystems.

2) All types of FADs, anchored or drifting, would be considered in the ad hoc working group.

3) As several coastal states with limited capacities are primarily concerned by anchored FADs, the IOTC Secretariat should ensure that special provisions be made for those countries in terms of compiling and assimilating the data as required for the ad hoc working group. This support could be included in the data collection tasks of the IOTC Secretariat.

4) The IOTC Secretariat should consider using the meeting participation fund (MPF) to facilitate the participation of scientists from IOTC coastal states who would contribute significantly in the FAD working group.

5) The access to data used for the FAD working group will follow the confidentiality policy and procedures presented in Resolution 12/02.

6) The ad hoc Working Group should be composed by scientists, fisheries managers, fishing industry Representatives, administrators and other interested stakeholders.

7) The ad hoc Working Group on FAD would not happen more than once a year, and shall report on its work to the WPTT and WPEB annual sessions.

8) The IOTC, at its annual session, will review the progress and outcomes of the FAD working group and will decide on the necessity for its continuation.

APPENDIX IX
TERMS OF REFERENCE: PROTOCOLS DEVELOPED FOR CPUE WORKSHOP AMONG LONGLINE FLEETS FOR TROPICAL TUNAS

The following ToR covers the most important issues that have been highlighted by different working parties. Work should be carried out, for those factors relevant to them, for the following:

- Fleets: Japan longline; Taiwan,China longline, Rep. of Korea longline
- Stocks: Bigeye tuna and yellowfin tuna

Background

Based on some key recommendations that came out of the CPUE Workshop held in San Sebastian, an inter-sessional meeting was recommended between Taiwan, China, Japan, Korea and China to understand why the CPUE series diverged for various temperate and tropical tuna in the Indian Ocean. The rationale or possible reasons for the divergence are taken directly from points 63 and 64 in the report (IOTC–WPCPUE-1 2013):

> "*Major reasons of discrepancies may be the different data processing methods by different scientists in Taiwan,China or fundamental differences in nominal catch between 2 fleets. We need to elucidate real causes of discrepancies, so that we may be able to utilize all STD_CPUEs in the future*".

> "*There may also be issues relating to different analytical approaches implemented by different analysts that may result in different CPUE indices for the same fleet. It was recommended that where significant differences arose between CPUE indices that the national analysts should collaborate to attempt to reconcile these differences. An initial starting point in a comparative analysis could include undertaking parallel analyses based on a core area of the fishery*".

One of the strongest recommendations made at the workshop by the participants was the following:

> *"In areas where CPUE's diverged the CPC's were encouraged to meet inter-sessional to resolve the differences. In addition, the major CPC's were encouraged to develop a combined CPUE from multiple fleets so it may capture the true abundance better. Approaches to possibly pursue are the following: i) Assess filtering approaches on data and whether they have an effect, ii) examine spatial resolution on fleets operating and whether this is the primary reason for differences, and iii) examine fleet efficiencies by area, iv) use operational data for the standardization, and v) have a meeting amongst all operational level data across all fleets to assess an approach where we may look at catch rates across the broad areas".*

In 2014, CPC's (Japan and Taiwan,China) worked inter-sessionally to deal with the issues identified in paragraph 63, above. Papers presented at the 16th IOTC Working Party of Tropical Tunas in Bali, Indonesia, demonstrated significant progress towards addressing the discrepancies, but the WPTT acknowledged the need for further work.

> *The WPTT NOTED the extensive work on addressing the recommendations made on longline catch rate standardisations at WPTT15. While much progress has been made, additional joint analysis of operational level data from Japan, Taiwan,China and Rep. of Korea longline fisheries is still needed.*

> *The WPTT NOTED the willingness for continuing this work on operational level data by scientists from Japan, Taiwan,China and Rep. of Korea, assisted by an invited expert and the IOTC Secretariat, with the intent of identifying the most appropriate method of standardising these data.*

> *The WPTT REQUESTED that the involved CPCs and Secretariat work to ensure that confidentiality concerns can be fully addressed and to seek the necessary funding to support the activity.*

> *The WPTT NOTED that considering the importance of this work for future yellowfin tuna and bigeye tuna stock assessments, ISSF would consider providing additional financial support for the activity as it already had in 2014.*

To address these concerns, a work plan with some protocols is defined below. These are meant to be guidelines and analysts could use these or some other measures to examine these effects.

Protocols

To assess why the CPUE's may diverge, and to identify improved methods for developing and selecting appropriate indices of abundance for Yellowfin and Bigeye Tuna. The following issues will be addressed:

High Priority

1) Conduct analyses to characterise the fisheries, including exploratory analyses of the data to develop understanding of factors likely to affect CPUE.
2) Assess filtering criteria used by the primary CPC's to test whether differences arise due to different ways of filtering the data, and rerunning the analysis with similar criteria.
3) Use the approach demonstrated by Hoyle and Okamoto (2011) in WCPFC to assess fleet efficiency by decade and then calibrate the signal to assess if we have similar trends by area.
4) Use approaches to determine targeting and then filter the data and reanalyze with respect to directed species for analysis.
5) Use operational level data in analyses of data for each fleet, and also in a joint meeting across the CPC's.

To support these analysis, consider alternative stock and fishery hypotheses (suggested by Campbell 2013 in review, see Appendix).

Budget and Location for the Inter-sessional meeting

To conduct analyses towards addressing the issues identified above and in the CPUE Workshop Report (IOTC–2013–WPCPUE–01), an estimated budget is provided in Table 1. Expected attendees include Japan, Rep. of Korea, and Taiwan,China, with the location to be decided. The consultant will work on Korean data in Korea for one to two weeks, followed by work in Taiwan,China on Taiwanese and Japanese data for 2 to 3 weeks. Following this, the consultant will return to reanalyse the data, and deliver a final report to the secretariat a month later where a a meeting between the CPC's of Japan, Taiwan,China, Rep. of Korea, China and the IOTC Secretariat will be held to discuss the findings of the analysis (after/before Commission meeting in April in Rep. of Korea/ Taiwan,China or Japan where the results will be discussed by the CPC's involved, and the secretariat).

TABLE 1. Estimated costs for an inter-sessional meeting to investigate CPUE standardisation from the main longline fleets operating in the IOTC area of competence

Description	Unit price	Units required	Total
Meeting venues across all CPC's	US$0	Hosts to provide	-
Travel (Invited Expert three countries 1 week at a time)+ 1 week for Final results	US$15,000	SA Consultant 1	15,000
Time Consultant	$500/day	50 days	25,000
Time SA Scientist (IOTC)	0 (as time donated)	10 days	0
Final Meeting with IOTC Secretariat and CPC (Travel for 3 staff scientists and IOTC Secretariat-Location TBD)		3 days + 1 day travel	$10,000
Total estimate (US$)			**$50,000**

Appendix: Stock and Fishery Hypothesis to examine (*Campbell, R. 2013 in review*)

Spatial-Temporal Hypothesis Concerning the Stock

- ***Option 1:***
  a) S1a: The spatial extent of the stock remains constant over time.
  b) S1b: The spatial extent of the stock can vary over time.
- ***Option 2:***
  a) S2a: The distribution of the stock remains constant over time, such that the proportional increase or decrease in the density of the stock between years is similar in all regions. (i.e. on average, the proportional change is independent of the density in a given region).

b) S2b: The distribution of the stock changes over time, such that the proportional increase or decrease in the density of the stock between years can vary between regions. (i.e. on average, the proportional change is a function of the density in a given region, or other factors.)

- ***Option 3:***
  a) S3a: There is strong continuity in the spatial distribution of the stock over time.
  b) S3b: There is weak continuity in the spatial distribution of the stock over time.
- ***Option 4:***
  c) S4a: There is strong continuity in the spatial/temporal migration patterns of the stock over time.
  d) S4b. There is weak continuity in the spatial/temporal migration patterns of the stock over time.

Spatial-Temporal Hypotheses Concerning Fishing Effort

- ***Option 1:***
  a) E1a: On average the areas fished have a similar stock density to the areas not fished.
  b) E1b: On average, the areas fished have a greater stock density than the areas not fished.
- ***Option 2:***
  a) E2a: There are no management restrictions which limit the choice of areas which are available to the fishing fleets.
  b) E2b: There are management restrictions which limit the choice of areas which are available to the fishing fleets.
- ***Option 3:***
  a) E3a: There are no socio-economic restrictions which limit the choice of areas which are available to the fishing fleets.
  b) E3b: There are socio-economic restrictions which limit the choice of areas which are available to the fishing fleets.

APPENDIX X
TERMS OF REFERENCE: PROTOCOLS FOR DEVELOPING AN INDEX OF ABUNDANCE BASED ON PURSE SEINE SPECIES COMPOSITION

The following ToR proposes the development of an alternative approach to deriving an index of abundance for skipjack tuna, which avoids the problem of increasing fishing power that afflicts purse seine CPUE. Work should be carried out to assess and develop the potential of this new method to provide an index or indicator of relative abundance for skipjack tuna.

Background

Stock assessments rely heavily upon indices of abundance, and assessing the Indian Ocean skipjack tuna stock is made difficult by the lack of reliable long term index. An index based on the purse seine fishery is desirable, but purse seine CPUE is problematic because the unit of effort is difficult to define. This is because 1) fishing is divided between drifting logs/FADs and free school sets, in proportions that change with various other factors, and it is difficult to allocate a vessel's search effort among set types; 2) search is conducted by purse seiners, support vessels, and FADs (including through information provided by echo-sounders), making it more difficult to identify an appropriate unit of search effort; 3) technological change in many aspects of the fishery has dramatically increased fishing power through time; 4) fish aggregate around FADs, and vessels share information and follow the aggregations, so that the relationship between purse seine catch rates and abundance may be hyperstable.

An index of abundance for skipjack has been proposed based on purse seine species composition (Maunder and Hoyle 2007), which would avoid using the problematic unit of effort. It was considered by the 16th WPTT, which urged that the method be further evaluated.

> *The WPTT NOTED additional information presented on standardisation of species composition from purse seine catches which included a novel approach to addressing some of the difficulties with using purse seine CPUE.*
>
> *The WPTT URGED that that methodology be further evaluated and presented at future WPTT meetings.*
>
> *The WPTT NOTED that the approach showed a reduction in the proportion of skipjack tuna in recent years. However, this proportion will be affected with changes in the abundance of other species, in particular yellowfin tuna. To obtain an index of skipjack tuna abundance it is necessary to incorporate independent estimates of yellowfin tuna abundance of the appropriate size.*

To develop this approach, a work plan with some protocols is defined below. These are meant to be guidelines and analysts could use these or some other measures to examine these effects.

Data availability

The European and associated flags purse seine fishing activities have been monitored by the Institut de Recherche pour le Développement (IRD), the Instituto Espanol de Oceanografia (IEO) and the Seychelles Fishing Authority (SFA) in the Indian Ocean during 1981-2014 through the collection of logbook, well maps, and records of unloading and transhipment. A multispecies sampling has been implemented since the early 1980s and is considered to be consistent since 1991. It consists in a simultaneous sampling to estimate both size and species composition of the catch. The sampling is made during the unloading of the purse seiners at fishing ports and consists in a 2-step approach: (i) the wells are selected from among those containing homogeneous strata (i.e. large spatial areas, quarter and fishing mode) and (ii) fishes are randomly collected, within size category, from the wells and counted and/or measured following a specific protocol. Samples combined with species-specific length-weight relationships are then used to estimate the size and species composition of the catch in each stratum.

Operational fisheries data and size-frequency samples would be made available for the modelling approach under a confidentiality agreement between the Institutes and the IOTC.

Protocols

1) Obtain data inputs, which include set by set purse seine CPUE data, with detailed information describing the operational characteristics of each set; and stock assessment output files for bigeye and yellowfin tuna assessments using Stock Synthesis or MULTIFAN-CL.
2) Apply statistical methods to standardize the skipjack species composition data by accounting for operational factors such as location and time of set. Extract the temporal components.

3) Estimate the trend of skipjack relative abundance by adjusting the skipjack species composition time series according to the estimated abundance trends of yellowfin and bigeye tuna.
4) Validate the approach by applying the same method to yellowfin species composition.

Budget

To conduct analyses towards addressing the issues identified above, an estimated budget is provided in Table 1. The consultant will work for 5 weeks on purse seine data from the European Union, and the latest stock assessments for Indian Ocean bigeye and yellowfin tunas, and present the results at the 17th Working Party on Tropical Tunas.

TABLE 1: Estimated costs for a study of an index of abundance based on purse seine species composition

Description	Unit price	Units required	Total
Travel	US$5,000	SA Consultant	5,000
Time Consultant	$500/day	40 days	20,000
Time E. Chassot (IRD)	0 (time donated)	5 days	0
Time SA Scientist (IOTC)	0 (time donated)	5 days	0
Total estimate (US$)			**$25,000**

References

Maunder, Mark N., and Simon D. Hoyle. "A novel method to estimate relative abundance from purse-seine catch-per-set data using known abundance of another species." *Inter-Amer. Trop. Tuna Comm., Stock Assessment Report* 7 (2007): 283-297.

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

Group	Chair/Vice-Chair	Chair	CPC/Affiliation	1st Term commencement date	Term expiration date (End date is until replacement is elected)	Comments
SC	Chair	Dr Tsutomu Nishida	Japan	17–Dec–11	End of SC in 2015	2nd term
	Vice-Chair	Mr Jan Robinson	Seychelles	17–Dec–11	End of SC in 2015	2nd term
WPB	Chair	Dr Jerome Bourjea	EU,France	08–Jul–11	End of WPB in 2015	2nd term
	Vice-Chair	Dr Miguel Santos	EU,Portugal	08–Jul–11	End of WPB in 2015	2nd term
WPTmT	Chair	Dr Zang Geun Kim	Korea, Rep. of	22–Sep–11	End of WPTmT in 2016	2nd term
	Vice-Chair	Dr Takayuki Matsumoto	Japan	06–Sep–12	End of WPTmT in 2016	2nd term
WPTT	Chair	Dr Shiham Adam	Maldives, Rep. of	19–Nov–14	End of WPTT in 2016	1st term
	Vice-Chair	Dr Gorka Merino	EU,Spain	19–Nov–14	End of WPTT in 2016	1st term
WPEB	Chair	Dr Rui Coelho	EU,Portugal	16–Sept–13	End of WPEB in 2015	1st term
	Vice-Chair	Dr Evgeny Romanov	EU,France	27–Oct–11	End of WPEB in 2015	2nd term
WPNT	Chair	Dr Prathibha Rohit	India	27–Nov–11	End of WPNT in 2015	2nd term
	Vice-Chair	Dr Farhad Kaymaram	I.R. Iran	27–Nov–11	End of WPNT in 2015	2nd term
WPDCS	Chair	Dr Emmanuel Chassot	EU,France	30–Nov–13	End of WPDCS in 2015	1st term
	Vice-Chair	Mr Stephen Ndegwa	Kenya	12–Dec–14	End of WPDCS in 2016	1st term
WPM	Chair	Dr Iago Mosqueira	EU,Spain	18–Dec–11	End of WPM in 2015	2nd term
	Vice-Chair	Dr Toshihide Kitakado	Japan	18–Dec–11	End of WPM in 2015	2nd term
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 XII
EXECUTIVE SUMMARY: ALBACORE

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

Status of the Indian Ocean albacore (ALB: *Thunnus alalunga*) resource

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

Area[1]	Indicators – 2014 assessment			2014 stock status determination 2012[2]
Indian Ocean		SS3	ASPIC*	(green)
	Catch 2013:	38,297 t	38,297 t	
	Average catch 2008–2013:	37,525 t	37,525 t	
	MSY (1,000 t) (80% CI):	47.6 (26.7–78.8)	34.7 (28.8–37.4)	
	F_{MSY} (80% CI):	0.31 (0.21–0.42)	0.50 (n.a.)	
	SB_{MSY} (1,000 t) (80% CI):	39.2 (25.4–50.7)	68.6 (n.a.)	
	F_{2012}/F_{MSY} (80% CI):	0.69 (0.23–1.39)	0.94 (0.68–1.61)	
	SB_{2012}/SB_{MSY} (80% CI):	1.09 (0.34–2.20)	1.05 (0.73–1.35)	
	SB_{2012}/SB_{1950} (80% CI):	0.21 (0.11–0.33)	0.43 (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.
*Total Biomass (B)

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)	(red)	(orange)
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)	(yellow)	(green)
Not assessed/Uncertain	(grey)	

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. Trends in the Taiwan,China CPUE series suggest that the longline vulnerable biomass has declined to about 47% of the level observed in 1980–82. There were 20 years of moderate fishing before 1980, and the catch has more than doubled since 1980. Catches have increased substantially since 2007, attributed to the Indonesian and Taiwan,China longline fisheries although there is substantial uncertainty remaining on the catch estimates. It is considered that recent catches have been above the MSY level for one of the models (ASPIC) examined and approaching MSY levels for the other model (SS3). Fishing mortality represented as F_{2012}/F_{MSY} is between 0.70 (Median: SS3) and 0.94 (Point estimate: ASPIC). Biomass is considered to be at or very near to the SB_{MSY} level (SB_{2012}/SB_{MSY} = 1.09) from the SS3 model, and also for the B_{MSY} level (B_{2012}/B_{MSY} = 1.05) from the ASPIC model (Table 1, Fig. 1). Thus, stock status in relation to the Commission's B_{MSY} and F_{MSY} target reference points indicates that the stock is **not overfished** and **not subject to overfishing** (Table 1), although considerable uncertainty remains in the SS3 and ASPIC assessments, indicating that a precautionary approach to the management of albacore should be applied by reducing fishing mortality or capping total catch levels to those taken in 2012 (34,000 t; Table 2).

Outlook. Maintaining or increasing effort in the core albacore fishing grounds is likely to result in further declines in albacore 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 unless management action is taken. There is a high risk of exceeding MSY-based reference points by 2015 if catches increase further (above 2012 levels) (50% risk that $SB_{2015}<SB_{MSY}$, and 39% risk that $F_{2015}>F_{MSY}$ (Table 2).

The following should be noted:

- **Maximum Sustainable Yield (MSY)**: Current catches (38,297 t in 2013) are below the current estimated MSY levels from both models (Table 1). However, maintaining or increasing effort will likely result in further declines in biomass, productivity and CPUE.
- 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.
- The use of aggregated data versus fine-scale operational data in the CPUE standardisations by the main fleet (Taiwan,China) introduces substantial uncertainty.
- The preliminary catch estimates for 2013, as of 2014 WPTmT05 meeting (~43,000 t) are one of the highest catches on record, and may be a cause for concern for the long-term sustainability of the stock if it remains at these levels. Note, a preliminary ASPIC analysis accounting for the larger catches in 2013 indicated no change in stock status from 2012.
- A Kobe 2 Strategy matrix was calculated to quantify the risk of different future catch scenarios, using the projections from the SS3 model (Table 2). The projections indicated that there is a 50% chance of violating the biomass based reference point by 2015 if catches are maintain or increased up to 20% (i.e. below SB_{MSY}) (Table 2).
- **Provisional reference points:** Noting that the Commission in 2013 adopted Resolution 13/10 to *On interim target and limit reference points and a decision framework*, the following should be noted:
  - **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, and the provisional limit reference point of $1.4*F_{MSY}$ (Fig. 1).
  - **Biomass**: Current spawning biomass is considered to be near the target reference point of SB_{MSY}, and therefore above the limit reference point of $0.4*SB_{MSY}$ (Fig. 1).
- **Main fishing gear** (2009–13): Longline ≈93% (fresh ≈56.4%, Frozen ≈36.6%).
- **Main fleets**: Taiwan,China ≈36%; Indonesia ≈32%; Japan ≈9%; China ≈7%.

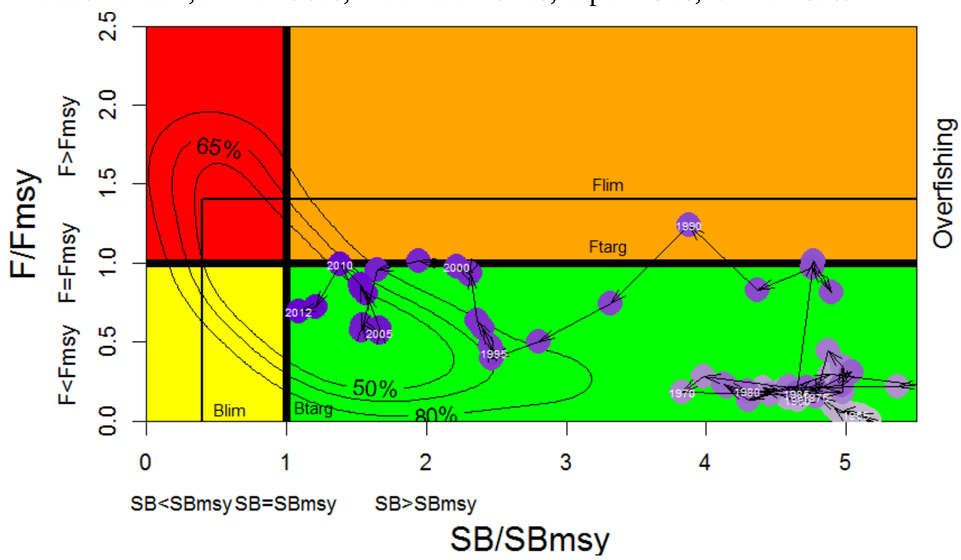


Fig. 1. Albacore: SS3 Aggregated Indian Ocean assessment Kobe plot (contours are the 50, 65 and 80 percentiles of the 2012 grid runs). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2012. Target (Ftarg and SBtarg) and limit (Flim and SBlim) reference points are shown.

TABLE 2. Albacore: SS3 aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target (top) and limit (bottom) reference points for nine constant catch projections (average catch level from 2011–013, ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2011–13) and probability (%) of violating MSY-based target reference points ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60% (22,084 t)	**70%** (25,764 t)	**80%** (29,445 t)	**90%** (33,125 t)	**100%** (36,806 t)	**110%** (40,487 t)	**120%** (44,167 t)	**130%** (47,848 t)	**140%** (51,528 t)
$SB_{2015} < SB_{MSY}$	31	33	39	42	50	50	50	53	61
$F_{2015} > F_{MSY}$	11	19	22	36	39	44	50	53	56
$SB_{2022} < SB_{MSY}$	11	19	22	33	39	44	47	53	56
$F_{2022} > F_{MSY}$	6	11	22	31	36	44	47	53	56

Reference point and projection timeframe	Alternative catch projections (relative to the average catch level from 2011–13) and probability (%) of violating MSY-based limit reference points ($SB_{lim} = 0.4\ B_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)								
	60% (22,084 t)	**70%** (25,764 t)	**80%** (29,445 t)	**90%** (33,125 t)	**100%** (36,806 t)	**110%** (40,487 t)	**120%** (44,167 t)	**130%** (47,848 t)	**140%** (51,528 t)
$SB_{2015} < SB_{Lim}$	0	0	6	8	17	22	28	33	33
$F_{2015} > F_{Lim}$	0	6	14	19	25	31	39	42	44
$SB_{2022} < SB_{Lim}$	0	6	14	19	28	33	36	42	47
$F_{2022} > F_{Lim}$	0	6	14	22	31	36	42	44	50

APPENDIX I

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 is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 14/05 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 13/09 *on the conservation of albacore caught in the IOTC area of competence*
- Resolution 12/11 *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 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Albacore: General

Overall, the biology of the 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 3 outlines some of the key life history traits of albacore specific to the Indian Ocean.

TABLE 3. Albacore: 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	10+ years
Maturity (50%)	**Age**: females 5–6 years; males 5–6 **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)	Reported to 128 cm FL in the Indonesian longline fishery $W = aL^b$ with $a = 5.691\times10^{-5}$, $b = 2.7514$.

n.a. = not available. Sources: Lee & Kuo 1988, Lee & Liu 1992, Lee & Yeh 2007, Froese & Pauly 2009, Xu & Tian 2011, Setyadji et al. 2012

Albacore – Catch trends

Albacore are currently caught almost exclusively using drifting longlines (over 90% of the total catches) (Table 4; Fig. 2), and South of 20°S (Table 5) with remaining catches recorded using purse seines and other gears. The catches increased markedly during the mid-1980's due to the use of drifting gillnets by Taiwan,China (Fig. 3), with total catches in excess of 30,000 t. The drifting gillnet fleet 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. Following the removal of the drifting gillnet fleets, catches dropped to less than 21,000 t by 1993 (Fig. 2). However, catches more than doubled over the period from 1993 (<21,000 t) to 2001 (46,000 t), the year in which the highest catches of albacore were reported. Since 2001, catches have been almost exclusively taken by drifting longlines. Catches for both 2011 and 2012 are estimated to be around 34,000 t (Table 4), 10,000 t lower than the catches recorded in 2010 (44,000 t) – the year in which the second highest catches were recorded. In 2013, catches are currently estimated at around 38,000 t. The majority of the catches of albacore are sold to international markets, mostly for canning. A component of the catches of albacore may not go for export, be sold in local markets or retained by the fishermen for direct consumption.

Catches of albacore in recent years have come almost exclusively from vessels flagged to Indonesia and Taiwan,China. The catches of albacore reported for the fresh tuna longline fishery of Indonesia have increased considerably since 2003, ranging between 8,000 t and 15,000 t in recent years, which represents approximately a third 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. Although 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 4,000 t.

In contrast to the Japanese longliners, catches by Taiwan,China deep-freezing longliners increased steadily from the 1950's to average around 10,000 t by the mid-1970s. Between 1998 and 2002 catches ranged between 20,000 t to 26,000 t, equating to just over 55% of the total Indian Ocean albacore catch. Between 2005 and 2012 the albacore catches by Taiwan,China deep-freezing longliners have been between 1,500 and 6,000 t, with the lowest catches recorded in 2012 (1,300 t), although catches recovered to around 2,800 t in 2013

Unlike deep-freezing longliners, the catch levels of albacore for the fresh-tuna longline fishery of Taiwan,China have increased in recent years, leading to a shift in the proportion of catches of albacore by deep-freezing and fresh-tuna longliners. In recent years, the catches of fresh-tuna longliners of Taiwan,China have represented 75% of the total catches of Taiwan,China longliners during 2010–12.

While most of the catches of albacore have traditionally come from the southwest Indian Ocean, in recent years a larger proportion of the catch has come from the southern and eastern Indian Ocean (Table 5; Fig. 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. In the western Indian Ocean, the catches of albacore mostly result from the activities of deep-freezing longliners and purse seiners. One consequence of Somali maritime piracy in the western tropical Indian Ocean in recent years has been the movement of part of the deep-freezing longline fleets from this area, for which the target species were tropical tunas or swordfish, to operate in southern waters of the Indian Ocean (Fig. 4) which has led to an increased contribution of albacore to the total catches of some longline fleets.

Fleets of oceanic gillnet vessels from I.R. 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.

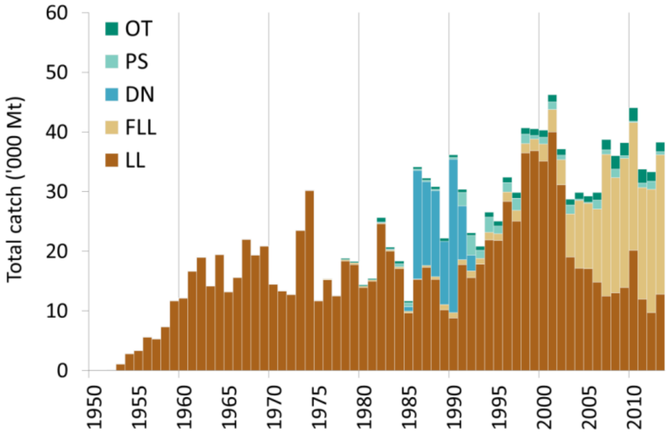


Fig. 2. Albacore: Catches of albacore by gear. Driftnet (DN; Taiwan,China); Freezing-longline (LL); Fresh-tuna longline (FLL); Purse seine (PS); Other gears NEI (OT) (Data as of October 2014).

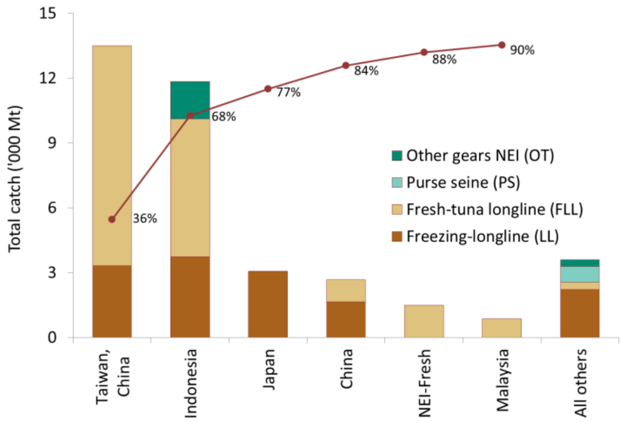


Fig. 3. Albacore: average catches in the Indian Ocean over the period 2010–12, ordered from left to right, according to the importance of catches of albacore reported. The red line indicates the (cumulative) proportion of catches of albacore for the countries concerned, over the total combined catches of albacore reported from all fisheries (Data as of October 2014).

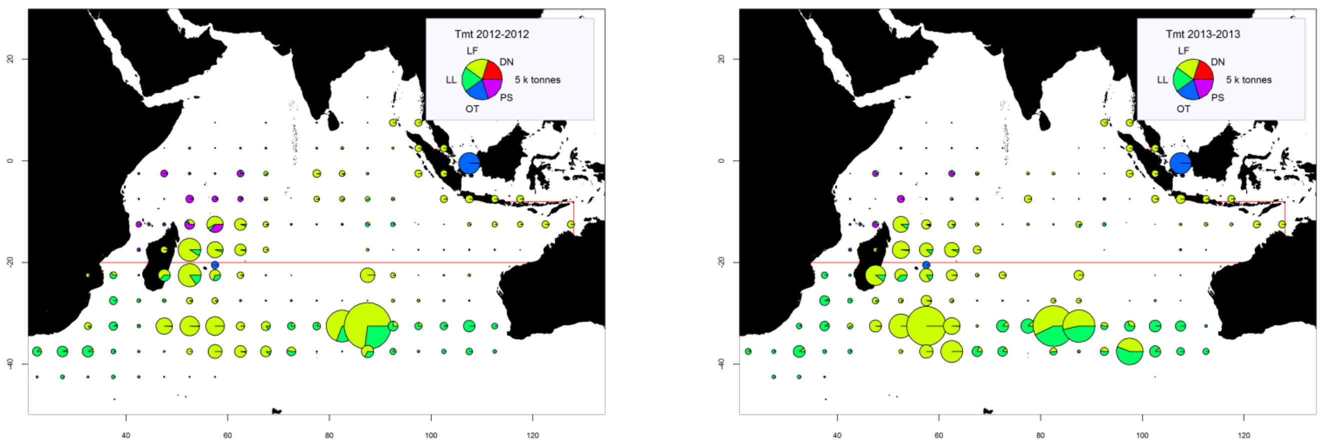


Fig. 4a–b. Albacore: Time-area catches (total combined in tonnes) of albacore estimated for 2012 (left) and 2013 (right) by year and type of gear. Red line depicts the area separation for Table 5. Deep-freezing longline (LL, green), Fresh-tuna longline (LF, light green), Driftnet (DN, red), Purse seine (PS, purple), Other fleets (OT, 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 (Data as of October 2014).

TABLE 4. Albacore: Best scientific estimates of the catches of albacore (*Thunnus alalunga*) by gear and main fleets [or type of fishery] by decade (1950s–2000s) and year (2004–2013), in tonnes. Catches by decade represent the average annual catch, noting that some gears were not used for all years (Data as of October 2014).

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013*
DN				5,823	3,735											
LL	3,715	17,228	16,967	15,827	23,038	21,396	17,187	17,088	14,804	12,510	13,046	13,944	20,195	12,006	9,728	12,800
FLL			80	314	1,324	11,720	11,299	10,971	12,250	23,736	19,332	21,662	21,399	18,696	20,691	23,399
PS				194	1,683	912	232	164	1,548	725	1,424	392	207	725	1,296	501
OT	20	33	94	413	769	1,418	1,174	1,035	1,226	1,765	2,250	2,235	2,235	2,303	1,611	1,597
Total	**3,736**	**17,262**	**17,142**	**22,570**	**30,550**	**35,446**	**29,893**	**29,258**	**29,828**	**38,737**	**36,051**	**38,233**	**44,036**	**33,731**	**33,327**	**38,297**

Fisheries: Driftnet (**DN**; Taiwan,China); Freezing-longline (**LL**); Fresh-tuna longline (**FLL**); Purse seine (**PS**); Other gears nei (**OT**).*Preliminary figures.

TABLE 5. Albacore: Best scientific estimates of the catches of albacore (*Thunnus alalunga*) by fishing area by decade (1950s–2000s) and year (2004–2013), in tonnes. The areas used are shown in Fig. 4 (Data as of October 2014).

Area	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013*
1-North	771	1,240	1,403	1,727	4,416	6,215	4,767	5,038	6,815	9,344	10,521	6,020	6,870	6,389	5,512	4,463
2-South	2965	16,022	15,738	20,844	26,134	29,231	25,125	24,220	23,013	29,392	25,531	32,213	37,166	27,341	27,814	33,834
Total	**3,736**	**17,262**	**17,142**	**22,570**	**30,550**	**35,446**	**29,893**	**29,258**	**29,828**	**38,737**	**36,051**	**38,233**	**44,036**	**33,731**	**33,327**	**38,297**

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

Albacore – Uncertainty of catches

While retained catches were fairly well known until the early-1990s (Fig. 5), the quality of catch estimates since that time has been compromised due to poor catch reports from some fleets, in particular:

- Longliners of Indonesia: The catches of albacore for the longline fleet of Indonesia were revised in 2013 by the DGCF and the IOTC Secretariat, using previous reports from Indonesia and information obtained from canning factories cooperating with the International Seafood Sustainability Foundation (ISSF). While the new catch estimates are considered more reliable than the previous, the lack of catch-and-effort data and insufficient monitoring of albacore landings in Indonesia makes it difficult to validate such estimates. According to the new estimates Indonesia has been catching 32% (around 11,000–13,000 t per year) of the total catches of albacore in the Indian Ocean over the period 2010–12. However, the catches of albacore reported by Indonesia for 2013, at over 16,000 t, are in contradiction with data from the canning factories, which shows a marked drop in imports.
- Longliners of Malaysia: To date, Malaysia has reported incomplete catches of albacore for its longline fleet, as monitoring by Malaysia does not cover the large component of the longline fleet that is based in ports outside Malaysia (in particular in Mauritius). In recent years Malaysia has reported between 5 and 59 active longliners in the Indian Ocean, with catches of albacore ranging between nil and 1,000 t for the same period. An additional 500–2,000 t of albacore were estimated for Malaysian longliners not based in Malaysia.
- Fleets using gillnets on the high seas, in particular I.R. Iran, Pakistan and Sri Lanka: Catches are likely to be less than 1,000 t.
- Non-reporting industrial longliners (NEI): Refers to catches from longliners operating under flags of non-reporting countries. While the catches were moderately high during the 1990s, they have not exceeded 3,000 t in recent years.

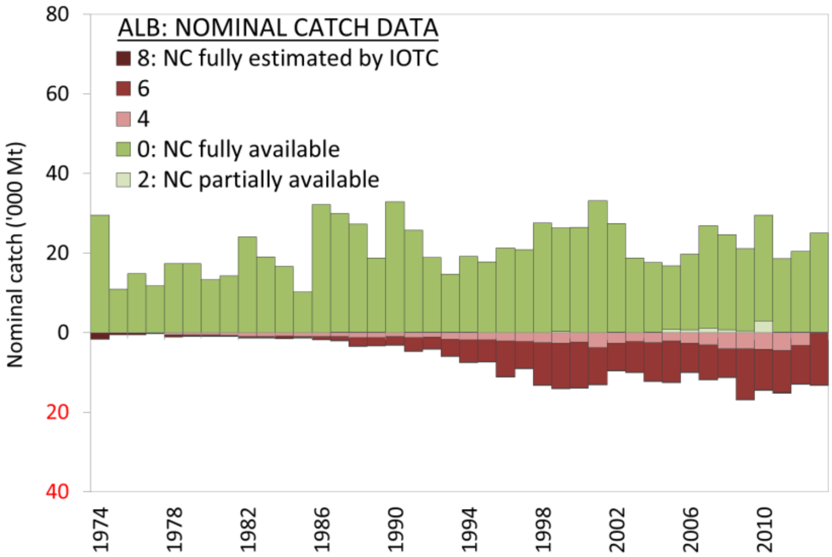


Fig. 5. Albacore: Uncertainty of nominal annual catch estimates (1950–2013). Catches are assessed against IOTC reporting standards, where a score of 0 indicates catches that are fully reported according to IOTC standards; catches assigned a score of between 2 – 6 are not reported fully by gear and/or species (i.e. partially adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; catches with a score of 8 refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat) (Data as of October 2014).

- Levels of discards are believed to be low although they are unknown for industrial fisheries other than European (EU) purse seiners (2003–07).
- Changes to the catch series: The catches of albacore have changed for some years since the WPTmT in 2012, including:
  - Minor to moderate increase in estimates of catches of albacore recorded for the period 1950–2003, following a review of the catches of albacore by coastal longliners in Indonesia.
  - Moderate decrease in estimates of catches of albacore in 2007 (11%) and marked decrease in 2008 (24%), following the review of catches of albacore by all fleets conducted for this period.
  - Minor changes in estimates of catches of albacore for other years.
- CPUE Series: 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, Malaysia, Oman, and Philippines;
  - No data for fresh-tuna longliners flagged in Taiwan,China during 1990–2006;
  - Non-reporting by industrial purse seiners and longliners (NEI).

Albacore – Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid for 2012 and 2013 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 2012 and 2013 are provided in Fig. 7.

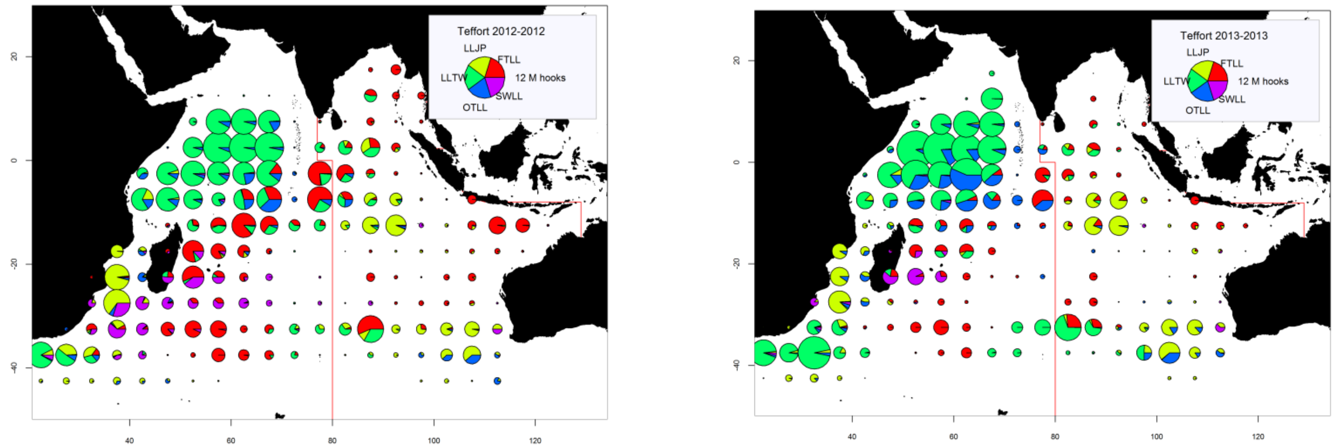


Fig. 6. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2012 (left) and 2013 (right). Red line depicts the IOTC West and East areas (Data as of October 2014).
LLJP (light green): deep-freezing longliners from Japan; **LLTW** (dark green): 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).

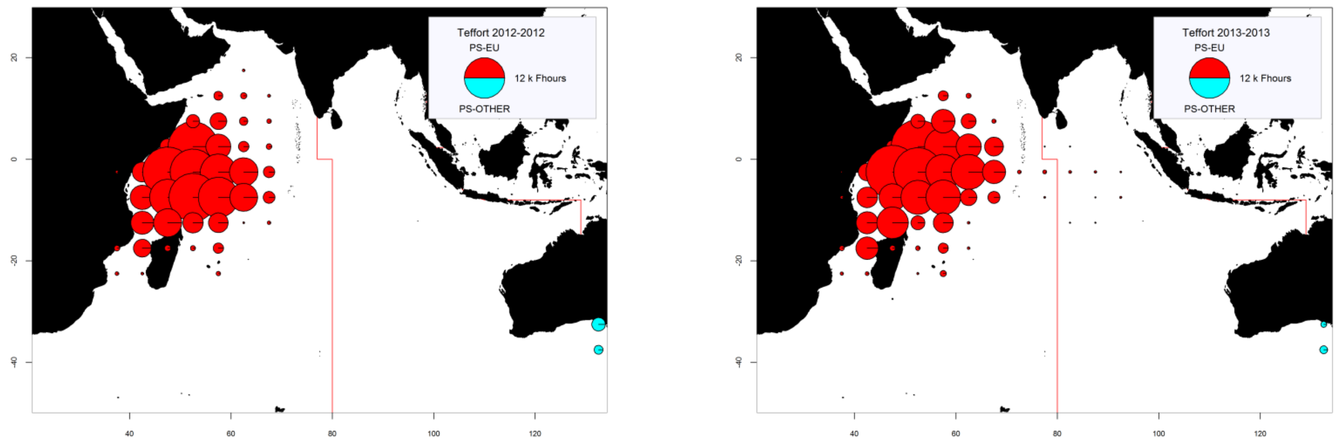


Fig. 7. Number of hours of fishing(Fhours in thousands: k) from purse seine vessels by 5 degree square grid and main fleets, for the years 2012 (left) and 2013 (right). Red line depicts the IOTC West and East areas (Data as of October 2014). **PS-EU** (red): Industrial purse seiners monitored by the 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)

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

The size frequency data for the Taiwan,China deep-freezing longline fishery for the period 1980–2013 is available. However, the lengths of albacore available for Taiwan,China since 2003 are very different from those available for earlier years. The length data and catch-and-effort data for the same time-periods and areas are also conflicting over most of the time series. 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 fleet is available; however, the number of specimens measured per stratum has been decreasing in recent years. Size data are also available for industrial purse seiners flagged in EU countries and the Seychelles. 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 some fisheries due to the issues identified above.
- **Catch-at-Size(Age):** Tables are available but the estimates are highly uncertain for some periods and fisheries (Fig. 8) 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 complete lack of size samples from the driftnet fishery of Taiwan,China over the entire fishing period (1982–92)

- the paucity of catch by area data available for some industrial fleets (Taiwan,China, NEI, India and Indonesia).

Albacore (Longline samples): size (in cm) Albacore (Longline): no. of samples (‘000)

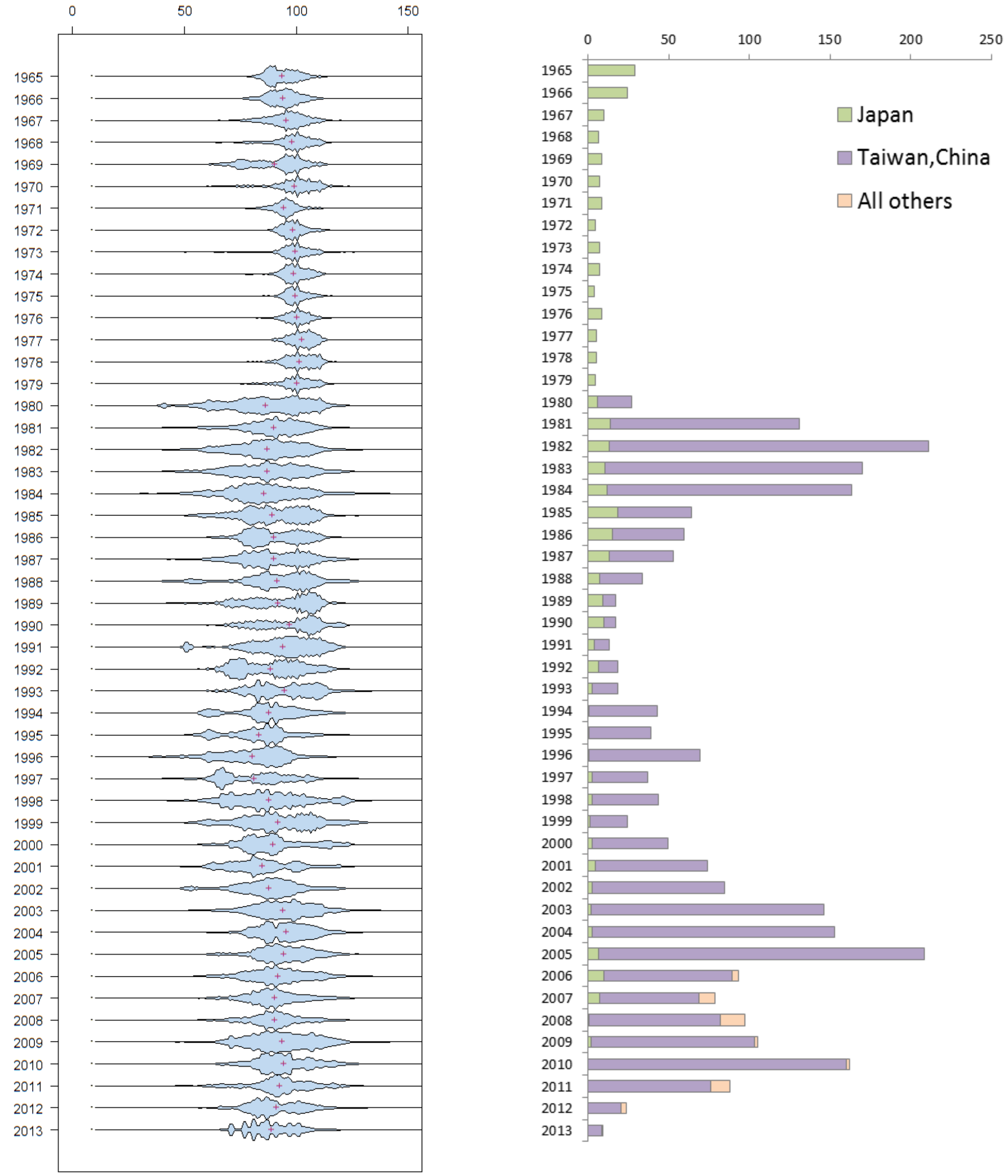


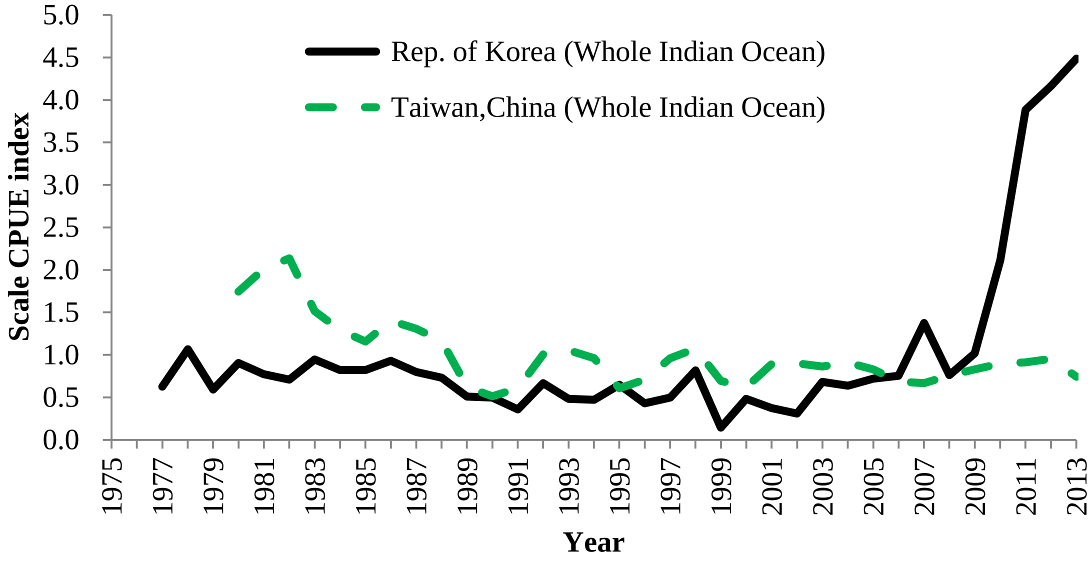
Fig. 8. Albacore: Left - Length frequency distributions (total amount of fish measured by 1 cm length class) derived from the data available at the IOTC Secretariat for freezing longline fisheries, by year. Right - Number of specimens sampled for lengths by main longline fleet.

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

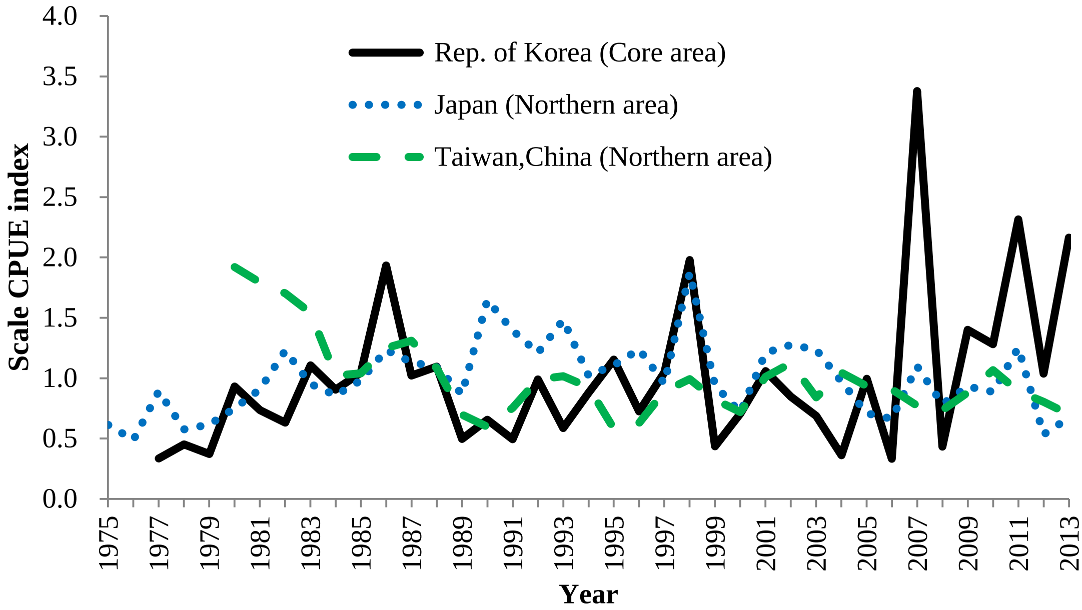
The CPUE series available for assessment purposes are listed below and shown in Fig. 9, although the Taiwan,China series (Southern area 1 and Southern area 2a; Fig. 9c) were used in the final stock assessment models for management advice purposes for the reasons discussed in IOTC–2012–WPTmT05–R.

- Japan data (1975–2012): 2 series from document IOTC–2014–WPTmT05–18 Rev_1
- Taiwan,China data (1980–2013): 4 series from document IOTC–2014–WPTmT05–19
- Rep. of Korea data (1977–2013): 2 series from document IOTC–2014–WPTmT05–20 Rev_1

a)



b)



c)

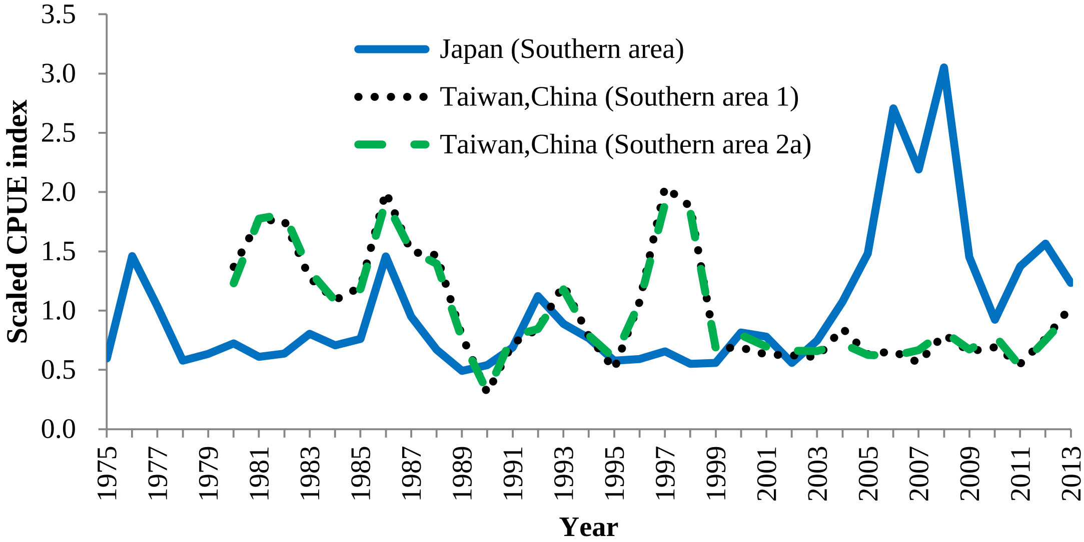


Fig. 9. Albacore: Comparison of the CPUE series for longline fleets fishing for albacore in the IOTC area of competence. a) Whole Indian Ocean b) Northern area and c) Southern area. Series have been rescaled relative to their respective means from 1975–2013.

STOCK ASSESSMENT

A range of quantitative modelling methods as detailed below (BBDM, ASAP, ASPIC, ASPM and SS3) were applied to the assessment of albacore in 2014, ranging from the highly aggregated ASPIC surplus production model to the age-, sex- and spatially-structured SS3 analysis.

The following is worth noting with respect to the various modelling approaches used in 2014:

- There was more confidence in the abundance indices this year due to the additional CPUE analyses from Japan and Taiwan,China, and the exploration of the Rep. of Korea catch and effort data. This has led to improved confidence in the overall assessments.
- The Taiwan,China CPUE is more likely to closely represent albacore abundance at this time, because a substantial part of the Taiwan,China fleet has always targeted albacore in the southern area (2a) as identified by Taiwan,China.
- Conversely, the Japanese CPUE seems to demonstrate very strong targeting shifts away from albacore (1960s) and back towards albacore in recent years (as a consequence of piracy in the western Indian Ocean, reduced or increased TAC for southern bluefin tuna, and increased commercial value for albacore). Similar trends are seen in the Rep. of Korea CPUE series.
- CPUE series should not be averaged across series with different trends as this is likely to result in spurious trends. Thus, only series which are considered to be most representative of abundance, in this case the Taiwan,China series, should be used in stock assessments while further work is carried out on the Japanese and Rep. of Korea longline series.
- 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. This was also apparent in the ASPM Model approach pursued in WPTmT 2014.

The stock structure of the Indian Ocean albacore resource is under investigation, but currently uncertain. The south-west region was identified as an area of interest, as it is likely that there is stock connectivity with the southern Atlantic albacore population. The albacore stock status should be determined by qualitatively integrating the results of the ASPIC and SS3 stock assessments undertaken in 2014 (Table 6). The two analyses were considered as equally informative.

The output of the ASPIC and SS3 models were considered to most likely be numerically and graphically representative of the current status of albacore in the Indian Ocean. This does not represent an endorsement of the SS3 or ASPIC over the other models used in 2014, as there are still substantial problems with the ASPIC and SS3 on some of the model runs pursued, and all of the models are considered to be informative of stock status.

TABLE 6. Albacore (*Thunnus alalunga*) key management quantities from the SS3 and ASPIC stock assessments.

Management Quantity	SS3	ASPIC*
2013 catch estimate	38,297 t	38,297 t
Mean catch from 2009–2013	37,525 t	37,525 t
MSY (1,000 t) (80% CI)	47.6 (26.7–78.8)	34.7 (28.8–37.4)
Data period used in assessment	1950–2012	1950–2012
F_{MSY} (80% CI)	0.31 (0.21–0.42)	0.50 (n.a.)
SB_{MSY} (1,000 t) (80% CI)	39.2 (25.4–50.7)	68.6 (n.a.)
F_{2012}/F_{MSY} (80% CI)	0.69 (0.23–1.39)	0.94 (0.68–1.61)
B_{2012}/B_{MSY} (80% CI)	–	1.05 (0.73–1.35)
SB_{2012}/SB_{MSY} (80% CI)	1.09 (0.34–2.20)	–
B_{2012}/B_{1950} (80% CI)	–	–
SB_{2012}/SB_{1950}	0.21 (0.11–0.33)	0.43 (n.a.)
$B_{2012}/B_{1950,\ F=0}$	–	–
$SB_{2012}/SB_{1950,\ F=0}$	–	–

*Total Biomass (B)

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APPENDIX XIII
EXECUTIVE SUMMARY: BIGEYE TUNA

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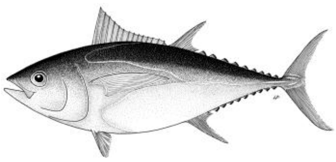


Status of the Indian Ocean bigeye tuna (BET: *Thunnus obesus*) resource

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

Area[1]	Indicators		2014 stock status[2] determination
Indian Ocean	Catch in 2013: Average catch 2009–2013:	109,343 t 105,924 t	
	MSY (1,000 t) (plausible range): F_{MSY} (plausible range): SB_{MSY} (1,000 t) (plausible range): F_{2012}/F_{MSY} (plausible range): SB_{2012}/SB_{MSY} (plausible range): SB_{2012}/SB_0 (plausible range):	132 (98–207)[3] n.a. (n.a.–n.a.)[3] 474 (295–677)[3] 0.42 (0.21–0.80)[3] 1.44 (0.87–2.22)[3] 0.40 (0.27–0.54)[3]	

[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 in the assessment.
[3]The point estimate is the median of the plausible models investigated in the 2013 SS3 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 ($F_{year}/F_{MSY} \leq 1$)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No new stock assessment was carried out for bigeye tuna in 2014, thus, stock status is determined on the basis of the 2013 assessment and other indicators presented in 2014. The 2013 stock assessment model results did not differ substantively from the previous (2010 and 2011) assessments; however, the final overall estimates of stock status differ somewhat due to the revision of the catch history and updated standardised CPUE indices. All the runs (except 2 extremes) carried out in 2013 indicate the stock is above a biomass level that would produce MSY in the long term (i.e. $SB_{2012}/SB_{MSY} > 1$) and in all runs that current fishing mortality is below the MSY-based reference level (i.e. $F_{2012}/F_{MSY} < 1$) (Table 1 and Fig. 1). The median value of MSY from the model runs investigated was 132,000 t with a range between 98,000 and 207,000 t. Current spawning stock biomass was estimated to be 40% (Table 1) of the unfished levels. Catches in 2013 (≈109,000 t) remain lower than the estimated MSY values from the 2013 stock assessments (Table 1). The average catch over the previous five years (2009–13; ≈106,000 t) also remains below the estimated MSY. In 2012 catch levels of bigeye tuna increased markedly (≈26% over values in 2011), but have declined in 2013 by 9% from 2012 levels. Thus, on the weight-of-evidence available in 2014, the bigeye tuna stock is determined to be **not overfished** and is **not subject to overfishing** (Table 1).

Outlook. Declines in longline effort since 2007, particularly from the Japanese, Taiwan,China and Republic of Korea longline fleets, as well as purse seine 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 in the near future. The Kobe strategy matrix based on all plausible model runs from SS3 in 2013 illustrates the levels of risk associated with varying catch levels over time and could be used to inform future management actions (Table 2). The SS3 projections from the 2013 assessment show that there is a low risk of exceeding MSY-based reference points by 2015 and 2022 if catches are maintained at catch levels of 115,800 t at the time of the last assessment (0% risk that $B_{2022}<B_{MSY}$ and 0% risk that $F_{2022}>F_{MSY}$) (Table 2).

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: The median value of MSY from the model runs investigated was 132,000 t with a range between 98,000 and 207,000 t (range expressed as the different runs of SS3 done in 2013 using steepness values of 0.7, 0.8 and 0.9; different natural mortality values; and catchability increase for longline CPUE) (see Table 1 for further description). Current stock size is above SB_{MSY} and predicted to increase on the short term. Catches at the level of 132,000 t have a low probability of reducing the stock below SB_{MSY} in the short term (3–5 years) and medium term (10 years). Therefore, the annual catches of bigeye tuna should not exceed the median value of MSY. However, for lower productivity model options, catches at the median MSY level will reduce stock biomass over the long-term (10–15 years). If catch remains below the estimated MSY levels, 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.

- **Provisional reference points**: Noting that the Commission in 2013 agreed to Resolution 13/10 *on interim target and limit reference points and a decision framework*, the following should be noted:
  - o **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, and therefore below the provisional limit reference point of 1.4*F_{MSY} (Fig. 1).
  - o **Biomass**: Current spawning biomass is considered to be above the target reference point of SB_{MSY}, and therefore above the limit reference point of 0.4*SB_{MSY} (Fig. 1).
- **Main fishing gear** (2009–13): Longline ≈56.7% (frozen ≈43.6%, fresh ≈13.1%); Purse seine ≈22.6% (log ≈17.5% and free swimming school ≈5.1%);
- **Main fleets**: Indonesia ≈28%; Taiwan,China ≈25%; European Union ≈15% (EU,Spain: ≈9%; EU,France: ≈6%); Seychelles ≈11%.

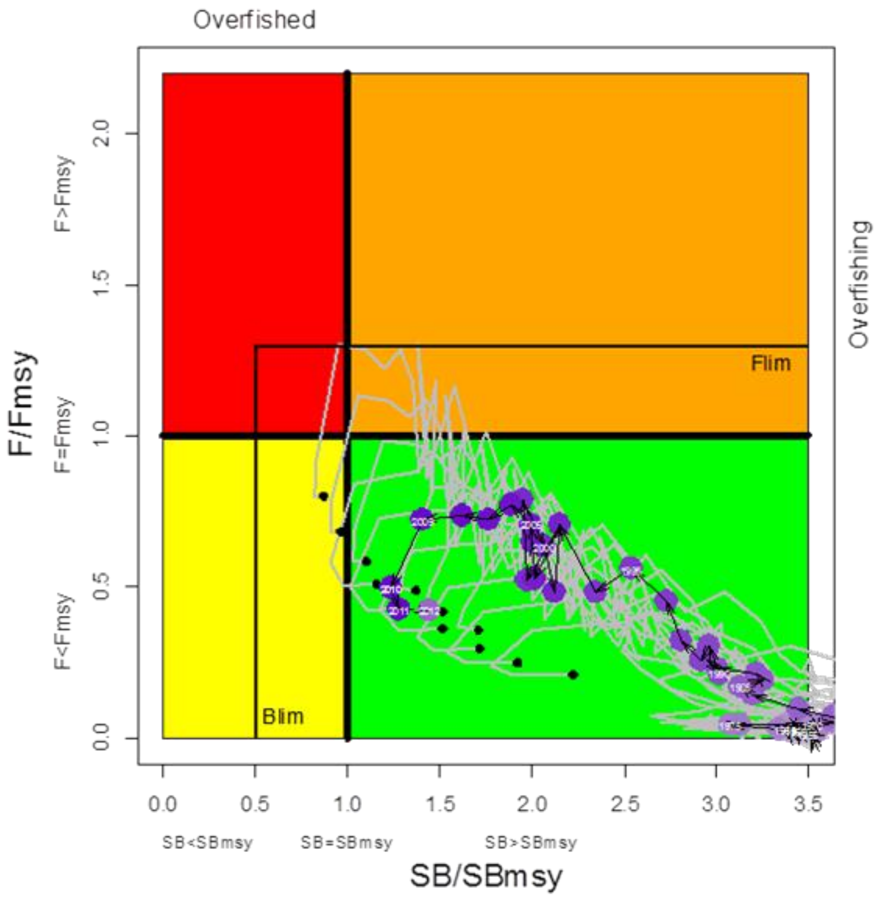


Fig. 1. Bigeye tuna: SS3 Aggregated Indian Ocean assessment Kobe plot. The Kobe plot presents the trajectories for the range of 12 plausible model options included in the formulation of the final management advice (grey lines with the black point representing the terminal year of 2012). The trajectory of the median of the 12 plausible model options (purple points) is also presented. The biomass (B_{lim}) and fishing mortality limit (F_{lim}) reference points are also presented.

Table 2. Bigeye tuna: 2013 SS3 aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of weighted distribution of models violating the MSY-based reference points for five constant catch projections (2012 catch level, ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years. Note: from the 2013 stock assessment using catch estimates at that time.

Reference point and projection timeframe	Alternative catch projections (relative to the average catch level for 2012) and probability (%) of violating MSY-based target reference points ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)								
	60% (69,480 t)	**70%** (81,060 t)	**80%** (92,640 t)	**90%** (104,220 t)	**100%** (115,800 t)	**110%** (127,400 t)	**120%** (139,000 t)	**130%** (150,500 t)	**140%** (162,100 t)
$SB_{2015} < SB_{MSY}$	n.a.	n.a.	n.a.	n.a.	0	0	0	0	0
$F_{2015} > F_{MSY}$	n.a.	n.a.	n.a.	n.a.	0	0	0	8	17
$SB_{2022} < SB_{MSY}$	n.a.	n.a.	n.a.	n.a.	0	0	8	17	25
$F_{2022} > F_{MSY}$	n.a.	n.a.	n.a.	n.a.	0	0	8	17	25
Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level for 2012) and probability (%) of violating MSY-based limit reference points ($SB_{lim} = 0.5\ SB_{MSY}$; $F_{Lim} = 1.3\ F_{MSY}$)**								
	60% (69,480 t)	**70%** (81,060 t)	**80%** (92,640 t)	**90%** (104,220 t)	**100%** (115,800 t)	**110%** (127,400 t)	**120%** (139,000 t)	**130%** (150,500 t)	**140%** (162,100 t)
$SB_{2016} < SB_{Lim}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$F_{2016} > F_{Lim}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$SB_{2023} < SB_{Lim}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$F_{2023} > F_{Lim}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

APPENDIX I

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 14/02 *for the conservation and management of tropical tunas stocks in the IOTC area of competence*.
- Resolution 14/05 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 13/10 *On interim target and limit reference points and a decision framework*
- Resolution 13/11 *On a ban on discards of bigeye tuna, skipjack tuna, yellowfin tuna and a recommendation for non-targeted species caught by purse seine vessels in the IOTC area of competence*
- Resolution 12/11 *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 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Bigeye tuna – 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.

TABLE 3. Bigeye tuna: 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

Bigeye tuna – Fisheries and catch trends

Bigeye tuna is mainly caught by industrial longline (54% in 2013) and purse seine (31% in 2013) fisheries, with the remaining 16% of the catch taken by other fisheries (Table 4). However, in recent years the catches of bigeye tuna by gillnet fisheries are likely to be higher, due to major changes experienced in some of these fleets (e.g., Sri Lanka and I.R. Iran) - notably changes in boat size, fishing techniques and fishing grounds, with vessels using deeper gillnets on the high seas in areas where catches of bigeye tuna by other fisheries are important.

Table 4. Bigeye tuna: Best scientific estimates of the catches of bigeye tuna (*Thunnus obesus*) by gear and main fleets [or type of fishery] by decade (1950–2009) and year (2004–2013), in tonnes. Data as of September 2014. Catches by decade represent the average annual catch, noting that some gears were not used since the beginning of the fishery (refer to Fig. 2).

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
BB	21	50	266	1,536	2,968	5,070	4,519	5,566	5,176	6,048	6,109	6,874	6,696	6,784	6,820	6,560
FS	0	0	0	2,340	4,823	6,196	4,085	8,484	6,406	5,672	9,646	5,302	3,792	6,223	7,180	4,654
LS	0	0	0	4,856	18,317	20,273	19,308	17,556	18,522	18,105	19,875	24,708	18,486	16,387	10,435	22,814
LL	6,488	21,984	30,284	42,893	62,312	71,275	90,622	75,863	72,934	74,172	51,599	51,557	32,255	35,803	66,605	44,562
FL	0	0	218	3,066	26,306	23,471	22,366	19,636	18,789	22,451	23,323	15,809	12,759	14,603	12,429	14,000
LI	43	294	658	2,384	4,278	5,774	5,601	6,230	5,740	6,700	6,683	7,338	7,706	7,510	7,237	8,423
OT	37	63	164	859	1,407	3,971	3,130	4,129	4,831	4,750	5,361	6,694	6,231	7,361	8,691	8,330
Total	**6,589**	**22,393**	**31,592**	**57,935**	**120,412**	**136,030**	**149,630**	**137,467**	**132,399**	**137,898**	**122,596**	**118,284**	**87,926**	**94,669**	**119,396**	**109,343**

Gears: Pole-and-Line (**BB**); Purse seine free-school (**FS**); Purse seine associated school (**LS**); Deep-freezing longline (**LL**); Fresh-tuna longline (**FL**); Line (handline, small longlines, gillnet & longline combine) (**LI**); Other gears nei (gillnet, trolling & other minor artisanal gears)(**OT**).

Table 5. Bigeye tuna: Best scientific estimates of the catches of bigeye tuna (*Thunnus obesus*) by area [as used for the assessment] by decade (1950–2009) and year (2004–2013), in tonnes. Data as of September 2014. Catches by decade represent the average annual catch.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
A1	2,484	12,090	17,529	34,656	58,595	76,990	89,600	84,915	81,683	80,195	67,501	57,782	38,665	39,095	71,770	64,204
A2	3,900	7,272	10,225	18,768	46,960	48,829	47,358	43,128	44,828	53,685	50,436	56,967	44,123	49,840	41,198	37,724
A3	205	3,031	3,838	4,511	14,856	10,211	12,672	9,426	5,888	4,018	4,660	3,535	5,137	5,734	6,429	7,414
Total	**6,589**	**22,393**	**31,592**	**57,935**	**120,412**	**136,030**	**149,630**	**137,467**	**132,399**	**137,898**	**122,596**	**118,284**	**87,926**	**94,669**	**119,396**	**109,343**

Areas: West Indian Ocean, including Arabian sea (A1); East Indian Ocean, including Bay of Bengal (A2); Southwest and Southeast Indian Ocean, including southern (A3). Catches in Areas (**0**) were assigned to the closest neighbouring area for the assessment.

Total annual catches have increased steadily since the start of the fishery, reaching the 100,000 t level in 1993 and peaking at over 160,000 t in 1999 (Fig. 2). Catches dropped since then to values between 130,000–150,000 t (2000–07), before dropping even further in recent years to values under 90,000 t (e.g., 2010–11), before increasing in 2012 to nearly 120,000 t. The SC believes that the drop in catches between 2008 and 2011 could be related, at least in part, with the expansion of piracy in the northwest Indian Ocean (West A1, Table 5, Fig. 3b), which led to a marked drop in the levels of longline effort in the core fishing area of these species in 2010–11 (Fig. 3).

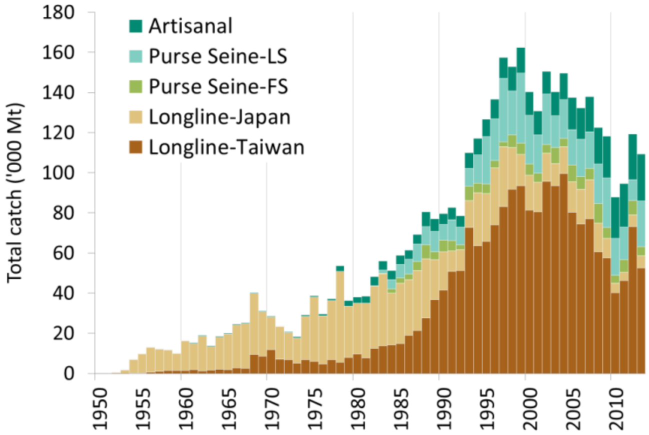


Fig. 2. Bigeye tuna: Annual catches of bigeye tuna by gear (1950–2012). Data as of September 2014. Gears (as agreed by WPTT): Longline Taiwan,China and associated fleets (Longline-Taiwan); Longline Japan and associated fleets (Longline-Japan); Purse seine free-school (FS); Purse seine associated school (LS); Other gears nei (Pole-and-Line, handline, small longlines, gillnet, trolling & other minor artisanal gears) (Artisanal).

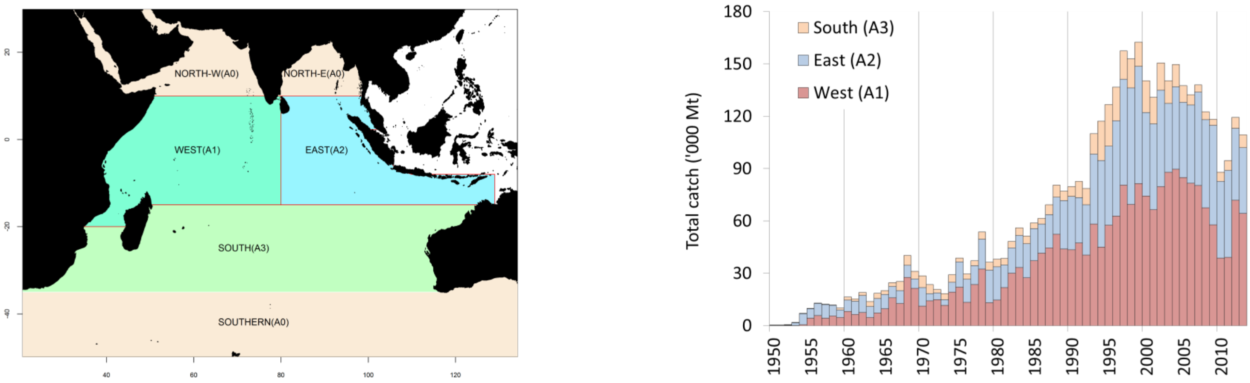


Fig. 3(a-b). Bigeye tuna: Catches of bigeye tuna by area by year estimated for the WPTT (1950–2012). (Data as of September 2014). Catches outside the areas presented in the Map were assigned to the closest neighbouring area for the assessment. **Areas**: West Indian Ocean (**A1**); East Indian Ocean (**A2**); Southwest and Southeast Indian Ocean (**A3**). Catches in Areas (**0**) were assigned to the closest neighbouring area for the assessment.

Bigeye tuna have been caught by industrial longline fleets since the early 1950's, but before 1970 only represented an incidental catch. After 1970, the introduction of fishing practices that improved catchability of the bigeye tuna resource, combined with the emergence of a *sashimi* market, resulted in bigeye tuna becoming a primary target species for the main industrial longline fleets. Large bigeye tuna (averaging just above 40 kg) are primarily caught by longliners, in particular deep setting longliners.

Total catches of bigeye tuna by longliners in the Indian Ocean increased steadily from the 1970's attaining values over 90,000 t between 1996 and 2007, and dropping markedly thereafter (Fig. 2). Since 2007 catches of bigeye tuna by longliners have been relatively low, with catches less than half the catch levels recorded before the onset of piracy in the Indian Ocean (e.g., ≈50,000 t). Since 2012 longline catches appear to show signs of recovery (e.g., 79,000 t in 2012), as a result of a reduction in the threat of piracy and return of fleets that appear to be resuming fishing activities in their main fishing grounds in the north-west Indian Ocean (West (A1), Fig. 3b).

Since the late 1980's Taiwan,China has been the major longline fleet fishing for bigeye tuna in the Indian Ocean, taking as much as 40-50% of the total longline catch in the Indian Ocean (Fig. 4). However, catches of longliners from Taiwan,China between 2007 and 2011 decreased markedly (≈20,000 t), to values three times lower than those from the early-2000's. Although catches in 2012 were higher than in recent years, they still remain far below levels recorded in 2003 and 2004.

Since the late 1970's, bigeye tuna has been caught by purse seine vessels fishing on tunas aggregated on floating objects and, to a lesser extent, associated to free swimming schools (Fig. 2) of yellowfin tuna or skipjack tuna. The highest catch of bigeye tuna by purse seiners in the Indian Ocean was recorded in 1999 (≈44,000 t). Catches since 2000 have been between 20,000 and 30,000 t. Purse seiners under flags of EU countries and Seychelles take the majority of purse seine caught bigeye tuna in the Indian Ocean (Fig. 4). Purse seiners mainly take small juvenile bigeye (averaging around 5 kg) compared to longliners which catch much larger and heavier fish. While purse seiners take lower tonnages of bigeye tuna compared to longliners, they take larger numbers of individual fish. Even though the activities of purse seiners have been affected by piracy in the Indian Ocean, the impacts have not been as marked as for longline fleets. The main reason for this is the presence of security personnel onboard purse seine vessels of the EU and Seychelles, which has made it possible for purse seiners under these flags to continue operating in the northwest Indian Ocean (Fig. 5).

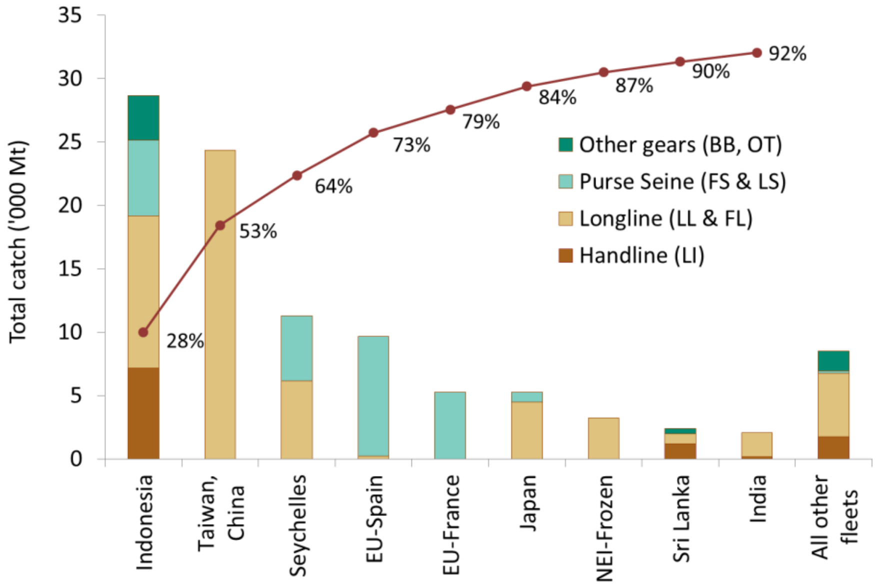


Fig. 4. Bigeye tuna: average catches in the Indian Ocean over the period 2010–12, by fleet. Fleets are ordered from left to right, according to the importance of catches of bigeye reported. The red line indicates the (cumulative) proportion of catches of bigeye for the fleets concerned, over the total combined catches of this species reported from all fleets and fisheries (Data as of September 2014).

By contrast with yellowfin tuna and skipjack tuna, for which the major catches are taken in the western Indian Ocean, bigeye tuna is also exploited in the eastern Indian Ocean (East (A2**)**, Fig. 3 and Table 4). The relative increase in catches in the eastern Indian Ocean in the late 1990's was mostly due to increased activity of small longliners fishing tuna to be marketed fresh. This fleet started its operation in the mid 1970's. However, catches of bigeye tuna in the eastern Indian Ocean have shown a decreasing trend in recent years, as some of the vessels moved south to target albacore.

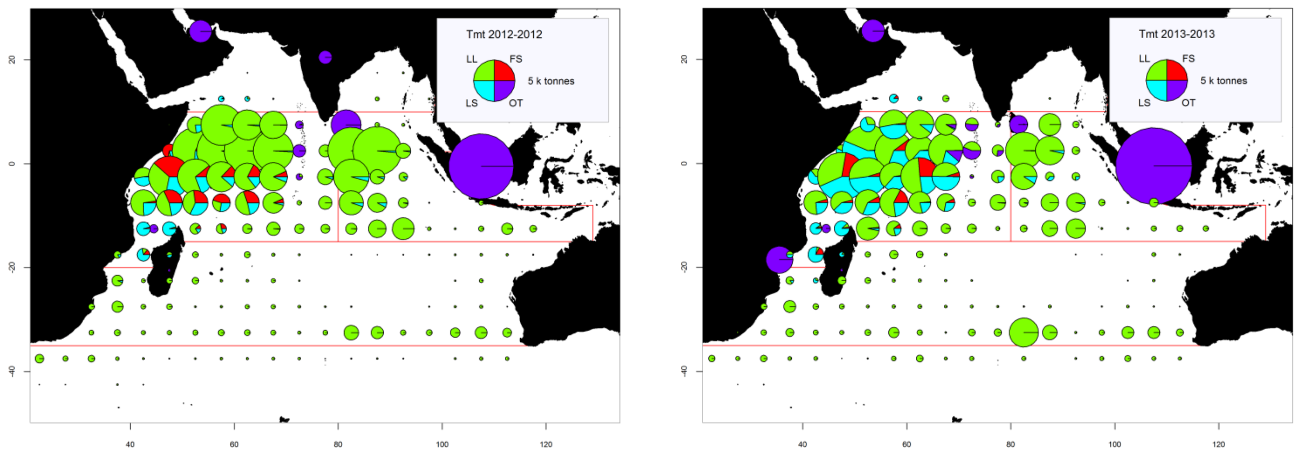


Fig. 5(a-b). Bigeye tuna: Time-area catches (total combined in tonnes) of bigeye tuna estimated for 2002 and 2013 by type of gear. Longline (**LL**), Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), and other fleets (**OT**), including pole-and-line, drifting gillnets, and various coastal fisheries (Data as of September 2014). The catches of fleets for which the flag countries do not report detailed time and area data to the IOTC are recorded within the area of the countries concerned, in particular driftnets from Iran, gillnet and longline fishery of Sri Lanka, and coastal fisheries of Indonesia.

Bigeye tuna: Status of fisheries statistics at the IOTC

Retained catches: Thought to be well known for the major fleets (Fig. 6a); but are less certain for non-reporting industrial purse seiners and longliners (NEI) and for other industrial fisheries (e.g. longliners of India). Catches are also uncertain for some artisanal fisheries including the pole-and-line fishery in the Maldives, the gillnet fisheries of I.R. Iran (before 2012) and Pakistan, the gillnet and longline combination fishery in Sri Lanka and the artisanal fisheries in Indonesia, Comoros (before 2011) and Madagascar.

Discards: Believed to be low although they are unknown for most industrial fisheries, excluding industrial purse seiners flagged in EU countries for the period 2003–07.

Changes to the catch series: There have been no major revisions to the catch series since WPTT meeting in 2013.

Catch-Per-Unit-Effort (CPUE) series: Catch-and-effort data 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 (Fig. 6b), 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 data for the fresh-tuna longline fishery of Taiwan,China are only available since 2006
- uncertain data from significant fleets of industrial purse seiners from Iran and longliners from India, Indonesia, Malaysia, Oman, and Philippines.
- incomplete data for the driftnet fisheries of I.R. Iran and Pakistan and the gillnet/longline fishery of Sri Lanka, especially in recent years.

Fish size or age trends (e.g. by length, weight, sex and/or maturity): 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 and Taiwan,China longline) (Figs. 6, 7, 8, 9, 10)

Catch-at-Size(Age) (Fig. 6c): This is available but the estimates are more uncertain for some years and some fisheries due to:

- 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 and Taiwan,China)
- the paucity of catch by area data available for some industrial fleets (NEI, India, Indonesia, I.R. Iran, Sri Lanka)

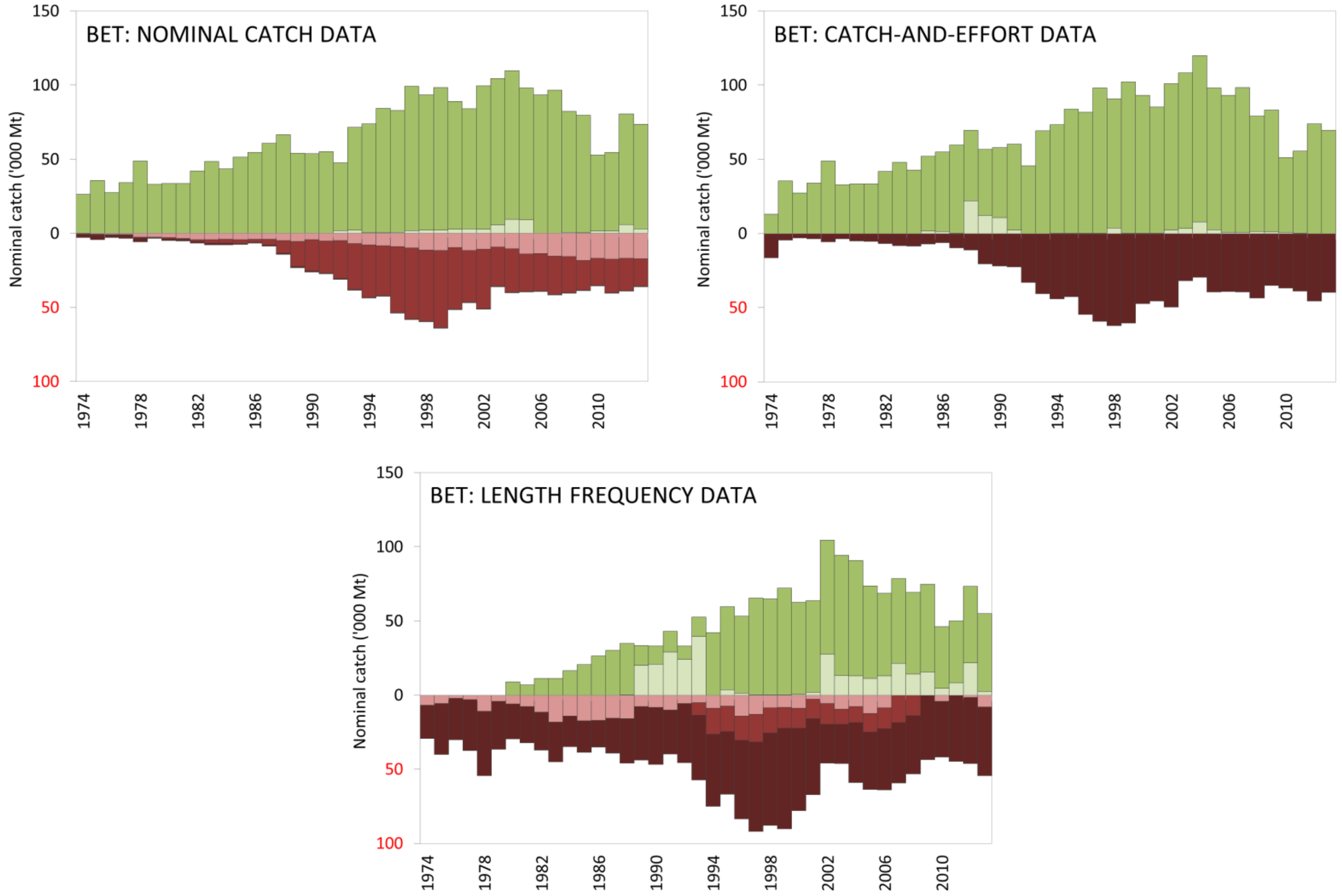


Fig. 6a-c. Bigeye tuna: data reporting coverage (1974–2013). Each IOTC dataset (a) nominal catch, b) catch-and-effort, and c) length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available (Data as of September 2014).

Key to IOTC Scoring system

Nominal Catch	By species	By gear
Fully available	0	0
Partially available (part of the catch not reported by species/gear)*	2	2
Fully estimated (by the IOTC Secretariat)	4	4

*Catch assigned by species/gear by the IOTC Secretariat; or 15% or more of the catches remain under aggregates of species

Catch-and-Effort	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

Size frequency data	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 1 fish measured by metric ton of catch)	2	
Not available at all	8	

Key to colour coding

- Total score is 0 (or average score is 0-1)
- Total score is 2 (or average score is 1-3)
- Total score is 4 (or average score is 3-5)
- Total score is 6 (or average score is 5-7)
- Total score is 8 (or average score is 7-8)

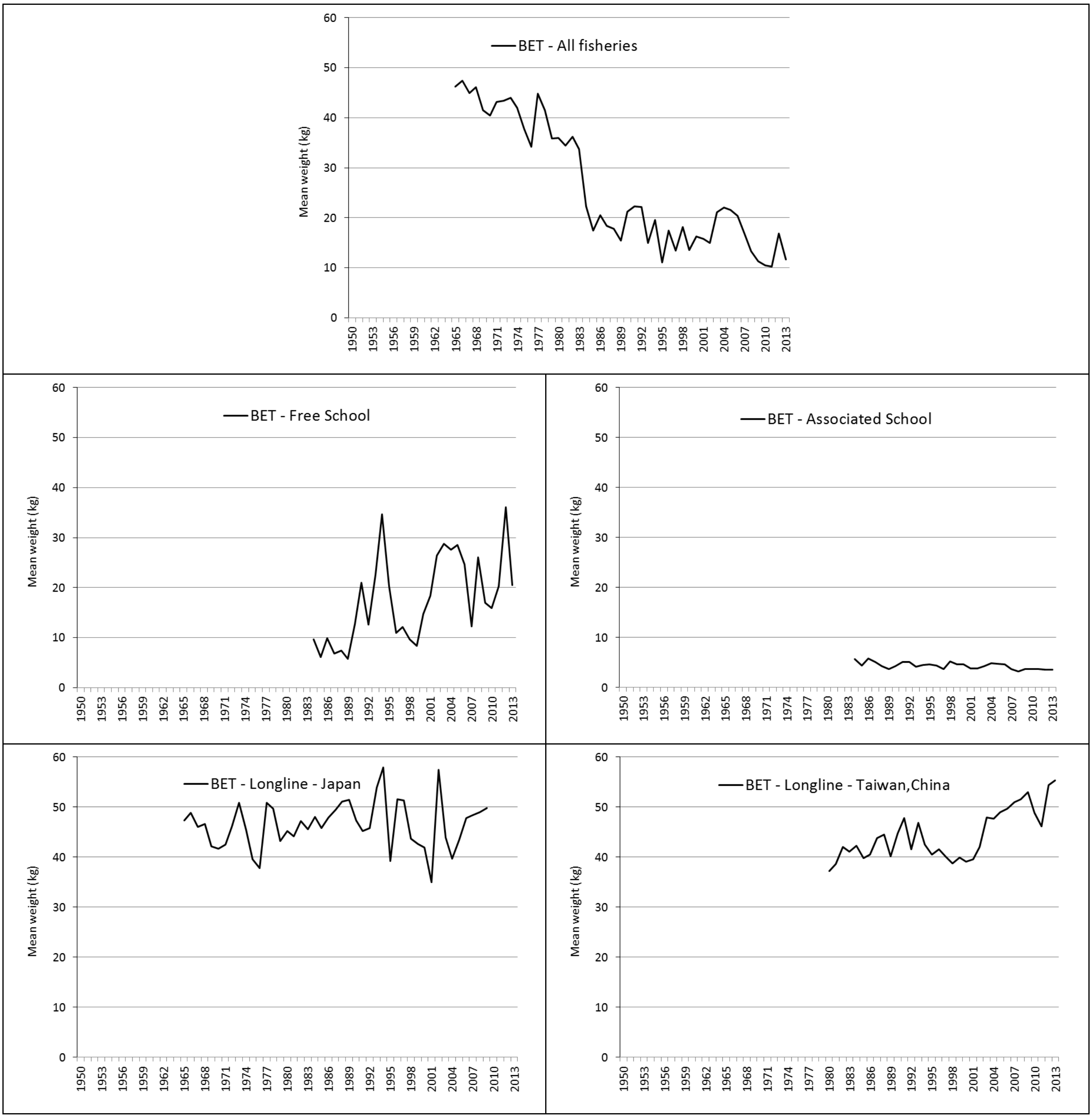


Fig. 7. Bigeye tuna: Average weight of bigeye tuna (BET) taken by: All fisheries combined (top) Purse seine on free (top left) and associated (top right) schools, Longlines from Japan (botom left) and Taiwan,China (bottom right).

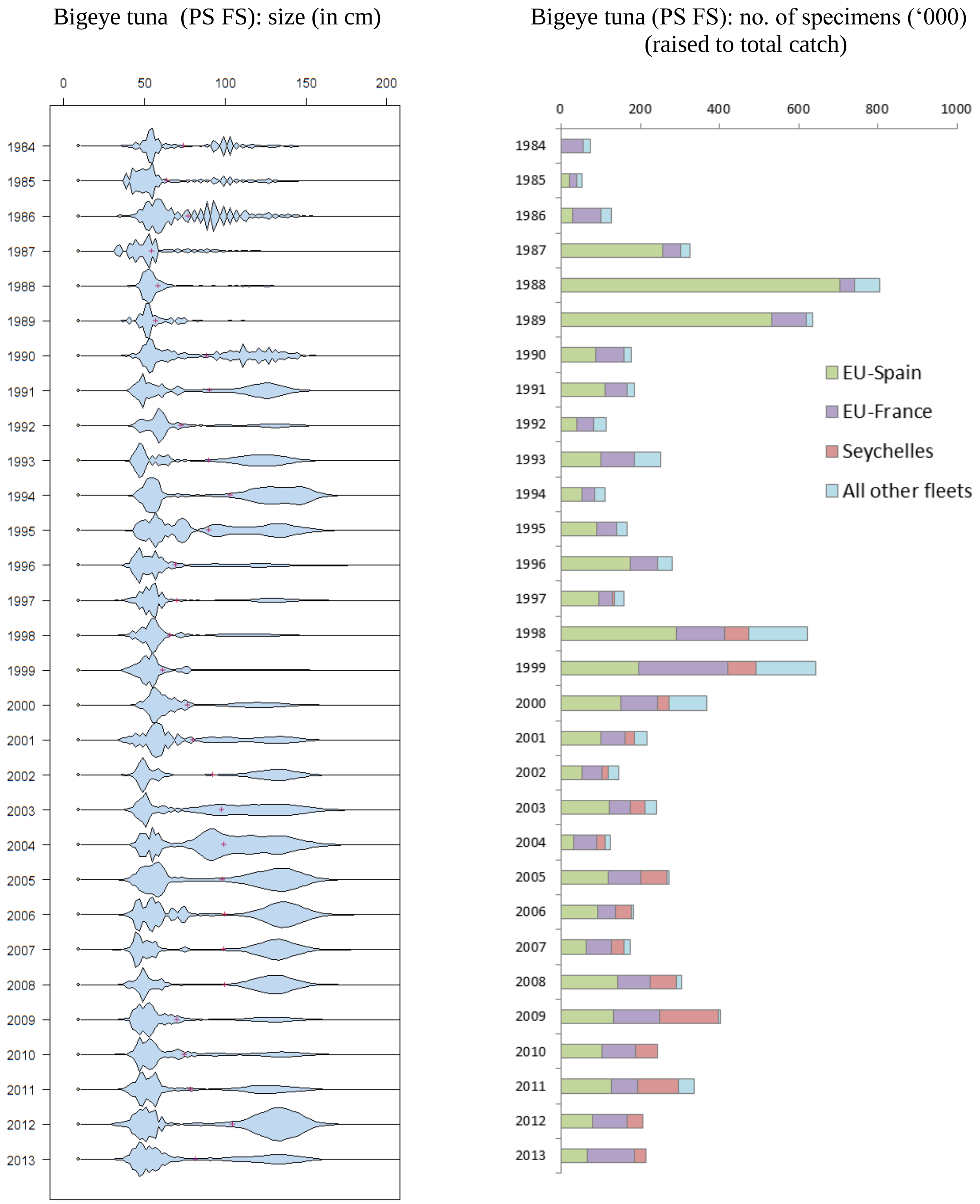


Fig. 8. Bigeye tuna (PS Free school): **Left:** length frequency distributions for PS Free School fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of bigeye tuna specimens sampled for lengths (raised to total catch), by fleet (PS Free School only). FS: Free swimming school.

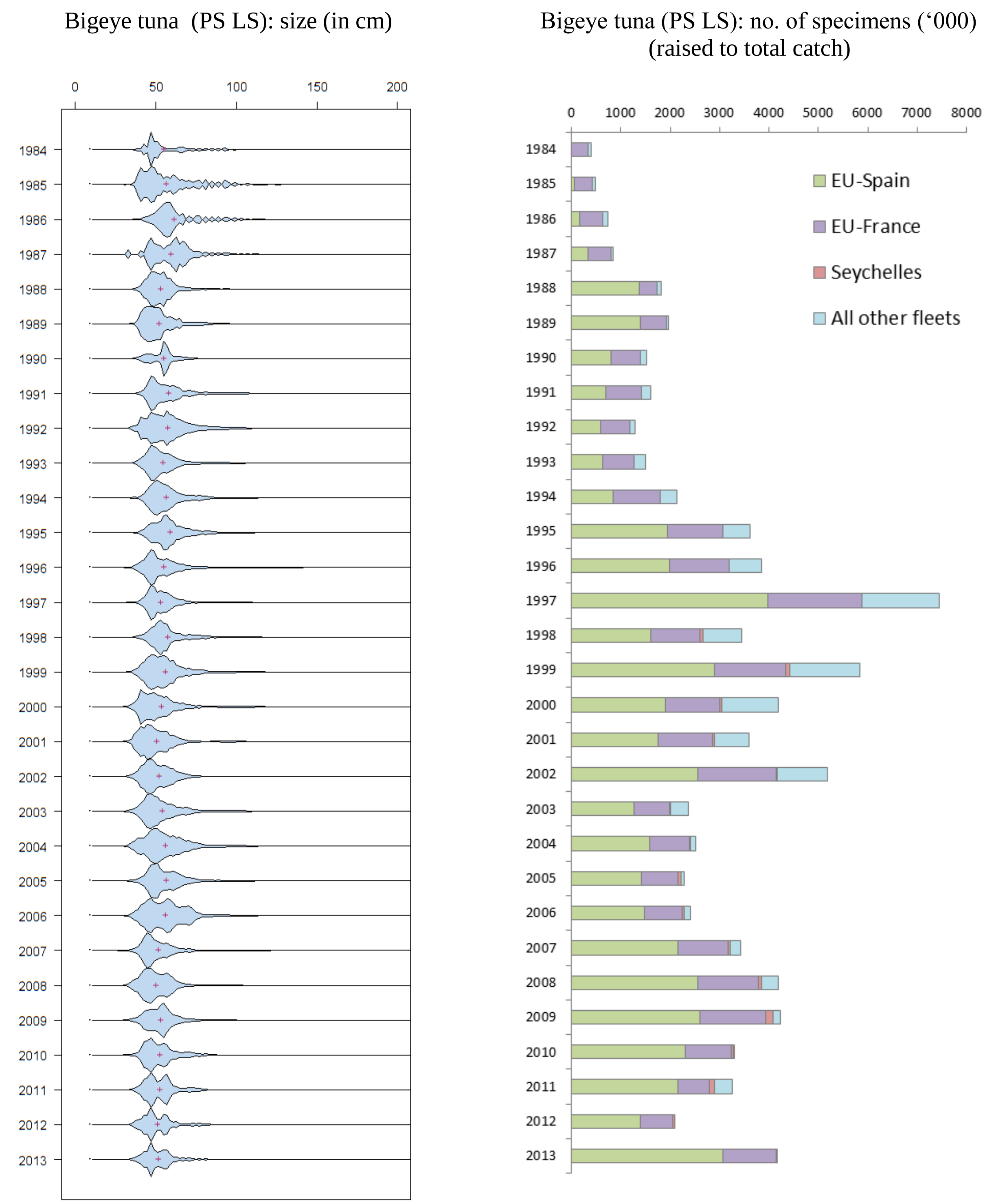


Fig. 9. Bigeye tuna (PS Associated school): **Left:** length frequency distributions for PS Associated school fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of bigeye tuna specimens sampled for lengths (raised to total catch), by fleet (PS Associated school only). LS: Log school.

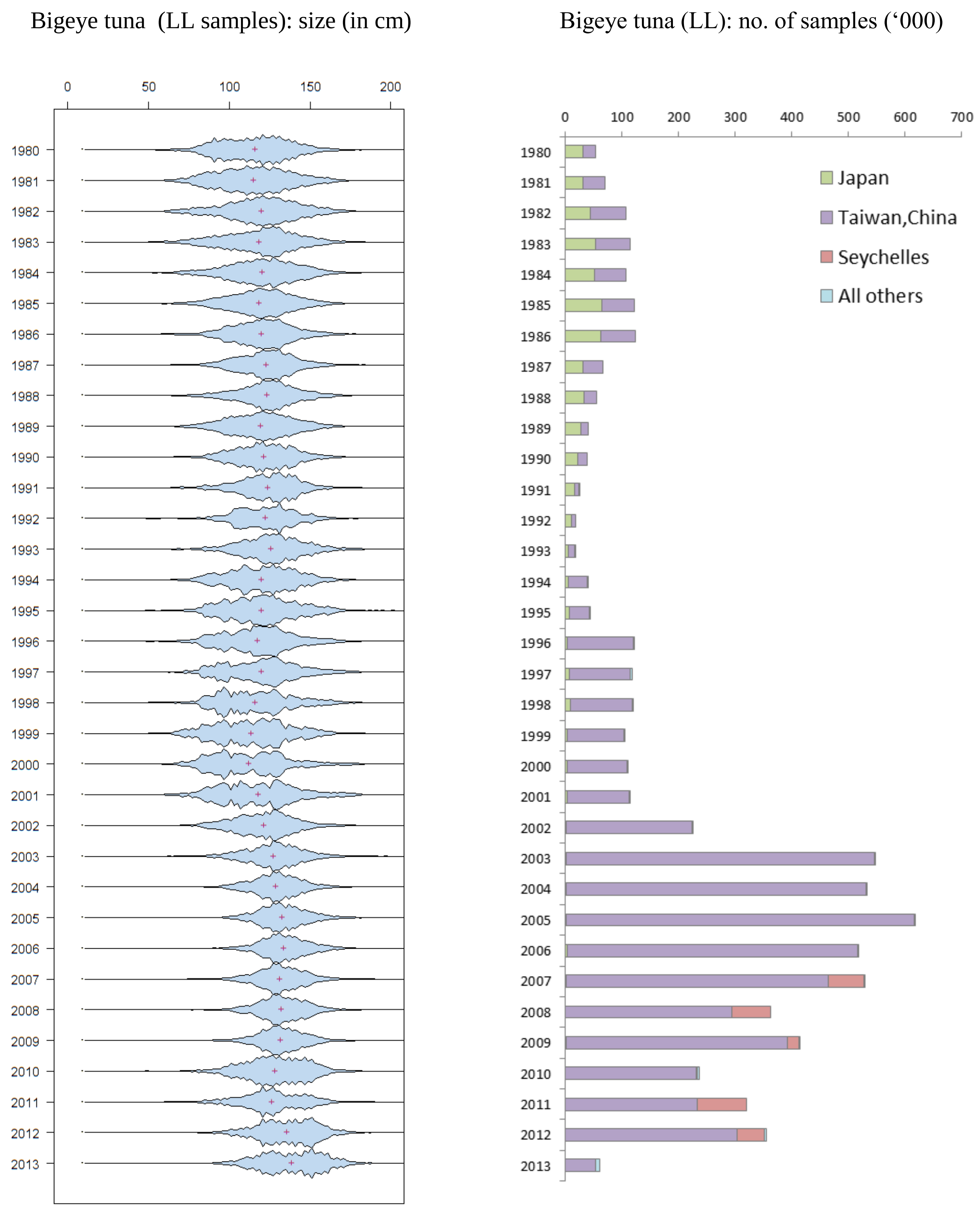


Fig. 10. Bigeye tuna (LL: longline): **Left:** length frequency distributions for longline fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of bigeye tuna specimens sampled for lengths, by fleet (longline only).

Bigeye tuna – Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2012 and 2013 are provided in Fig. 11, 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 2012 and 2013 are provided in Fig. 12. Total effort exerted by pole-and-line fleets in the Indian Ocean for the years 2011 and 2012 are providedin Fig. 13. Effort data for 2013 has not yet been reported.

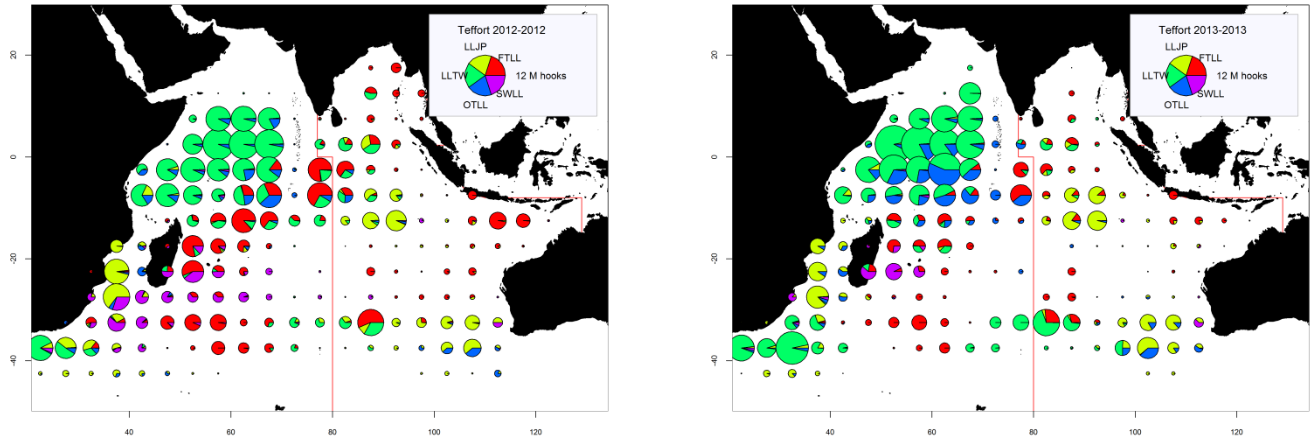


Fig. 11. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014). **LLJP** (light green): deep-freezing longliners from Japan; **LLTW** (dark green): deep-freezing longliners from Taiwan,China; **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).

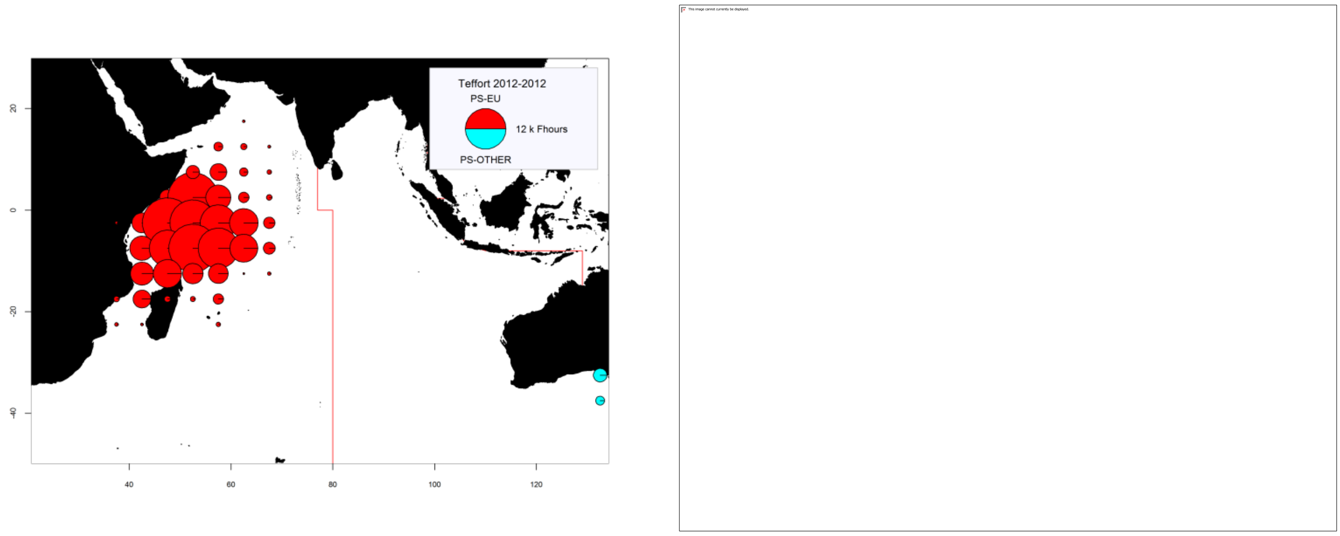


Fig. 12. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014). **PS-EU** (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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).

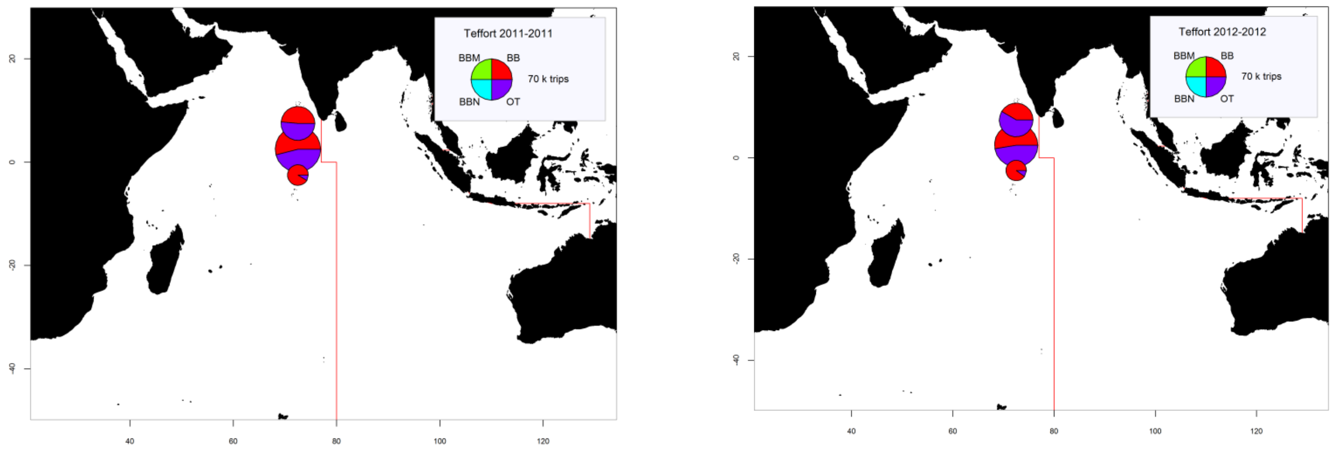
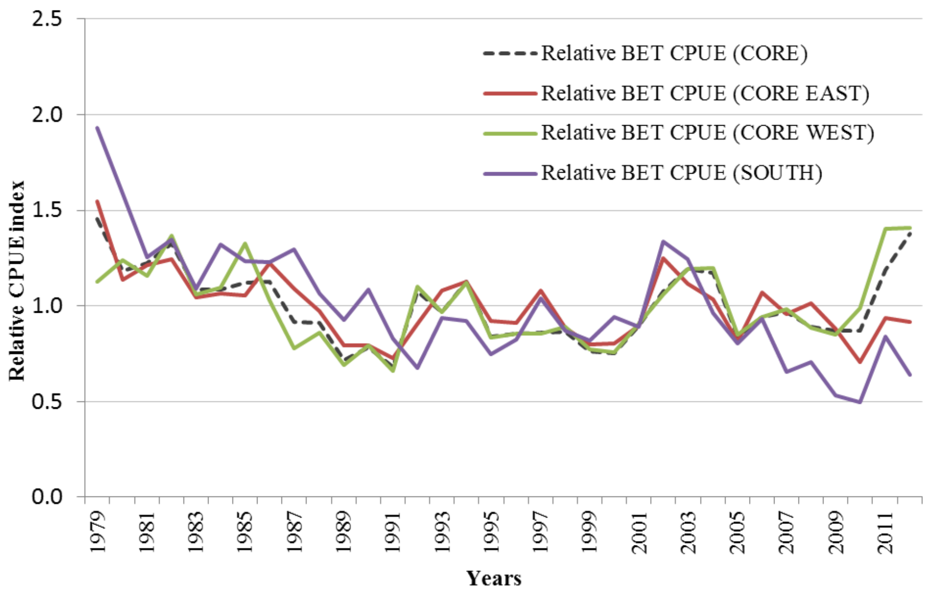


Fig. 13. Effort exerted by pole-and-line fleets in the Indian Ocean, in thousands (k) of trips (equivalent to fishing days), for the years 2011 (left) and 2012 (right) (Data as of September 2014). Note: Effort data for 2014 has not yet been reported. **BBM** (green): Pole-and-line (mechanized baitboats); **BBN** (blue): Pole-and-line (non-mechanized baitboats) **BB** (red): Pole-and-line (all types of baitboat, especially mechanized); **OT** (purple): Pole-and-line and other gears unidentified (effort not available by gear). 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.

Bigeye tuna: Standardised catch–per–unit–effort (CPUE) trends

The CPUE series presented at the WPTT16 meeting in 2014 are listed below. However, only the Japanese longline CPUE index (quarterly) for the whole Indian Ocean (1960–2013) (Fig. 14) was utilised for the final stock assessment model runs and in the development of management advice, noting that the Japanese series from the tropical areas and the Indian Ocean as a whole, showed very similar trends.

- Taiwan,China data (1979–2012): Series (core, core east, core west, south) from document IOTC–2014–WPTT16–55.
- Japan data (1960–2013): Series (whole Indian Ocean, tropical area, temperate area) from document IOTC–2014–WPTT16–29 Rev_1.
- Rep. of Korea data (1977–2013): Series (whole Indian Ocean, tropical area, southern area) from document IOTC–2014–WPTT16–30.



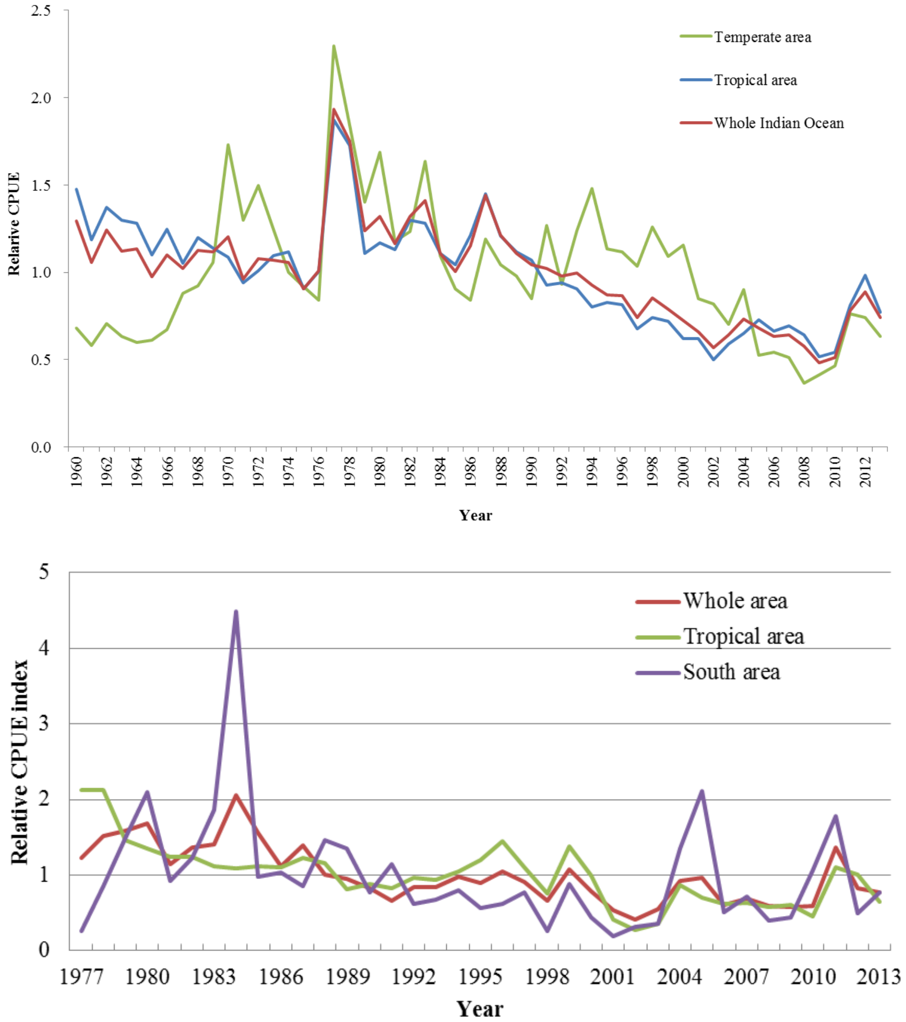


Fig. 14. Bigeye tuna: Standardised CPUE series for: top) Comparison of the standardised longline CPUE series (by area) for Taiwan,China. Series have been rescaled relative to their respective means from 1979–2012; middle) Comparison of the standardised longline CPUE series for Japan. Series have been rescaled relative to their respective means from 1960–2013; bottom) Comparison of the standardised longline CPUE series for the Rep. of Korea. Series have been rescaled relative to their respective means from 1977–2013.

Bigeye tuna: Tagging data

A total of 35,997 bigeye tuna (17.9%) were tagged during the Indian Ocean Tuna Tagging Programme (IOTTP). Most of them (96.0%) were tagged during the main Regional Tuna Tagging Project-Indian Ocean (RTTP-IO) and released off the coast of Tanzania in the western Indian Ocean, between May 2005 and September 2007 (Fig. 15). The remaining were tagged during small-scale projects, and by other institutions with the support of the IOTC Secretariat, in the Maldives, India, and in the south west and the eastern Indian Ocean. To date, 5,806 specimens (16.1% of releases for this species) have been recovered and reported to the IOTC Secretariat. These tags were mainly reported from the purse seine fleets operating in the Indian Ocean (90.9%), while 5.3% were recovered from longline vessels.

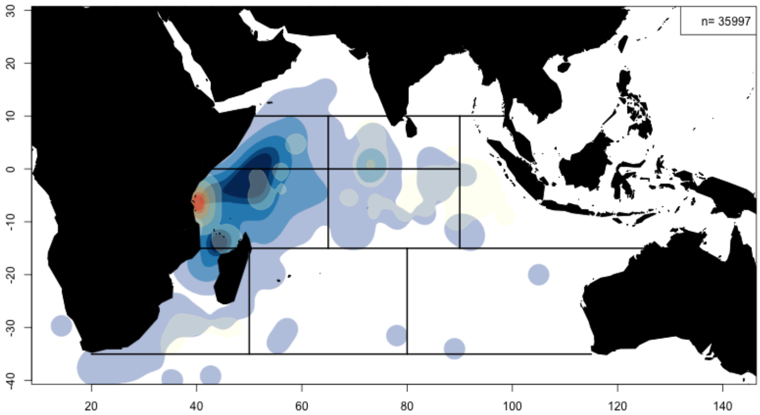
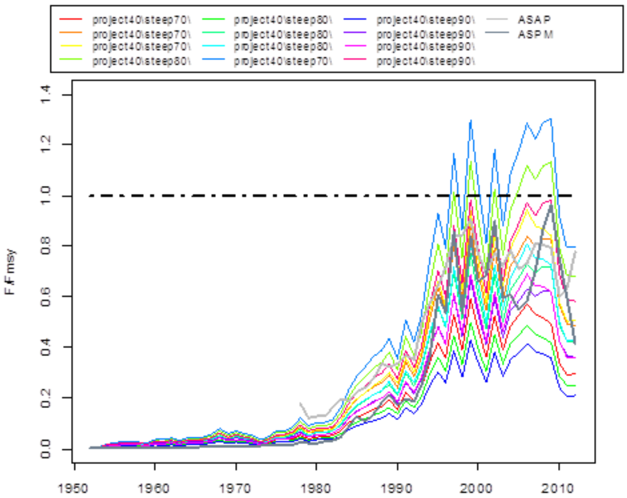


Fig. 15. Bigeye tuna: Densities of releases (in red) and recoveries (in blue). The black line represents the stock assessment areas. Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s (Data as of September 2012).

STOCK ASSESSMENT

No new assessments were carried out on bigeye tuna in 2014. A range of quantitative modelling methods (ASAP, ASPM and SS3) were applied to bigeye tuna in 2013. Management advice for bigeye tuna is based on the range of results from the SS3 models. The SS3 results were preferred to the other assessment platforms (ASPM and ASAP) because a more comprehensive range of model options were investigated and a range of diagnostics indicated that the models represented a reasonable fit to the main datasets. The range of plausible SS3 model options was considered to adequately represent the range of uncertainty in the assessment. Integrating across all outcomes, the 2013 stock assessment model results did not differ substantively from the previous (2010 and 2011) assessments or amongst the models applied, although, the final overall estimates of stock status differ somewhat due to the revision of the catch history, new information, and updated standardised CPUE indices.

All the runs (except 2 extremes) carried out in 2013 indicate that the stock is above a biomass level that would produce MSY in the long term (i.e. $SB_{2012}/SB_{MSY} > 1$) and in all runs that current fishing mortality is below the MSY-based reference level (i.e. $F_{2012}/F_{MSY} < 1$). This is illustrated in Fig. 16, which shows the time trajectories in F/F_{MSY} and B/B_{MSY} across the range of model results applied to characterise uncertainty in stock status.



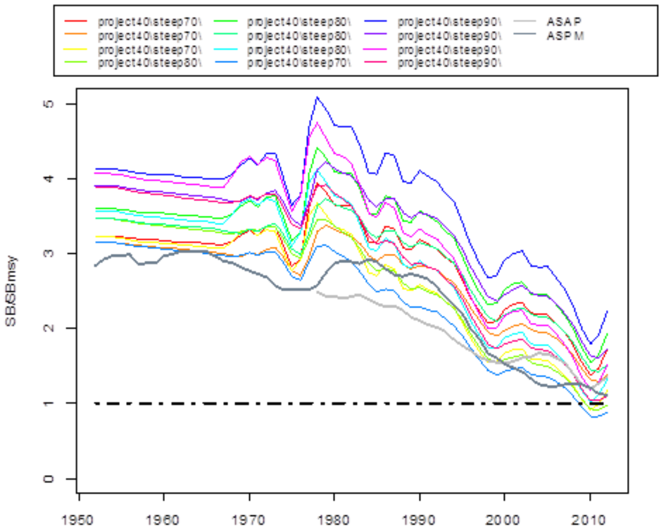


Fig. 16. Bigeye tuna: Ranges of F/F_{MSY} (top) and B/B_{MSY} (bottom) over time, indicating the range of uncertainty in stock assessment outcomes from the stock assessment models used in 2013 (SS3). ASAP and ASPM base cases are presented for comparative purposes.

Key assessment results for the 2013 SS3 stock assessment are shown in Table 6; Fig. 1.

Table 6. Bigeye tuna: Key management quantities from the SS3 assessment, for the aggregate Indian Ocean.

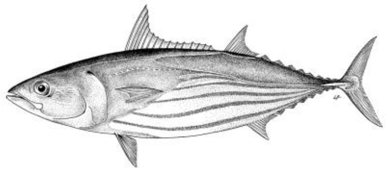
Management Quantity	Aggregate Indian Ocean
2013 catch estimate	109,343 t
Mean catch from 2009–2013	105,924 t
MSY [plausible range] (1,000 t)	132 [98–207]
Data period used in assessment	1952–2012
F_{MSY} [plausible range]	n.a. (n.a.–n.a.)
SB_{MSY} (1,000 t) [plausible range]	474 (295–677)
F_{2012}/F_{MSY} [plausible range]	0.42 [0.21–0.80]
B_{2012}/B_{MSY}	n.a.
SB_{2012}/SB_{MSY} [plausible range]	1.44 [0.87–2.22]
B_{2012}/B_{1952}	n.a.
SB_{2012}/SB_{1952} [plausible range]	0.40 [0.27–0.54]
$B_{2012}/B_{2012,\ F=0}$	n.a.
$SB_{2012}/SB_{2012,\ F=0}$	0.40 [0.27–0.54]

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 XIV
EXECUTIVE SUMMARY: SKIPJACK TUNA

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



Status of the Indian Ocean skipjack tuna (SKJ: *Katsuwonus pelamis*) resource

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

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Catch 2013: Average catch 2009–2013:	424,580 t 401,132 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): C_{2013}/C_{MSY} (80% CI): SB_{2013}/SB_{MSY} (80% CI): SB_{2013}/SB_0 (80% CI):	684 (550–849) 0.65 (0.51–0.79) 875 (708–1,075) 0.62 (0.49–0.75) 1.59 (1.13–2.14) 0.58 (0.53–0.62)	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.

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		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. The 2014 stock assessment model results did not differ substantively from the previous (2012 and 2011) assessments; however, the final overall estimates of stock status differ somewhat due to the revision of the input parameters and updated standardised CPUE indices. All the runs carried out in 2014 indicate the stock is above a biomass level that would produce MSY in the long term (i.e. SB_{2013}/SB_{MSY} > 1) and in all runs that the current proxy for fishing mortality is below the MSY-based reference level (i.e. $C_{current}/C_{MSY}$ < 1) (Table 1 and Fig. 1). The median value of MSY from the model runs investigated was 684,000 t with a range between 550,000 and 849,000 t. Current spawning stock biomass was estimated to be 57% (Table 1) of the unfished levels. Catches in 2014 (≈424,000 t) remain lower than the estimated MSY values from the 2014 stock assessments (Table 1). The average catch over the previous five years (2009–13; ≈401,000 t) also remains below the estimated MSY. Thus, on the weight-of-evidence available in 2014, the skipjack tuna stock is determined to be **not overfished** and is **not subject to overfishing** (Table 1).

Outlook. The recent declines in catch/sets on FADs (in parallel to the increased number of FADs deployed by the purse seine fleet) as well as the large decrease on free school skipjack tuna are thought to be of some concern as the WPTT does not fully understand the cause of those declines. There remains considerable uncertainty in the assessment, and the range of runs analysed illustrate a range of stock status to be between 0.73–4.31 of SB_{2013}/SB_{MSY} based on all runs examined. 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 conducted in 2013, there is a low risk of exceeding MSY-based reference points by 2016 and 2023 if catches are maintained at the current levels of around 425,000 t (< 1 % risk that $B_{2016} < B_{MSY}$ and 1 % risk that C_{2023}>MSY as proxy of $F > F_{MSY}$).

The following key points should be noted:

- Maximum Sustainable Yield (MSY): The median MSY value from the model runs investigated was 684,000 t with a range between 550,000 and 849,000 t (Table 1); However, MSY reference levels from these models were not well determined. Historically, catches in excess of 6000,000 t were estimated to coincide with the time that the stock fell below 40% of the unfished level, which maybe a more robust proxy for MSY in this case. Considering the average catch level from 2009–2013 was 401,000 t, the stock appears to be in no immediate threat of breaching target and limit reference points. Current stock size is above $SB_{40\%}$ and predicted to increase on the short term. Catches at the level of 425,000 t have a low probability of reducing the stock below $SB_{40\%}$ in the short term (3–5 years) and medium term (10 years). However, taking into account the uncertainty related to current skipjack assessment as well as other indicators such the low catch rates of

FADs and increased effort, it is recommended that annual catches of skipjack tuna should not exceed the lower value of MSY of the range (550,000 t) in order to ensure that stock biomass levels could sustain catches at the MSY level in the long term. If catch remains below the estimated MSY levels, 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.

- 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.
- **Provisional reference points:** Noting that the Commission in 2013 agreed to Resolution 13/10 *on interim target and limit reference points and a decision framework*, the following should be noted:
  - **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, and therefore below the provisional limit reference point of 1.5*F_{MSY} (Fig. 1). Based on the current assessment there is a very low probability that the limit reference points of 1.5*F_{MSY} at the current catch levels will be exceeded in 3 or 10 years.
  - **Biomass**: Current spawning biomass is considered to be above the target reference point of SB_{MSY}, and therefore above the limit reference point of 0.4*SB_{MSY} (Fig. 1). Based on the current assessment, there is a low probability that the spawning stock biomass, at the current catch levels, will be below the limit reference point of 0.4*SB_{MSY} in 3 or 10 years.
- **Main fishing gear** (2009–13): Other (NEI) ≈48%; Purse seine ≈32.6% (log ≈30.7% and free swimming school ≈1.8%); Pole-and-line ≈19.5%.;
- **Main fleets**: European Union ≈23% (EU,Spain: ≈16%; EU,France: ≈7%); Indonesia ≈21%; Sri Lanka ≈18%; ≈Maldives 16%; Seychelles ≈8%.

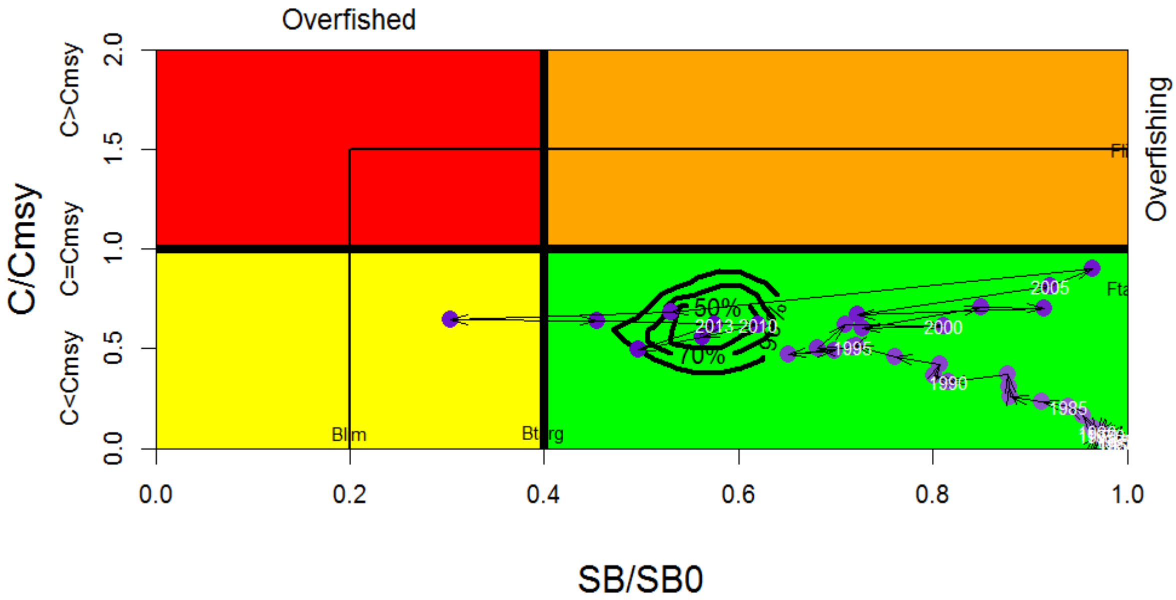


Fig. 1. Skipjack tuna: SS3 Aggregated Indian Ocean assessment Kobe plot (contours are the 50, 70 and 90 percentiles of the 2013 estimate). Blue circles indicate the trajectory of the point estimates for the SB/SB0 ratio and F proxy ratio for each year 1950–2013 estimated as C/C_{MSY}. Interim target (Ftarg and SBtarg) and limit (Flim and SBlim) reference points, are based on 0.4 (0.2) B_0 and C//C_{MSY}=1 (1.5) as suggested by WPTT.

TABLE 2. Skipjack tuna: SS3 aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target (top) and limit (bottom) reference points for nine constant catch projections (average catch level from 2013 (424,580 t), ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	Alternative catch projections (relative to the average catch level from 2013) and probability (%) of violating MSY-based target reference points (SB_{targ} = SB_{MSY}; F_{targ} = F_{MSY})								
	60% (254,748 t)	**70%** (297,206 t)	**80%** (339,664 t)	**90%** (382,122 t)	**100%** (424,580 t)	**110%** (467,038 t)	**120%** (509,496 t)	**130%** (551,954 t)	**140%** (594,412 t)
$SB_{2016} < SB_{MSY}$	0	n.a.	1	n.a.	1	n.a.	1	n.a.	9
$F_{2016} > F_{MSY}$	0	n.a.	1	n.a.	1	n.a.	5	n.a.	12
$SB_{2023} < SB_{MSY}$	0	n.a.	1	n.a.	1	n.a.	6	n.a.	25
$F_{2023} > F_{MSY}$	0	n.a.	1	n.a.	1	n.a.	5	n.a.	20

Reference point and projection timeframe	Alternative catch projections (relative to the average catch level from 2013) and probability (%) of violating MSY-based limit reference points (SB_{lim} = 0.4 B_{MSY}; F_{Lim} = 1.4 F_{MSY})								
	60% (254,748 t)	**70%** (297,206 t)	**80%** (339,664 t)	**90%** (382,122 t)	**100%** (424,580 t)	**110%** (467,038 t)	**120%** (509,496 t)	**130%** (551,954 t)	**140%** (594,412 t)
$SB_{2016} < SB_{Lim}$	0	n.a.	0	n.a.	0	n.a.	0	n.a.	0
$F_{2016} > F_{Lim}$	1	n.a.	1	n.a.	1	n.a.	1	n.a.	1
$SB_{2023} < SB_{Lim}$	0	n.a.	0	n.a.	0	n.a.	0	n.a.	0
$F_{2023} > F_{Lim}$	0	n.a.	1	n.a.	1	n.a.	1	n.a.	6

APPENDIX I

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 is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 14/02 *for the conservation and management of tropical tunas stocks in the IOTC area of competence*.
- Resolution 14/05 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 13/10 *On interim target and limit reference points and a decision framework*
- Resolution 13/11 *On a ban on discards of bigeye tuna, skipjack tuna, yellowfin tuna and a recommendation for non-targeted species caught by purse seine vessels in the IOTC area of competence*
- Resolution 12/11 *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 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Skipjack tuna – 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. Skipjack tuna: 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, Dortel et al. 2012, Eveson et al. 2012
NOAA http://www.nmfs.noaa.gov/fishwatch/species/atl_skipjack.htm 14/12/2011

Skipjack tuna: Fisheries and 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 fleets using pole-and-lines and gillnets (Table 4; Fig. 2). The catches increased rapidly with the arrival of the purse seiners in the early 1980s, and skipjack became one of the most important commercial tuna species in the Indian Ocean. Annual catches peaked at over 600,000 t in 2006 (Table 4). Since 2006 catches have declined to around 340,000 t in 2012 – the lower catches recorded since 1998 – although preliminary figures for 2013 indicate an increase in catch levels to around 424,000 t.

Table 4. Skipjack tuna: Best scientific estimates of the catches of skipjack tuna (*Katsuwonus pelamis*) by gear and main fleets [or type of fishery] by decade (1950–2009) and year (2004–2013), in tonnes. Data as of September 2014. Catches by decade represent the average annual catch, noting that some gears were not used since the beginning of the fishery.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
BB	10,007	15,148	24,684	41,705	77,079	109,528	112,142	139,660	147,937	107,383	99,104	75,761	83,458	69,355	68,788	93,016
FS	0	0	41	15,251	30,614	25,724	18,565	43,166	34,930	24,199	16,274	10,433	8,774	9,000	2,984	5,775
LS	0	0	125	34,474	124,015	163,799	137,232	168,018	211,509	120,951	128,448	148,135	144,097	123,056	80,989	119,839
OT	4,999	11,712	21,951	38,282	87,732	177,024	187,541	204,363	221,524	213,015	195,418	203,406	186,560	180,998	185,283	205,951
Total	**15,006**	**26,860**	**46,801**	**129,713**	**319,440**	**476,075**	**455,481**	**555,208**	**615,900**	**465,547**	**439,243**	**437,736**	**422,889**	**382,409**	**338,045**	**424,580**

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

The increase in skipjack tuna catches by purse seine vessels (Fig. 2) is due to the development of a fishery in association with drifting Fish Aggregating Devices (FADs) (Table 4) in the 1980s. In recent years, over 90% of the skipjack tuna caught by purse seine vessels is taken from around FADs. Catches by purse seiners increased steadily since 1984 with the highest catches recorded in 2002 and 2006 (>240,000 t). Catches of skipjack dropped in the years 2003 and 2004, probably as a consequence of high purse seine catch rates on free schools of yellowfin tuna during those years. 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 (and the technology associated with them) used in the fishery. In 2007 purse seine catches declined by around 100,000 t (from around 245,000 t in 2005 145,000 t in 2007). The sharp decline in purse seine catches since 2007 coincided with a similar decline in the catches by Maldivian baitboats.

Table 5. Skipjack tuna: Best scientific estimates of the catches of skipjack tuna (*Katsuwonus pelamis*) by area [as used for the assessment] by decade (1950–2009) and year (2004–2013), in tonnes (Data as of September 2014). Catches by decade represent the average annual catch.

	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
R1	4,524	9,951	19,291	34,586	80,757	118,327	119,042	114,269	109,016	137,688	139,941	151,487	153,432	152,943	149,001	159,360
R2	1,483	4,110	8,235	59,667	170,901	257,243	231,897	310,526	370,153	232,052	213,718	221,230	197,872	176,977	137,910	192,638
R2b	9,000	12,800	19,275	35,459	67,782	100,505	104,542	130,412	136,730	95,807	85,584	65,018	71,585	52,489	51,134	72,583
Total	**15,006**	**26,860**	**46,801**	**129,713**	**319,441**	**476,075**	**455,481**	**555,208**	**615,900**	**465,547**	**439,243**	**437,736**	**422,889**	**382,409**	**338,046**	**424,581**

Areas: East Indian Ocean (**R1**); West Indian Ocean, (**R2**); Maldives pole-and-line (R2b).

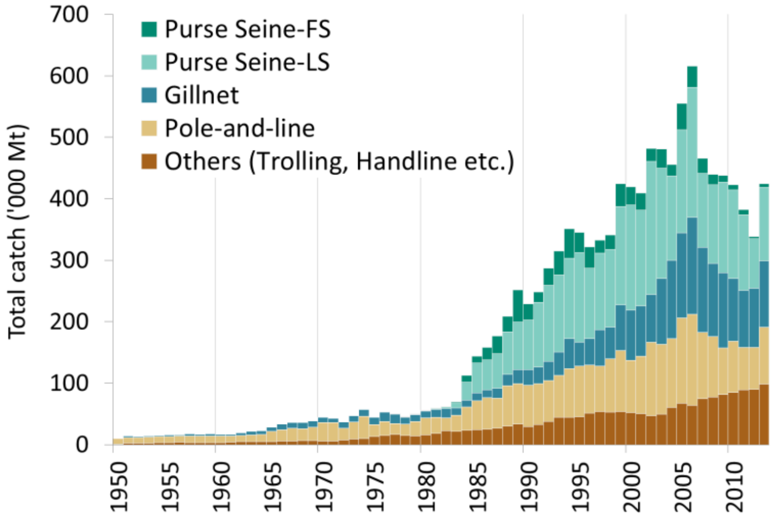


Fig. 2. Skipjack tuna: Annual catches of skipjack tuna by gear (1950–2013) (Data as of September 2014).

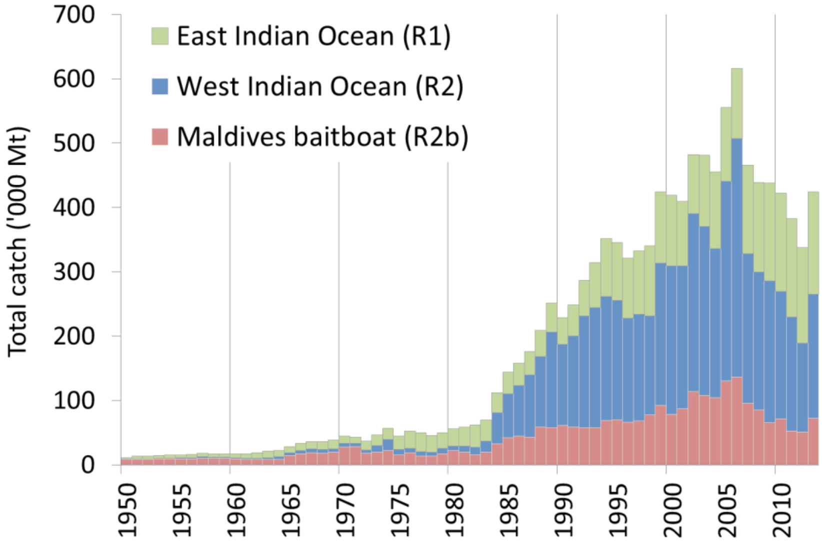


Fig. 3. Skipjack tuna: Catches of skipjack tuna by area by year estimated for the WPTT (1950–2013) (Data as of September 2014). **Areas**: East Indian Ocean (**R1**); West Indian Ocean (**R2**); Maldives baitboat (**R2b**).

The Maldivian fishery (Fig. 2) has effectively increased its fishing effort with the mechanisation of its pole-and-line fleet since 1974, including an increase in boat size and power and the use of anchored FADs since 1981. Skipjack tuna represents around 80% of the total catch of Maldives, where skipjack catch rates regularly increased between 1980 and 2006 – the year in which the highest skipjack catch was recorded for this fishery (≈140,000 t). Catches of skipjack tuna reported by Maldives have since declined in recent years to as low as 55,000 t, representing less than half the catches taken in 2006, although catches of around 75,000 t have been reported in 2013. The recent decline in skipjack catches by Maldives is, in part, related to the introduction of handlines targeting large specimens of yellowfin tuna.

Several fisheries using gillnets have reported large catches of skipjack tuna in the Indian Ocean (Figs. 4, 5), including the gillnet/longline fishery of Sri Lanka, driftnet fisheries of Iran and Pakistan, and gillnet fisheries of Indonesia. In recent years gillnet catches have represented as much as 20% to 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.

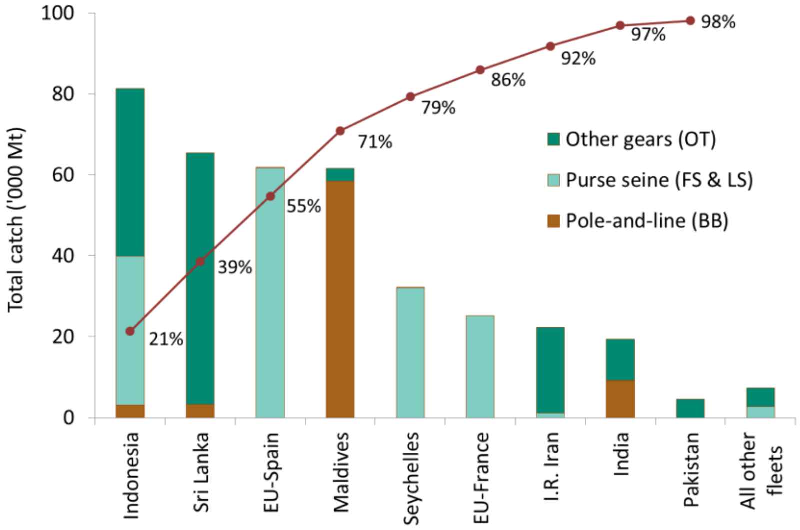


Fig. 4. Skipjack tuna: average catches in the Indian Ocean over the period 2010–12, by fleet. Fleets are ordered from left to right, according to the importance of catches of skipjack tuna reported. The red line indicates the (cumulative) proportion of catches of skipjack tuna for the fleets concerned, over the total combined catches of this species reported from all fleets and fisheries (Data as of September 2014).

The majority of the catches of skipjack tuna originate from the western Indian Ocean (Fig. 3). Since 2007 however, catches of skipjack tuna in the western Indian Ocean have dropped considerably, especially in areas off Somalia, Kenya, Tanzania and around the Maldives. The drop in catches are considered by the SC to be partially explained by the reduction in fishing effort by some fisheries due to the effects of piracy in the western Indian Ocean region, including industrial purse seiners and fleets using driftnets from Iran and Pakistan; and, as already noted, a decrease in catches of skipjack tuna by Maldivian baitboats following the introduction of handlines targeting yellowfin tuna.

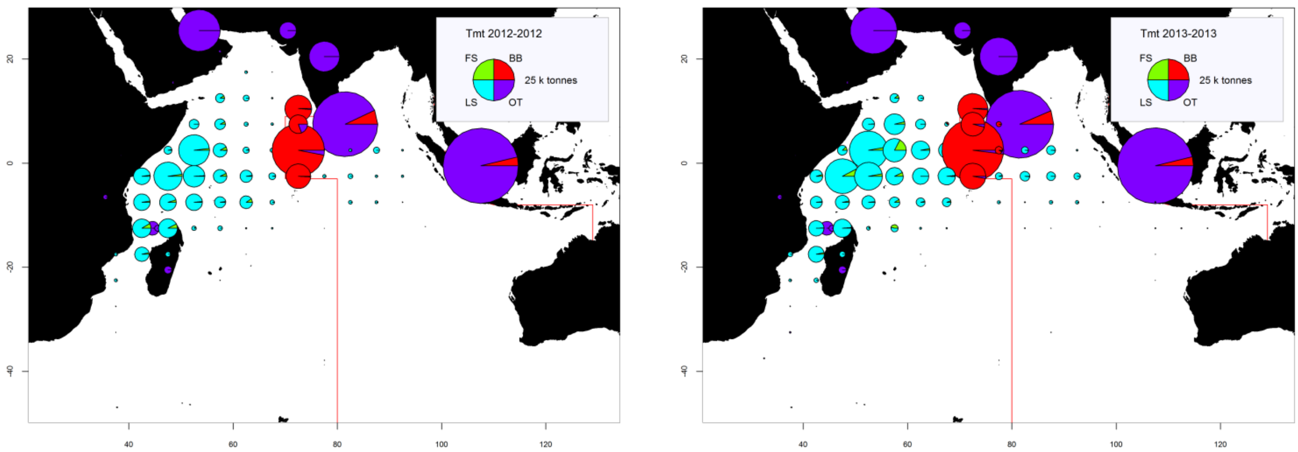


Fig. 5 (a-f). Skipjack tuna**:** Time-area catches (total combined in tonnes) of skipjack tuna estimated for the period 2004–08 by type of gear and for 2009–13, by year and type of gear. Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (BB), and other fleets (**OT**), including longline, drifting gillnets, and various coastal fisheries (Data as of September 2014). The catches of fleets for which the flag countries do not report detailed time and area data to the IOTC are recorded within the area of the countries concerned, in particular driftnets from Iran and Pakistan, gillnet and longline fishery of Sri Lanka, and coastal fisheries of Comoros, Indonesia and India.

Skipjack tuna: Status of Fisheries Statistics at the IOTC

Retained catches: Generally well known for the industrial fisheries but are less certain for many artisanal fisheries (Fig. 6a), notably because:

- catches are not being reported by species
- there is uncertainty about the catches from some significant fleets including the Sri Lankan coastal fisheries, and the coastal fisheries of Madagascar.

Discards: Believed to be low although they are unknown for most industrial fisheries, excluding industrial purse seiners flagged in EU fleets for the period 2003–2007.

Changes to the catch series: There have been no major changes to the catches of skipjack tuna since the WPTT in 2012.

Catch–per–unit–effort (CPUE) Series: Catch and effort data are available from various industrial and artisanal fisheries (Fig. 6b). However, these data are not available from some important fisheries or they are considered to be of poor quality for the following reasons:

- insufficient data available for the gillnet fisheries of Iran and Pakistan
- the poor quality effort data for the gillnet/longline fishery of Sri Lanka

no data are available from important coastal fisheries using hand and/or troll lines, in particular Indonesia, India and Madagascar.

Fish size or age trends (e.g. by length, weight, sex and/or maturity) (Figs. 7, 8, 9): Cannot be assessed before the mid-1980s and are incomplete for most artisanal fisheries thereinafter, namely hand lines, troll lines and many gillnet fisheries (Indonesia).

Catch-at-Size table: CAS are available but the estimates are uncertain for some years and fisheries due to (Fig. 6c):

- 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).

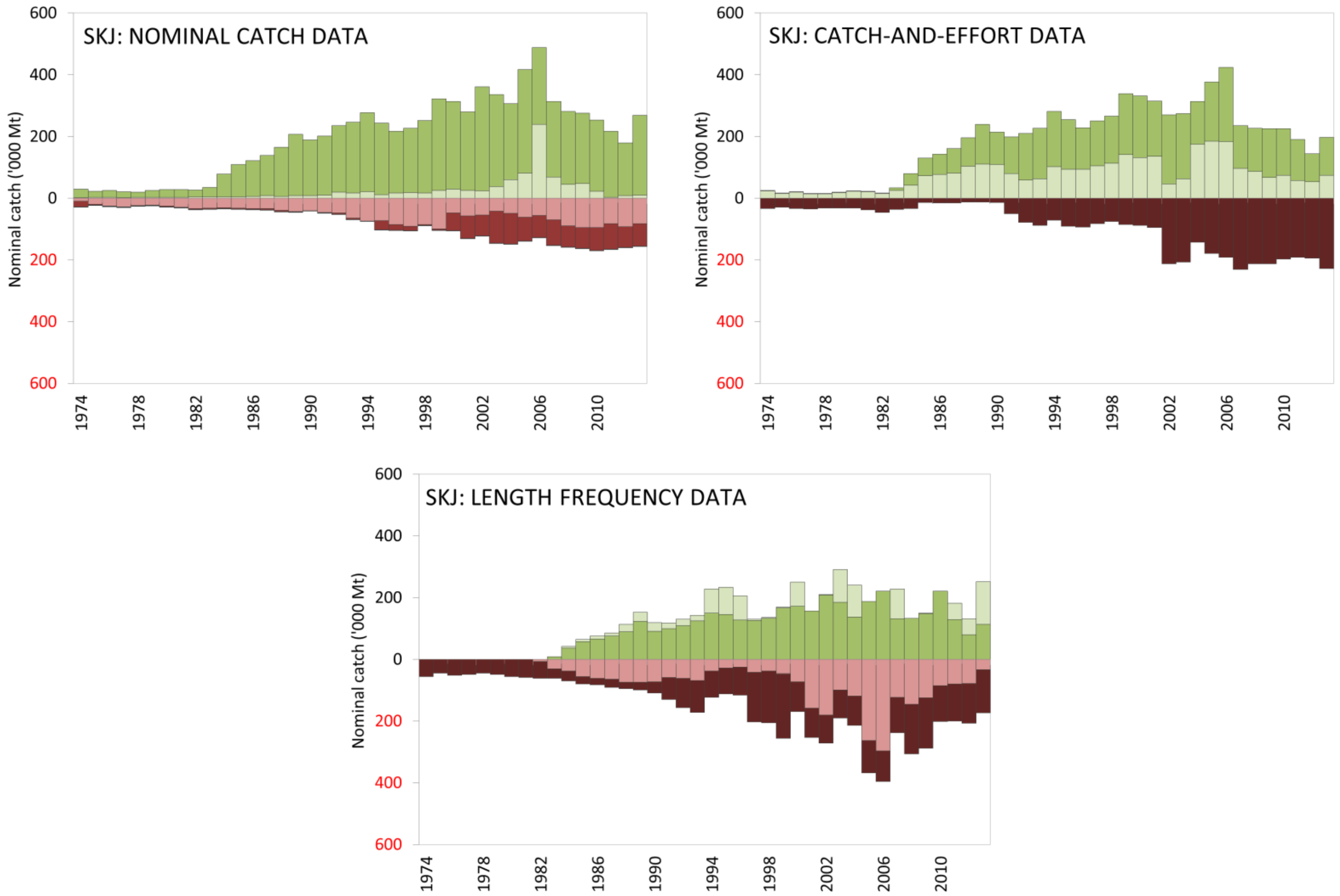


Fig. 6a-c. Skipjack tuna: data reporting coverage (1974–2013). Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available (Data as of September 2014).

Key to IOTC Scoring system

Nominal Catch	By species	By gear
Fully available	0	0
Partially available (part of the catch not reported by species/gear)*	2	2
Fully estimated (by the IOTC Secretariat)	4	4

*Catch assigned by species/gear by the IOTC Secretariat; or 15% or more of the catches remain under aggregates of species

Catch-and-Effort	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

Size frequency data	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 1 fish measured by metric ton of catch)	2	
Not available at all	8	

Key to colour coding

- Total score is 0 (or average score is 0-1)
- Total score is 2 (or average score is 1-3)
- Total score is 4 (or average score is 3-5)
- Total score is 6 (or average score is 5-7)
- Total score is 8 (or average score is 7-8)

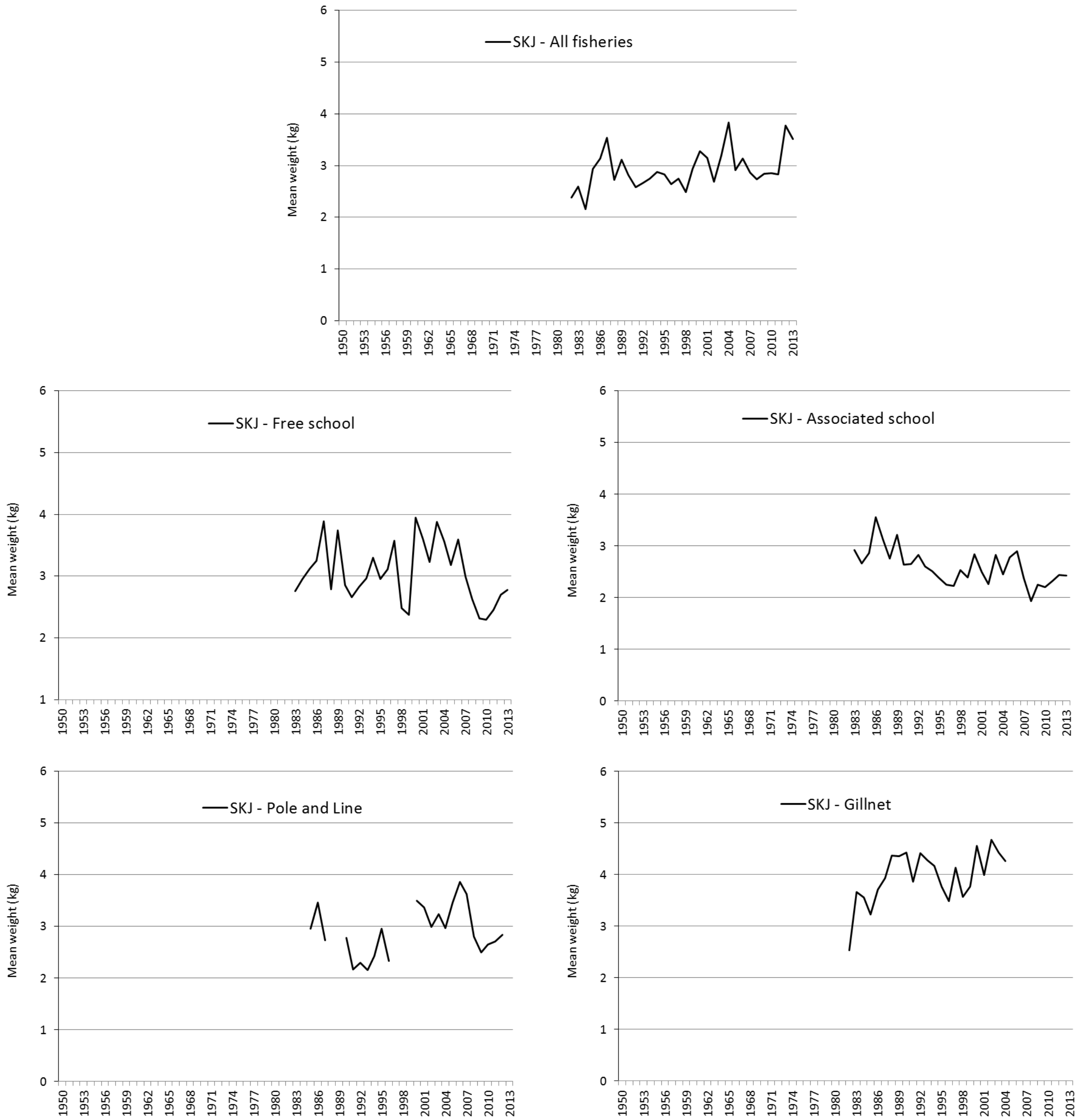
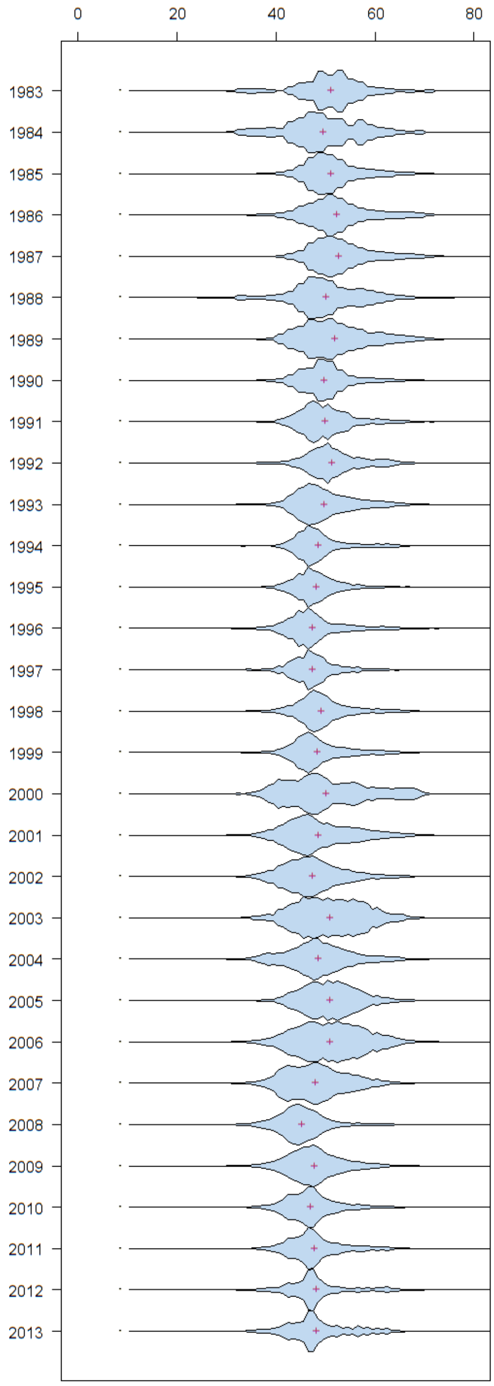


Fig. 7. Skipjack tuna: Average weight of skipjack tuna (SKJ) taken by All fleets combined (top), Purse seine on free (top left) and associated (top right) schools, Pole-and-line from Maldives and India (bottom left), Gillnets from Sri Lanka, Iran, and other countries (bottom right).

Skipjack tuna (PS LS): size (in cm)



Skipjack tuna (PS LS): no. of specimens ('000)
(raised to total catch)

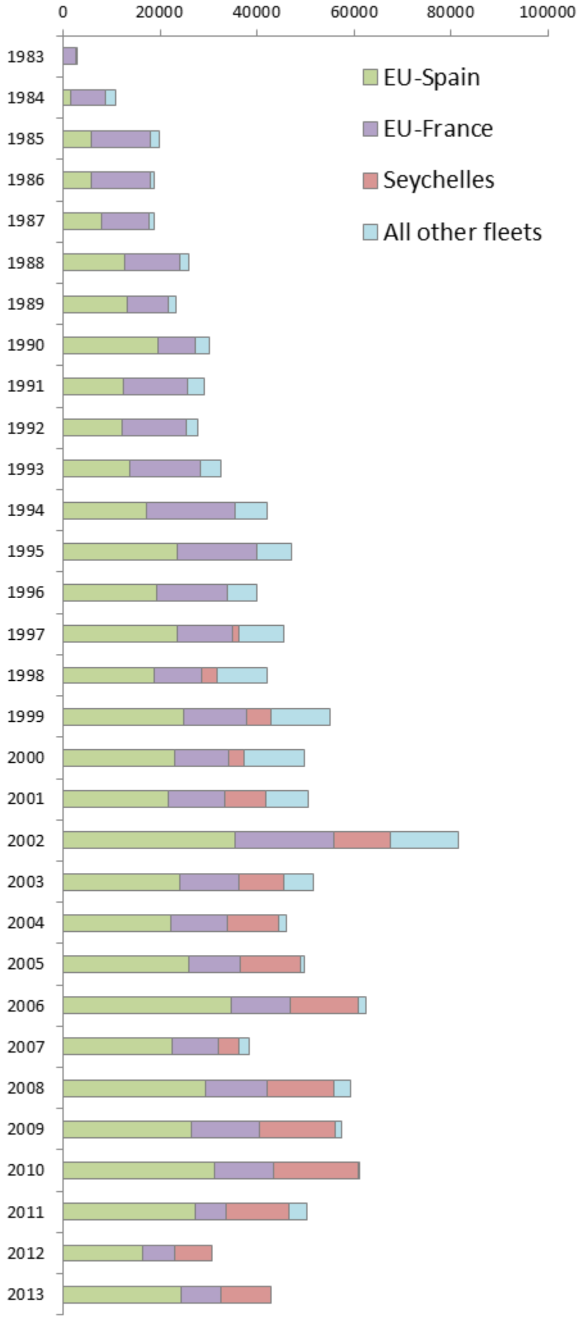
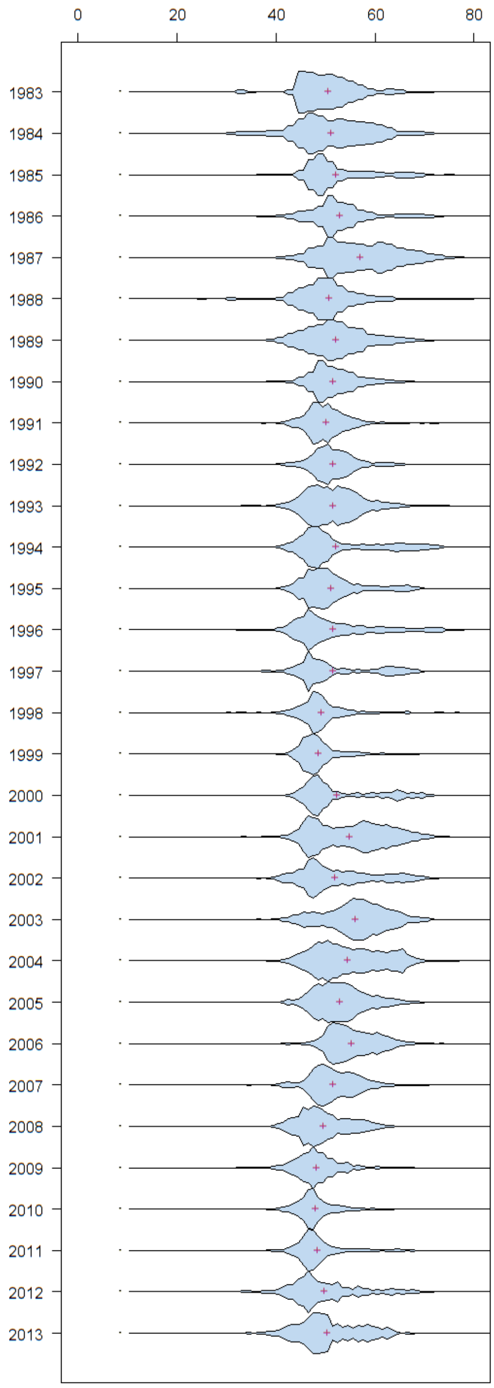


Fig. 8. Skipjack tuna (PS Associated school): **Left:** length frequency distributions for PS Associated school fisheries (total amount of fish measured by 1 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of skipjack tuna specimens sampled for lengths (raised to total catch), by fleet (PS Associated school only). LS: Log school.



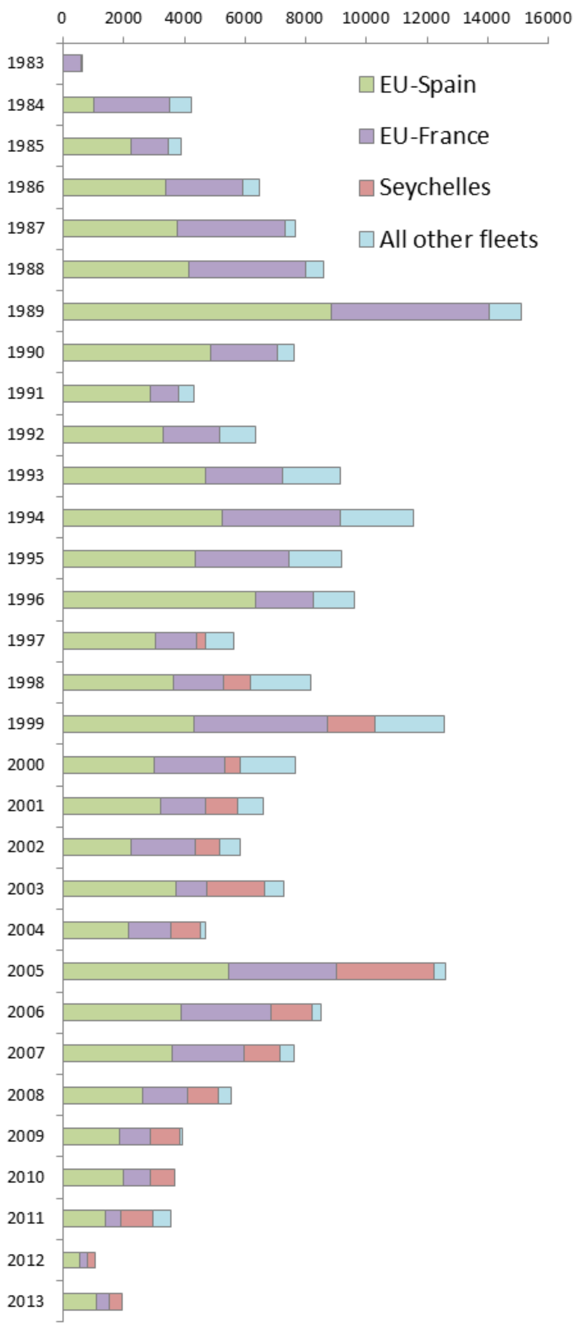


Fig. 9. Skipjack tuna (PS Free school): **Left:** length frequency distributions for PS Free school fisheries (total amount of fish measured by 1 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of skipjack tuna specimens sampled for lengths (raised to total catch), by fleet (PS Free school only). FS: Free swimming school.

Skipjack tuna – Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2012 and 2013 are provided in Fig. 10, 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 2013 and 2014 are provided in Fig. 11. Total effort exerted by pole-and-line fleets in the Indian Ocean for the years 2011 and 2012 are providedin Fig 12. Effort data for 2014 has not yet been reported.

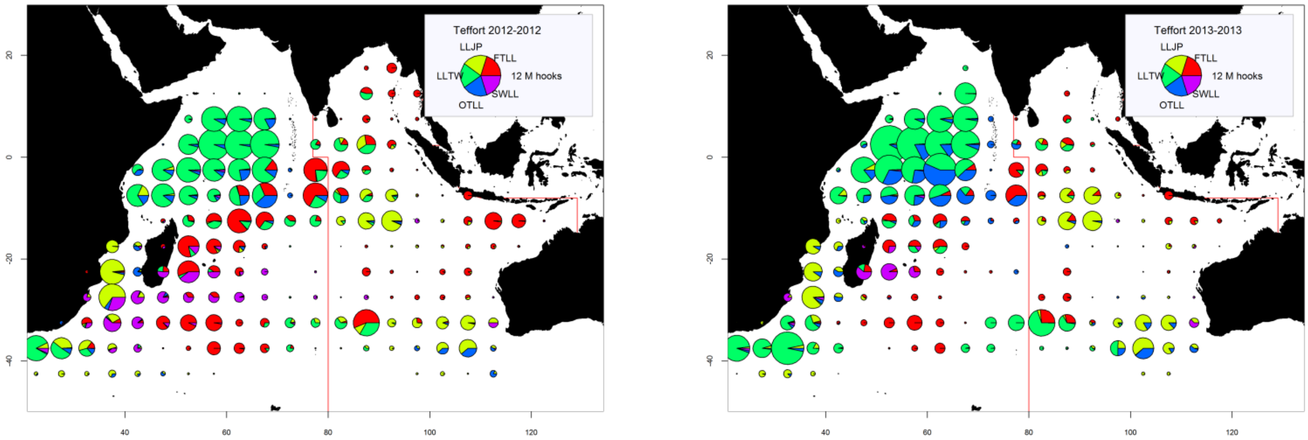


Fig. 10. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014). **LLJP** (light green): deep-freezing longliners from Japan; **LLTW** (dark green): deep-freezing longliners from Taiwan,China; **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).

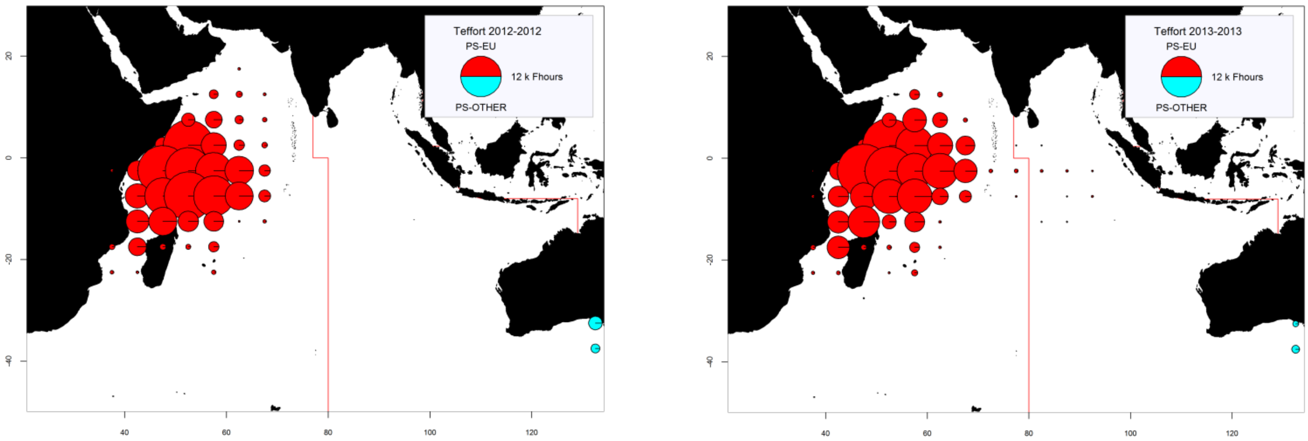


Fig. 11. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014). **PS-EU** (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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).

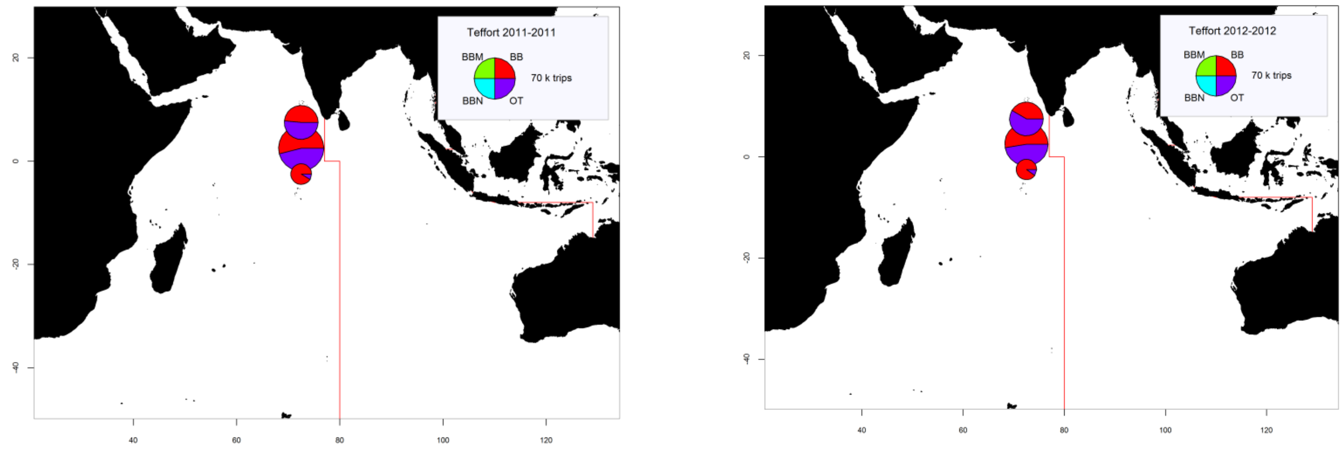


Fig. 12. Effort exerted by pole-and-line fleets in the Indian Ocean, in thousands (k) of trips (equivalent to fishing days), for the years 2011 (left) and 2012 (right) (Data as of September 2014). Note: Effort data for 2014 has not yet been reported. **BBM** (green): Pole-and-line (mechanized baitboats); **BBN** (blue): Pole-and-line (non-mechanized baitboats) **BB** (red): Pole-and-line (all types of baitboat, especially mechanized); **OT** (purple): Pole-and-line and other gears unidentified (effort not available by gear). 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.

Skipjack tuna: Standardised catch–per–unit–effort (CPUE) trends

The CPUE series presented at the WPTT16 meeting in 2014 are detailed below:

EU,France purse seine CPUE from paper IOTC–2014–WPTT16–41 (Fig. 13) which examined skipjack tuna CPUE trends using alternative indices from the EU,France purse seine logbooks.

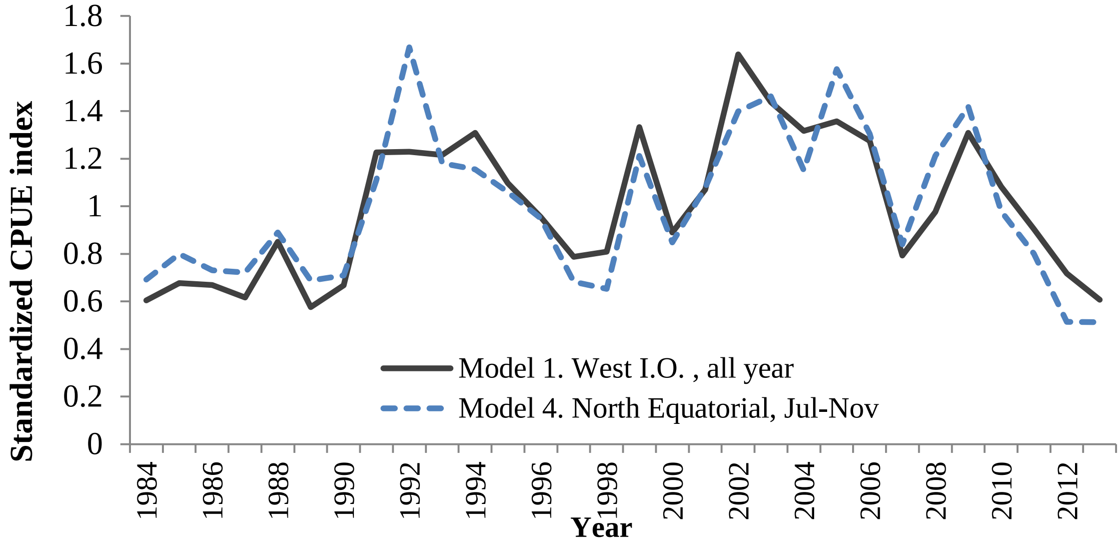


Fig. 13. Skipjack tuna: EU,France purse seine standardised CPUE series for skipjack tuna from 1984–13.

Maldives pole and line CPUE standardisation from paper IOTC–2014–WPTT16–42 (Fig. 14) which provided a standardised CPUE series for the Maldives skipjack pole and line fishery from 2004 to 2012, including the reconstruction of historic CPUE until 1985. The CPUE indices for the Maldives are likely to provide a representative index of abundance only for the Maldives area.

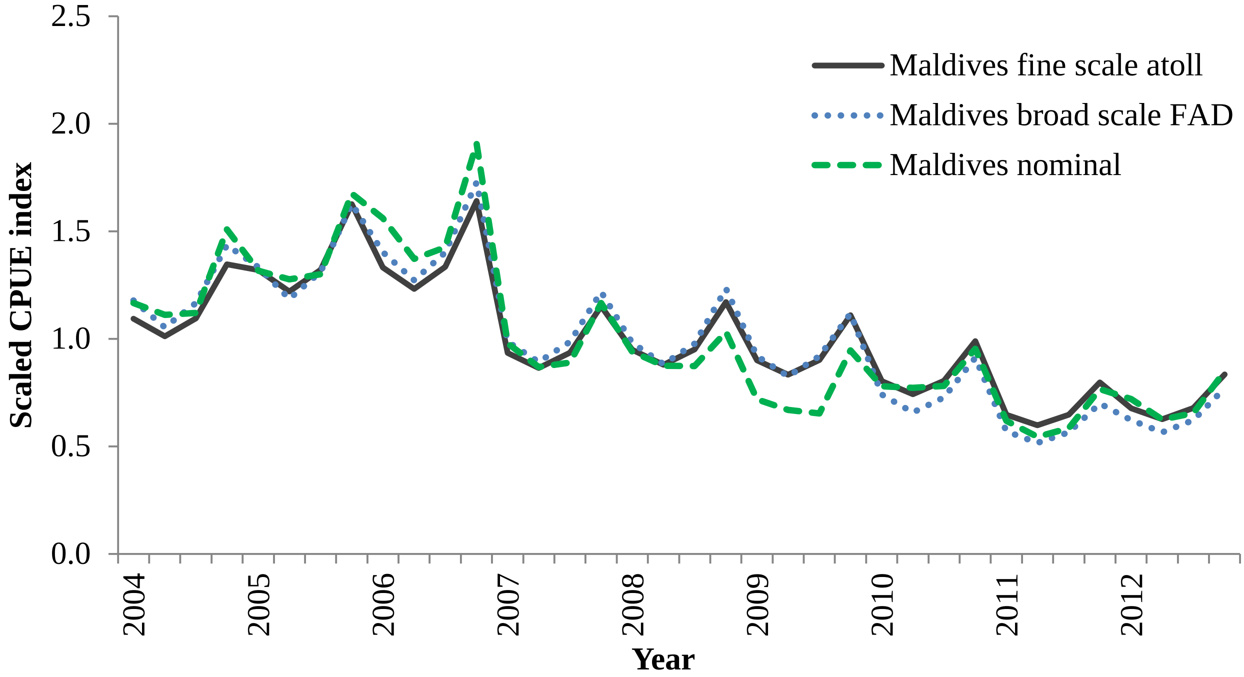


Fig. 14. Skipjack tuna: Maldives pole-and-line nominal and standardised CPUE series for skipjack tuna from 2004–13.

European Union and Associated purse seine CPUE from paper IOTC–2014–WPTT16–INF05 (Fig. 15) which examined skipjack tuna CPUE trends using alternative indices from the European Union and Associated purse seine logbooks.

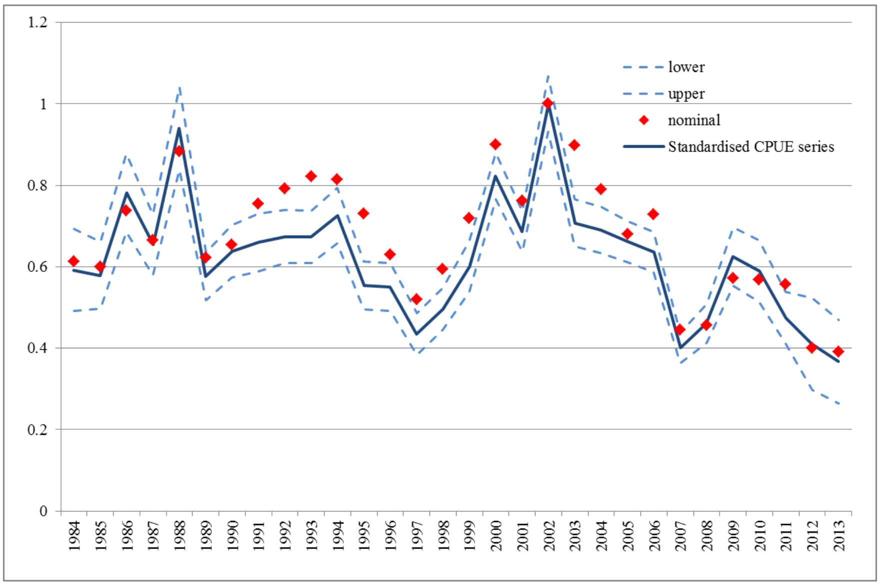


Fig. 15. Skipjack tuna: European Union and Associated purse seine nominal and standardised CPUE series for skipjack tuna from 1984–13.

Skipjack tuna – Tagging data

A total of 101,212 skipjack (representing 50.2% of the total number of fish tagged) were tagged during the Indian Ocean Tuna Tagging Programme (IOTTP). Most of them, 77.4%, were released during the main Regional Tuna Tagging Project-Indian Ocean (RTTP-IO) and were released around Seychelles, in the Mozambique Channel and off the coast of Tanzania, between May 2005 and September 2007 (Fig. 16). The remaining were tagged during small-scale tagging projects, and by other institutions with the support of IOTC, around the Maldives, India, and in the south west and the eastern Indian Ocean. To date, 17,667 specimens (17.5% of releases for this species), have been recovered and reported to the IOTC Secretariat. Around 69.6% of the recoveries were from the purse seine fleets operating from the Seychelles, and around 28.8% by the pole-and-line vessels mainly operating from the Maldives. The addition of the data from the past projects in the Maldives (in 1990s) added 14,506 tagged skipjack tuna to the databases, of which 1,960 were recovered mainly in the Maldives.

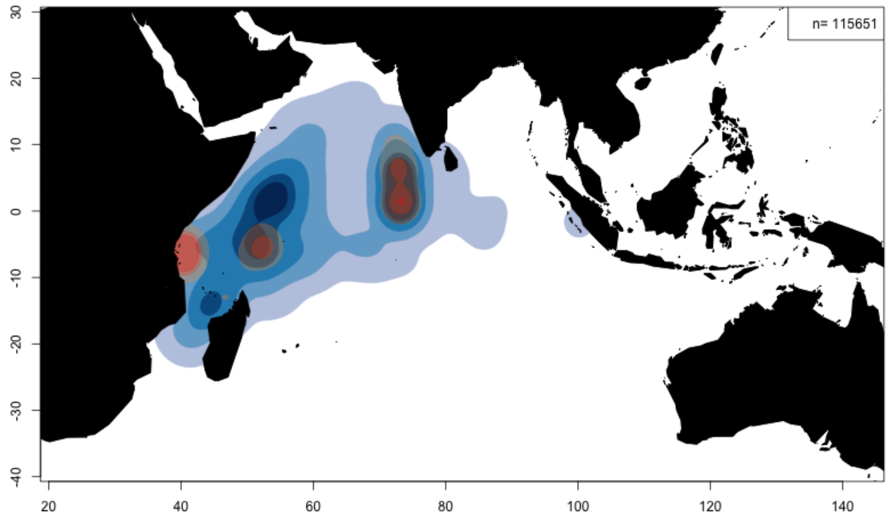


Fig. 16. Skipjack tuna: Densities of releases (in red) and recoveries (in blue). Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s (Data as of September 2012).

STOCK ASSESSMENT

A new stock assessment was carried out in 2014. The following was noted with respect to the SS3 modelling approach presented at the WPTT16 meeting:

- The runs with a high weighting of the tags showed bad fit to tagging data resulting in too many pessimistic results. Thus, an alternative grid that used the M (0.7, 0.8 and 0.9), and h(0.7,0.8 and 0.9), lower weighting of tags along with length composition and CPUE series was proposed and presented.
- The model had issues with estimating MSY related to reference points. C/C_{MSY} was used as in previous assessments (although it should be noted there are concerns with the estimation of this value as well), for the Kobe trajectories.

Some fishery indicators may indicate a lower MSY reference points than SS3, as follows:

- A decline of catches of large skipjack tuna in the last 10 years resulting in a decline of average weight observed for pole-and-line and purse seine fisheries;
- A decline of FAD catch per set by purse seine, during a period of major increase in FAD seeding;
- A decline in the purse seine CPUE of free swimming schools skipjack tuna in most areas;
- A lesser proportion of skipjack tuna relative to other species in the FAD sets;
- There were still issues on the spatial complexity and the use of tags that needed to be further understood. The present model based on a single area does not take into account the complex movement patterns that have been observed from the tagged skipjack tuna recoveries. A new model structure based on MFCL/SS3 could be investigated in future years;
- Mixing rates need to be evaluated under a new model structure with more areas to avoid discounting the first three quarters, as this leads to eliminating more than 70% of the recoveries;
- There were concrens raised about the pole-and-line and purse seine indices of abundance used in the assessment;
- Thus, a stock trajectory based on B_t/B_0 (with a reference at 40% as a proxy MSY as is used for other fisheries) along with a plot of the increasing fishing mortality, F as shown in Fig. 17, was agreed to be used.

Further analysis should be conducted or better indices of abundance should be developed.

- The grid based approach accounted for uncertainty in natural mortality, h, CPUE and growth, but for the future assessments models that estimate M within the model structure, and uses a wider range of precision in the variability of growth than the current estimate does (CV=0.2).

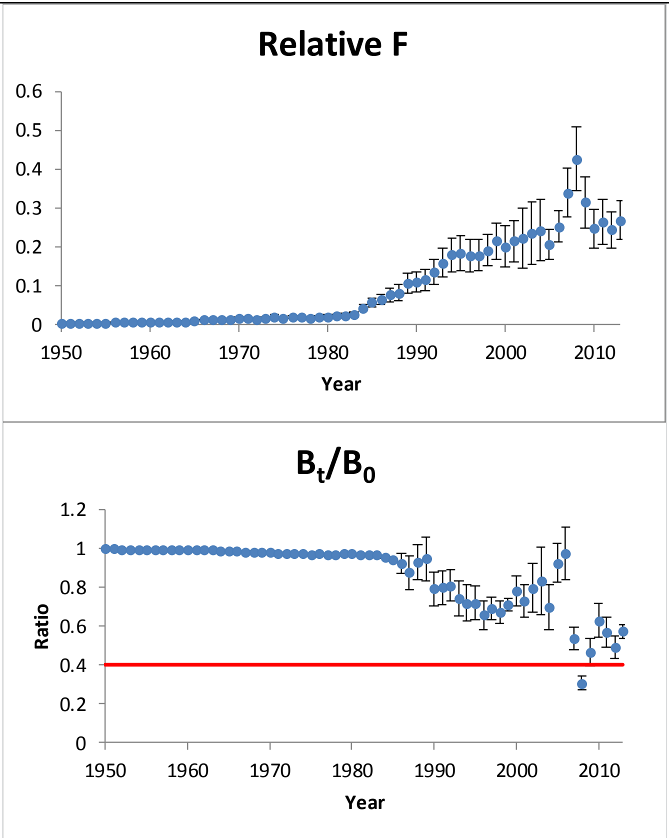


Fig. 17. Skipjack tuna: Top: relative fishing mortality over time. Bottom: B_{MSY}/B_0. Note, these figures were suggested as alternative figures for evaluation as F_{MSY} is not estimated well, reference point $0.4B_0$ was suggested as a target and $0.2B_0$ as a limit for skipjack tuna by the WPTT.

The advice on the status of skipjack tuna in 2014 (Table 6) is be derived from the grid agreed using an integrated statistical assessment method. 81 model formulations were investigated to ensure that various plausible sources of uncertainty were incorporated and represented in the final result. In general, the data did not seem to be sufficiently informative to justify the selection of any individual model, and the results are shown as a grid and the median value of the grid. The grid based approach covered the uncertainty in the assessment which is large.

Table 6. Skipjack tuna: Key management quantities from the SS3 assessment, for the Indian Ocean.

Management Quantity	**Indian Ocean**
2013 catch estimate	424,580
Mean catch from 2009–2013	401,100
MSY (1,000 t) (80% CI)	684 (550–849)
Data period used in assessment	1950–2013
F_{MSY} (80% CI)*	0.65 (0.51–0.79)
SB_{MSY} (1,000 t) (80% CI)	875 (708.5–1,075)
F_{2013}/F_{MSY} (80% CI)*	0.42 (0.25–0.62)
C_{2013}/C_{MSY} (80% CI)*	0.62 (0.49–0.75)
B_{2013}/B_{MSY} (80% CI)	n.a.
SB_{2013}/SB_{MSY} (80% CI)	1.59 (1.13–2.14)
B_{2013}/B_{1950} (80% CI)	n.a.
SB_{2013}/SB_{1950} (80% CI)	0.58 (0.53–0.62)
$B_{2013}/B_{1950, F=0}$ (80% CI)	n.a.
$SB_{2013}/SB_{1950, F=0}$ (80% CI)	n.a.

* Not estimable accurately in SS-III as ascending limb missing from equilibrium yield curve. Instead the target proxy would be C_{2013}/C_{MSY} (80% CI) is 0.62 (0.49-0.75)

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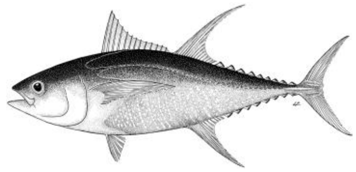
APPENDIX XV
EXECUTIVE SUMMARY: YELLOWFIN TUNA

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



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

TABLE 1. Yellowfin tuna: Status of yellowfin tuna (*Thunnus albacares*) in the Indian Ocean.

Area[1]	Indicators			2014 stock status determination
Indian Ocean	Catch 2013: Average catch 2009–2013:	402,084 t 339,359 t		
		Multifan[2]	ASPM[3]	
	MSY (1,000 t) (80% CI):	344 (290–453)	320 (283–358)	
	F_{MSY} (80% CI):	n.a (n.a.–n.a.)	n.a (n.a.–n.a.)	
	SB_{MSY} (1,000 t) (80% CI):	881 (784–986)	n.a (n.a.–n.a.)	
	F_{curr}/F_{MSY} (80% CI):	0.69 (0.59–0.90)	0.61 (0.31–0.91)	
	SB_{curr}/SB_{MSY} (80% CI):	1.24 (0.91–1.40)	1.35 (0.96–1.74)	
	SB_{curr}/SB_0 (80% CI):	0.38 (0.28–0.38)	–	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2] most recent years data 2010. Range = range of the point estimates from the different runs.
[3] most recent years data 2011. Range: 80% CI.

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		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No new stock assessment was carried out for yellowfin tuna in 2014, thus, stock status is determined on the basis of the 2012 assessment and other indicators presented in 2014. The stock assessment model results from 2012 did not differ substantively from the previous (2011) assessments; however, the final overall estimates of stock status differ somewhat due to the refinement in the selection of the range of model options due to increased understanding of key biological parameters (primarily natural mortality). Two trajectories are presented that compare the Kobe plots obtained from the MFCL and ASPM assessments. While the MFCL assessment indicates that fishing mortality is below the limit and target reference points during the whole time series, the ASPM model run indicates that the target reference points may have been exceeded during the period of high catches in the mid 2000's (2003–2006). However, estimates of total and spawning stock biomass show a marked decrease from 2004 to 2009 in both cases, corresponding to the very high catches of 2003–2006. Recent reductions in effort and, hence, catches resulted in a slight improvement in stock status in 2010. Spawning stock biomass in 2010 was estimated to be 38% (31–38%) (Table 1) of the unfished levels. Total catch has continued to increase with 400,292 t and 402,084 t landed in 2012 and 2013, respectively, well in excess of previous MSY estimates (≈17% above the MSY level of 344,000 t; Table 1), in comparison to 327,453 t landed in 2011 and 299,713 t landed in 2010. Catches in 2010 (299,713) were within the lower range of MSY level and the last assessment indicated that catch of about the 2010 level were sustainable in the longer term. The previous assessment showed that the stock was unlikely to support substantially higher yields based on the estimated levels of recruitment from the last 15 years although higher yield would be expected if recruitment corresponds to the long term average. However, catch rates have improved in the purse seine fishery while remaining stable for the Japanese longline fleet. Therefore it is difficult to know whether the stock is moving towards a state of being subject to overfishing. Thus, on the weight-of-evidence available in 2014, the yellowfin tuna stock is determined to be **not overfished** and **not subject to overfishing** (Table 1 and Fig. 1).

Outlook. The decrease in longline and purse seine 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 continue 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.

The Kobe strategy matrix (Table 2) based on the projections were carried out using 12 different scenarios of the assessment: 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 and the probabilities in the matrices were computed as the percentage of the 12 scenarios being $SB>SB_{MSY}$ 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.

There was considerable discussion on the ability of the WPTT to carry out the projections with MFCL for yellowfin tuna. For example, it was not clear how the projection redistributed the recruitment among regions as recent distribution of recruitment differs from historic; which was assumed in the projections. The WPTT agreed that the true uncertainty is unknown and that the current characterisation is not complete; however, the WPTT feels that the projections may provide a relative ranking of different scenarios outcomes.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY):** estimate for the whole Indian Ocean is 344,000 t with a range between 290,000–453,000 t for MFCL; 320,000 t with a range between 283,000 and 358,000 t for ASPM (Table 1). The management advice in 2012 indicated that 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. Catches have exceeded this level in 2011, 2012 and 2013. Recent recruitment estimated by MFCL 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. On the contrary, long term recruitment would give larger yield.
- **Provisional reference points**: Noting that the Commission in 2013 agreed to Resolution 13/10 *on interim target and limit reference points and a decision framework*, the following should be noted:
  - **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, and therefore below the provisional limit reference point of $1.4*F_{MSY}$ (Fig. 1).
  - **Biomass**: Current spawning biomass is considered to be above the target reference point of SB_{MSY}, and therefore above the limit reference point of $0.4*SB_{MSY}$ (Fig. 1).
- **Main fishing gear** (2009–13): Purse seine ≈33.8% (log ≈21.8% and free swimming school ≈12.0%); Longline ≈19.3% (frozen ≈11.7%, fresh ≈7.6%); Handline ≈17.3%; Gillnet ≈15.6%.
- **Main fleets**: European Union ≈26% (EU,Spain: ≈15%; EU,France: ≈11%); Sri Lanka ≈10%; Maldives ≈10%; Indonesia ≈10%; I.R. Iran ≈9%; Seychelles ≈8%.

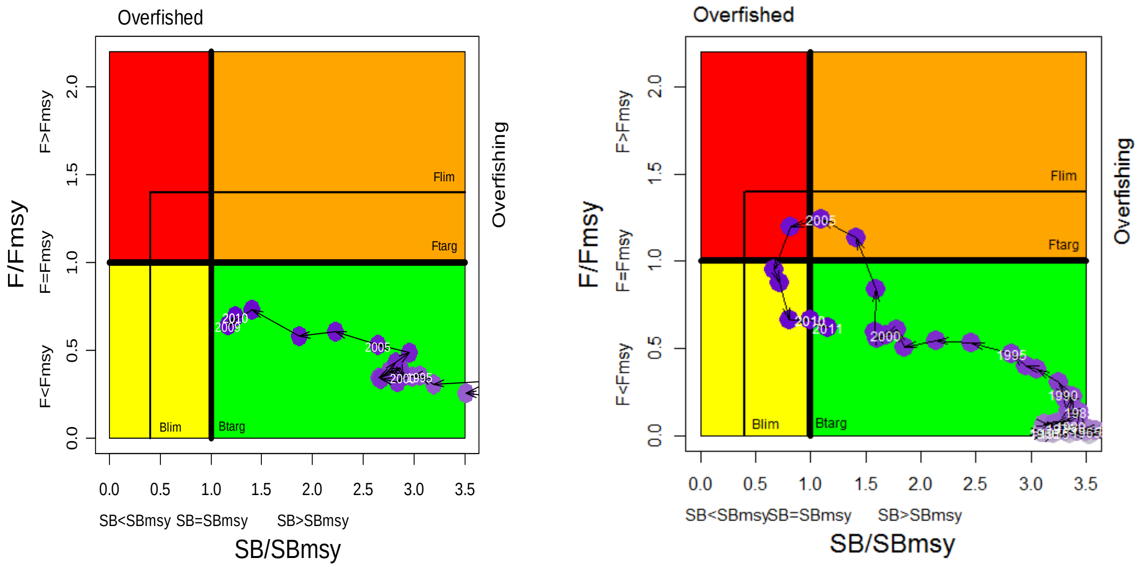


Fig. 1. Yellowfin tuna: MULTIFAN-CL and ASPM Indian Ocean yellowfin tuna stock assessment Kobe plots. Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio. The left panel is output obtained from the base case run in MFCL for each year 1972–2010 for a steepness value of 0.8. The right panel is obtained from the ASPM base case model run for each year 1972–2011 with steepness value of 0.9.

TABLE 2. Yellowfin tuna: 2011 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, ±10%, ± 20%, ± 30% 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. Note: from the 2011 stock assessment using catch estimates at that time.

Reference point and projection timeframe	**Alternative catch projections (relative to the catch level for 2010) and probability (%) of violating MSY-based target reference points ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60% (165,600t)	**70%** (193,200t)	**80%** (220,800t)	**90%** (248,400t)	**100%** (276,000t)	**110%** (303,600t)	**120%** (331,200t)	**130%** (358,800t)	**140%** (386,400t)
$SB_{2013} < SB_{MSY}$	<1		<1		<1		<1		<1
$F_{2013} > F_{MSY}$	<1		<1		58.3		83.3		100
$SB_{2020} < SB_{MSY}$	<1		<1		8.3		41.7		91.7
$F_{2020} > F_{MSY}$	<1		41.7		83.3		100		100
Reference point and projection timeframe	**Alternative catch projections (relative to the catch level for 2010) and probability (%) of violating MSY-based limit reference points ($SB_{lim} = 0.4\ SB_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)**								
	60% (165,600t)	**70%** (193,200t)	**80%** (220,800t)	**90%** (248,400t)	**100%** (276,000t)	**110%** (303,600t)	**120%** (331,200t)	**130%** (358,800t)	**140%** (386,400t)
$SB_{2013} < SB_{Lim}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$F_{2013} > F_{Lim}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$SB_{2020} < SB_{Lim}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$F_{2020} > F_{Lim}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

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APPENDIX I

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 14/02 *for the conservation and management of tropical tunas stocks in the IOTC area of competence*.
- Resolution 14/05 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 13/10 *On interim target and limit reference points and a decision framework*
- Resolution 13/11 *On a ban on discards of bigeye tuna, skipjack tuna, yellowfin tuna and a recommendation for non-targeted species caught by purse seine vessels in the IOTC area of competence*
- Resolution 12/11 *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 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Yellowfin tuna: General

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

TABLE 3. Yellowfin tuna: 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

Yellowfin tuna: Fisheries and catch trends

Catches of yellowfin tuna (Table 4; Fig. 2) 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. The catches increased rapidly with the arrival of the purse seiners in the early 1980s and increased activity of longliners and other fleets, reaching over 400,000 t in 1993. Catches of yellowfin tuna between 1994 and 2002 remained stable, between 330,000 and 350,000 t. Yellowfin tuna catches during 2003, 2004, 2005 and 2006 were much higher than in previous years, with the highest catches ever recorded in 2004 (over 525,000 t), while catches of bigeye tuna which are generally associated with the same fishing grounds as yellowfin tuna remained at average levels. After 2006 catches of yellowfin tuna dropped markedly, with the lowest catches recorded in 2009 at less than 270,000 t. Since 2009 catches of yellowfin tuna have once again been increasing, with catches over 400,000 t recorded in 2012 and 2013.

Table 4. Yellowfin tuna: Best scientific estimates of the catches of yellowfin tuna (*Thunnus albacares*) by gear and main fleets [or type of fishery] by decade (1950–2009) and year (2004–2013), in tonnes (Data as of September 2014). Catches by decade represent the average annual catch, noting that some gears were not used since the beginning of the fishery.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
FS	0	0	18	31,555	64,956	89,204	168,146	123,997	85,044	53,526	74,986	36,050	32,136	36,453	64,594	34,458
LS	0	0	17	17,616	56,293	61,892	59,901	69,877	74,612	43,778	41,546	51,352	73,383	76,659	66,166	101,905
LL	22,131	42,460	31,016	37,274	76,926	76,814	108,277	137,677	94,955	71,439	45,764	41,893	43,720	38,842	43,417	30,606
LF	0	0	615	4,286	47,572	34,149	32,938	35,949	31,751	33,303	34,343	23,125	21,501	20,510	27,182	36,326
BB	2,111	2,318	5,810	8,295	12,805	16,076	15,876	16,843	18,043	16,327	18,279	16,826	14,098	14,003	15,506	24,119
GI	1,572	4,115	7,838	11,899	39,420	49,243	74,001	61,210	62,488	43,452	47,978	41,945	50,780	51,053	63,626	56,843
HD	588	566	3,236	8,301	20,705	36,647	44,249	43,373	35,154	36,465	33,840	32,079	36,660	62,093	83,543	78,585
TR	1,102	1,981	4,335	6,912	11,568	16,010	20,609	17,186	18,180	19,783	18,221	16,586	19,717	19,940	28,049	31,007

OT	80	193	453	1,871	3,373	5,424	4,834	5,831	5,804	6,837	6,611	7,401	7,717	7,901	8,209	8,236
Total	**27,584**	**51,633**	**53,339**	**128,008**	**333,619**	**385,459**	**528,832**	**511,945**	**426,033**	**324,911**	**321,567**	**267,255**	**299,713**	**327,453**	**400,292**	**402,084**

Gears: 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. Yellowfin tuna: Best scientific estimates of the catches of yellowfin tuna (*Thunnus albacares*) by area by decade (1950–2009) and year (2004–2013), in tonnes (Data as of September 2014). Catches by decade represent the average annual catch. The areas are presented in Fig. 3a.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
R1	2,041	4,282	6,619	16,158	76,021	87,775	129,790	133,335	113,553	80,990	73,850	57,508	64,989	79,716	103,730	108,224
R2	11,870	23,055	21,135	71,743	134,778	174,247	261,240	239,622	188,414	120,829	131,981	99,716	117,940	140,865	173,989	175,352
R3	766	7,404	5,510	9,308	23,201	24,159	26,350	24,900	24,196	24,837	21,082	19,513	18,942	20,356	18,418	22,100
R4	997	1,919	1,633	1,325	3,633	3,337	5,674	4,372	3,090	1,293	1,225	1,145	1,364	1,431	1,408	1,707
R5	11,911	14,973	18,442	29,474	95,986	95,941	105,781	109,717	96,779	96,959	93,429	89,372	96,479	85,088	102,751	94,699
Total	**27,584**	**51,633**	**53,339**	**128,008**	**333,619**	**385,459**	**528,832**	**511,945**	**426,033**	**324,911**	**321,567**	**267,255**	**299,713**	**327,453**	**400,292**	**402,084**

Areas: Arabian Sea (**R1**); Off Somalia (**R2**); Mozambique Channel including southern (**R3**); South Indian Ocean including southern (**R4**); East Indian Ocean including Bay of Bengal(**R5**).

Although some Japanese purse seine vessels have fished in the Indian Ocean since 1977, the purse seine (Fig. 2) fishery developed rapidly with the arrival of European vessels between 1982 and 1984. Since then, there has been an increasing number of yellowfin tuna caught, with a larger proportion of the catches consisting of adult fish, as opposed to catches of bigeye tuna, which are mostly composed of juvenile fish. Purse seine vessels typically take fish ranging from 40 to 140 cm fork length (FL), while smaller fish are more common in catches taken north of the equator.

Catches of yellowfin tuna by purse seiners increased rapidly to around 130,000 t in 1993, and subsequently fluctuated around that level, until 2003–05 when catches increased substantially (i.e., around 200,000 t). The amount of effort exerted by the EU purse seine vessels (fishing for yellowfin tuna and other tunas) varies seasonally and from year to year.

The purse seine fishery is characterised by the use of two different fishing modes (Table 4 and Fig. 2). The fishery on floating objects (FADs) catches large numbers of small yellowfin tuna in association with skipjack tuna and juvenile bigeye tuna, compared to the 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 accounted for 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 2003–06 (64%) was much higher than in previous or following years (at around 50%).

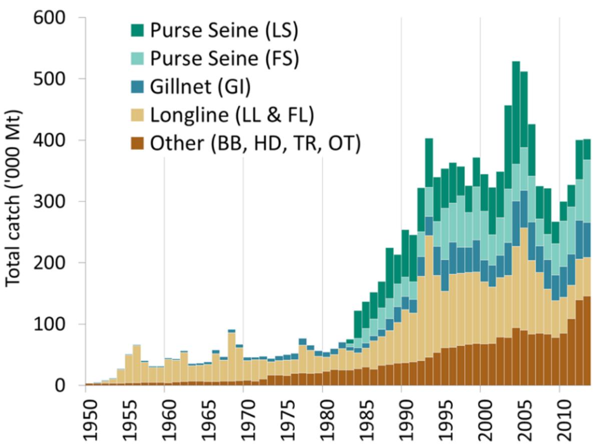


Fig. 2. Yellowfin tuna: Annual catches of yellowfin tuna by gear (1950–2013) (Data as of September 2014).

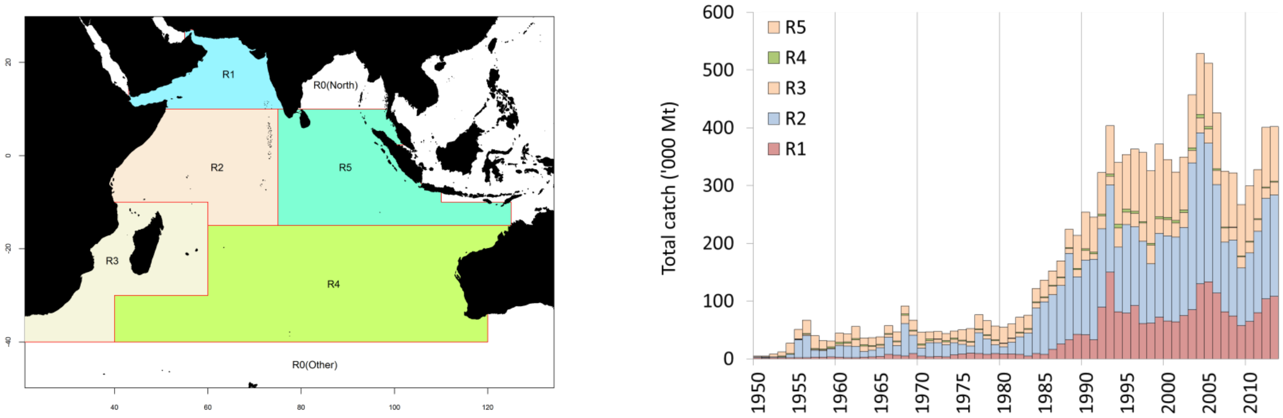


Fig. 3a, b. Yellowfin tuna: Catches of yellowfin tuna by area by year estimated for the WPTT (1950–2013) (Data as of September 2014). Catches in areas R0 were assigned to the closest neighbouring area for the assessment. **Areas:** Arabian Sea (**R1**); Off Somalia (**R2**); Mozambique Channel, including southern (**R3**); South Indian Ocean including southern (**R4**); East Indian Ocean, including Bay of Bengal (**R5**).

The longline fishery (Table 4; Fig. 2) started in the early 1950's and expanded rapidly over throughout the Indian Ocean. Longline gear mainly catches large fish, from 80 to 160 cm FL, although smaller fish in the size range 60 cm – 100 cm (FL) have been taken by longliners from Taiwan,China since 1989 in the Arabian Sea. The longline fishery targets several tuna species in different parts of the Indian Ocean (Fig. 3), 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) (Fig. 4).

The total longline catch of yellowfin tuna reached a maximum in 1993 (≈200,000 t). Catches between 1994 and 2004 fluctuated between 85,000 t and 130,000 t. The second highest catches of yellowfin tuna by longliners were recorded in 2005 (≈165,000 t). Similar to the trend for the purse seine fleets, since 2005 longline catches have declined with current catches estimated to be at around 60,000 t – more than a 60% decrease in catch levels compared to 2005. The recent drop in longline catches could be related, at least in part, with the expansion of piracy in the northwest Indian Ocean, which led to a marked drop in the levels of longline effort in one of the core fishing areas of the species (i.e., Area R2) (Fig. 3**)**.

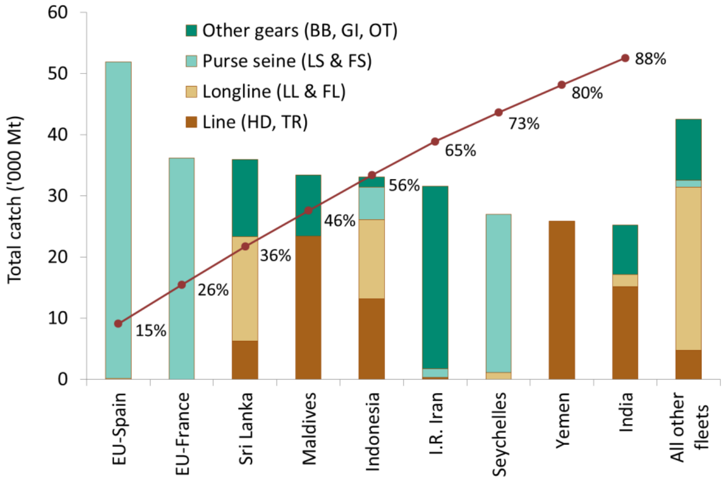


Fig. 4. Yellowfin tuna: average catches in the Indian Ocean over the period 2010–12, by fleet. Fleets are ordered from left to right, according to the importance of catches of yellowfin tuna reported. The red line indicates the (cumulative) proportion of catches of yellowfin tuna for the fleets concerned, over the total combined catches of this species reported from all fleets and fisheries (Data as of September 2014).

Catches by other gears, namely pole-and-line, gillnet, troll, hand line and other minor gears, have increased steadily since the 1980s (Table 4; Fig. 2). Contrary to the situation in other oceans, the artisanal fishery component of catches in the Indian Ocean are substantial, accounting for around 30% of the total catches of yellowfin tuna until the early 2000s. In recent years artisanal catches of yellowfin tuna have been around 135,000 t, increasing to over 200,000 t in

2012 and 2013 – more than half the total catches of yellowfin tuna in each of the last two years. Artisanal catches of yellowfin tuna are dominated by gillnets, with catches of around 50,000 t since 2011.

Purse seiners currently take the bulk of the yellowfin tuna catch, mostly from the western Indian Ocean, around Seychelles and off the coast of Somalia (area R2) and Mozambique Channel (area R3) (Tables 4, 5; Fig. 3). However in recent years the catches of yellowfin tuna in the western Indian Ocean have dropped considerably, especially in areas off Somalia, Kenya and Tanzania between 2007 and 2011 (Fig. 5). The drop in catches is, in part, the consequence of a drop in fishing effort due to the effect of piracy in the western Indian Ocean region – although the effects have not been as marked as with longline vessels. The main reason for this is the presence of security personnel onboard purse seine vessels of the EU and Seychelles, which has made it possible for purse seiners under these flags to continue operating in the northwest Indian Ocean. Longline effort levels in the western tropical area have also increased in 2012 and 2013, as a consequence of increased security in the region.

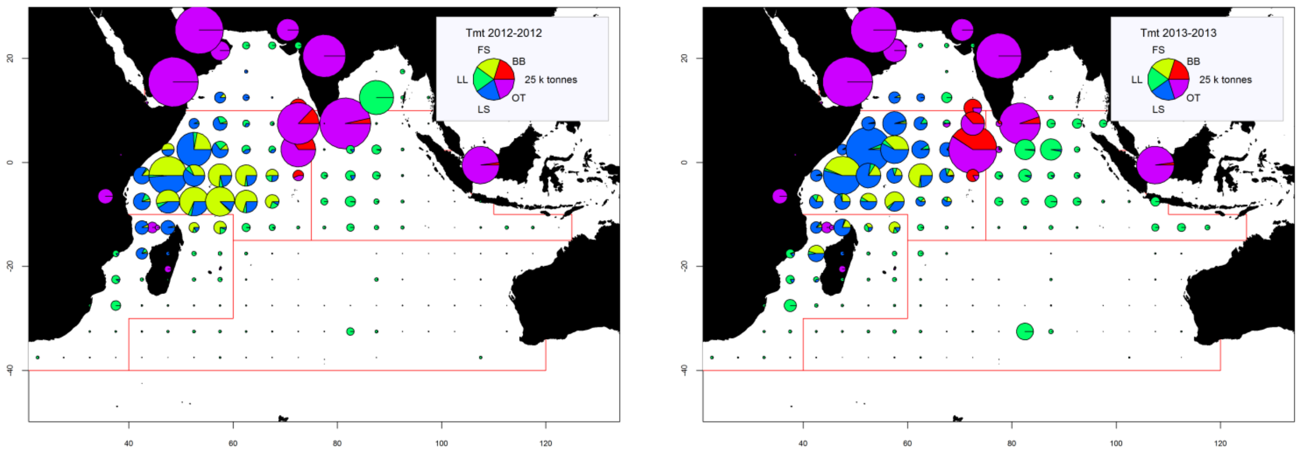


Fig. 5a, b. Yellowfin tuna: Time-area catches (total combined in tonnes) of yellowfin tuna estimated for the period 2004–08 by type of gear and for 2009–13, by year and type of gear. Longline (**LL**), Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (**BB**), and other fleets (**OT**), including drifting gillnets, and various coastal fisheries (Data as of September 2014). The catches of fleets for which the flag countries do not report detailed time and area data to the IOTC are recorded within the area of the countries concerned, in particular driftnets from I.R. Iran and Pakistan, gillnet and longline fishery of Sri Lanka, and coastal fisheries of Yemen, Oman, Comoros, Indonesia and India.

Yellowfin tuna: Status of Fisheries Statistics at the IOTC

Retained catches are generally well known (Fig. 6a); however, catches are less certain for:

- many coastal fisheries, notably those from Indonesia, Sri Lanka, Yemen, and Madagascar
- the gillnet fishery of Pakistan
- non-reporting industrial purse seiners and longliners (NEI), and longliners of India.

Discard levels 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.

CPUE Series: Catch-and-effort data are available from the major industrial and artisanal fisheries (Fig. 6b). However, these data are not available for some important 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 data for the fresh-tuna longline fishery of Taiwan,China are only available since 2006
- insufficient data for the gillnet fisheries of Iran and Pakistan
- 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, and Madagascar.

Trends in average weight (Figs. 6, 7, 8, 9, 10): 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.

Catch-at-Size table: This is available (Fig. 6c) 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, and in recent years (Japan and Taiwan,China)
- the paucity of catch by area data available for some industrial fleets (NEI, Iran, India, Indonesia, Malaysia).

Changes to the catch series: There have been no significant changes to the total catches of yellowfin tuna since the WPTT in 2013.

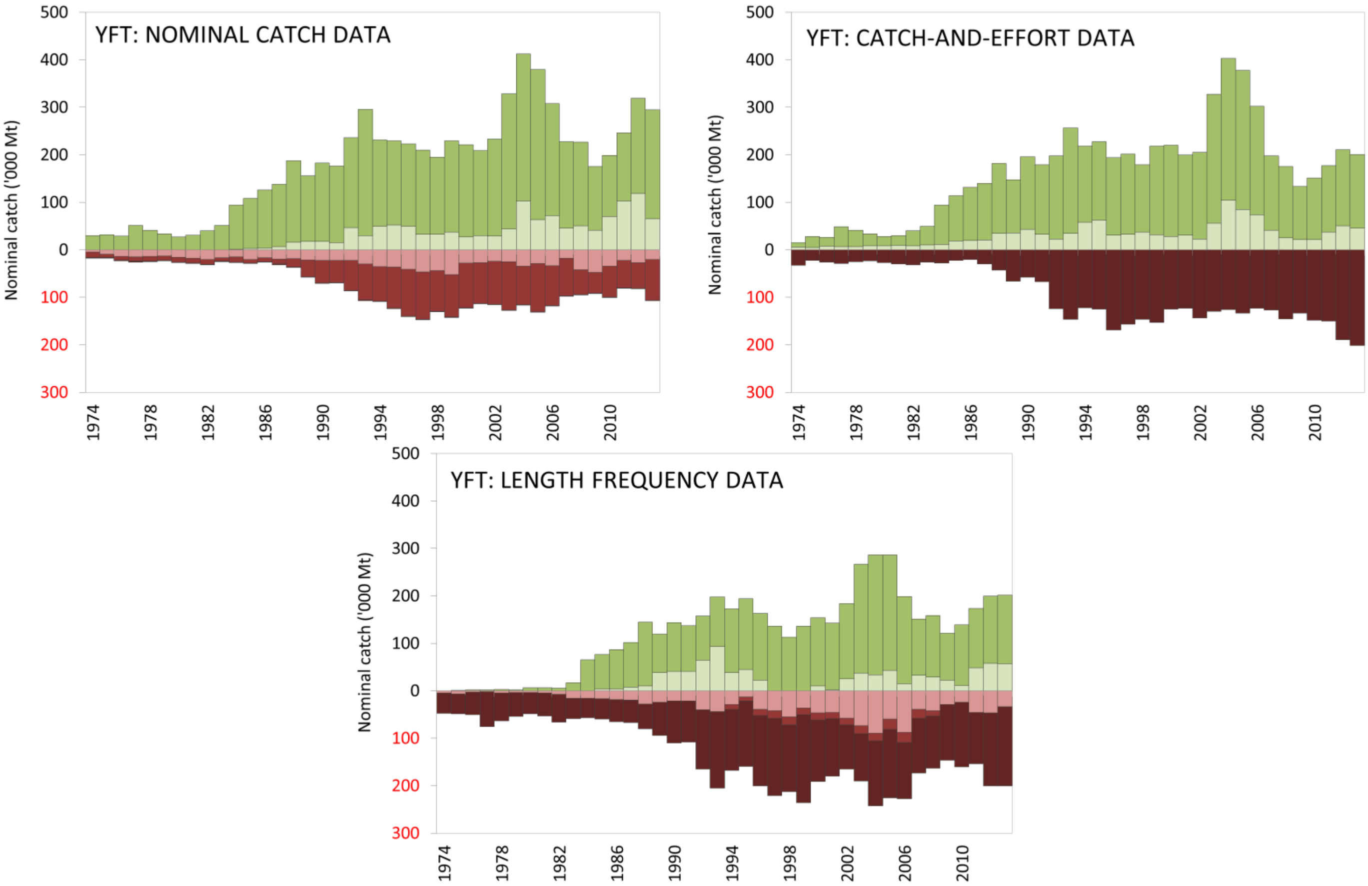


Fig. 6a-c. Yellowfin tuna: data reporting coverage (1974–2013). Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available (Data as of September 2014).

Key to IOTC Scoring system

Nominal Catch	By species	By gear
Fully available	0	0
Partially available (part of the catch not reported by species/gear)*	2	2
Fully estimated (by the IOTC Secretariat)	4	4

*Catch assigned by species/gear by the IOTC Secretariat; or 15% or more of the catches remain under aggregates of species

Catch-and-Effort	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

Size frequency data	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 1 fish measured by metric ton of catch)	2	
Not available at all	8	

Key to colour coding

- Total score is 0 (or average score is 0-1)
- Total score is 2 (or average score is 1-3)
- Total score is 4 (or average score is 3-5)
- Total score is 6 (or average score is 5-7)
- Total score is 8 (or average score is 7-8)

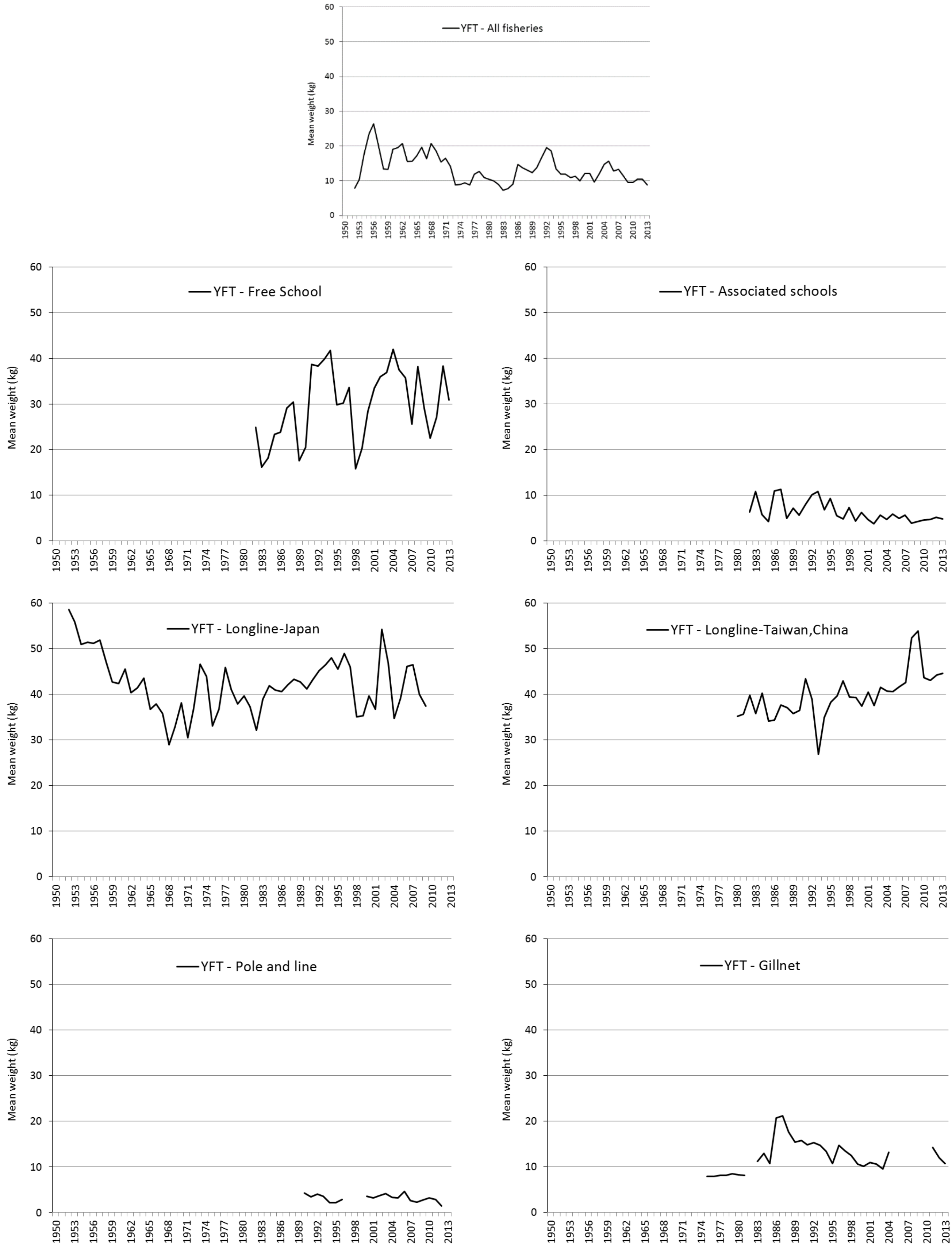
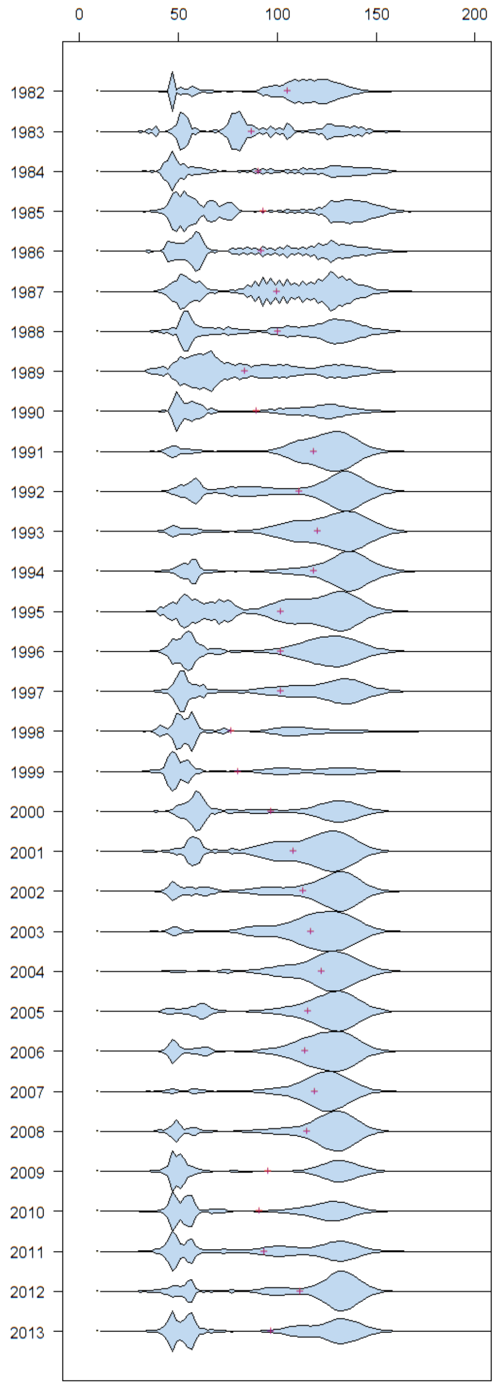


Fig. 7. Yellowfin tuna: Average weight of yellowfin tuna (YFT) taken by All fisheries combined (top), Purse seine on free (top left) and associated (top right) schools, Longlines from Japan (mid left) and Taiwan,China (mid right), Pole-and-line from Maldives and India (bottom left), Gillnets from Sri Lanka, Iran, and other countries (bottom right).

Yellowfin tuna (PS FS): size (in cm)



Yellowfin tuna (PS FS): no. of specimens ('000) (raised to total catch)

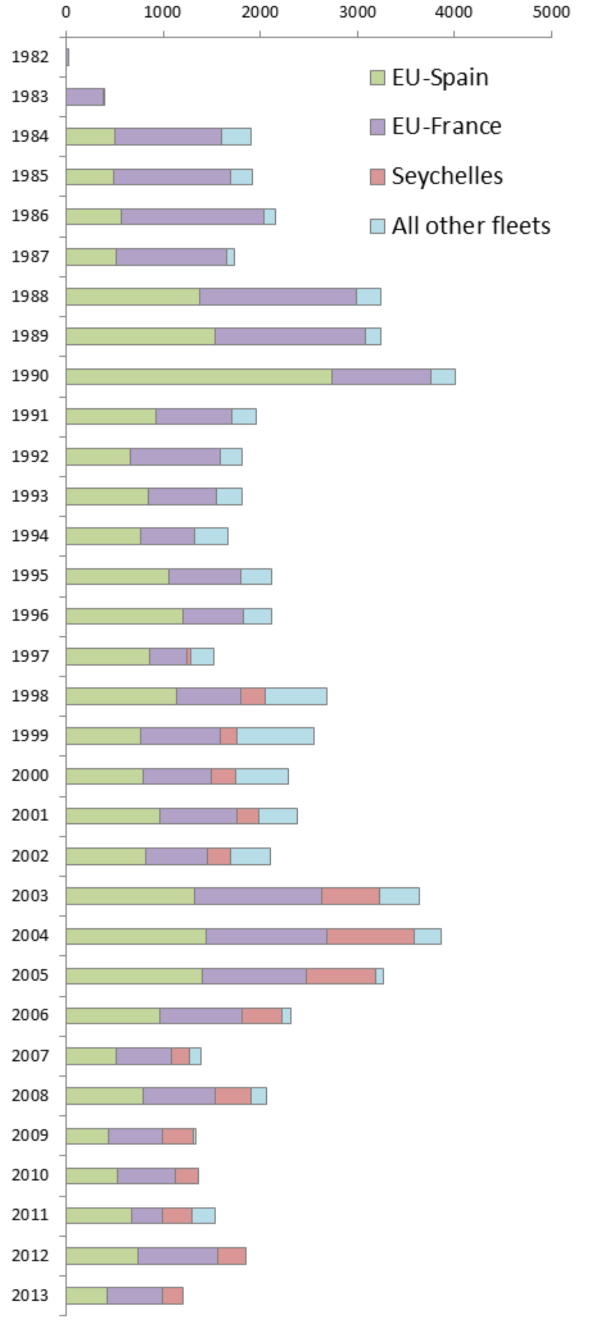
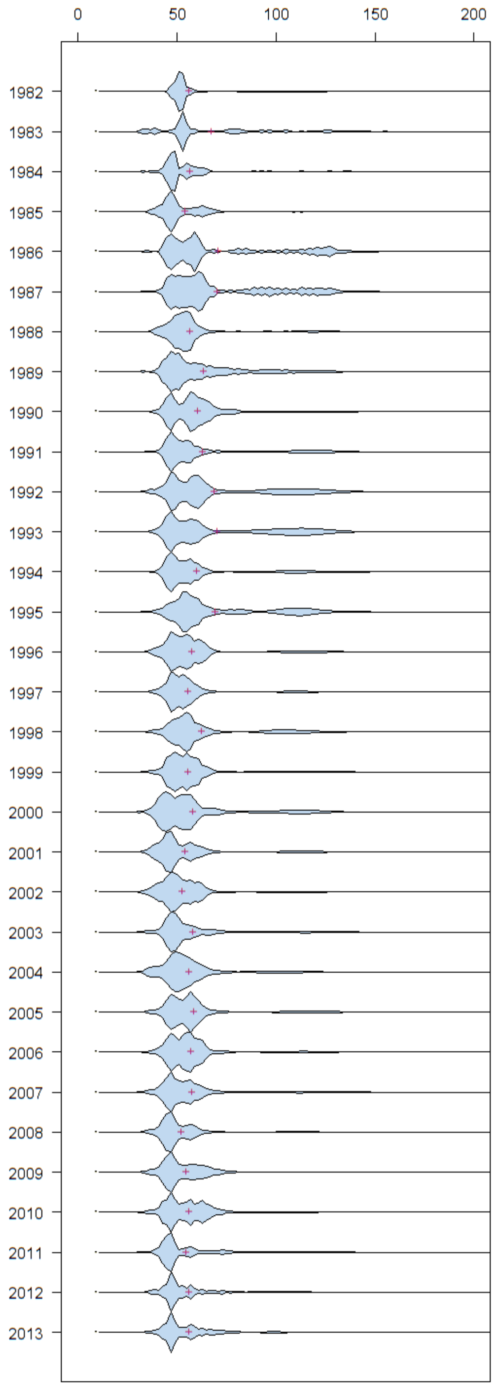


Fig. 8. Yellowfin tuna (PS Free school): **Left:** length frequency distributions for PS Free school fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of yellowfin tuna specimens sampled for lengths (raised to total catch), by fleet (PS Free school only). FS: Free swimming school.

Yellowfin tuna (PS LS): size (in cm)



Yellowfin tuna (PS LS): no. of specimens (‘000)
(raised to total catch)

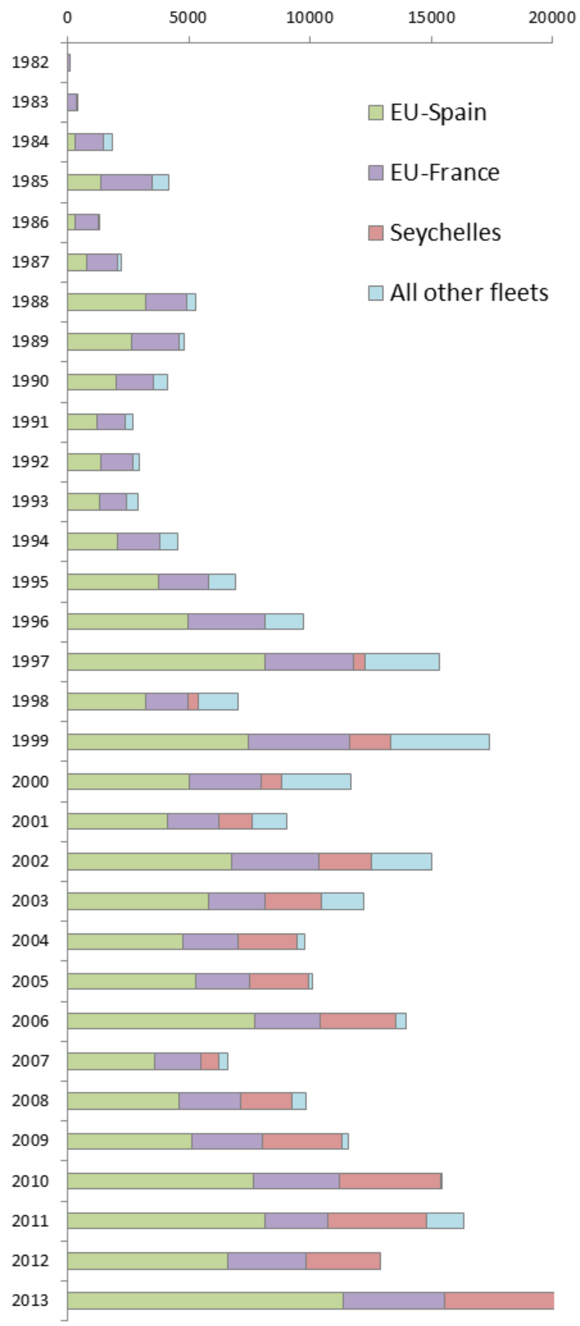


Fig. 9. Yellowfin tuna (PS Associated school): **Left:** length frequency distributions for PS Associated school fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of yellowfin tuna specimens sampled for lengths (raised to total catch), by fleet (PS Associated school only). LS: Log school.

Yellowfin tuna (LL samples): size (in cm)

Yellowfin tuna (LL): no. of samples (‘000)

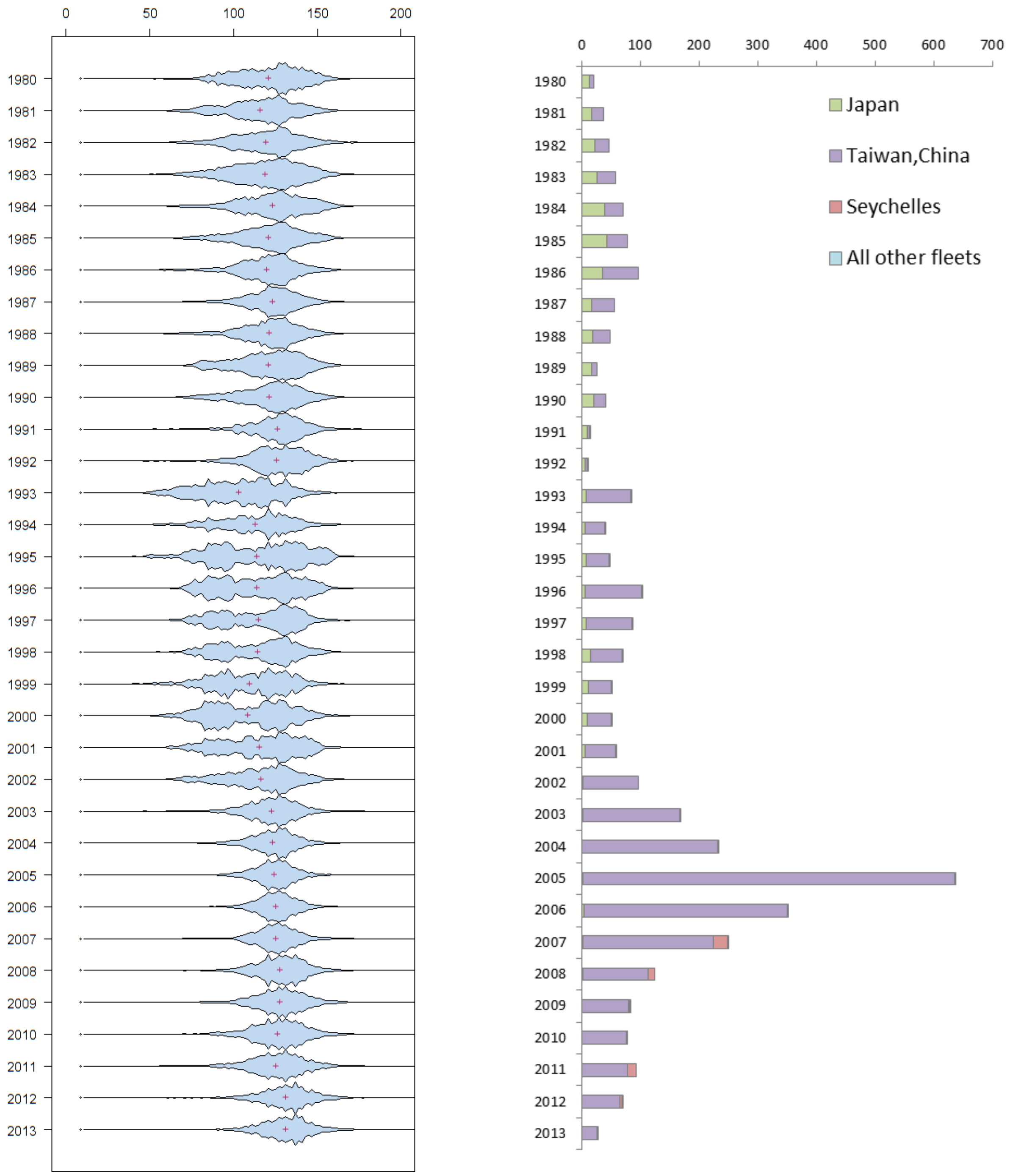


Fig. 10. Yellowfin tuna (longline: LL): **Left:** length frequency distributions for longline fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of yellowfin tuna specimens sampled for lengths, by fleet (longline only).

Yellowfin tuna: Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2012 and 2013 are provided in Fig. 11, 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 2012 and 2013 are provided in Fig. 12. Total effort exerted by pole-and-line fleets in the Indian Ocean for the years 2011 and 2012 are providedin Fig. 13. Effort data for 2013 has not yet been reported.

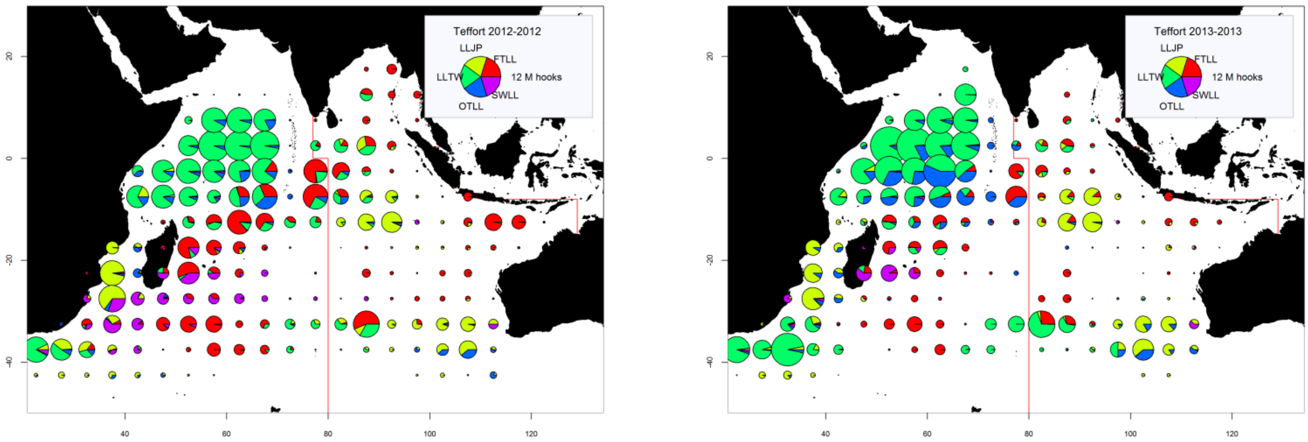


Fig. 11. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014). **LLJP** (light green): deep-freezing longliners from Japan; **LLTW** (dark green): deep-freezing longliners from Taiwan,China; 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)

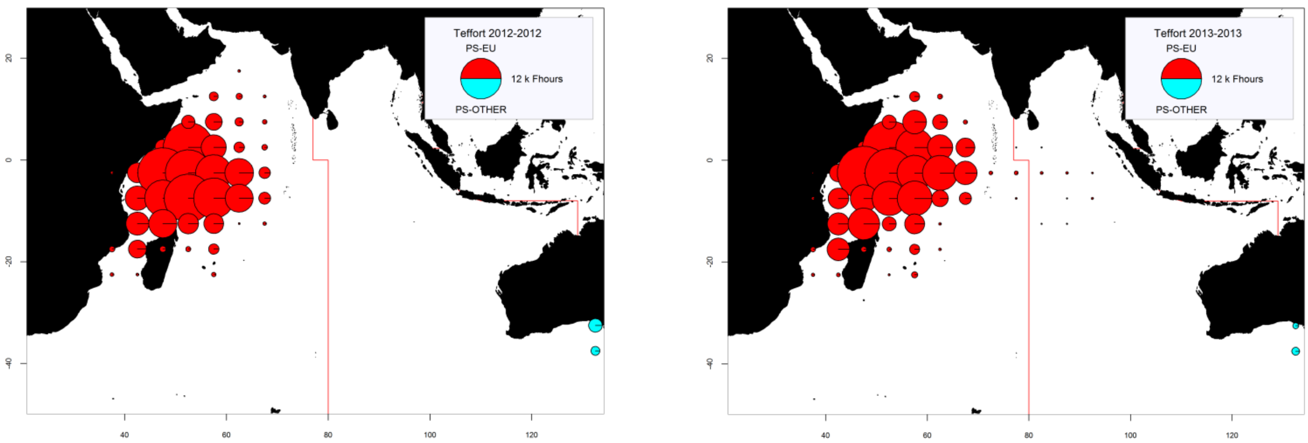


Fig. 12. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014). **PS-EU** (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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).

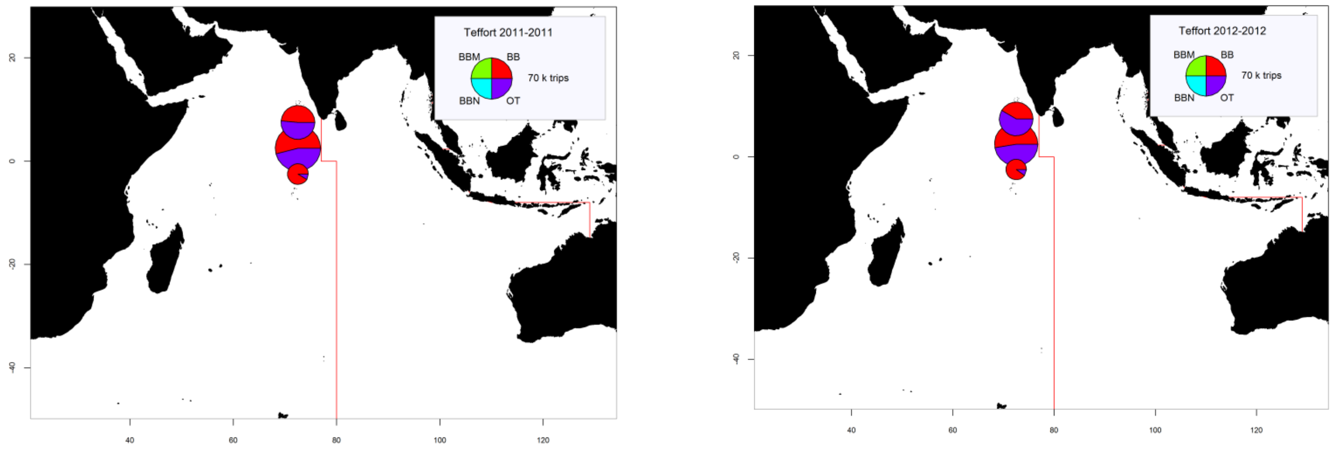


Fig. 13. Effort exerted by pole-and-line fleets in the Indian Ocean, in thousands (k) of trips (equivalent to fishing days), for the years 2011 (left) and 2012 (right) (Data as of September 2014). Note: Effort data for 2014 has not yet been reported. **BBM** (green): Pole-and-line (mechanized baitboats); **BBN** (blue): Pole-and-line (non-mechanized baitboats) **BB** (red): Pole-and-line (all types of baitboat, especially mechanized); **OT** (purple): Pole-and-line and other gears unidentified (effort not available by gear). 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.

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

For the longline fisheries (LL fisheries in regions 1–5; Fig. 14, CPUE indices were derived using generalised linear models (GLM) from the Japan longline fleet (LL regions 2–5) and for the Taiwan,China longline fleet (LL region 1) to be used in the stock assessment. Standardised longline CPUE indices for the Taiwan,China fleet were available for 1979–2008. The GLM analysis used to standardise the Japan longline CPUE indices was refined for the 2011 and 2012 assessments 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 2012 assessment (Fig. 15). There is considerable uncertainty associated with the Japan CPUE indices for region 2 in the most recent year (2010) and no CPUE indices are available for region 1 for 2009–10.

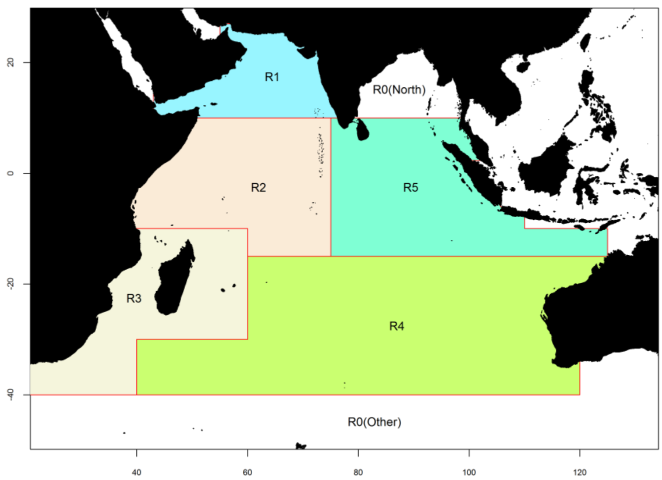


Fig. 14. Yellowfin tuna: Spatial stratification of the Indian Ocean for the MFCL assessment model carried out in 2012.

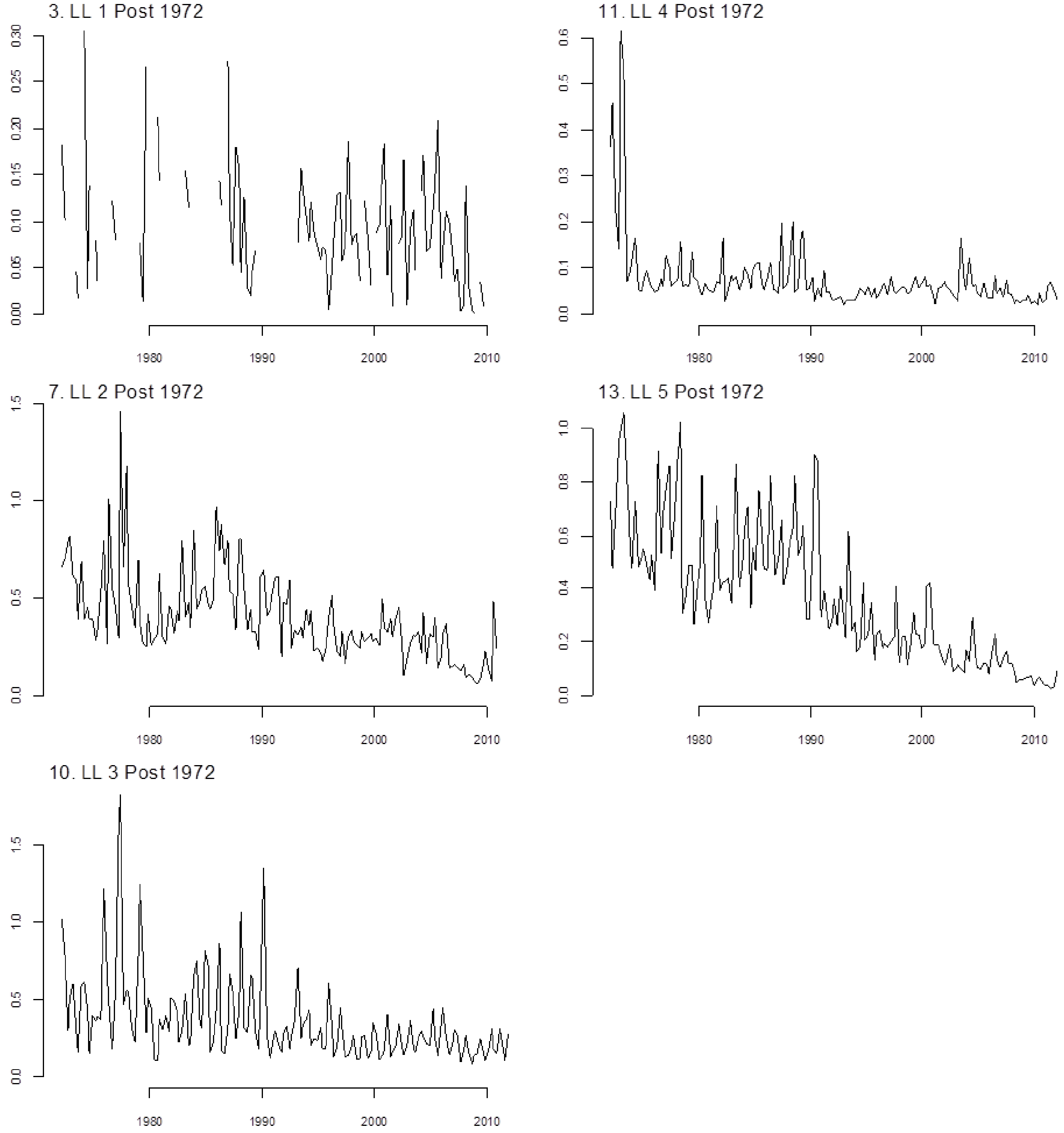


Fig. 15. Yellowfin tuna: Quarterly GLM standardised catch-per-unit-effort (CPUE) for the principal longline fisheries (LL 1 to 5) scaled by the respective region scalars.

In 2014, updated CPUE standardisations were presented for three of the main fleets as follows:

Japan – Catch-per-unit-of-effort (CPUE) from paper IOTC–2014–WPTT16–47 Rev_1 (Fig. 16) which provided the Japanese longline CPUE for yellowfin tuna in the Indian Ocean up to 2013 standardised by generalized linear model.

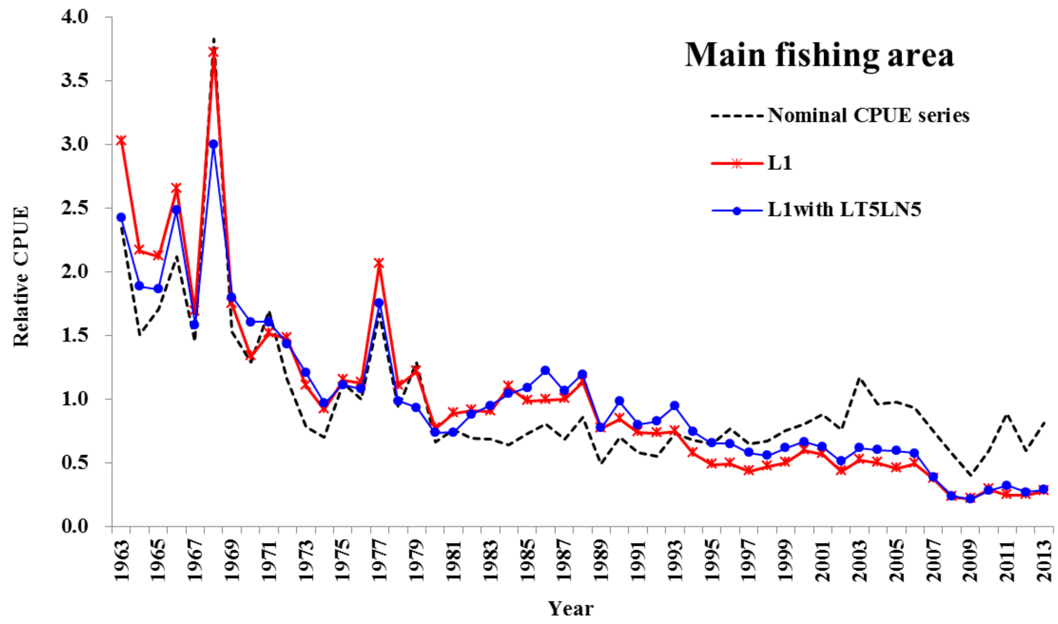


Fig. 16. Yellowfin tuna: Comparison of annual based area aggregated CPUE between the models with the effect of subarea and LT5LN5, standardised for the main fishing grounds expressed in relative scale overlaid with nominal CPUE. Series have been rescaled relative to their respective means from 1963–2013.

Rep. of Korea – Catch-per-unit-of-effort (CPUE) from paper IOTC–2014–WPTT16–49 (Fig. 17) which provided the CPUE standardisation of yellowfin tuna caught by Rep. of Korea tuna longline fishery in the Indian Ocean.

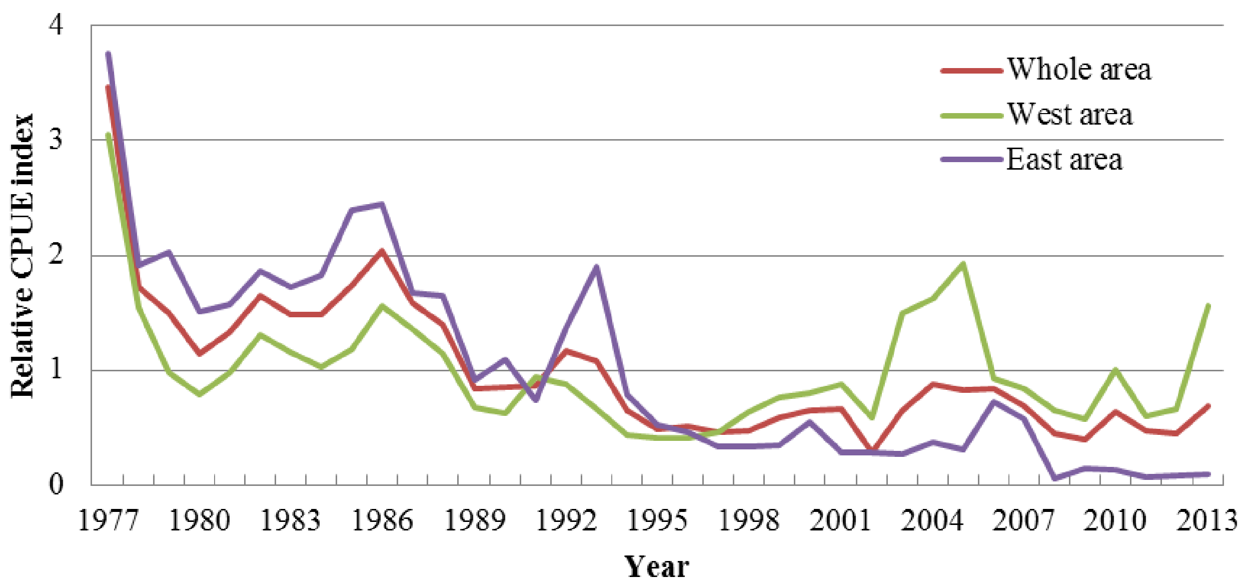


Fig. 17. Yellowfin tuna: Comparison of the standardised longline CPUE series for the Rep. of Korea. Series have been rescaled relative to their respective means from 1977–2013.

Taiwan,China longline CPUE comparison for bigeye tuna and yellowfin tuna from paper IOTC–2014–WPTT16–55 (Fig. 18) which detailed an analysis of Taiwna,China longline fisheries based on operational catch and effort data for bigeye tuna and yellowfin tuna in the Indian Ocean from 1979 to 2013.

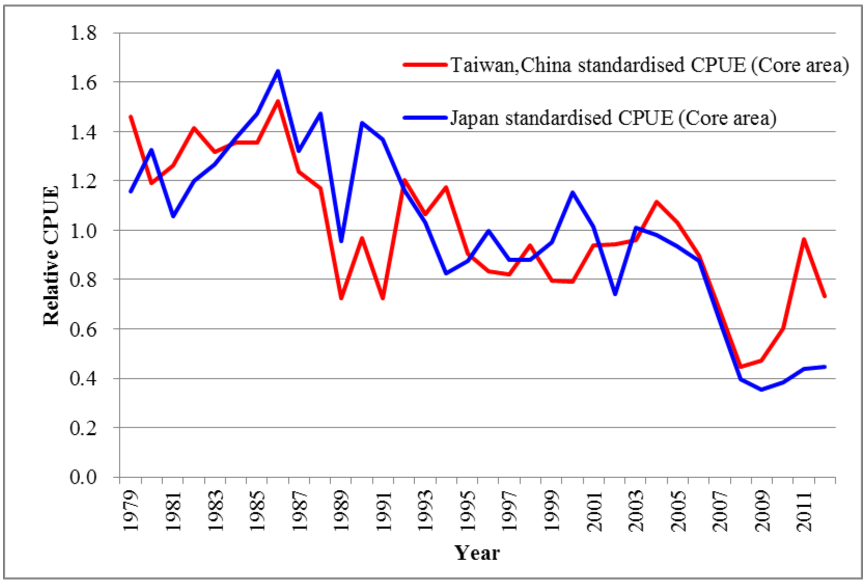


Fig. 18. Yellowfin tuna: Comparison of the standardised longline CPUE series (by area) for Taiwan,China. Series have been rescaled relative to their respective means from 1979–2013.

Yellowfin tuna – tagging data

A total of 63,328 yellowfin tuna (representing 31.4% of the total number of specimens tagged) were tagged during the Indian Ocean Tuna Tagging Programme (IOTTP). Most of them (86.4%) were released during the main Regional Tuna Tagging Project-Indian Ocean (RTTP-IO) and were released around Seychelles, in the Mozambique Channel, along the coast of Oman and off the coast of Tanzania, between May 2005 and September 2007 (Fig. 19). The remaining were tagged during small-scale tagging projects, and by other institutions with the support of IOTC Secretariat, in Maldives, India, and in the south west and the eastern Indian Ocean. To date, 10,834 specimens (17.1%), have been recovered and reported to the IOTC Secretariat. More than 85.9% of these recoveries we made by the purse seine fleets operating in the Indian Ocean, while around 9.1% were made by pole-and-line and less than 1% by longline vessels. The addition of the data from the past projects in the Maldives (in 1990s) added 3,211 tagged yellowfin tuna to the databases, of which 151 were recovered, mainly from the Maldives.

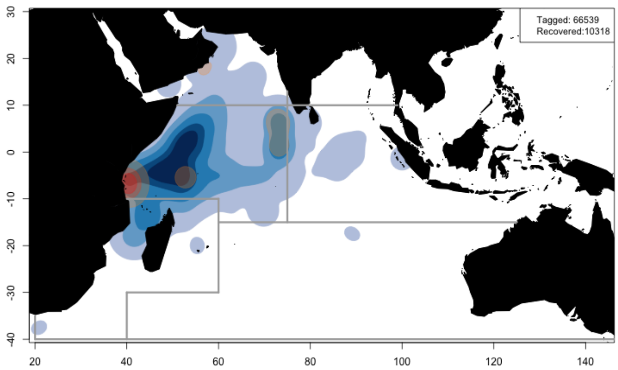


Fig. 19. Yellowfin tuna: Densities of releases (in red) and recoveries (in blue). The red line represents the stock assessment areas (Data as of September 2012).

STOCK ASSESSMENT

As no formal stock assessment was carried out in 2014, the management advice for yellowfin tuna was based on the 2012 MFCL stock assessment (Table 6; based upon the base case analysis with short term recruitment with alternative steepness of the stock-recruitment relationship of 0.7, 0.8 and 0.9), the ASPM based case using steepness of 0.9, and current catch and effort trends presented at the current meeting. A major limitation of the ASPM model is that it is not spatially structured and thus does not allow the internal incorporation of tagging data, although it does externally by using the improved catch-at-age table and natural mortality estimates based on tagging data.

A range of quantitative modelling methods were applied to the yellowfin tuna assessment in 2012, ranging from the non-spatial, age-structured production model (ASPM) to the age and spatially-structured MULTIFAN-CL and SS3 analysis. The different assessments were presented to the WPTT in documents IOTC–2012–WPTT14–38, 39 and 40 Rev_2.

The following is worth noting with respect to the MFCL (MULTIFAN-CL) modelling and estimation approach used in 2012:

- The main features of the model in the 2012 assessment included a fixed growth curve (with variance) with an inflection, an age-specific natural mortality rate profile (M), the modelling of 25 fisheries including the separation of two purse seine fisheries into three time blocks, using logistic and cubic spline functions to estimate longline selectivities, separation of the analysis into five regions of the Indian Ocean as well as the three steepness parameters for the stock recruitment relationship (h=0.7, 0.8 and 0.9).
- In addition to another year of data, the 2012 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 except for Region 2 in 2011; no update was available for the Taiwan,China index for Region 1; All of the analyses were conducted using a new version of MFCL provided by the Secretariat of the Pacific Community.

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 results of the MFCL model were studied in detail to improve the understanding of the estimated population dynamics and address specific properties of the model that were inconsistent with the general understanding of the yellowfin tuna stock and fisheries. The main issues identified are as follows:

- The model estimates a strong temporal decline in recruitment and in biomass within the eastern equatorial region (Region 5). This declining trend in recruitment is driven by the decline in the Japanese longline CPUE indices over the model period. There are limited data to reliably estimate recruitment in the region as the size data included in the model are considered uninformative. Consequently, the resulting recruitment and biomass trends may be unreliable. A participant noted that during this period the Taiwan,China longline fleet, a fleet more active than the Japanese longline fleet in this area, showed a stable nominal CPUE trend and high stable catches.
- The model estimates limited movement between the two equatorial regions. This is consistent with the low number of tag recoveries from the eastern equatorial region, an area from where recovery rates are difficult to estimate but probably low. Nonetheless, the low movement rate is consistent with the oceanographic conditions that prevailed during the main tag recovery period (see papers IOTC–2012–WPTT14–9 and 31). The model assumes a constant movement pattern throughout the model period and estimated movement pattern may not persist under different oceanographic conditions.
- Similarly, movement rates between the western equatorial region and the Arabian Sea (Region 1) were estimated to be very low. Although various recoveries crossing the border limit of 10°N line in both directions may suggest a higher mixing rate, the observation is consistent with the tag release/recovery observations (few tag releases from Region 2 were recovered in Region 1 and vice versa). However, reporting rates of most fisheries operating in Region 1 are estimated to be low and this may underestimate the low mixing rate observed by the model.
- The model estimated that fishing mortality rates within the western equatorial region did not increase during 2002–2006 period to the extent that would be anticipated given the large increase in catch from the purse seine fishery during that period (on average 470,000 t: well above all estimated MSY values). The large increase of catch, previously described due mainly to a catchability increased, will suggest an expected corresponding increase in fishing mortality well above the level of F_{MSY}. The explanation for this is that the longline standardised CPUE remained relatively constant during the period of high purse seine catch and in the subsequent years. To fit to the longline CPUE indices during this period the model increases the level of recruitment in the period that precedes the high purse seine catches which may be considered unreliable. This recruitment pattern was evident in all model options. However, further examination of the size frequency data is warranted to confirm that this recruitment trend is consistent with the other fisheries data. The status of the yellowfin tuna stock assessed by the model during the period of very high catches (2003–2006), estimated to be in the middle of the green area of the Kobe plot, was questioned by some participants.

The final base model option for the 2012 assessment incorporated the 5–region spatial structure, full selectivity of the older age classes by the longline fishery and estimated (average) natural mortality within the MFCL model, and a period of 4 quarter for tag mixing. For sensitivity analysis, a tag mixing period of 2 quarters was also analysed. In both cases three values of steepness (0.7, 0.8 and 0.9) were considered plausible. The estimated level of natural mortality was considerably higher than the level of natural mortality assumed in previous assessments. However, the estimated level of natural mortality was generally consistent with an external analysis of the tag release/recovery data (IOTC–2012–WPTT14–32), especially for younger ages, and with levels of natural mortality assumed for the assessment of yellowfin tuna by other RFMOs.

Biomass was estimated to have declined to about the B_{MSY} level, while fishing mortality rates had remained well below the F_{MSY} level. The base model estimated recent (1997–2011) recruitment levels that were considerably lower (approximately 25%) than the long term level of recruitment. This resulted in an apparent inconsistency between the annual trend in MSY based fishing mortality and biomass reference points and the observed catch trajectory. Biomass was estimated to have declined to about the B_{MSY} level, while fishing mortality rates had remained well below the F_{MSY} level. This pattern was evident for the range of steepness values considered for the stock-recruitment relationship. The recruitment trend may be an artefact of the model as there are limited data to reliably estimate the time series of recruitment and, hence, the model has considerable freedom to estimate recruitments to account for the observed decline in the longline CPUE abundance trend. The resulting estimates of MSY (380,000–450,000 t) are considerably higher than levels of catch sustained from the fishery and are considered to be overly optimistic. Similarly, the corresponding estimates of stock status are considered to be highly uncertain or unreliable.

It is considered more appropriate to formulate stock status advice based on the more recent period of recruitment on the basis that the level of recruitment from the early period is highly uncertain and that, at least in the short-term, recruitment would be more likely to be in line with recent levels. Estimating the stock status based on the recent (average 1997–2011) recruitment level resulted in lower MSY values, levels of fishing mortality that were comparable to the base model, and a more optimistic level of biomass relative to B_{MSY}.

The potential yield from the stock from different harvesting patterns was investigated by comparing alternative age specific patterns of fishing mortality that corresponded to the estimated selectivity of the main fisheries. A shift in the strategy to exclusively harvest the stock by longline or free-school purse seine would result in a substantial increase (50%) in the overall yield from the fishery relative to current yields. Conversely, a harvest pattern consistent with the purse seine FAD based fishery would result in a large (42%) reduction in overall yields. A shift to a gillnet based harvest pattern had a neutral effect relative to current yield. This analysis simply illustrates the relative yield per recruit of the individual fisheries, however, the results are theoretical and do not consider the complex nature of the operation of this multi-gear/multi-species fishery or the practicalities of substantially changing the harvest pattern.

Table 6. Yellowfin tuna: Key management quantities from the MFCL assessment, for the agreed scenarios of yellowfin tuna in the Indian Ocean. The range values represent the point estimates of different scenarios analysis (6 scenarios showing long term and short term recruitment with three values of steepness as well as the sensitivity analysis with 2 quarter for tag mixing, long- and short term recruitment and 0.8 value of steepness). The range is described by the range values between those scenarios.

Management Quantity	**Indian Ocean**
2013 catch estimate	402,084 t
Mean catch from 2009–2013	339,359 t
MSY (1,000 t) (80% CI)	344 (290–453)
Data period used in assessment	1972–2011
F_{MSY} (80% CI)	n.a (n.a.–n.a.)
SB_{MSY} (1,000 t) (80% CI)	881 (784–986)
F_{2010}/F_{MSY} (80% CI)	0.69 (0.59–0.90)
B_{2010}/B_{MSY} (80% CI)	1.28 (0.97–0.1.38)
SB_{2010}/SB_{MSY} (80% CI)	1.24 (0.91–1.40)
B_{2010}/B_0 (80% CI)	n.a.
SB_{2010}/SB_0 (80% CI)	0.38 (0.28–0.38)
$B_{2010}/B_{0,\ F=0}$ (80% CI)	n.a.
$SB_{2010}/SB_{0,\ F=0}$ (80% CI)	n.a.

LITERATURE CITED

Froese R, Pauly DE (2009) *FishBase*, version 02/2009, FishBaseConsortium, www.fishbase.org.

APPENDIX XVI
EXECUTIVE SUMMARY: SWORDFISH

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

Status of the Indian Ocean swordfish (SWO: *Xiphias gladius*) resource

TABLE 1. Swordfish: Status of swordfish (*Xiphias gladius*) in the Indian Ocean.

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Catch 2013: Average catch 2009–2013:	31,804 t 26,510 t	(green)
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2013}/F_{MSY} (80% CI): SB_{2013}/SB_{MSY} (80% CI): SB_{2013}/SB_{1950} (80% CI):	39.40 (33.20–45.60) 0.138 (0.137–0.138) 61.4 (51.5–71.4) 0.34 (0.28–0.40) 3.10 (2.44–3.75) 0.74 (0.58–0.89)	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.

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)
Not assessed/Uncertain	(grey)	

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. The SS3 model, used for stock status advice indicated that MSY-based reference points were not exceeded for the Indian Ocean population as a whole ($F_{2013}/F_{MSY} < 1$; $SB_{2013}/SB_{MSY} > 1$). All other models applied to swordfish also indicated that the stock is above a biomass level that would produce MSY and current catches are below the MSY level. Spawning stock biomass in 2013 was estimated to be 58–89% (from Table 1; Fig. 1) of the unfished levels. The most recent catch estimate of 31,804 t in 2013 indicate that the stock status is unlikely to have changed. Thus, the stock remains **not overfished** and **not subject to overfishing**.

Outlook. The decrease in longline catch and effort from 2005 to 2011 lowered the pressure on the Indian Ocean stock as a whole, and despite the recent increase in total recorded catches, current fishing mortality is not expected to reduce the population to an overfished state over the next decade. Management measures are not required which would pre-empt current Resolutions and planned management strategy evaluation for swordfish. There is a very low risk of exceeding MSY-based reference points by 2022 if catches are maintained at current levels (<1% risk that $SB_{2022} < SB_{MSY}$, and <1% risk that $F_{2022} > F_{MSY}$) (Table 2). **NOTE:** Advice specific to the southwest region is provided below, as requested by the Commission.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is 39,400 t.
- **Provisional reference points**: Noting that the Commission in 2013 agreed to Resolution 13/10 *on interim target and limit reference points and a decision framework*, the following should be noted:
  a. **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY} and below the provisional limit reference point of $1.4*F_{MSY}$ (Fig. 1).
  b. **Biomass**: Current spawning biomass is considered to be above the target reference point of SB_{MSY}, and therefore above the limit reference point of $0.4*SB_{MSY}$ (Fig. 1).
- **Main fishing gear** (2010–13): Longline catches are currently estimated to comprise approximately 85% of the total estimated swordfish catch in the Indian Ocean.
- **Main fleets** (2010–13): Taiwan,China: 18%; Sri Lanka: 16%; Indonesia: 15%; EU,Spain: 14%.
- **Improvements required**: Continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in the assessments.

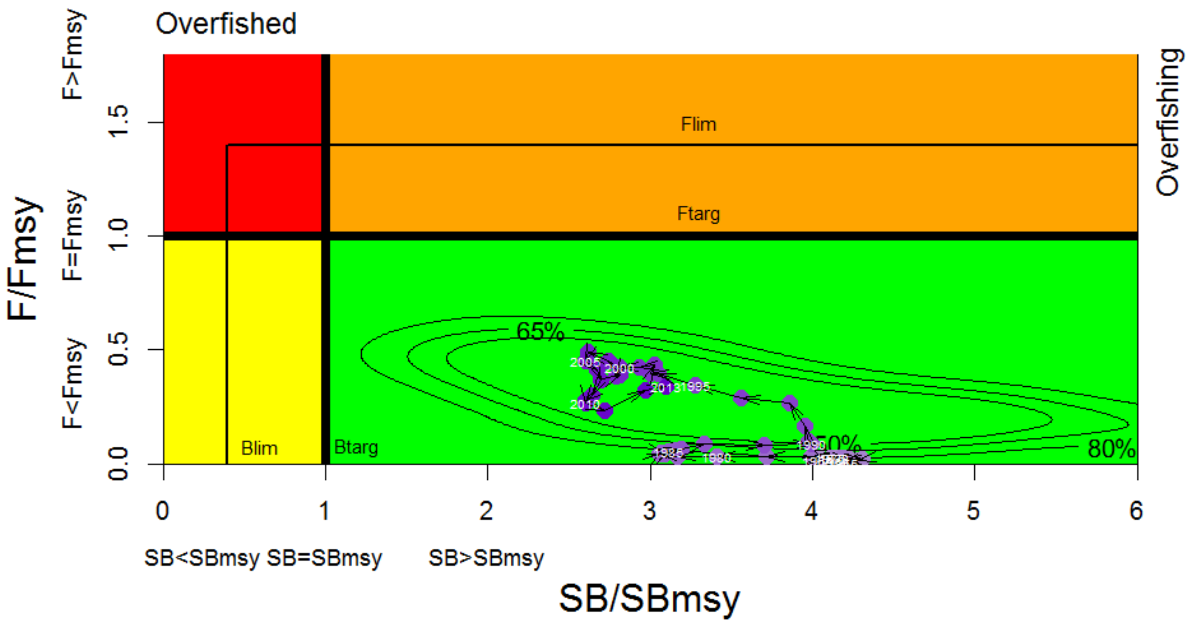


Fig. 1. Swordfish: SS3 Aggregated Indian Ocean assessment Kobe plot (contours are the 50, 65 and 80 percentiles of the 2013 estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2013. Interim target (F_{targ} and SB_{targ}) and limit (F_{lim} and SB_{lim}) reference points, as set by the Commission, are shown.

TABLE 2. Swordfish: SS3 aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target (top) and limit (bottom) reference points for nine constant catch projections (average catch level from 2011–13 (27,809 t), ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2011–13) and probability (%) of violating MSY-based target reference points ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60% (16,685 t)	**70%** (19,466 t)	**80%** (22,247 t)	**90%** (25,028 t)	**100%** (27,809 t)	**110%** (30,590 t)	**120%** (33,371 t)	**130%** (36,152 t)	**140%** (38,933 t)
$SB_{2016} < SB_{MSY}$	0	0	0	0	0	0	0	0	0
$F_{2016} > F_{MSY}$	0	0	0	0	0	0	0	0	2
$SB_{2023} < SB_{MSY}$	0	0	0	0	0	0	0	0	0
$F_{2023} > F_{MSY}$	0	0	0	0	0	0	0	0	4

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2011–13) and probability (%) of violating MSY-based limit reference points ($SB_{lim} = 0.4\ SB_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)**								
	60% (16,685 t)	**70%** (19,466 t)	**80%** (22,247 t)	**90%** (25,028 t)	**100%** (27,809 t)	**110%** (30,590 t)	**120%** (33,371 t)	**130%** (36,152 t)	**140%** (38,933 t)
$SB_{2016} < SB_{Lim}$	0	0	0	0	0	0	0	0	0
$F_{2016} > F_{Lim}$	0	0	0	0	0	0	0	0	4
$SB_{2023} < SB_{Lim}$	0	0	0	0	0	0	0	0	0
$F_{2023} > F_{Lim}$	0	0	0	0	0	0	0	0	4

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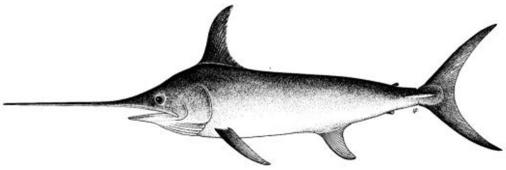

Status of the southwest Indian Ocean swordfish (SWO: *Xiphias gladius*) resource

TABLE 3. Swordfish: Status of swordfish (*Xiphias gladius*) in the southwest Indian Ocean.

Area[1]	**Indicators**		**2014 stock status determination**
Southwest Indian Ocean	Catch 2013:	7,349 t	
	Average catch 2009–2013:	7,265 t	
	MSY (1,000 t) (80% CI):	9.86 (9.11–10.57)	
	F_{MSY} (80% CI):	0.63 (0.59–0.70)	
	B_{MSY} (1,000 t) (80% CI):	12.68 (12.52–12.78)	
	F_{2013}/F_{MSY} (80% CI):	0.89 (0.61–1.14)	
	B_{2013}/B_{MSY} (80% CI):	0.94 (0.68–1.23)	
	B_{2013}/B_{1950} (80% CI):	0.16 (n.a.)	

[1]Boundaries for southwest Indian Ocean stock assessment are defined in IOTC–2014–WPB12–07 Rev_2.

Colour key	Stock overfished(B_{year}/B_{MSY}< 1)	Stock not overfished (B_{year}/B_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		
Not assessed/Uncertain		

NOTE: The following advice is provided on the basis of the following:

Commission request: *The Commission* ***REQUESTED*** *that the southwest region continue to be analysed as a special resource, as it appears to be highly depleted compared to the Indian Ocean as a whole.*

Scientific Committee: *The SC* ***NOTED*** *that although the results of the IOSSS project did not reveal any structure within the Indian Ocean with the markers used, however the hypothesis of a population structuring at the regional level cannot be discarded and needs to be investigated using different markers or approaches.*

NOTE: Comment from the 12th Working Party on Billfish:

The WPB ***NOTED*** *that information received after the last stock assessment carried out in 2011, indicated that there is no evidence for a separate stock in the southwest Indian Ocean (Paper IOTC–2012–WPB10–15 and published as Muths et. al 2013 (see IOTC–2013–WPB11–10). Hence, from a biological point of view, it does not make sense to conduct a separate assessment for this region.*

Working Party on Billfish: Paragraph from the WPB10 Report on the two papers cited above*: The WPB* ***RECOMMENDED*** *that the SC note that although the results of the IOSSS project did not reveal any structure within the Indian Ocean with the markers used, however the hypothesis of a population structuring at the regional level cannot be discarded and needs to be investigated using different markers or approaches. Results obtained from the markers used may simply be a matter of the resolving power of the markers used, which may simply have been insufficient for detecting population subdivision*. (para. 127 of the WPB10 Report).

SOUTHWEST INDIAN OCEAN – MANAGEMENT ADVICE

Stock status. The assessments carried out in 2014 produced substantially conflicting results (ASIA, BBDM and ASPIC). However, the ASPIC model runs are presented here just for consistency with the previous advice. The southwest Indian Ocean region has been subject to localised depletion over the past decade and biomass remains below the level that would produce MSY (B_{MSY}). Declines in catch and effort brought fishing mortality rates to levels below F_{MSY}. In 2013, 7,349 t of swordfish catches were recorded from this region, which equals 110% of the recommended maximum catch of 6,678 t agreed to by the SC in 2011 (Table 3). If catches are maintained at 2013 levels, the probabilities of violating target reference points in 2016 are ≈ 81% for F_{MSY} and ≈ 40% for B_{MSY} (Table 4). Thus, the resource remains **not subject to overfishing** but **overfished**.

Outlook. The decrease in catch and effort over the last few years in the southwest region has reduced pressure on this resource. However, from 2010 to 2013 catches exceeded the maximum recommended by the WPB09 and SC14 in 2011 (6,678 t). The WPB10 estimated that there is a low to moderate risk of exceeding MSY-based reference points by 2023 if catches are reduced by 20% from 2013 levels (≈ 1% risk that $B_{2023} < B_{MSY}$, and ≈ 5% risk that $F_{2023} > F_{MSY}$) (Table 4). There is however a high risk of reversing the rebuilding trend if there is any increase in catch in this region (Table 4).

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the southwest Indian Ocean is 9,100–10,400 t (Table 3). 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}.
- **Provisional reference points**: Noting that the Commission in 2013 agreed to Resolution 13/10 *on interim target and limit reference points and a decision framework*, the following should be noted:
  a. **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, and hence, below the provisional limit reference point of $1.4*F_{MSY}$ (Fig. 1).
  b. **Biomass**: Current spawning biomass is considered to be below the target reference point of SB_{MSY}, but above the limit reference point of $0.4*SB_{MSY}$ (Fig. 1).
- **Main fishing gear** (2010–13): Longline catches are currently estimated to comprise approximately 85% of the total estimated swordfish catch in the Indian Ocean.
- **Main fleets** (2010–13): Taiwan,China: 18%; Sri Lanka: 16%; Indonesia: 15%; EU,Spain: 14%.
- **Improvements required**: Continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in the assessments.

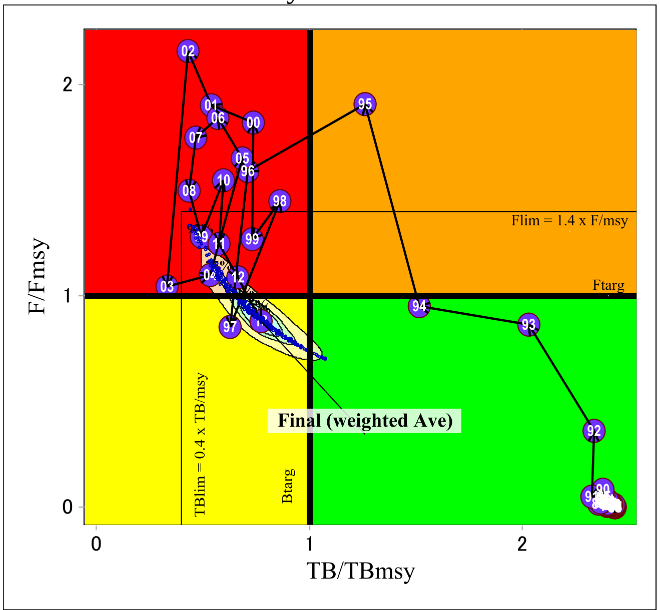

Fig. 2. Swordfish: ASPIC southwest Indian Ocean assessment Kobe plot (The horizontal blue line represents F_{LIM} and the vertical blue line represents B_{LIM}). The results are from a preferred model option: Model weighted average using the inverse of the Root Mean Square errors across models (scenario) 2 and 4 (IOTC–2014–WPB12–24 Rev_2).

TABLE 4. Swordfish: ASPIC **southwest** Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based reference points for nine constant catch projections (average catch level from 2011–13 (7,236 t), ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	Alternative catch projections (relative to the average catch level from 2011–13) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)								
	60% (4,342 t)	**70%** (5,065 t)	**80%** (5,789 t)	**90%** (6,512 t)	**100%** (7,236 t)	**110%** (7,960 t)	**120%** (8,683 t)	**130%** (9,407 t)	**140%** (10,130 t)
$B_{2016} < B_{MSY}$	9	13	19	28	40	53	65	82	86
$F_{2016} > F_{MSY}$	3	6	30	56	81	91	98	99	100
$B_{2023} < B_{MSY}$	0	0	1	3	14	41	87	100	100
$F_{2023} > F_{MSY}$	0	0	5	67	92	98	99	100	100

Reference point and projection timeframe	Alternative catch projections (relative to the average catch level from 2011–13) and probability (%) of violating MSY-based limit reference points (B_{lim} = 0.4 B_{MSY}; F_{Lim} = 1.4 F_{MSY})								
	60% (4,342 t)	**70%** (5,065 t)	**80%** (5,789 t)	**90%** (6,512 t)	**100%** (7,236 t)	**110%** (7,960 t)	**120%** (8,683 t)	**130%** (9,407 t)	**140%** (10,130 t)
$B_{2016} < B_{Lim}$	4	6	8	14	20	23	40	45	65
$F_{2016} > F_{Lim}$	3	6	15	15	20	33	45	67	100
$B_{2023} < B_{Lim}$	0	0	0	6	24	26	49	74	100
$F_{2023} > F_{Lim}$	0	0	0	10	22	45	67	96	100

APPENDIX I

SUPPORTING INFORMATION

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

Swordfish in the Indian Ocean is currently subject to a single direct Conservation and Management Measure adopted by the Commission: Resolution 12/11 *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 2012 and 2013. Swordfish is also subject to the following non species-specific Conservation and Management Measures adopted by the Commission:

- Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 13/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*
- Resolution 11/04 *on a regional observer scheme*
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Swordfish: General

Swordfish (*Xiphias gladius*) is a large oceanic apex predator that inhabits all the world's oceans (Fig. 3). 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.

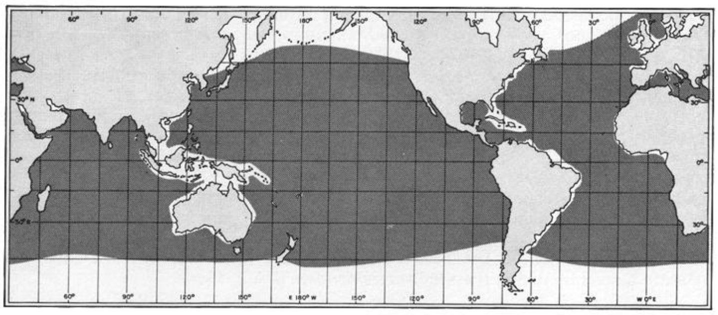

Fig. 3. Swordfish: The worldwide distribution of swordfish (Source: Nakamura 1984).

TABLE 5. Swordfish: Biology of Indian Ocean swordfish (*Xiphias gladius*).

Parameter	**Description**
Range and stock structure	Entire Indian Ocean down 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. A recent genetic study did not reveal any structure within the Indian Ocean with the markers used, however the hypothesis of a population structuring at the regional level cannot be discarded and needs to be investigated using different markers or approaches. Results obtained from the markers used may simply be a matter of the resolving power of the markers used, which may simply have been insufficient for detecting population subdivision. 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 LJFL; males ~120 cm LJFL
Spawning season	Highly fecund batch spawner. May spawn as frequently as once every three days over a period of several months in spring. Known spawning ground and season are: tropical waters of Southern hemisphere from October to April, including 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; ~50 cm LJFL for longline fisheries. 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). L-W relationships for the Indian Ocean are: females TW=0.00002409*LJFL^2.86630, males TW=0.00006289*LJFL**2.66196, both sexes mixed TW=0.00001443*LJFL^2.96267. TW in kg, LJFL in cm

Sources: Froese & Pauly 2009, Muths et al. 2009, Poisson & Fauvel 2009, Bach et al. 2011, Romanov, Romanova, 2012

Swordfish: Catch trends

Over 90% of swordfish are caught mainly using drifting longlines (>85%) (Fig. 4), on longline fisheries directed to tunas (Table 6, LL) or swordfish (Table 6, ELL), while the remaining the catches are taken by other fisheries, in particular drifting gillnets. 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. 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).

The catches of swordfish markedly increased after 1990, from around 8,000 t in 1991 to a peak of 36,000 t in 1998 and 37,000 t in 2004. The change in target species from tunas to swordfish by part of the fleet of Taiwan,China along with the development of longline fisheries in Australia, Reunion island, Seychelles and Mauritius and the arrival of longline fleets from the Atlantic Ocean (EU,Portugal, EU,Spain the EU,UK and other fleets operating under various flags[1]), all targeting swordfish, are the main reasons for this significant increase.

Since 2004, annual catches have declined steadily, 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. 5).

Catches of swordfish of up to 6,000 t have been recorded in recent years for a fleet of deep-freezing and fresh tuna longliners operating under flags of non-reporting countries (Not Elsewhere Included (NEI)). The catches have been low since 2007, at around 1,000 t.

The catches of Swordfish of industrial longliners from Japan have increased proportionally to those of yellowfin tuna, the target species of this fleet during the first years of the fishery, and have remained stable until the early 1990’s. The average annual catches over the last two decades have amounted to around 1,600 t, rising to over 2,500 t in 1994 and 1997, although most recently in 2012 and 2013 catches of between 600 t to 700 t have been reported.

[1] Senegal, Guinea, etc.

Sri Lanka swordfish catches have ranged between 2,400 and 5,500 t over the last decade, with the highest catches recorded in 2013. These are taken mostly by vessels that use a combination of drifting gillnets and longlines. Results from the sampling conducted by NARA[2] during 2005 and 2006 with the support of the IOTC-OFCF[3] Project in different locations in Sri Lanka led to a re-estimation of the historical catch series in 2012[4].

The catches of Indonesian fresh-tuna longliners operating in Indian Ocean waters increased steadily until 2003 (3,400 t), and have decreased since then. It is, however, likely that the catches recorded for the swordfish are incomplete, as the statistics for years before 2003 are thought to be more uncertain (as port sampling was only initiated in 2003), and coverage of the frozen component of catches from port sampling, which is likely to contain substantial amounts of swordfish, was not sufficient. Catch estimates for 2012 and 2013 are three-fold those in 2011 and remain uncertain.

During the last two decades, several domestic longline fisheries targeting swordfish started to operate in Reunion (EU,France), Australia, Seychelles, South Africa and, more recently, Mauritius, with total accumulated catches estimated to be between 2,000 t and 3,000 t in recent years (see ‘All other fleets, Fig. 5).

EU longliners flagged to Spain, Portugal and the UK coming from the Atlantic Ocean have been operating in the Indian Ocean since the early 90s with current accumulated catches around 5,000 t. Around 25% of the catches of swordfish in the Indian Ocean have been taken by vessels operating under EU flags in recent years.

The annual catches of swordfish by longliners from the Rep. of Korea, recorded since 1965, have rarely exceeded 1,000 t. The highest catch, 1,100 t, was recorded in 1994. In 2010 the IOTC Secretariat revised the catches of swordfish for Rep. of Korea over the time-series using catches reported as nominal catches and catch-and-effort.

Swordfish is mostly exploited in the western Indian Ocean (Fig. 6), in waters off Somalia, and in the southwest Indian Ocean. Other important fisheries operate in waters off Sri Lanka, Western Australia and Indonesia. In 2009–11 the catches of swordfish in the western tropical Indian Ocean have dropped considerably, especially in areas off Somalia, Kenya and Tanzania, from around 13,000 t in 2005 to 6,500 t in 2008, and in particular 2,500 t in 2011. The drop in catches is the consequence of a drop in fishing effort in the area by longline fisheries, due to either piracy or decreased fish abundance, or a combination of both. Catches in 2012 in this area were three-fold those in 2011.

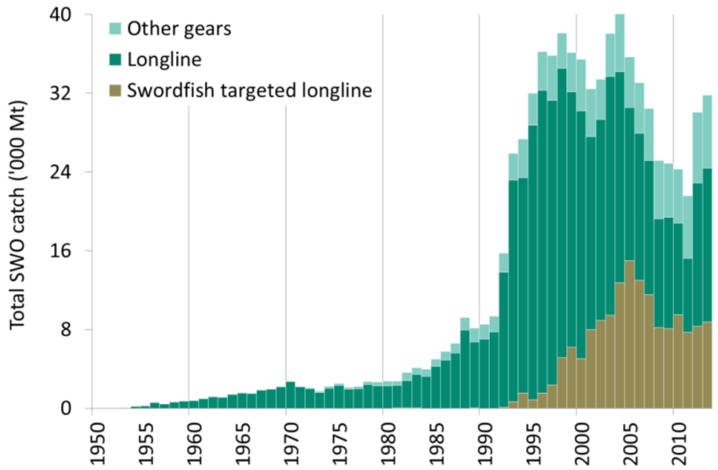

Fig. 4 Swordfish: Catches of swordfish by gear and year recorded in the IOTC Database (1950–2013).

[2] National Aquatic Resources and Development Agency of Sri Lanka

[3] Overseas Fisheries Cooperation Foundation of Japan

[4] Moreno et al. (2012). Pilot project to improve data collection for tuna, sharks and billfish from artisanal fisheries in the Indian Ocean. Part II: Revision of catch statistics for India, Indonesia and Sri Lanka (1950-2011). Assignment of species and gears to the total catch and issues on data quality. Document presented at the 15th Session of the IOTC Scientific Committee, Seychelles, 10-15 December 2012. IOTC–2012–SC15–38

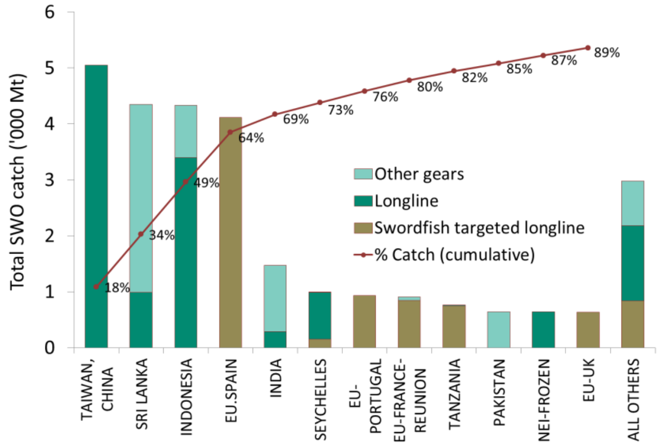

Fig. 5. Swordfish: average catches in the Indian Ocean over the period 2010–13, by fleet or country, ordered from left to right, according to the importance of catches of swordfish reported. The red line indicates the (cumulative) proportion of catches of swordfish for the fleets or countries concerned, over the total combined catches of this species reported from all fleets or countries and fisheries.

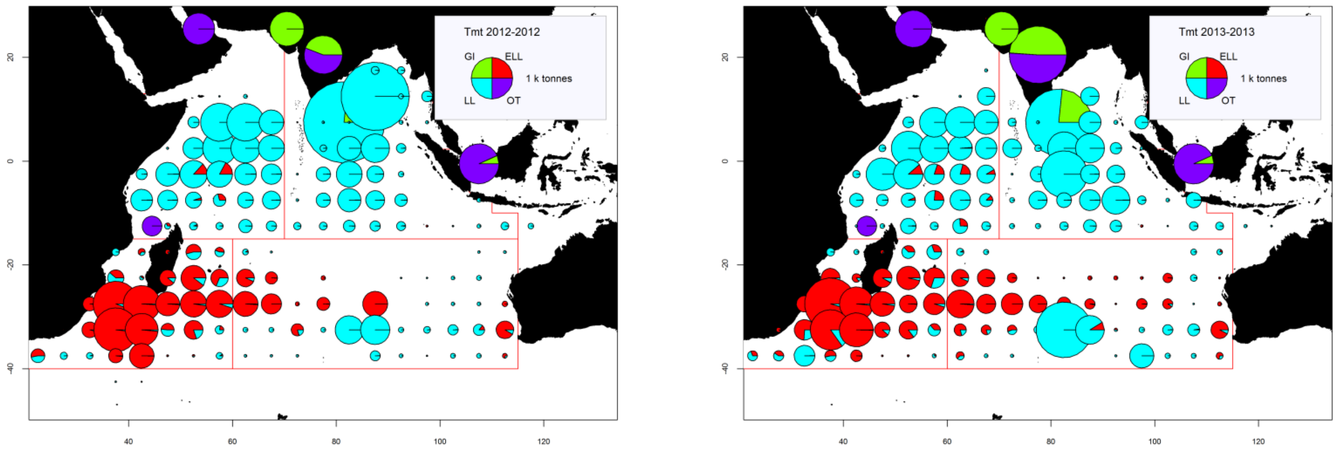

Fig. 6a–b. Swordfish: Time-area catches (total combined in tonnes) of swordfish for longline fisheries targeting swordfish (ELL), other longline fisheries (LL), gillnet fisheries (GI), and for all other fleets combined (OT), for the period 2004–08 by type of gear and for 2009–13, by year and type of gear. Red lines represent the areas used for the assessments of swordfish.

TABLE 6. Swordfish: Best scientific estimates of the catches of swordfish by type of fishery for the period 1950–2013 (in metric tons) (Data as of September 2014).

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
ELL	-	-	-	9	1,841	9,993	12,740	14,965	13,009	11,543	8,173	8,106	9,510	7,686	8,337	8,785
LL	282	1,425	2,136	4,372	22,689	20,048	24,204	17,390	17,129	16,080	13,497	13,726	11,740	10,332	17,484	17,575
OT	37	39	186	807	1,998	2,846	3,324	3,337	2,936	2,810	3,482	3,019	3,020	3,545	4,237	5,445
Total	**320**	**1,465**	**2,322**	**5,189**	**26,527**	**32,886**	**40,267**	**35,693**	**33,074**	**30,433**	**25,153**	**24,852**	**24,270**	**21,564**	**30,058**	**31,804**

Fisheries: Swordfish longline (**ELL**); Longline (**LL**); Other gears (**OT**)

TABLE 7. Swordfish: Best scientific estimates of the catches of swordfish by fishing area for the period 1950–2013 (in metric tons) (Data as of September 2014).

Area	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
NW	100	547	776	1,888	8,278	10,180	12,868	12,254	10,785	8,430	6,321	4,506	2,668	2,483	8,690	8,683
SW	14	254	406	606	8,624	7,682	6,325	9,791	8,995	7,423	6,437	6,381	8,211	7,005	7,354	7,349
NE	168	453	756	2,168	6,504	9,296	11,400	7,975	9,275	9,359	8,889	10,862	9,896	9,147	11,796	12,489
SE	37	203	307	387	3,034	5,709	9,641	5,656	4,014	5,207	3,502	3,097	3,483	2,923	2,215	3,283
OT	0	8	76	140	88	20	33	16	6	15	5	5	11	6	4	1
Total	**320**	**1,465**	**2,322**	**5,189**	**26,527**	**32,886**	**40,267**	**35,693**	**33,074**	**30,433**	**25,153**	**24,852**	**24,270**	**21,564**	**30,058**	**31,804**

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. 7a); however catches are uncertain for:

- **Drifting gillnet** fisheries of IR Iran and Pakistan: The IOTC Secretariat used the catches of swordfish and marlins reported by IR Iran for the years 2012 and 2013 to rebuild historical catches of billfish for this fishery. However, catch rates and species composition for the Iranian and Pakistani gillnet fisheries differ and they are also in contradiction with other estimates, derived from sampling in Pakistan. Estimates of catches of swordfish by drifting gillnet in Pakistan and IR Iran have represented over 4% of the total combined catches of swordfish reported, from all fisheries.
- **Longline** fishery of Indonesia: The catches of swordfish for the longline fishery of Indonesia may have been underestimated over the time series due to insufficient sampling coverage. Although the new catches estimated by the IOTC Secretariat for the period 2003–09 are thought to be more accurate, swordfish catches remain uncertain, especially in recent years (where they represent around 12% of the total catches of swordfish in the Indian Ocean).
- **Longline fishery of India:** India has reported very incomplete catches and catch-and-effort data for its commercial longline fishery. Although the new catches estimated by the IOTC Secretariat are thought to be more accurate, catches of swordfish remain uncertain (catches of swordfish in recent years represent less than 4% of the total catches of swordfish in the Indian Ocean).
- **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 (they represent around 3% of the total catches of swordfish in the Indian Ocean).

Discards: 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 IR Iran, as this species has no commercial value in this country.

Changes to the catch series: There have been relatively minor revisions to the catches of swordfish since the WPB meeting in 2013. Any differences in the data series since the last WPB are relatively small changes to the nominal catch as a result of reallocation of catch reported as other billfish species or as aggregated species groups reported by Sri Lanka, and Pakistan to a lesser extent. These changes, however, did not lead to very significant changes in the total catch estimates for swordfish.

Catch–per–unit–effort (CPUE) Series (Fig. 7b): Catch and effort series are available from some industrial longline fisheries. Nevertheless, catch and effort are not available from some fisheries or they are considered poor quality, especially since the early 90s (Indonesia, fresh-tuna longliners from Taiwan,China[5], Non-reporting longliners (NEI)). In addition, catch-and-effort data are not available for the gillnet and longline fishery of Sri Lanka and the drifting gillnet fisheries of IR Iran and Pakistan.

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 (Fig. 7c).

- **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.

Catch-at-Size(Age) (Figs. 8, 9): data are available but the estimates are thought to have been compromised for some years and fisheries due to:

- the uncertainty in the length frequency data recorded for longliners of Japan and Taiwan,China, for which average weights of swordfish derived from length frequency data and catch-and-effort data are very different.
- the uncertainty in the catches of swordfish for the drifting gillnet fisheries of IR Iran and the 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, IR Iran, Pakistan, NEI).

[5] Catch-and-effort statistics for the fresh-tuna longline fishery of Taiwan,China are available since 2007, although logbook coverage levels are still low.

- the paucity of biological data available, notably sex-ratio and sex-length-age keys.

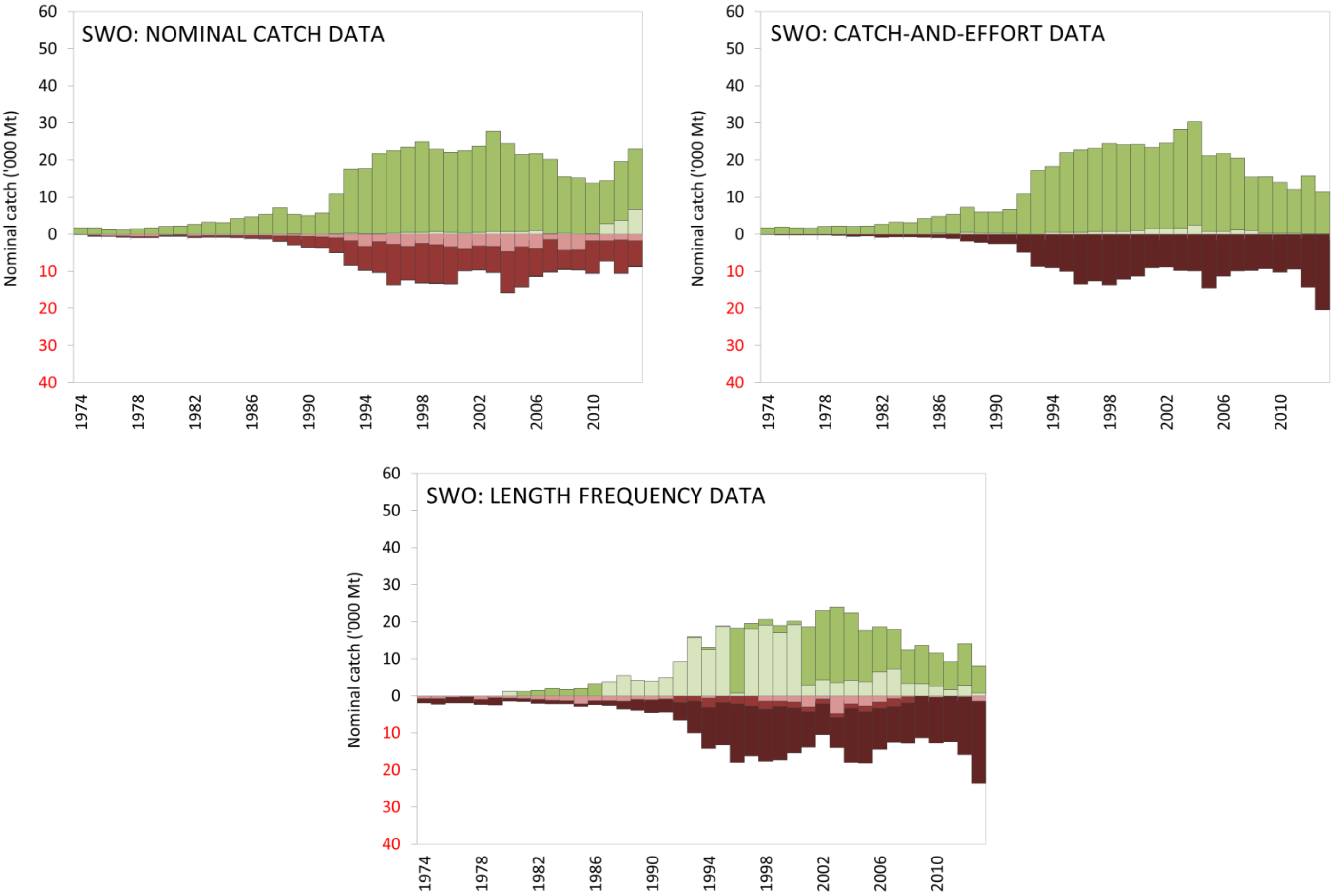

Fig. 7a-c. Swordfish: data reporting coverage (1974–2013). a) nominal catch data; b) catch-and-effort data; c) length frequency data. Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available (Data as of September 2014).

Key to IOTC Scoring system

Nominal Catch	By species	By gear
Fully available	0	0
Partially available (part of the catch not reported by species/gear)*	2	2
Fully estimated (by the IOTC Secretariat)	4	4

*Catch assigned by species/gear by the IOTC Secretariat; or 15% or more of the catches remain under aggregates of species

Catch-and-Effort	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

Size frequency data	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 1 fish measured by metric ton of catch)	2	
Not available at all	8	

Key to colour coding

- Total score is 0 (or average score is 0-1)
- Total score is 2 (or average score is 1-3)
- Total score is 4 (or average score is 3-5)
- Total score is 6 (or average score is 5-7)
- Total score is 8 (or average score is 7-8)

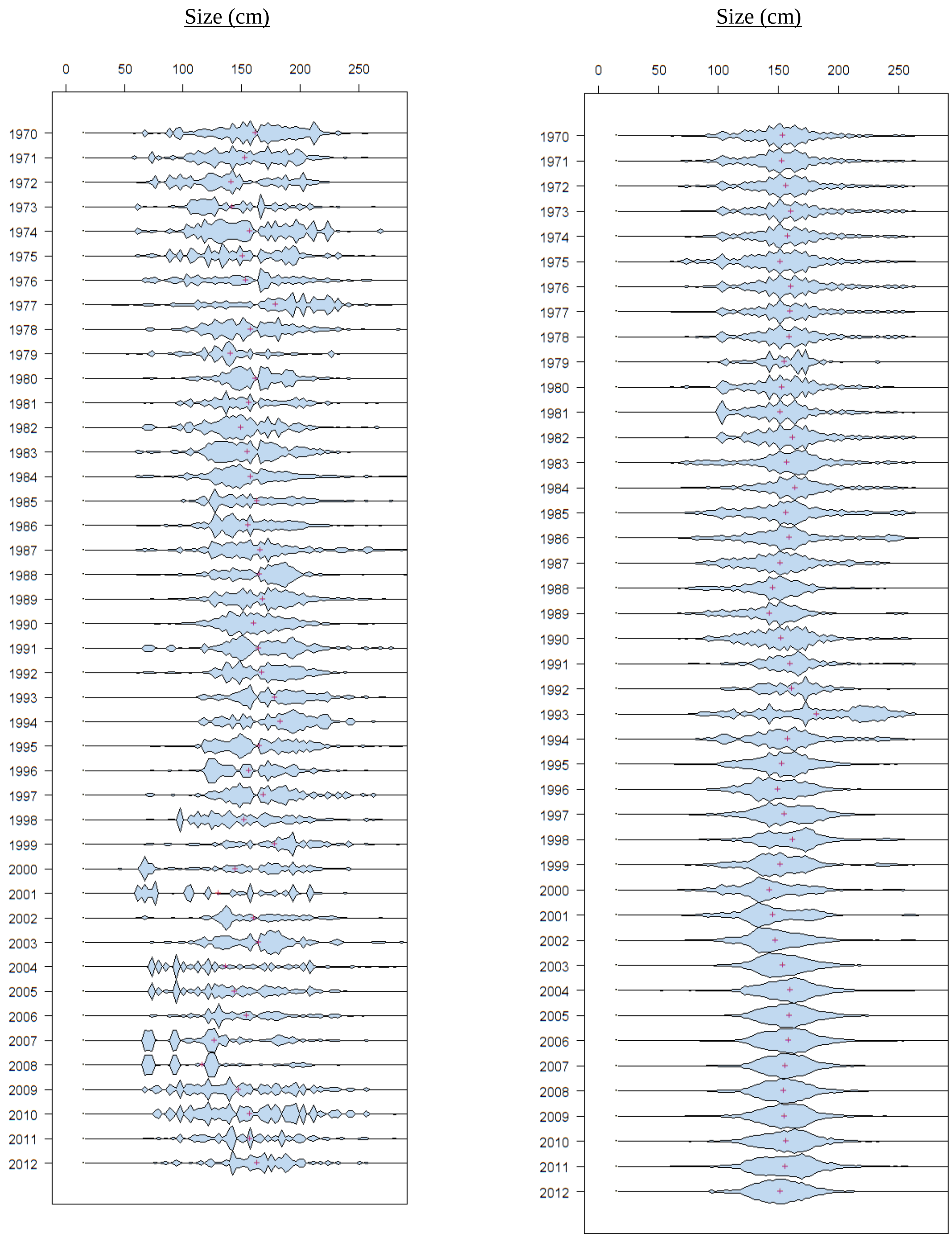

Fig. 8. Swordfish: Longline catch-at-size length distributions for Japan (left) and Taiwan,China (right) (Data as of September 2014).

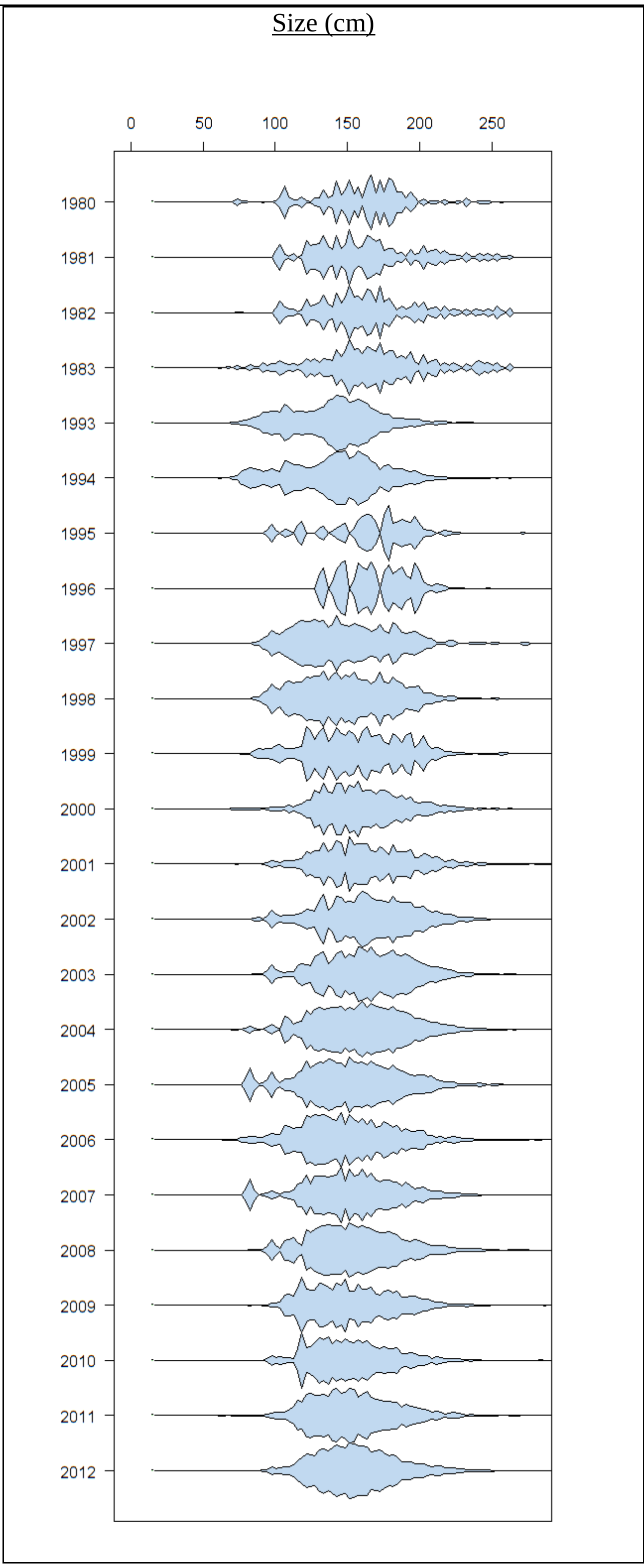

Fig. 9. Swordfish: Longline catch-at-size length distributions for combined EU,Spain, EU,Portugal and EU,UK vessels (Data as of September 2014).

Swordfish: Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2012 and 2013 are provided in Fig. 10, 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 2012 and 2013 are provided in Fig. 11.

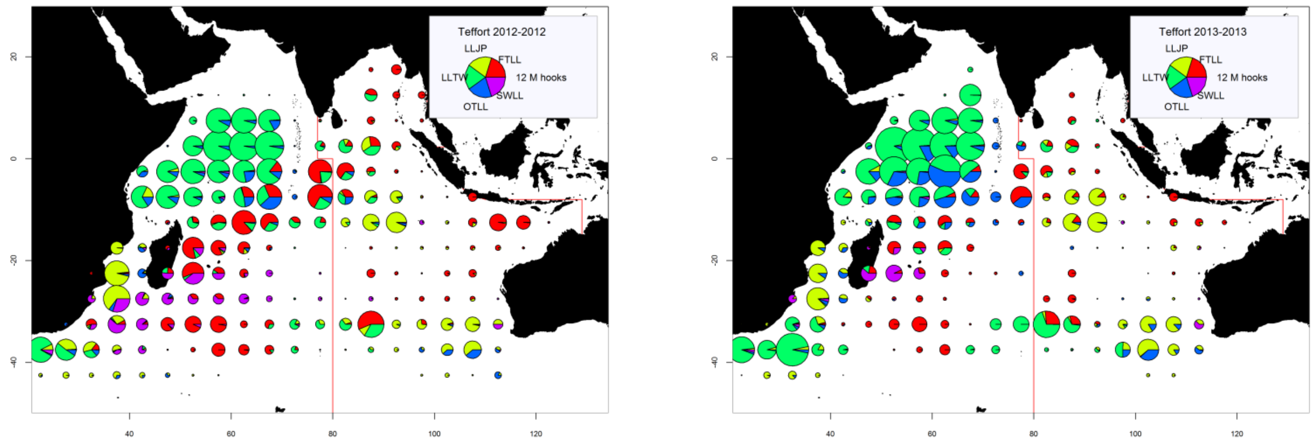

Fig. 10. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014). **LLJP** (light green): deep-freezing longliners from Japan; **LLTW** (dark green): deep-freezing longliners from Taiwan,China; **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).

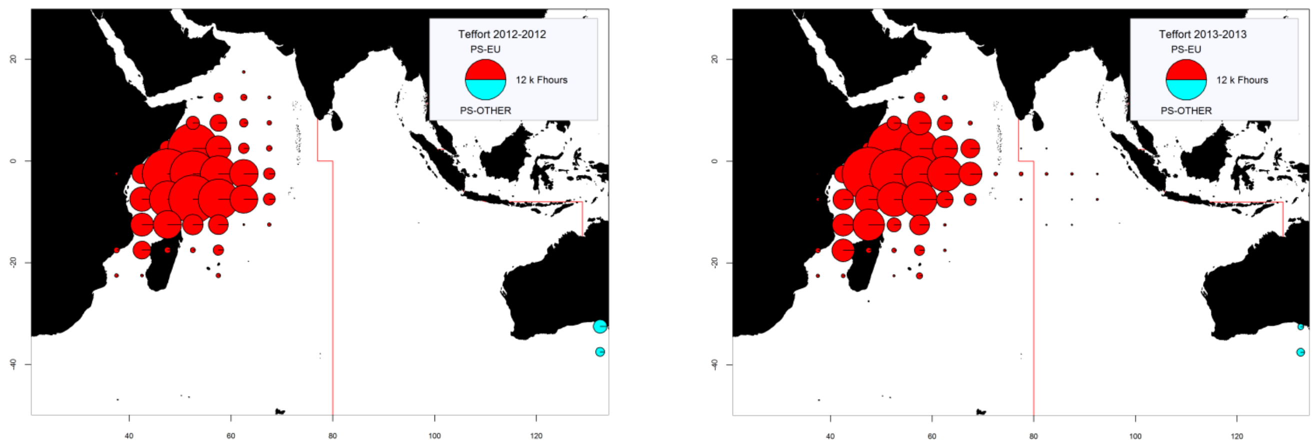

Fig. 11. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014). **PS-EU** (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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).

Swordfish: Catch–per–unit–effort (CPUE) trends

Of the CPUE series available for assessment purposes, the Japan, Taiwan,China, EU,Portugal and EU,Spain series were used in the final stock assessment models investigated in 2014, for the reasons discussed above (Figs. 12, 13).

- EU,Portugal data (2000–2013): Model 2 from IOTC–2014–WPB12–19
- EU,Spain data (2001–2012): Run 4 from document IOTC–2014–WPB12–20 Rev_1 and Run 2 for the assessment of whole Indian Ocean.

- Japan data (1971–2013): Case 5 (SWO cluster, SWO data) and case 3 (NHBF, all data) from document IOTC–2014–WPB12–21 Rev_1.
- Taiwan,China data (1980–2012): Series 2 from document IOTC–2014–WPB12–22.

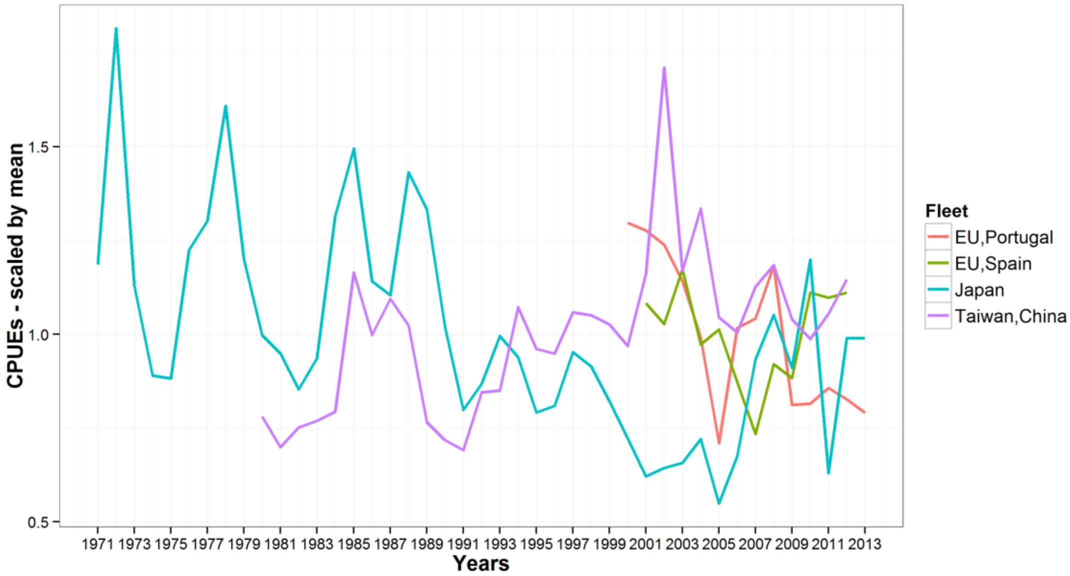

Fig. 12. Aggregate whole Indian Ocean Swordfish: CPUE series for the Indian Ocean swordfish assessments (ASIA, ASPIC and BBDM) in 2014. Series have been rescaled relative to their respective means (for different overlapping time periods).

The Japan, Taiwan,China, EU,Portugal and EU,Spain series, by area, were used in the final SS3 stock assessment model to develop management advice (Fig. 13).

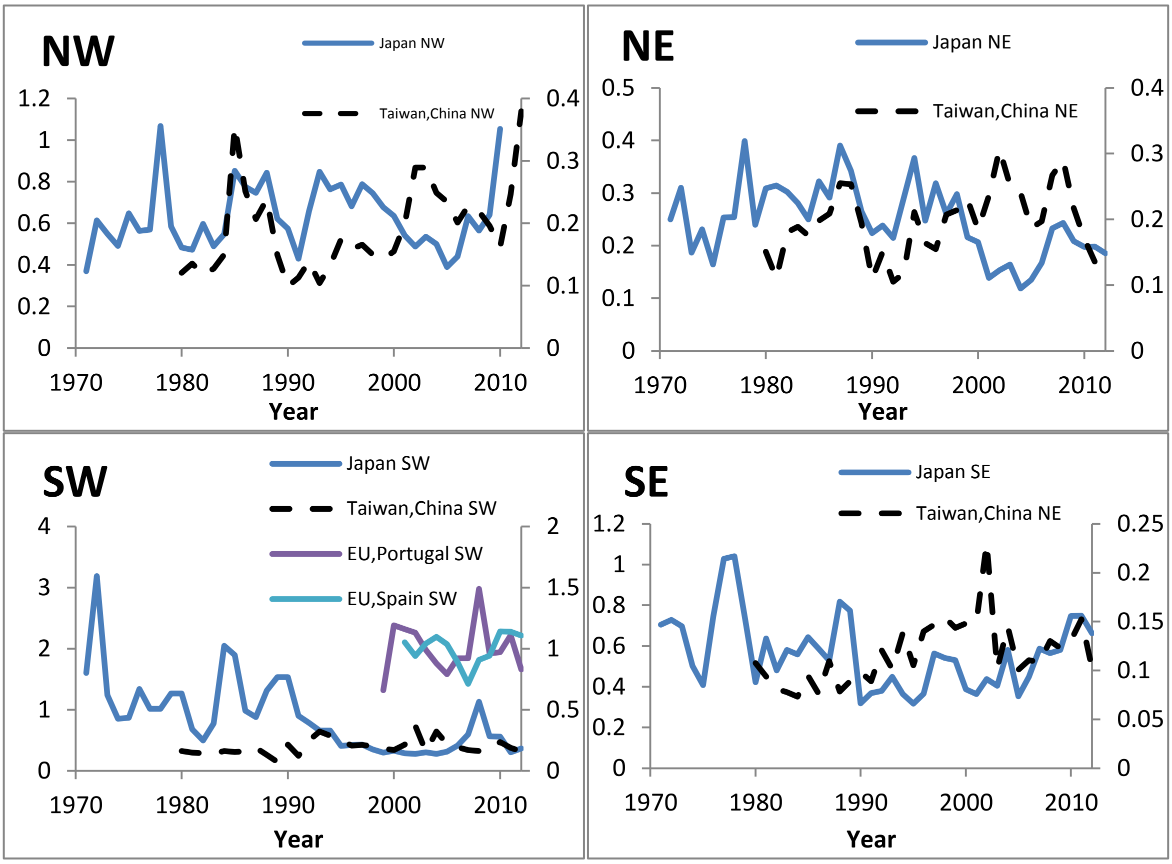

Fig. 13. Swordfish: CPUE series used in the final SS3 stock assessment model in 2014 by sub-region. Series have been rescaled relative to their respective means (for different overlapping time periods). NW – north-west; SW – southwest; NE – northeast; SE – southeast Indian Ocean.

Southwest Indian Ocean CPUE summary

The CPUE series used in the southwest Indian Ocean stock assessment models for 2014 (shown in Fig. 14). Of the CPUE series available for the southwest Indian Ocean for assessment purposes, listed below, the Japanese case (scenario) 3 in paper IOTC–2014–WPB12–21 Rev_1 (Fig. 14) was used in the final stock assessment model for management advice.

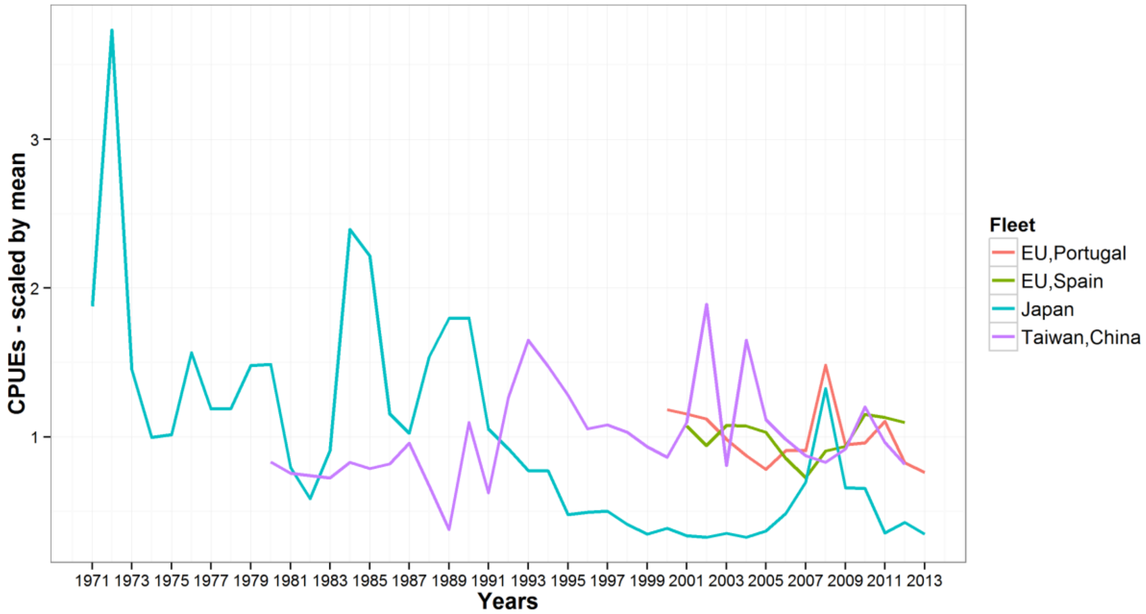

Fig. 14. Swordfish: CPUE series for the **southwest** Indian Ocean swordfish assessments in 2014. Series have been rescaled relative to their respective means (for different overlapping time periods).

STOCK ASSESSMENT

The following should be noted with respect to the various modelling approaches used in 2014:

- There was more confidence in the abundance indices this year due to the additional exploratory CPUE analyses from Japan and Taiwan,China. This has led to improved confidence in the overall assessments.
- The Japan longline CPUE series is more likely to closely represent swordfish abundance at this time, because a substantial part of the Japan longline fleet has a long term series of swordfish bycatch even though it has never targeted swordfish. In addition, it is the only CPUE series that decreases as catch increases.
- Conversely, the Taiwan,China CPUE seems to demonstrate very strong targeting shifts away from swordfish in the core area and back towards swordfish in recent years.
- CPUE series should not be averaged across series with different trends as this is likely to result in spurious trends. Thus, only series which are considered to be most representative of abundance, in this case the Japan longline series, should be the primary CPUE series used in stock assessments while further work is carried out on the other series (Taiwan,China, EU,Spain and EU,Portugal).
- 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.

The swordfish stock status for the aggregate Indian Ocean is determined from the SS3 stock assessment undertaken in 2014 as it was considered most likely to numerically and graphically represent the current status of swordfish in the Indian Ocean (Table 8). The other analysis were treated as being informative of the results. There is value in undertaking a number of different modelling approaches to facilitate comparison. 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 southwest Indian Ocean assessments had substantial conflicting results based on the different model runs (ASIA, BBDM and ASPIC: Table 8).

TABLE 8. Swordfish: Key management quantities from the SS3 assessment for aggregate Indian Ocean, using a base case with the growth curve from paper IOTC–2010–WPB08–08 Rev_1, M=0.25, and steepness=0.75, ESS=200, and all CPUE data used for point estimates). CI values are 80% from the base case run; and from the ASPIC assessment for the southwest Indian Ocean.

Management Quantity	Aggregate Indian Ocean	Southwest Indian Ocean
2013 catch estimate	31,804 t	7,349
Mean catch from 2009–2013	26,510 t	7,265
MSY (1,000 t) (80% CI)	39.40 (33.20–45.60)	9.86 (9.11–10.57)
Data period used in assessment	1950–2013	1950–2013
F_{MSY} (80% CI)	0.138 (0.137–0.138)	0.63 (0.59–0.70)
SB_{MSY} (1,000 t) (80% CI)	61.4 (51.5–71.40)	12.68 (12.52–12.78)
F_{2013}/F_{MSY} (80% CI)	0.34 (0.28–0.40)	0.89 (0.61–1.14)
B_{2013}/B_{MSY} (80% CI)	n.a.	0.94 (0.68–1.23)
SB_{2013}/SB_{MSY} (80% CI)	3.10 (2.44–3.75)	n.a.
B_{2013}/B_{1950} (80% CI)	n.a.	0.16 (n.a.)
SB_{2013}/SB_{1950} (80% CI)	0.74 (0.58–0.89)	n.a.
$B_{2013}/B_{1950,\ F=0}$ (80% CI)	n.a.	n.a.
$SB_{2013}/SB_{1950,\ F=0}$ (80% CI)	n.a.	n.a.

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APPENDIX XVII
EXECUTIVE SUMMARY: BLACK MARLIN

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

Status of the Indian Ocean black marlin (BLM: *Makaira indica*) resource

TABLE 1. Black marlin: Status of black marlin (*Makaira indica*) in the Indian Ocean

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Catch 2013: Average catch 2009–2013:	14,400 t 11,962 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2013}/F_{MSY} (80% CI): B_{2013}/B_{MSY} (80% CI): B_{2013}/B_{1950} (80% CI):	10.2 (7.6–13.8) 0.25 (0.08–0.45) 37.8 (14.6–62.3) 1.06 (0.39–1.73) 1.13 (0.73–1.53) 0.57 (0.37–0.76)	

[1]Boundaries for the Indian Ocean = IOTC area of competence;

Colour key	Stock overfished(B_{year}/B_{MSY}< 1)	Stock not overfished (B_{year}/B_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. Data poor methods for stock assessment using Stock reduction analysis (SRA) techniques indicate that the stock is not overfished but and close to or just over the maximum sustainable yield levels (Table 1, Fig. 1). This is the second time that the WPB has applied a SRA technique to black marlin and further testing of how sensitive this technique is to model assumptions and available time series of catches needs to be undertaken. However, the WPB considers that the assessment is the best information currently available and as such, should be used to tentatively determine stock status, with the intention that alternative techniques be applied in 2015 to validate the results. Thus, the stock status for black marlin in the Indian Ocean is **not overfished** but **subject to overfishing**. The stock appears to show an increase in catch rates which is a cause of concern, indicating that fishing mortality levels are likely to have become too high (Fig. 1). Aspects of the biology, productivity and fisheries for this species combined with the data poor status on which to base a more formal assessment are a major cause for concern. Research emphasis on developing possible CPUE indicators and further exploration of alternative stock assessment approaches for data poor fisheries are warranted to validate these findings. Given the limited data being reported for coastal gillnet fisheries, and the importance of sports fisheries for this species, efforts must be made to rectify these information gaps.

Outlook. Total catch for black marlin in recent years has continued to increase to a total of 14,400 t in 2013. There is a moderate to high risk of exceeding MSY-based reference points by 2016 if catches increase further (20% increase) (≈ 44% risk that $B_{2016} < B_{MSY}$, and ≈ 78% risk that $F_{2016} > F_{MSY}$) (Table 2).

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is between 7,600 and 13,800 t.
- **Provisional reference points**: Although the Commission adopted interim reference points for swordfish in Resolution 13/10 *on interim target and limit reference points and a decision framework*, no such interim points have been established for black marlin.
- **Main fishing gear** (2010–13): gillnet catches are currently estimated to comprise approximately 62% of the total estimated black marlin catch in the Indian Ocean.

- **Main fleets** (2010–13): Sri Lanka: 26 %; I.R. Iran: 20%; India: 18%.
- **Improvements required**: improvement in data collection and reporting, particularly for coastal gillnet and sports fisheries, is required to further assess the stock.

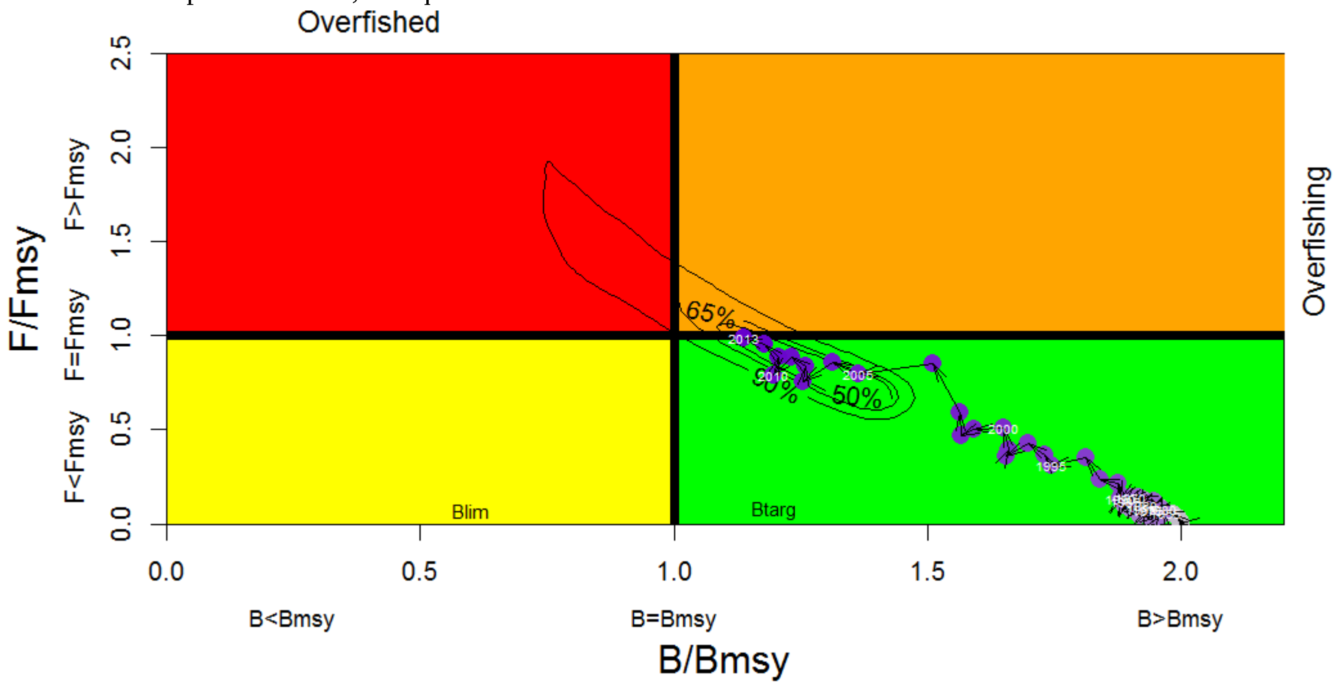

Fig. 1. Black marlin: Stock reduction analysis (Catch MSY Method) aggregated Indian Ocean assessment Kobe plots for black marlin (contours are the 50, 65 and 90 percentiles of the 2013 estimate). Black line indicates the trajectory of the point estimates (blue circles) for the spawning biomass (B) ratio and F ratio for each year 1950–2013.

TABLE 2. Black Marlin: Indian Ocean stock reduction analysis (SRA) Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target reference points for nine constant catch projections (average catch level from 2011–13 (12,940 t), ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2011–13) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60% (7,764 t)	**70%** (9,058 t)	**80%** (10,352 t)	**90%** (11,646 t)	**100%** (12,940 t)	**110%** (14,234 t)	**120%** (15,528 t)	**130%** (16,822 t)	**140%** (18,116 t)
$SB_{2016} < SB_{MSY}$	17	n.a.	24	n.a.	33	n.a.	44	n.a.	56
$F_{2016} > F_{MSY}$	12	n.a.	30	n.a.	53	n.a.	78	n.a.	99
$SB_{2023} < SB_{MSY}$	10	n.a.	28	n.a.	60	n.a.	95	n.a.	100
$F_{2023} > F_{MSY}$	7	n.a.	28	n.a.	63	n.a.	100	n.a.	100

APPENDIX I

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 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 13/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*

- Resolution 11/04 *on a regional observer scheme*
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Black marlin: General

Black marlin (*Makaira indica*) is a large oceanic apex predator that inhabits tropical and subtropical Indo-Pacific oceans (Fig. 2). Table 3 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.

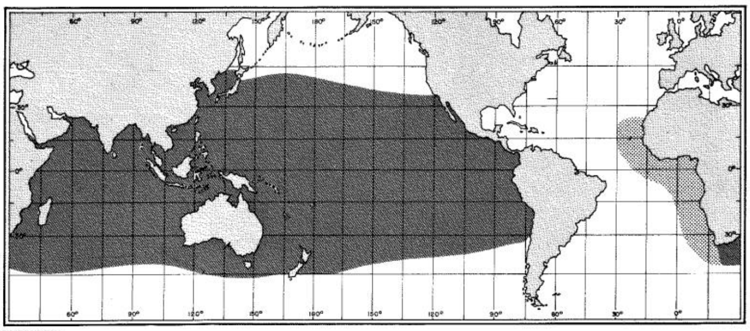

Fig. 2. Black marlin: The worldwide distribution of black marlin (Source: Nakamura 1984).

TABLE 3. Black marlin: 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. Black marlin is a highly migratory, large oceanic apex predator that inhabits tropical and subtropical waters of the Indian and Pacific oceans. Some rare 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 inhabits oceanic surface waters above the thermocline and typically near land masses, islands and coral reefs; however rare excursions to mesopelagic waters down to depths of 800 m are known. Thought to associate with schools of small tuna, which is one of its primary food sources (also reported to feed on other fishes, squids and other cephalopods, 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. Long distance migrations at least in the eastern Indian Ocean (two black marlins tagged in Australia were caugh off east Indian coast and Sri Lanka) support a single stock hypothesis. It is known that black marlin forms dense nearshore spawning aggregations, making this species vulnerable to exploitation even by small-scale fisheries. Spatial heterogeneity in stock indicators (catch–per–unit–effort trends) for other billfish species indicates that there is potential for localised depletion.
Longevity	No data available for the Indian Ocean. In the Pacific (Australia) 11–12 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 ocean. Spawning hotspot off eastern Australia apparently has no links with Indian Ocean stock. Spawning individuals apparently prefer water temperatures above 26–27°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 460 cm FL and weigh 800 kg total weight. In the Indian Ocean it reach at least 360 cm LJFL. 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. In the Indian Ocean documented maximum size for females: 306 cm LJFL, 307 kg total weight; males: 280 cm LJFL, 147 kg total weight. Most black marlin larger than 200 kg are female. Recruitment into the fishery: varies by fishing method; ~60 cm LJFL for artisanal fleets and methods. The average size of black marlin taken in Indian Ocean longline fisheries is not available. L-W relationships for the Indian Ocean are: females TW=0.00000010*LJFL**3.7578, males TW=0.00002661*LJFL**3.7578, both sexes mixed TW=0.00000096*LJFL**3.35727, TW in kg, LJFL in cm. However these relationships were obtained from small sample sizes (n=75), therefore it should be treated with caution.

Sources: Nakamura 1985, Cyr et al. 1990, Gunn et al. 2003, Speare 2003; Sun et al. 2007, Froese & Pauly 2009, Romanov & Romanova 2012, Domeier & Speare 2012

Black marlin: Catch trends

Black marlin are caught mainly using drifting longlines (30%) and gillnets (50%) with remaining catches recorded using troll and hand lines (Table 4, Fig. 3). Black marlin are the bycatch of industrial and artisanal fisheries. In recent years, the fleets of Sri Lanka (longline and gillnet), I.R. Iran (gillnet), India (gillnet and troll), Indonesia (troll and hand lines) and Pakistan (gillnet) account for around 90% of the catch of black marlin (Fig. 4). Catches of black marlin have increased steadily since the 1990s, from 2,700 t in 1991 to over 10,000 t in 2011. The highest catches over the time series of black marlin were recorded in 2013, at over 14,000 t (Table 4).

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 (Fig. 5). 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. 5).

In 2013 and 2014 I.R. Iran reported catches of swordfish and marlins for its drifting gillnet fisheries for the first time. The catches of black marlin reported, 3,000 t in 2012 and 4,000 t in 2013, were used to re-build historical catches for I.R. Iran. Pakistan has also reported catches of marlins for its fishery in recent years, with catches of black marlin at around 1,000 t in 2012–13. The new catches estimated for drifting gillnet fisheries represent over 30% of the total catches of black marlin in the Indian Ocean.

The catches of black marlin in Sri Lanka have risen steadily since the mid-1990's as a result of the development of the fishery using a combination of drifting gillnets and longlines, from around 1,000 t in the early 1990s to over 4,500 t in 2011. In 2012 and 2013 catches dropped to 3,000 and 2,500 t, respectively. In recent years (2011–13) India has reported higher catches of black marlin for its fisheries, amounting to around 1,500 t to 3,500 t, largely from increases in catches from gillnet and trolling).

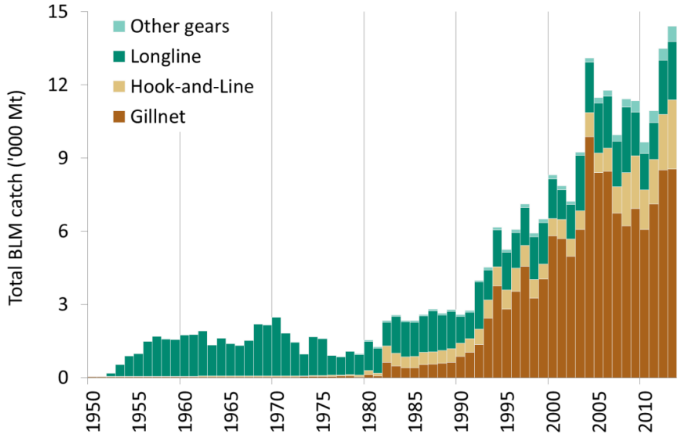

Fig. 3. Black marlin: Catches of black marlin by gear and year recorded in the IOTC Database (1950–2013).

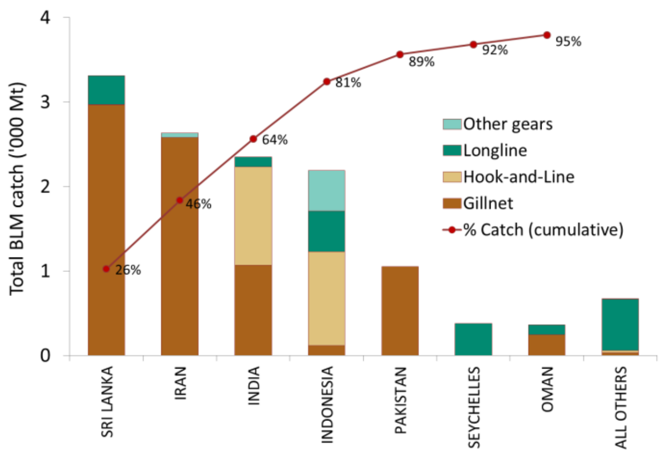

Fig. 4. Black marlin: Average catches in the Indian Ocean over the period 2010–13, by country. Countries are ordered from left to right, according to the importance of catches of black marlin reported. The red line indicates the (cumulative) proportion of catches of black marlin for the countries concerned, over the total combined catches of this species reported from all countries and fisheries.

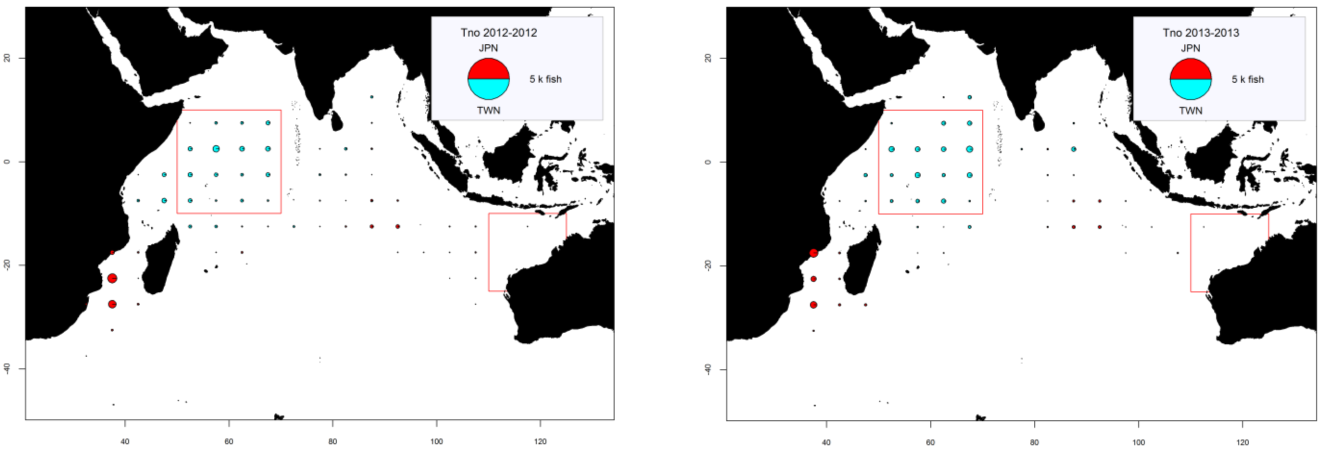

Fig. 5a–b. Black marlin: Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for a) 2012 and b) 2013 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

TABLE 4. Black marlin: Best scientific estimates of the catches of black marlin by type of fishery for the period 1950–2013 (in metric tons) (Data as of September 2014).

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LL	846	1,633	1,288	1,370	1,485	1,911	2,071	2,053	2,120	1,872	2,684	1,788	1,484	1,501	2,226	2,374
GN	26	31	44	439	2761	6,916	9,870	8,390	8,458	6,738	6,222	6,931	6,065	7,113	8,516	8,551
HL	24	27	42	446	727	1,032	996	812	954	1,078	1,351	2,164	1,634	1,836	2,267	2,837
OT	0	0	4	65	112	226	170	227	237	257	329	460	465	482	479	637
Total	**896**	**1,692**	**1,377**	**2,320**	**5,085**	**10,085**	**13,107**	**11,483**	**11,769**	**9,944**	**10,585**	**11,343**	**9,649**	**10,932**	**13,487**	**14,400**

Fisheries: Gillnet (**GN**); Longline (**LL**); Hook-and-Line (**HL**), including handline, trolling, baitboat, and sport fisheries; Other gears (**OT**)

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 IOTC Secretariat.

Retained catches: uncertain for some fisheries (Fig. 6a), 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 IOTC Secretariat for some years and artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, I.R. Iran and Pakistan) and industrial (longliners of Indonesia and the Philippines) fisheries.
- catches of non-reporting industrial longliners (India and Not Elsewhere Included (NEI)) and the gillnet fishery of Indonesia are estimated by the IOTC Secretariat using alternative information.
- catches are likely to be incomplete for industrial fisheries as the black marlin is not a target species.
- conflicting catch reports have been received for longline catches from the Rep. of Korea, which 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 IOTC Secretariat revised the catches of black marlin for the Rep. of Korea over the time-series using both datasets. Although the new catches estimated by the IOTC 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: unknown for most industrial fisheries, mainly longliners. Discards of black marlin may also occur in some driftnet fisheries.

Changes to the catch series: There have been relatively large revisions to catches of black marlin since the WPB meeting in 2013, mostly the result of changes to catch-by-species for I.R. Iran, and to a lesser extent Indonesia.

As previously noted, in 2014 I.R. Iran provided detailed catches for billfish species that substantially revised the catch-by-species previously estimated by the IOTC Secretariat; the main change being the proportion of catches assigned as black marlin rather than blue marlin for I.R. Iran's offshore gillnet fishery.

As a result of changes in the catch series for I.R. Iran in 2012 and 2013 – and revision of the catch-by-species for the offshore fishery for earlier years – total catches of black marlin have been revised upwards by as much as 30% to 50% for a number of years around the mid-2000's (e.g. in 2005 total catches of black marlin in the Indian Ocean have been revised from around 7,400 t to nearly 11,500 t).

Catch–per–unit–effort (CPUE) Series (Fig. 6b): Standardised CPUE series have not yet been developed. Nominal CPUE series are however available from some industrial longline fisheries (primarily the Japanese longline fleet); 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).

Fish size or age trends (e.g. by length, weight, sex and/or maturity) (Fig. 6c): 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. The length frequency distributions derived from samples collected by fishermen on Taiwanese longliners are likely to be biased.

Catch-at-Size(Age): tables have not been built for black marlin due to a lack of information reported by CPCs and the issues identified with some datasets. Fish size is derived from various length and weight information, however the reliability of the size data is reduced for some fleets or when relatively few fish out of the total catch are measured.

Sex ratio: data have not been provided to the IOTC Secretariat by CPCs.

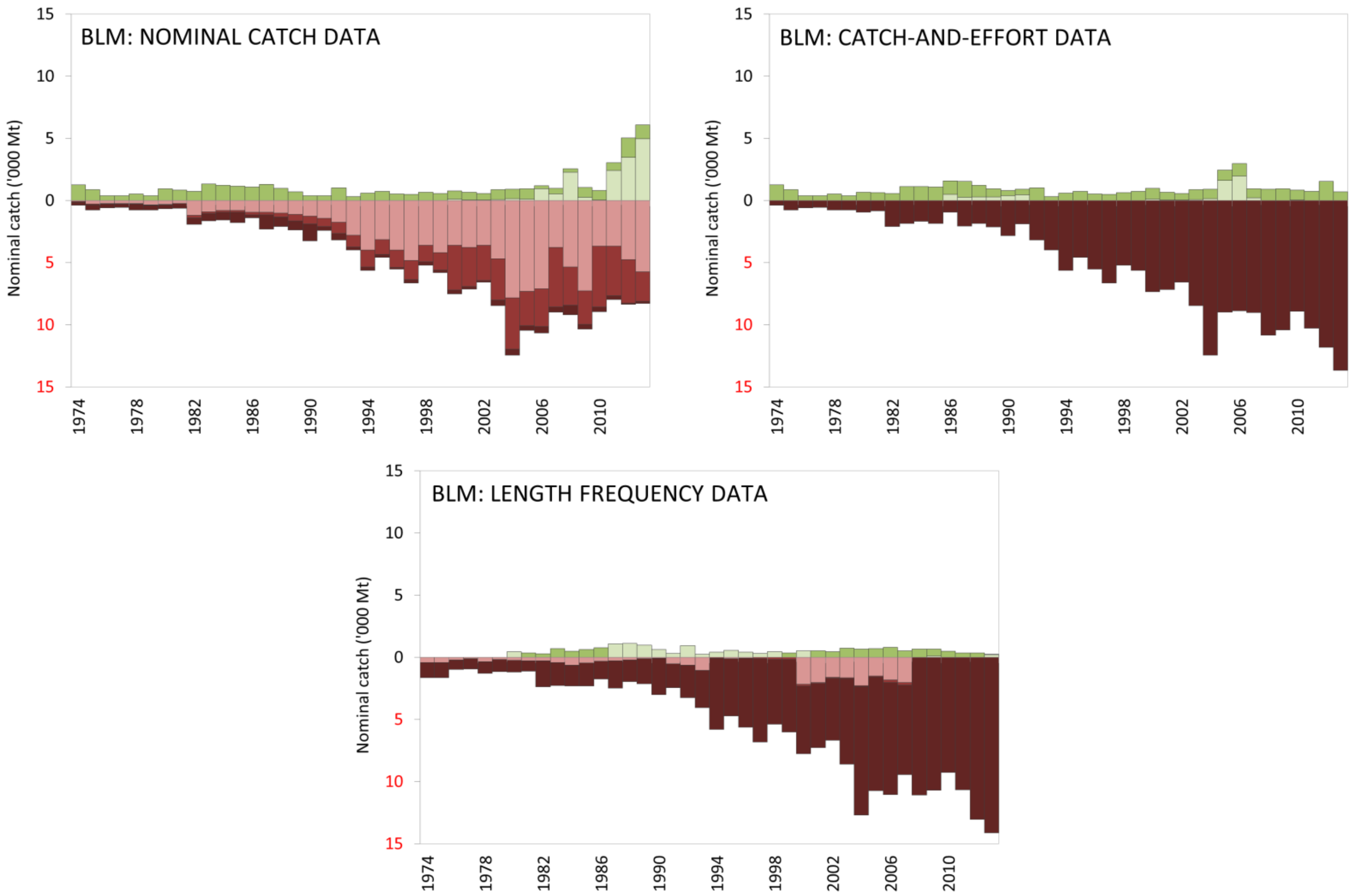

Fig. 6a–c. Black marlin: data reporting coverage (1974–2013). a) nominal catch data; b) catch-and-effort data; c) length frequency data. Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available (Data as of September 2014).

Key to IOTC Scoring system

Nominal Catch	By species	By gear
Fully available	0	0
Partially available (part of the catch not reported by species/gear)*	2	2
Fully estimated (by the IOTC Secretariat)	4	4

*Catch assigned by species/gear by the IOTC Secretariat; or 15% or more of the catches remain under aggregates of species

Catch-and-Effort	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

Size frequency data	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 1 fish measured by metric ton of catch)	2	
Not available at all	8	

Key to colour coding

- Total score is 0 (or average score is 0-1)
- Total score is 2 (or average score is 1-3)
- Total score is 4 (or average score is 3-5)
- Total score is 6 (or average score is 5-7)
- Total score is 8 (or average score is 7-8)

Black marlin: Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2012 and 2013 are provided in Fig. 8, 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 2012 and 2013 are provided in Fig. 9.

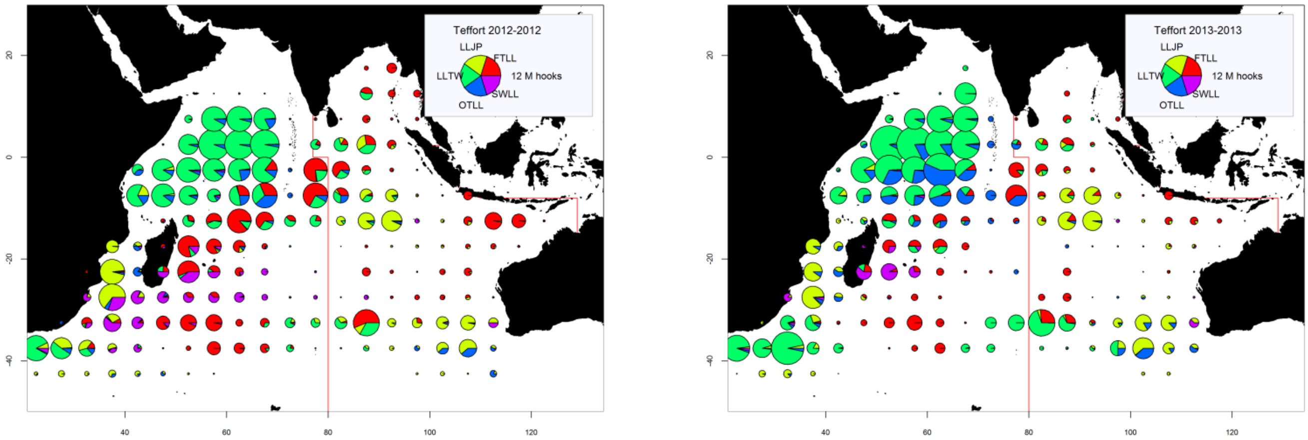

Fig. 8. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014). **LLJP** (light green): deep-freezing longliners from Japan LLTW (dark green): deep-freezing longliners from Taiwan,China; **SWLL** (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).

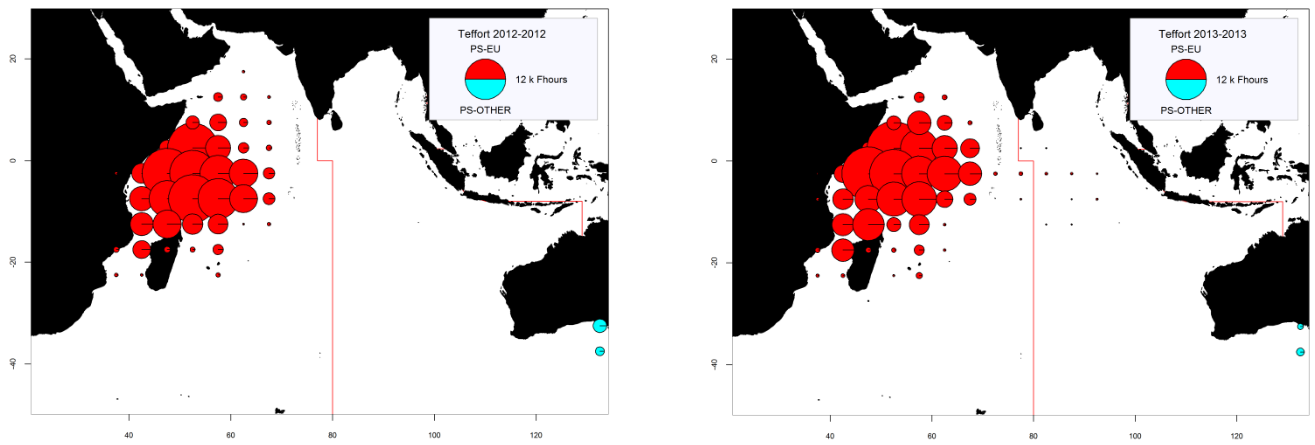

Fig. 9. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014). **PS-EU** (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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).

Black marlin: Catch–per–unit–effort (CPUE) trends

Catch rate time series for the longline fleets of Japan and Taiwan,China (Fig. 10) show a similar decreasing trend from 1960's until the end of 2000's. There is no available data for the longline fleet of Taiwan,China for the 1950's and part of the 1960's. Catch rates as calculated based on Japanese dataset show a strong decreasing trend in the early 1950's, in the very beginning of the commercial fisheries. Nevertheless it is important to highlight the doubts on the reliability of the results based on aggregated data sets not fully reviewed by experts on Japanese longline fisheries. The sharp decline between 1952 and 1958 in the Japanese black marlin CPUE series does not reflect the trend in abundance.

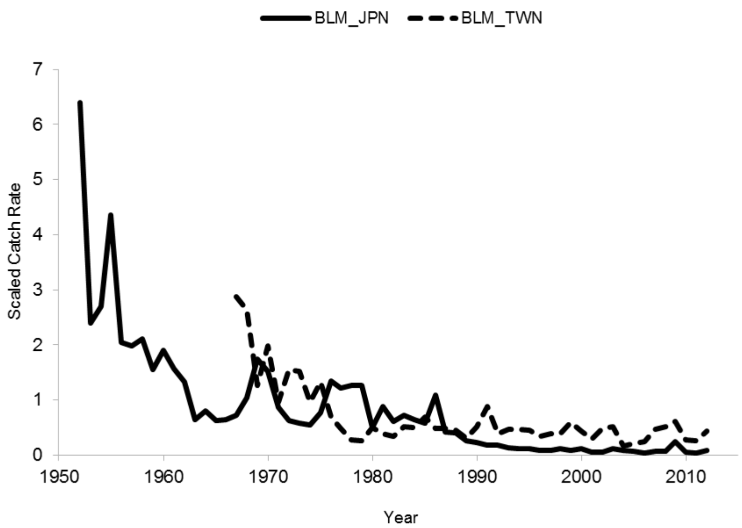

Fig. 10. Black marlin: Standardised catch rates of black marlin for Japan (JPN) and Taiwan,China (TWN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period.

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).

STOCK ASSESSMENT

Alternative approaches should continue to be explored using the following:

- More effort should be made in examining the standardised CPUE data for use in the assessments as these are the basis for assessments without any age/length data available.

- More attention should be paid to the amount of effective hooks at the depth where the marlins are abundant.
- Age/Length data over time should be collected so that alternative approaches could be examined.
- Further examination of the data poor approaches along with a further developed Bayesian SP Model should be focussed on in 2015 when marlin are next assessed. Since the State-Space model developed is still in beta mode, further work needs to be done on this before endorsing the method.

A sensitivity analysis should be performed using Stock Reduction Analysis methodology, using different series of catch data to assess how robust the estimation of reference points for management are, and how the stock status determination performs.

The results of the stock assessment of black marlin (Table 5) are based on very limited information and in particular are compromised by the uncertainty in the estimates of catches for this species, over the time series. For this reason, the status of the stock is considered to have a high degree of uncertainty. The precautionary approach calls for a more conservative approach for data poor stocks. Thus, the stock status summary for black marlin reflects the results of the assessment but at the same time incorporates information about the approach used.

TABLE 5. Black marlin (*Makaira indica*): Key management quantities from the Stock Reduction Analysis model, for the Indian Ocean Black marlin.

Management Quantity	Indian Ocean
2013 catch estimate	11,443 t
Mean catch from 2009–2013	10,803 t
MSY (1,000 t) (80% CI)	10.20 (8.40–12.30)
Data period used in assessment	1950–2013
F_{MSY} (80% CI)	0.25 (0.14–0.38)
B_{MSY} (1,000 t) (80% CI)	37.80 (22.90–52.04)
F_{2013}/F_{MSY} (80% CI)	1.06 (0.62–1.50)
B_{2013}/B_{MSY} (80% CI)	1.13 (0.87–1.39)
SB_{2013}/SB_{MSY} (80% CI)	n.a.
B_{2013}/B_{1950} (80% CI)	0.57 (0.44–0.70)
SB_{2013}/SB_{1950} (80% CI)	n.a.
$B_{2013}/B_{1950,\ F=0}$ (80% CI)	n.a.
$SB_{2013}/SB_{1950,\ F=0}$ (80% CI)	n.a.

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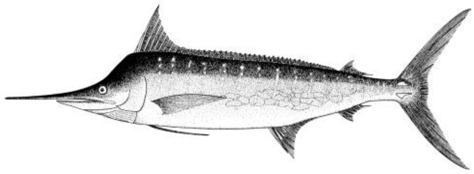
APPENDIX XVIII
EXECUTIVE SUMMARY: BLUE MARLIN

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



Status of the Indian Ocean blue marlin (BUM: *Makaira nigricans*) resource

TABLE 1. Blue marlin: Status of blue marlin (*Makaira nigricans*) in the Indian Ocean

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Catch 2013:	13,834 t	
	Average catch 2009–2013:	11,531 t	
	MSY (1,000 t) (80% CI):	11.70 (8.02–12.40)	
	F_{MSY} (80% CI):	0.49 (n.a.)	
	B_{MSY} (1,000 t) (80% CI):	23.70 (n.a.)	
	F_{2011}/F_{MSY} (80% CI):	0.85 (0.63–1.45)	
	B_{2011}/B_{MSY} (80% CI):	0.98 (0.57–1.18)	
	B_{2011}/B_{1950} (80% CI):	0.48 (n.a.)	

[1]Boundaries for the Indian Ocean = IOTC area of competence; n.a. = not available

Colour key	Stock overfished(B_{year}/B_{MSY}< 1)	Stock not overfished (B_{year}/B_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No new assessment was undertaken for blue marlin in 2014. Thus, stock status is based on the previous assessment undertaken in 2013, as well as indicators available in 2014. Although the point estimated suggests the stock as being overfished, most confidence surfaces estimates suggested that the stock is not overfished. The standardised longline CPUE series indicate a decline in abundance in the early 1980s, followed by a constant or slightly increasing abundance over the last 20 years. In 2013, an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicated the stock is currently being exploited near sustainable levels and that the stock is at the optimal biomass level. Two other approaches examined in 2013 came to similar conclusions, namely a Bayesian State Space model, and a data poor stock assessment method: Stock Reduction Analysis using only catch data. The Kobe plot (Fig. 1) from the ASPIC model indicated that the stock was subject to overfishing in the past which reduced the stock biomass to below the B_{MSY} level. In the recent past, the stock experienced reduced fishing pressure and as a result, the stock biomass recovered to the B_{MSY} level (Fig. 1). Total reported landings increased substantially in 2012 to 17,252 t, well above the MSY estimate of 11,690 t. In 2013 reported catches declined slightly to 13,843 t, still above the MSY level. Given the sharp increase in reported catches over the last two years, that are well above the MSY level, the stock is likely to have moved to a state of being subject to overfishing. However, the impact that these increased catches is likely to have on biomass is uncertain. Thus, on the weight-of-evidence available to the WPB, and due to consistency among executive summaries, the stock status was changed from that reported in 2013 and is determined to be **overfished** but **not subject to overfishing** (Table 1; Fig. 1).

Outlook. The uncertainty in the data available for assessment purposes and the CPUE series suggests that the advice should be interpreted with caution as the stock may be in an overfished state (biomass less than B_{MSY}) and given that reported catches over the last two years have been well in excess of the MSY levels recommended, fishing effort is likely to be a serious concern, suggesting the stock may have moved back to a subject to overfishing status. The limited data being reported for gillnet fisheries, and the importance of sports fisheries for this species, require efforts to be made to rectify these information gaps urgently. It is likely that there is a low risk of exceeding MSY-based reference points by 2015 if catches are maintained at 2011 levels, although projections are not provided as per Table 2. These will be calculated during the next assessment of blue marlin.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is between 8,023–12,400 t, and catches should not exceed the upper estimate.
- **Provisional reference points**: Although the Commission adopted interim reference points for swordfish in Resolution 13/10 *on interim target and limit reference points and a decision framework,* no such interim points have been established for blue marlin.
- **Main fishing gear** (2010–13): Longline and gillnet catches are currently estimated to comprise approximately 69% and 29% of the total estimated blue marlin catch in the Indian Ocean, respectively.
- **Main fleets** (2010–13): Taiwan,China: 35%; Indonesia: 24%; Pakistan: 15%.
- **Improvements required**: improvement in data collection and reporting is required to further assess the stock.

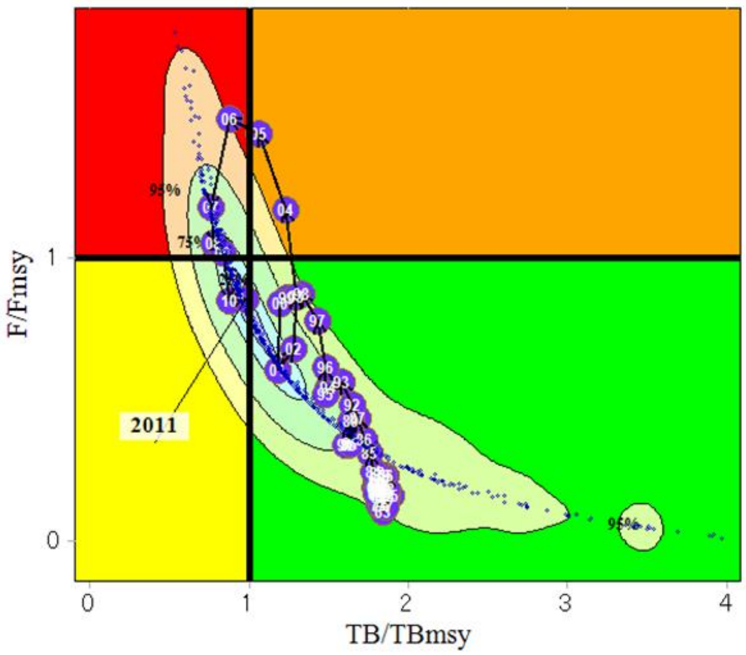


Fig. 1. Blue marlin: ASPIC Aggregated Indian Ocean assessment Kobe plot for blue marlin (90% bootstrap confidence surfaces shown around 2011 estimate). Blue line indicates the trajectory of the point estimates for the biomass (B) ratio (shown as TB) and F ratio for each year 1950–2011.

TABLE 2. Blue Marlin: Indian Ocean ASPIC Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target reference points for nine constant catch projections (average catch level from 2011–2013 (13,539 t), ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years. These will be calculated during the next assessment of blue marlin.

Reference point and projection timeframe	Alternative catch projections (relative to the average catch level from 2009–2011) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)								
	60% (8,123 t)	**70%** (9,477 t)	**80%** (10,831 t)	**90%** (12,185 t)	**100%** (13,539 t)	**110%** (14,892 t)	**120%** (16,247 t)	**130%** (17,601 t)	**140%** (18,955 t)
$B_{2015} < B_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$F_{2015} > F_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$B_{2022} < B_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$F_{2022} > F_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

APPENDIX I

SUPPORTING INFORMATION

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

CONSERVATION AND MANAGEMENT MEASURES

Blue marlin (*Makaira nigricans*) 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 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 13/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*
- Resolution 11/04 *on a regional observer scheme*
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Blue marlin: General

Blue marlin (*Makaira nigricans*) is a large oceanic apex predator that inhabits tropical and subtropical waters of the Indian and Pacific oceans (Fig. 2). Table 3 outlines some key life history parameters relevant for management.

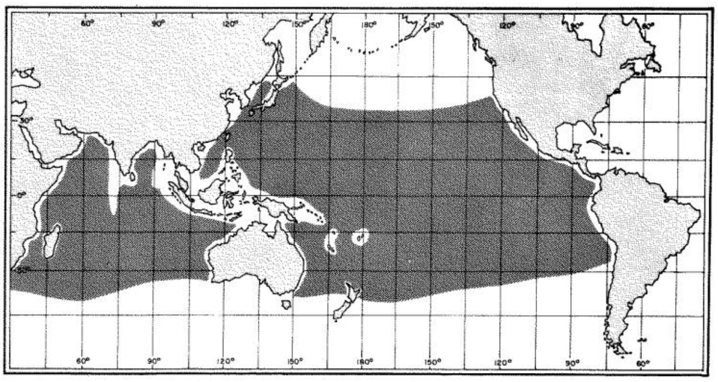


Fig. 2. Blue marlin: The worldwide distribution of blue marlin (Source: Nakamura 1984).

TABLE 3. Blue marlin: Biology of Indian Ocean blue marlin (*Makaira nigricans*).

Parameter	**Description**
Range and stock structure	Little is known on the biology of the blue marlin in the Indian Ocean. Blue marlin is a highly migratory, large oceanic apex predator that inhabits tropical and subtropical waters of the Indian and Pacific oceans. It is capable for long-distance migrations: in the Pacific Ocean a tagged blue marlin is reported to have travelled 3000 nm in 90 days. In the Indian Ocean a blue marlin tagged in South Africa was recaptured after 90 days at liberty off the southern tip of Madagascar crossing Mozambique Channel and travelling 1398 km with average speed 15.5 km/day. Other tagging off western Australia revealed potential intermixing of Indian Ocean and Pacific stocks: one individual was caught in the Pacific Indonesian waters. Blue marlin is a solitary species and prefers the warm offshore surface waters (>24°C); it is scarce in waters less than 100 m in depth or close to land. The blue marlin's prey includes octopuses, squid and pelagic fishes such as 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 LJFL (55 kgs whole weight); males ~80 cm LJFL (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, 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. L-W relationships for the Indian Ocean are: females TW=0.00000026*LJFL^3.59846 males TW=0.00001303*LJFL^2.89258, both sexes mixed TW=0.00000084*LJFL^3.39404. TW in kg, LJFL in cm

n.a. = not available. Sources: Nakamura 1985, Cry et al. 1990, Shimose et al. 2008, Froese & Pauly 2009, Romanov & Romanova 2012

Blue marlin: Catch trends

The catch series for the blue marlin was substantially revised in 2014, following new reports of catch for drifting gillnet fleets. Blue marlin are caught mainly using drifting longlines (70%) and gillnets (25%) with remaining catches recorded by troll and hand lines (Table 4, Fig. 2). Blue marlins are considered to be a bycatch of industrial and artisanal fisheries. Longline catches of 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 and handline), I.R. Iran and Pakistan (gillnet), and Sri Lanka (longline gillnet) account for around 90% of the total catch of blue marlin (Fig. 3). The distribution of blue marlin catches has changed since the 1980's with most of the catch now taken in the western areas of the Indian Ocean (Fig. 4).

Catch trends for blue marlin are variable; however, this may reflect the level of reporting. The catches of blue marlin by drifting longlines were more or less stable until the late-70's, at around 3,000 t to 4,000 t, and have steadily increased since then to reach values between 8,000 t and 13,000 t since the early 1990's. The largest catches reported by longlines were recorded in 2012 (~12,000 t) and 1998 (~11,000 t). The high catches in 2012 are likely to be the consequence of higher catch rates by some longline fleets, which resumed operation in the Western Tropical Indian Ocean. Catches by drifting longlines have been recorded under Taiwan,China and Japan fleets and, recently, Indonesia, India, Sri Lanka and several Not Elsewhere Included (NEI) fleets (Fig. 4). In recent years, the deep-freezing longliners from Taiwan,China and Japan have reported most of the catches of blue marlin in waters of the western and central tropical Indian Ocean and, to a lesser extent, the Mozambique Channel (Fig. 4).

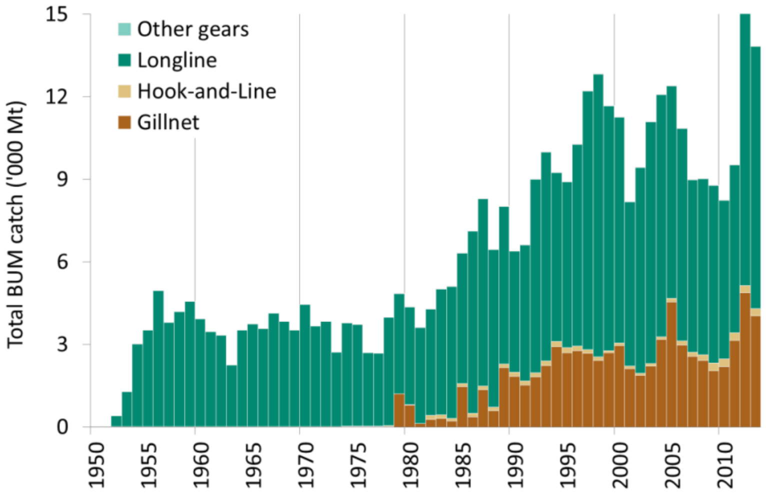


Fig. 2. Blue marlin: Catches of blue marlin by gear and year recorded in the IOTC Database (1950–2013).

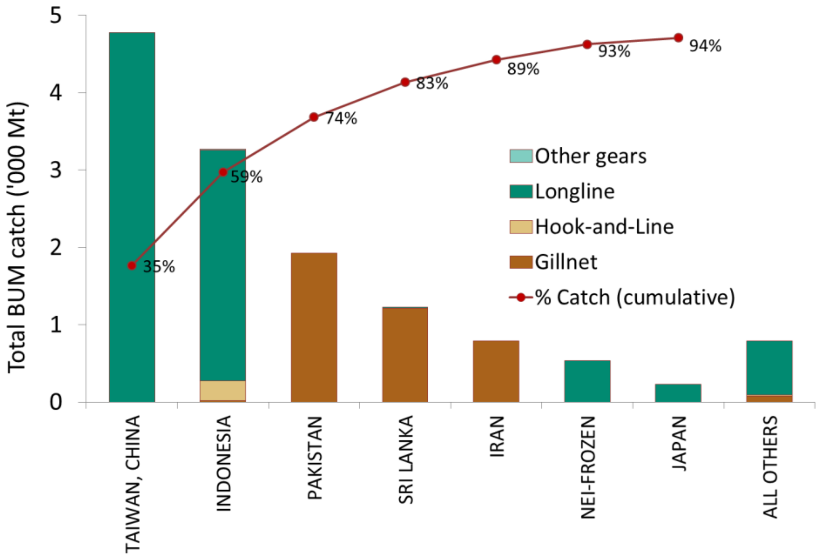


Fig. 3. Blue marlin: Average catches in the Indian Ocean over the period 2010–13, by fleet/countries, ordered from left to right, according to the importance of catches of blue marlin reported. The red line indicates the (cumulative) proportion of catches of blue marlin for the fleet/countries concerned, over the total combined catches of this species reported from all fleets/countries and fisheries.

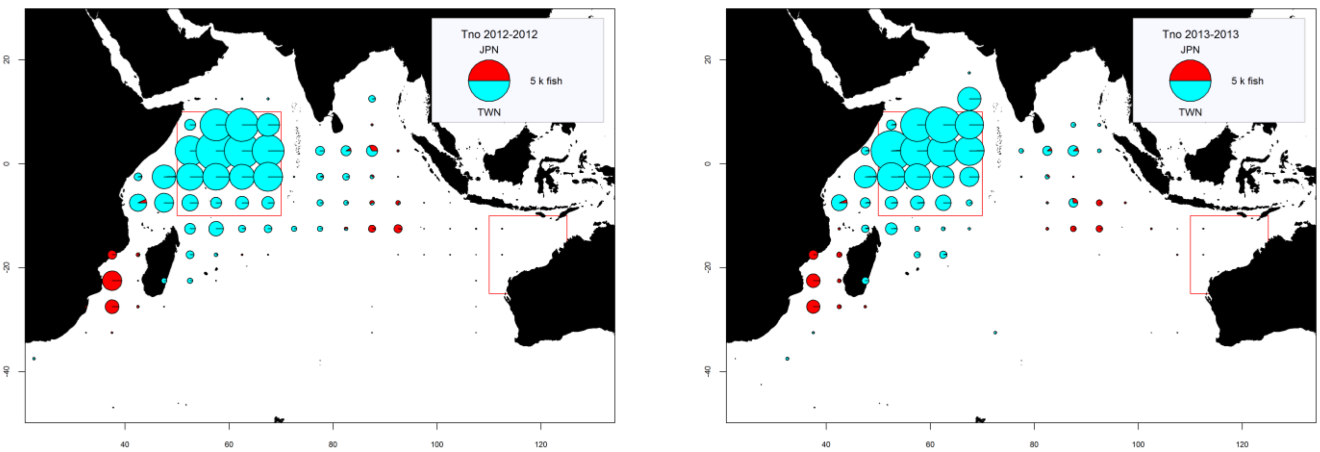


Fig. 4a–b. Blue marlin: Time-area catches (in number of fish) of blue marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for a) 2012 and b) 2013, by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

TABLE 4: Blue marlin: Best scientific estimates of the catches of blue marlin by type of fishery for the period 1950–2013 (in metric tons) (Data as of September 2014).

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LL	2,563	3,515	3,493	4,982	7,200	7,384	8,800	7,721	7,734	6,276	6,397	6,463	5,751	6,093	12,101	9,514
GN	1	2	124	761	2,357	2,687	3,172	4,545	2,977	2,559	2,410	2,049	2,198	3,148	4,879	4,032
HL	5	9	17	105	149	133	107	130	139	151	202	265	282	276	257	273
OT	0	0	0	2	4	7	5	7	8	8	11	15	15	16	15	16
Total	**2,570**	**3,527**	**3,634**	**5,850**	**9,711**	**10,211**	**12,085**	**12,404**	**10,857**	**8,994**	**9,019**	**8,791**	**8,246**	**9,532**	**17,252**	**13,834**

Fisheries: Gillnet (**GN**); Longline (**LL**); Hook-and-Line (**HL**), including handline, trolling, baitboat, and sport fisheries; Other gears (**OT**)

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 IOTC Secretariat.

Retained catches: poorly known for most fisheries (Fig. 5a) due to:

- catch reports often refer to total catches of all three marlin species combined or as an aggregate of all billfish species; catches by species are estimated by the IOTC Secretariat for some years and artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, I.R. 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 IOTC Secretariat using alternative information.
- catches are likely to be incomplete for industrial fisheries for which the blue marlin is not a target species.
- conflicting catch reports for longline catches from the Rep. of Korea, which 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 IOTC Secretariat revised the catches of blue marlin for the Rep. of Korea over the time-series using both datasets. Although the new catches estimated by the IOTC Secretariat are thought to be more accurate, catches of blue marlin remain uncertain for this fleet.
- a lack of catch data for most sport fisheries.

Discards: unknown for most industrial fisheries, mainly longliners. Discards of blue marlin may also occur in some gillnet fisheries.

Changes to the catch series: There have been relatively large revisions to the catch estimates of blue marlin since the WPB meeting in 2013, mostly the result of changes to catch-by-species for IR Iran, and to a lesser extent Indonesia.

In previous years IR Iran has reported aggregated catches for all billfish species, which were then estimated by species and gear by the IOTC Secretariat. In 2014 IR Iran provided catches by billfish species, for 2012 and 2013, which substantially revises the catch-by-species previously estimated by the IOTC Secretariat.

The main change is the substantially higher proportions of black marlin in the new catches reported by IR Iran rather than blue marlin, assigned to the offshore gillnet fishery. As a result of changes in the catch series for IR Iran – and revision of the catch-by-species for the offshore fishery for earlier years based on the 2012 and 2013 data – total catches of blue marlin have been revised down by as much as 20% for a number of years around the mid-2000's.

Catch–per–unit–effort (CPUE) Series (Fig. 5b): Nominal CPUE series are available from some industrial longline fisheries (primarily the Japanese longline fleet) although catches are likely 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 IR 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) (Fig. 5c): Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. However, the number of specimens measured on Japanese longliners in recent years is very low and miss-identification of striped marlin and blue marlin may occur in some longline fisheries; the length frequency distributions derived from samples collected by fishermen on Taiwan,China longliners are likely to be biased.

Catch-at-Size(Age) (Fig. 6): Fish size is derived from various length and weight information, however the reliability of the size data is reduced for some fleets and when relatively few fish out of the total catch are measured.

Sex ratio: data have not been provided to the IOTC Secretariat by CPCs.

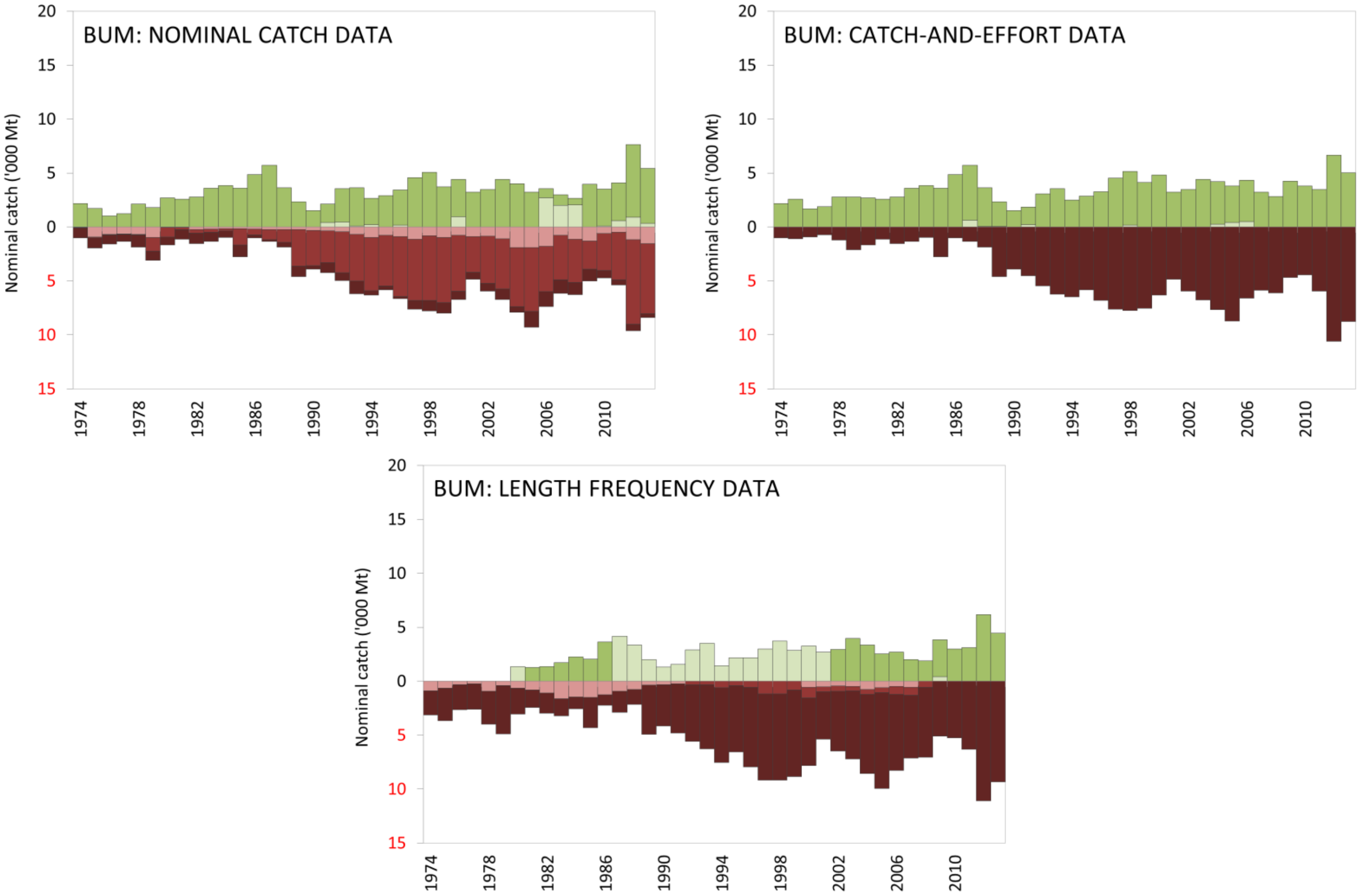


Fig. 5. Blue marlin: data reporting coverage (1974–2013). a) nominal catch data; b) catch-and-effort data; c) length frequency data. Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available (Data as of September 2014).

Key to IOTC Scoring system

Nominal Catch	By species	By gear
Fully available	0	0
Partially available (part of the catch not reported by species/gear)*	2	2
Fully estimated (by the IOTC Secretariat)	4	4

*Catch assigned by species/gear by the IOTC Secretariat; or 15% or more of the catches remain under aggregates of species

Catch-and-Effort	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

Size frequency data	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 1 fish measured by metric ton of catch)	2	
Not available at all	8	

Key to colour coding

- Total score is 0 (or average score is 0-1)
- Total score is 2 (or average score is 1-3)
- Total score is 4 (or average score is 3-5)
- Total score is 6 (or average score is 5-7)
- Total score is 8 (or average score is 7-8)

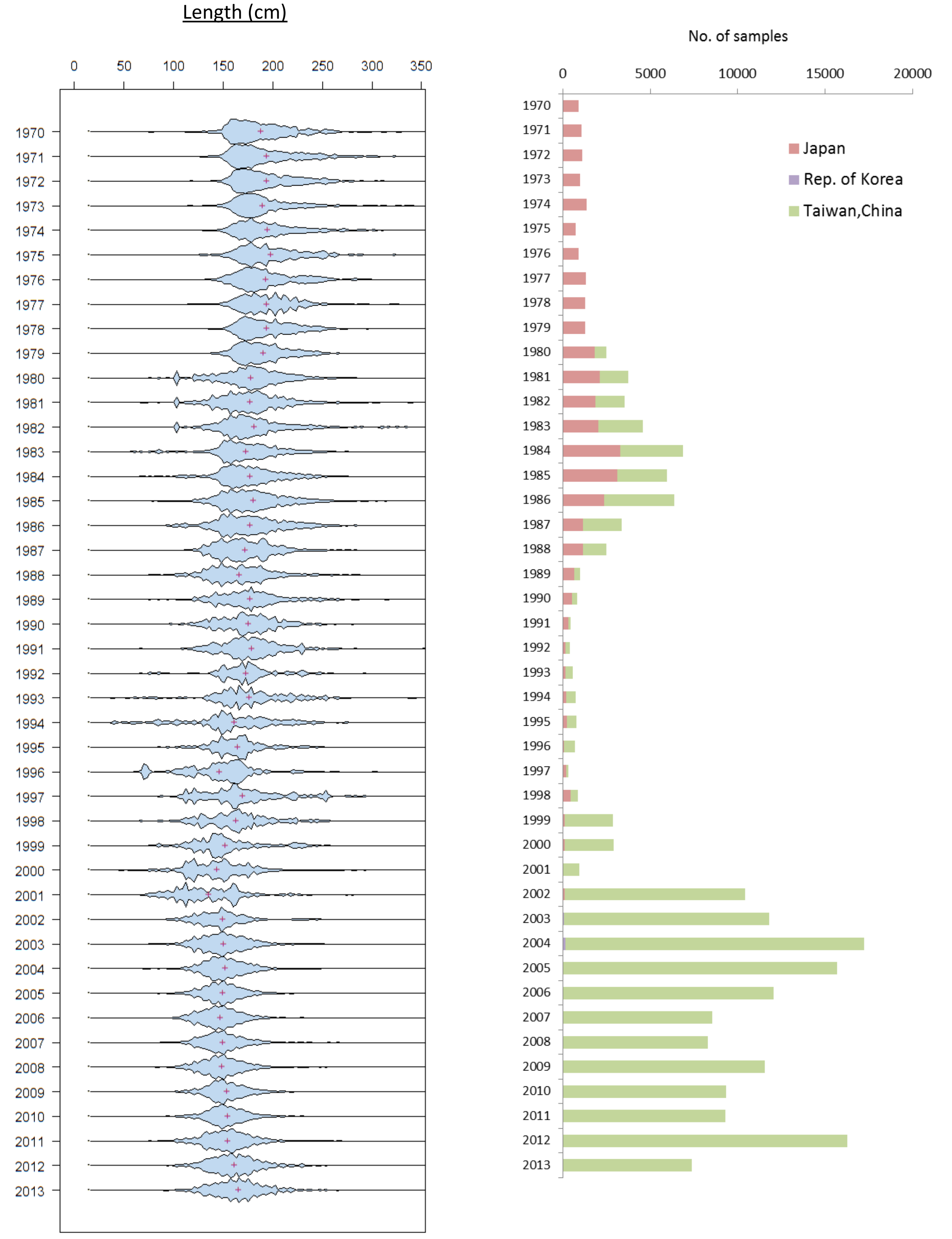


Fig. 6. Blue marlin: Longline catch-at-size length distributions (Data as of September 2014).

Blue marlin:* *Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2012 and 2013 are provided in Fig. 7, 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 2012 and 2013 are provided in Fig. 8.

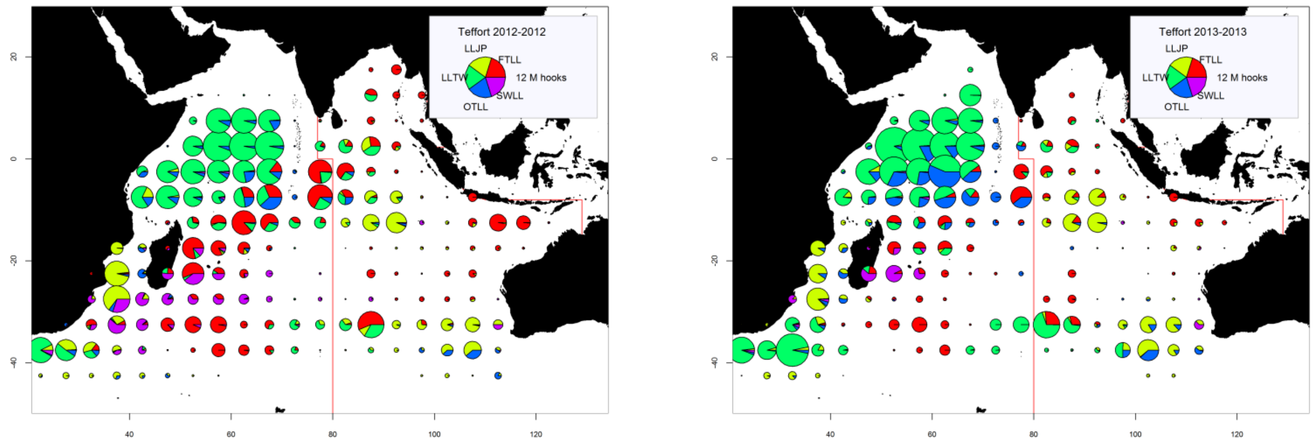


Fig. 7. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014). **LLJP** (light green): deep-freezing longliners from Japan LLTW (dark green): deep-freezing longliners from Taiwan,China; **SWLL** (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).

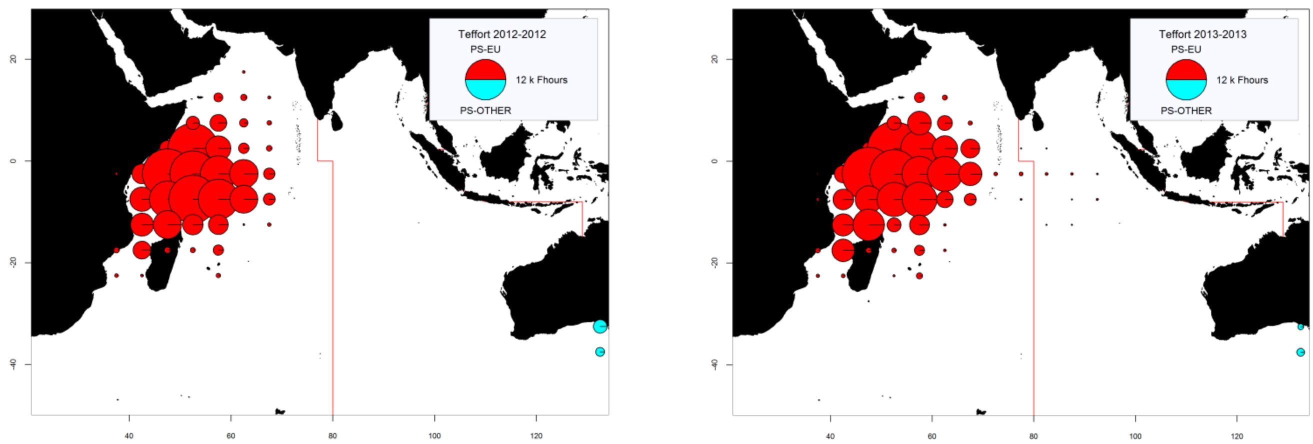


Fig. 8. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014). **PS-EU** (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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)

Blue marlin: Catch–per–unit–effort (CPUE) trends

The sharp decline between 1952 and 1956 in the Japanese blue marlin CPUE series does not reflect the trend in abundance, although the gradual decline identified since 1970 until 2011 is more likely to represent actual declines in stock abundance (Fig. 9). The catches and CPUE series estimated for blue marlin were very similar between the longline fleets of Japan and Taiwan,China, although there were two peaks in the Taiwan,China data series. In particular the longline fleet data for Taiwan,China was highly variable and warranted further investigation and documentation.

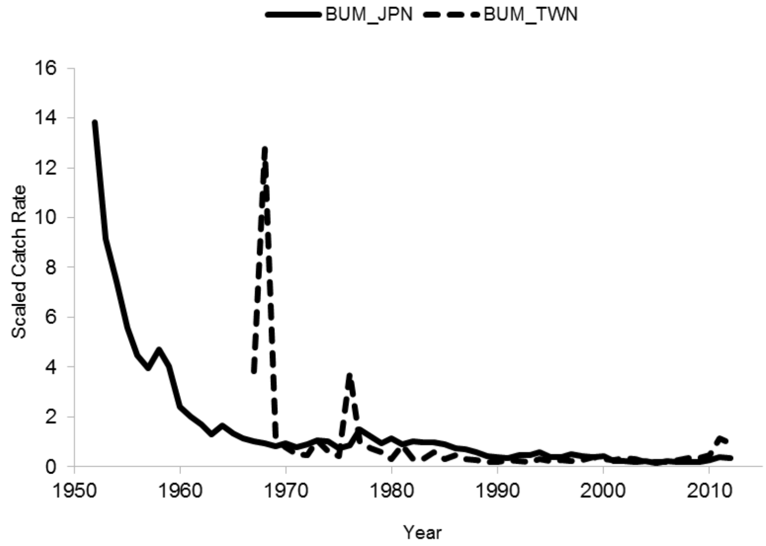


Fig. 9. Blue marlin: Standardised catch rates of blue marlin for Japan (JPN) and Taiwan,China (TWN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period.

Of the blue marlin CPUE series available for assessment purposes, the Japan and Taiwan,China CPUE series (Fig. 10) were used in the stock assessment model for 2013.

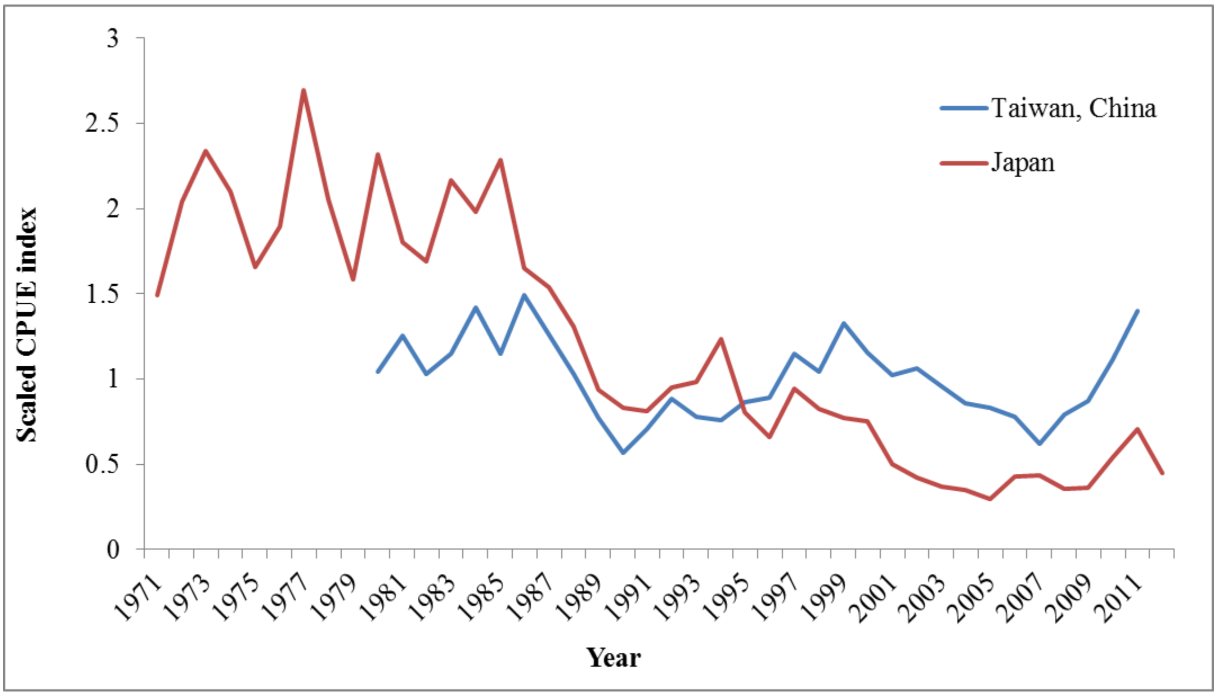


Fig. 10. Blue marlin: Comparison of the CPUE series for the longline fleets of Japan and Taiwan,China. Scaling was carried out using the average of the overlapped years.

Both Japan and Taiwan,China should undertake a historical review of their longline data and to document the changes in fleet dynamics for presentation and the next WPB meeting. The historical review should include as much explanatory information as possible regarding changes in fishing areas, species targeting, gear changes and other fleet characteristics to assist the WPB understand the current fluctuations observed in the data.

STOCK ASSESSMENT

A range of quantitative modelling methods (ASPIC, Bayesian Production Model, and Stock Reduction Analysis) were applied to the blue marlin in 2013. The models explored did not perform well as far as the residual diagnostics, or other were concerned, denoting high uncertainties. However, these models showed similar stock trajectories, and based on the weight-of-evidence approach, the WPB agreed to use the results from the ASPIC model for stock status advice. Further work needs to be conducted in future years to improve these assessments.

The standardised longline CPUE series indicate a decline in abundance in the early 1980s, followed by a constant or slightly increasing abundance over the last 20 years. In 2013, an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicates the stock is currently being exploited at sustainable levels and that the stock is at the optimal biomass level. Two other approaches examined in 2013 came to similar conclusions, namely a Bayesian State Space model, and a data poor stock assessment method, Stock reduction Analysis using only catch data. The Kobe plot (Fig. 1) from the ASPIC model indicates that the stock was most likely subject to overfishing in the recent past. Thus, on the weight-of-evidence available to the WPB, the stock is determined to be **not overfished** and **not subject to overfishing** (Tables 1, 5; Fig. 1). However, the uncertainty in the data available for assessment purposes and the CPUE series suggests that the advice should be interpreted with caution as the stock may still be in an overfished state (biomass less than B_{MSY}) (Table 1; Fig. 1). Given the recent declining effort trend, and a clear rebuilding trajectory (Fig. 1), fishing effort is not considered an immediate concern. Research emphasis on improving indicators and further exploration of stock assessment approaches for data poor fisheries are still warranted. Given the limited data being reported for gillnet fisheries, and the importance of sports fisheries for this species, efforts must be made to rectify these information gaps.

TABLE 5. Blue marlin: Blue marlin (*Makaira nigricans*) key management quantities from the ASPIC stock assessment.

Management Quantity	**Aggregate Indian Ocean**
2013 catch estimate	13,834 t
Mean catch from 2009–2013	11,531 t
MSY(1,000 t) (80% CI)	9,524 (6,004–15,105)
Data period used in assessment	1950–2011
F_{MSY} (80% CI)	–
B_{MSY} (80% CI) (1,000 t)	–
F_{2011}/F_{MSY} (80% CI)	1.05 (0.63–1.47)
B_{2011}/B_{MSY} (80% CI)	1.03 (0.03–2.31)
SB_{2011}/SB_{MSY} (80% CI)	–
B_{2011}/B_{1950} (80% CI)	0.59 (0.02–1.16)
SB_{2011}/SB_{1950} (80% CI)	–
$B_{2011}/B_{1950, F=0}$ (80% CI)	–
$SB_{2011}/SB_{1950, F=0}$ (80% CI)	–

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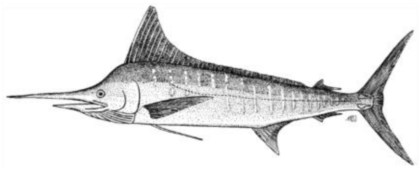
APPENDIX XIX
EXECUTIVE SUMMARY: STRIPED MARLIN

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



Status of the Indian Ocean striped marlin (MLS: *Tetrapturus audax*) resource

TABLE 1. Striped marlin: Status of striped marlin (*Tetrapturus audax*) in the Indian Ocean

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Catch 2013: Average catch 2009–2013:	4,429 t 3,667 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2011}/F_{MSY} (80% CI): B_{2011}/B_{MSY} (80% CI): B_{2011}/B_0 (80% CI):	4.41 t (3.54–4.58) 0.36 (n.a.) 12.43 t (n.a.) 1.28 (0.95–1.92) 0.416 (0.2–0.42) 0.18 (n.a.)	

[1]Boundaries for the Indian Ocean = IOTC area of competence; n.a. = not available

Colour key	Stock overfished(B_{year}/B_{MSY}< 1)	Stock not overfished (B_{year}/B_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No new assessment was undertaken for striped marlin in 2014. Thus, stock status is based on the previous assessment undertaken in 2013, as well as indicators available in 2014. The standardised CPUE series suggest that there was a sharp decline in the early 1980s, followed by slower decline since 1990. In 2013 an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicated the stock is currently subject to overfishing and that biomass is below the level which would produce MSY, using catch data up until 2011. Two other approaches examined in 2013 came to similar conclusions, namely a Bayesian State Space model, and a data poor stock assessment method, Stock Reduction Analysis using only catch data. The Kobe plot (Fig. 1) from the ASPIC model indicated that the stock has been subject to overfishing for some years, and that as a result, the stock biomass is well below the B_{MSY} level and shows little signs of rebuilding despite the declining effort trend. Total reported landings increased in 2012 to 6,088 t, well above the MSY estimate of 4,408 t. In 2013 reported catches declined to 4,429 t, still above the MSY level. Thus, on the weight-of-evidence available to the WPB in 2014, the stock is determined to be **overfished** and **subject to overfishing** (Table 1; Fig. 1).

Outlook. The decrease in longline catch and effort in the years 2009–11 lowered the pressure on the Indian Ocean stock as a whole, however, the increased catches reported in 2012 and 2013, combined with the concerning results obtained from the preliminary stock assessment carried out in 2012 and the follow-up assessment in 2013 for striped marlin, the outlook is pessimistic for the stock as a whole and a precautionary approach to the management of striped marlin should be considered by the Commission. There is a very high risk of exceeding the biomass MSY-based reference points by 2015 if catches increase further or are maintained at current levels (2011) until 2015 (>93% risk that $B_{2015} < B_{MSY}$), but a low risk that $F_{2019} > F_{MSY}$ (≈ 7% if maintained, ≈ 30% if increased by 10%) (Table 2).

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is 4,408 t (3,539–4,578). However, the biomass is well below the B_{MSY} reference point and fishing mortality is in excess of F_{MSY} at recent catch levels, of around 2,500 t. Catches should be reduced to below 2,500 t.
- **Provisional reference points**: Although the Commission adopted interim reference points for swordfish in Resolution 13/10 *on interim target and limit reference points and a decision framework*, no such interim points have been established for striped marlin.

- **Main fishing gear** (2013): Longline and gillnet catches are currently estimated to comprise approximately 73% and 19% of the total estimated striped marlin catch in the Indian Ocean, respectively.
- **Main fleets**: Taiwan,China: 32%; Indonesia: 26%; Pakistan: 9%; I.R. Iran: 8%.
- **Improvements required**: improvement in data collection and reporting is required to further assess the stock.

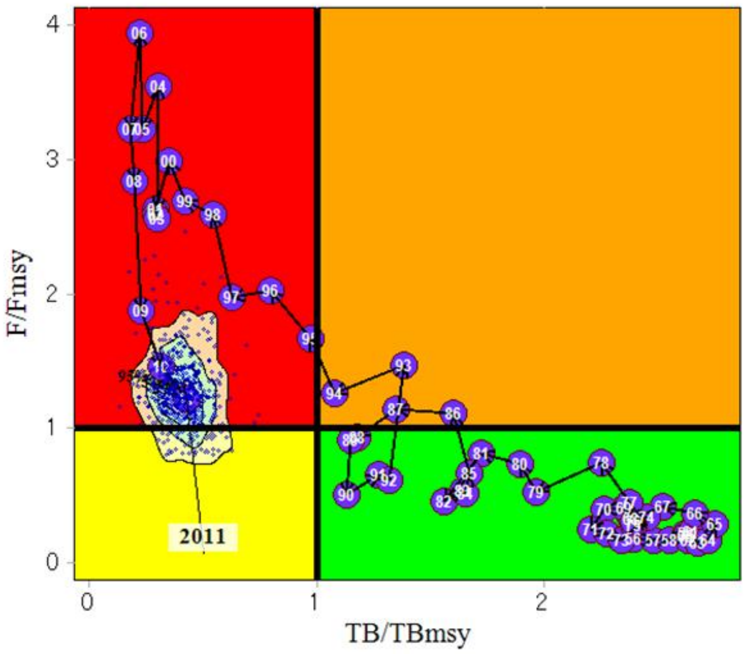


Fig. 1. Striped marlin: ASPIC Aggregated Indian Ocean assessment Kobe plots for striped marlin (90% bootstrap confidence surfaces shown around 2011 estimate – white dot). Blue line indicates the trajectory of the point estimates for the total biomass (B) ratio (shown as TB) and F ratio for each year 1950–2011. Note: The MSY is close to the upper limit of the confidence intervals, as the bootstrap mean and ASPIC mean results are slightly different.

TABLE 2. Striped Marlin: Indian Ocean ASPIC Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target reference points for nine constant catch projections (average catch level from 2009–2011 (2,607 t), ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2009–2011) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60% (1,564 t)	**70%** (1,825 t)	**80%** (2,086 t)	**90%** (2,346 t)	**100%** (2,607 t)	**110%** (2,868 t)	**120%** (3,128 t)	**130%** (3,389 t)	**140%** (3,650 t)
$B_{2015} < B_{MSY}$	41	59	77	85	93	96	99	99	100
$F_{2015} > F_{MSY}$	0	0	0	4	7	30	54	77	100
$B_{2022} < B_{MSY}$	0	0	0	0	0	2	4	52	100
$F_{2022} > F_{MSY}$	0	0	0	0	0	0	0	51	100

APPENDIX I

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 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 13/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*
- Resolution 11/04 *on a regional observer scheme*
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Striped marlin: General

Striped marlin (*Tetrapturus audax*) is a large oceanic apex predator that inhabits tropical and subtropical Indo-Pacific oceans (Fig. 2). Table 3 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.

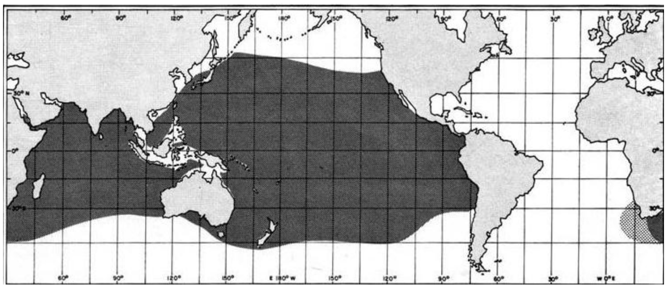


Fig. 2. Striped marlin: The worldwide distribution of striped marlin (Source: Nakamura, 1984).

TABLE 3. Striped marlin: Biology of Indian Ocean striped marlin (*Tetrapturus audax*).

Parameter	Description
Range and stock structure	A large oceanic apex predator that inhabits tropical and sub-tropical waters of the Indian and Pacific oceans. Some rare individuals have been reported in the Atlantic Ocean but there is no information to indicate the presence of a breeding stock in this area. Its distribution is different from other marlins in that it prefers more temperate or cooler waters however in the Indian Ocean it is common in tropical zone: off the east African coast (0-10ºS), the south and western Arabian Sea, the Bay of Bengal, and north-western Australian waters. Several transoceanic migrations were reported in the Indian Ocean (the longest is from Kenya to Australia). Therefore a single stock hypothesis apparently is most appropriate for stock assessement and management.
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. Usually spawn in the vicinity of oceanic islands, seamounts or coastal areas, associated with local increases in primary productivity. In the Indian Ocean larvae of this species was recorded off the Somalian coast, around Reunion and Mauritius and off north-western Australia.
Size (length and weight)	In the Indian Ocean documented maximum size for females 314 cm LJFL and 330 kg TW, for males 292 cm LJFL, 185 kg TW. However males longer than 260 cm LJFL are rare. 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. L-W relationships for the Indian Ocean are: females TW=0.00000009*LJFL**3.76598

	males TW=0.00005174*LJFL**2.59633, both sexes mixed TW=0.00000039*LJFL**3.50024, TW in kg, LJFL in cm.

n.a. = not available. Sources: Nakamura 1985, Gonzalez-Armas et al. 1999, Hyde et al. 2006, Froese & Pauly 2009, Kadagi et al. 2011, Romanov & Romanova 2012

Striped marlin: Catch trends

The catch series for the striped marlin was revised in 2014, following new reports of catch for drifting gillnets and the fisheries of Indonesia. Striped marlin are caught mainly using drifting longlines (72% of the total catch). The remaining catches are recorded under gillnets and troll lines (Table 4, Fig. 3). Striped marlin are generally considered to be a bycatch of industrial fisheries. Catch trends for striped marlin are variable, ranging from 2000 t to 8000 t per year; however, this may reflect the level of reporting. Similarly, catches reported using drifting longlines are highly variable, with lower catch levels between 2009 and 2011 largely due to declining catches reported by Taiwan,China, deep-freezing and fresh-tuna longliners. The catches of striped marlin increased in 2012 and 2013, as longline vessels resumed their activities in the Western tropical Indian Ocean.

Catches using drifting longlines have been recorded under Taiwan,China, Japan, Rep. of Korea fleets and, recently, Seychelles, Indonesia and several Not Elsewhere Included (NEI) fleets (Fig. 4). Large drops in the catches of striped marlin have been recorded for the longline fleets of Japan and Taiwan,China since the mid-1980's and mid-1990's, respectively. 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 recorded 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 (Fig. 5). 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. However, between 2007 and 2011, catches in the northwest Indian Ocean have dropped markedly, in tandem with a reduction of longline effort in the area as a consequence of maritime piracy off Somalia (Fig. 5). Catch levels increased substantially in 2012 and, to a lesser extent in 2013.

The catches of striped marlin reported by fleets using gillnets have been low over the entire time-series, amounting to between 500 t and 1,000 t in recent years. However, recent information received by the IOTC Secretariat tends to indicate that the catches of striped marlin by the gillnet fishery of Pakistan may be much higher than those officially reported, and a thorough review of the catch series may be required in the future for this species. Discards are believed to be low although they are unknown for most industrial fisheries, mainly longliners.

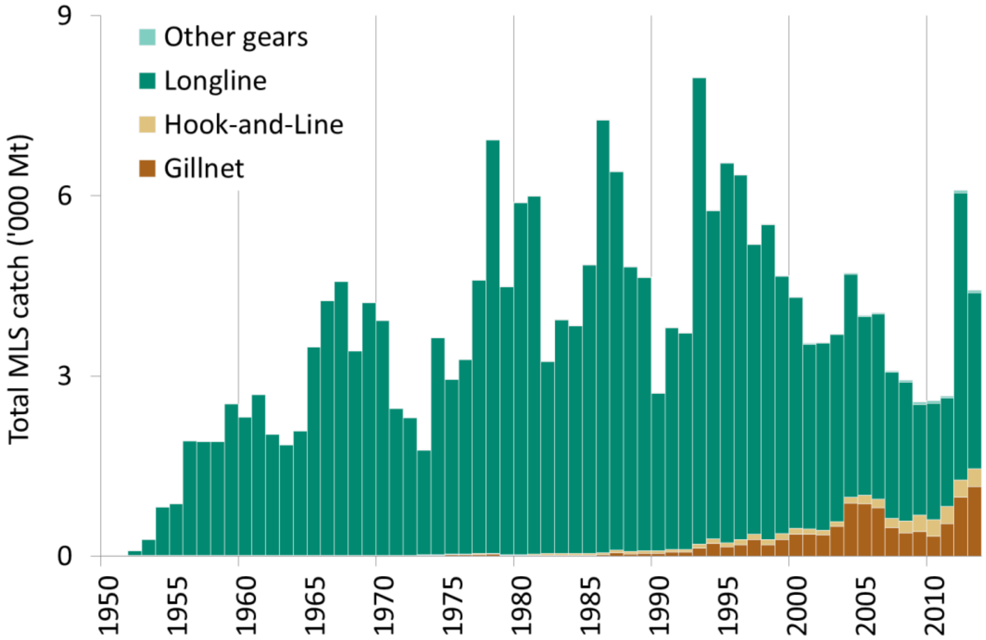


Fig. 3. Striped marlin: Catches of Striped marlin by gear and year recorded in the IOTC Database (1950–2013).

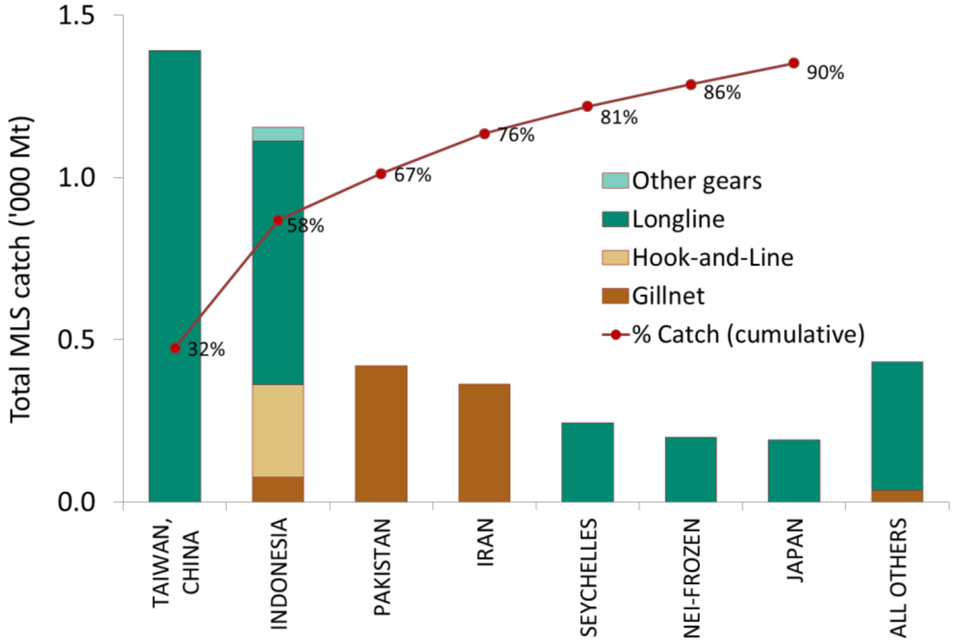


Fig. 4. Striped marlin: Average catches in the Indian Ocean over the period 2010–13, by fleet or country, ordered from left to right, according to the importance of catches of black marlin reported. The red line indicates the (cumulative) proportion of catches of striped marlin for the fleets or countries concerned, over the total combined catches of this species reported from all fleets or countries and fisheries.

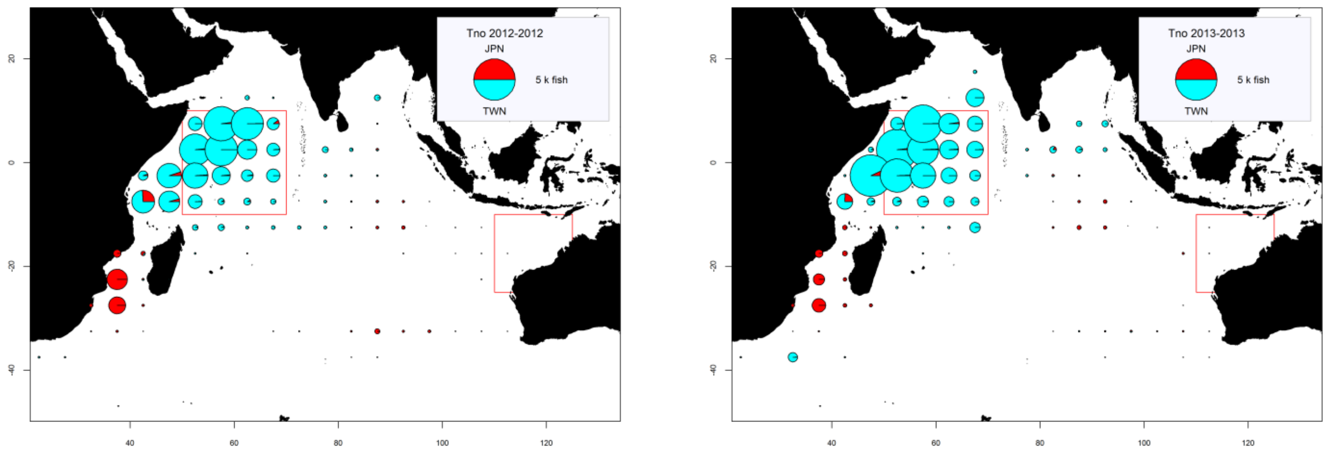


Fig. 5a–b. Striped marlin: Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for a) 2012 and b) 2013 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

TABLE 4. Striped marlin: Best scientific estimates of the catches of striped marlin by type of fishery for the period 1950–2013 (in metric tons) (Data as of September 2014).

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LL	1,024	3,076	3,605	5,029	4,990	2,951	3,713	2,974	3,086	2,433	2,313	1,846	1,935	1,801	4,778	2,937
GN	5	8	16	22	161	541	880	876	807	479	389	407	330	540	983	1,160
HL	3	5	10	32	69	135	102	135	142	153	195	273	277	286	284	289
OT	0	0	0	6	10	20	15	20	21	23	29	41	41	43	43	43
Total	**1,031**	**3,089**	**3,631**	**5,089**	**5,229**	**3,647**	**4,710**	**4,005**	**4,055**	**3,087**	**2,927**	**2,567**	**2,583**	**2,670**	**6,088**	**4,429**

Fisheries: Gillnet (**GN**); Longline (**LL**); Hook-and-Line (**HL**), including handline, trolling, baitboat, and sport fisheries; Other gears (**OT**)

Uncertainty of time–area catches

Retained catches: reasonably well known (Fig. 6a) 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 for the drifting gillnet fishery of Pakistan, with very high catches of striped marlins reported by alternative sources, as derived from sampling in different locations in Pakistan.
- Conflicting catch reports for longliners flagged to the Rep. 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.

Discards: Thought to be low although they are unknown for most industrial fisheries, mainly longliners. Discards of striped marlin may also occur in some driftnet fisheries.

Changes to the catch series: There have been minor changes to the catches of striped marlins since the WPB meeting in 2013. The main revisions occur around the mid-2000s as a result of improvements to the estimate of total catch and catch-by-species for IR Iran and Indonesia. These changes, however, did not lead to substantial changes in the catch estimates for striped marlins.

Fish size or age trends (e.g. by length, weight, sex and/or maturity (Fig. 6c): Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. However, the number of specimens measured on Japanese longliners in recent years is very low and miss-identification of striped marlin and blue marlin may be occurring in the Taiwan,China longline fishery; the length frequency distributions derived from samples collected on Taiwan,China longliners differ greatly from those collected on longliners flagged in Japan.

Catch–per–unit–effort (CPUE) series (Fig. 6b): Standardised CPUE series have not yet been developed. Nominal CPUE series are however available from some industrial longline fisheries (primarily the Japanese longline fleet) 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 IR Iran and Pakistan, gillnet/longlines of Sri Lanka, gillnets of Indonesia) or industrial fisheries (NEI longliners and all purse seiners).

Catch-at-Size(Age) (Fig. 7): 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 or the samples collected are unreliable.

Sex ratio: data have not been provided to the IOTC Secretariat by CPCs.

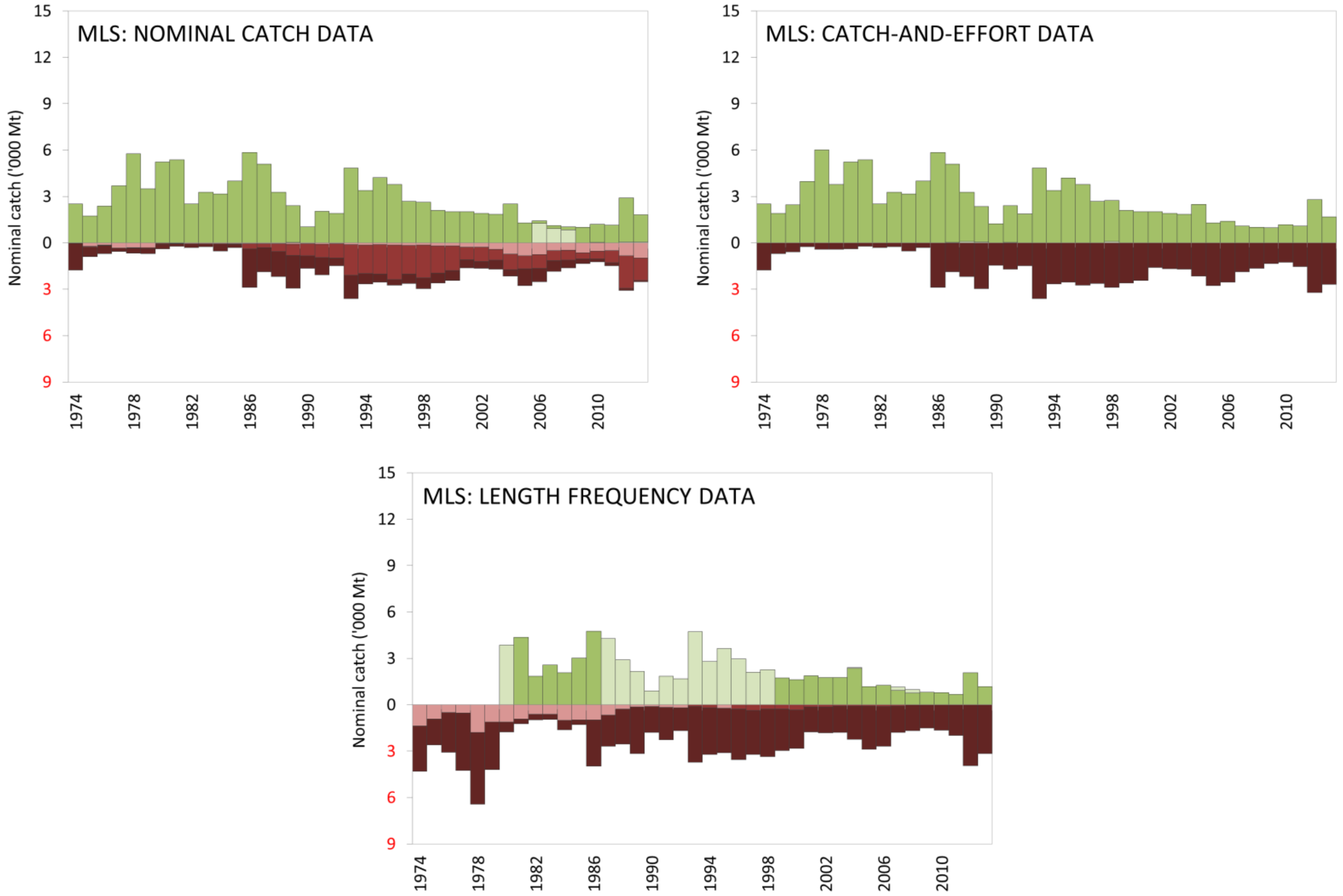


Fig. 6. Striped marlin: data reporting coverage (1974–2013). a) nominal catch data; b) catch-and-effort data; c) length frequency data. Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available (Data as of September 2014).

Key to IOTC Scoring system

Nominal Catch	By species	By gear
Fully available	0	0
Partially available (part of the catch not reported by species/gear)*	2	2
Fully estimated (by the IOTC Secretariat)	4	4

*Catch assigned by species/gear by the IOTC Secretariat; or 15% or more of the catches remain under aggregates of species

Catch-and-Effort	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

Size frequency data	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 1 fish measured by metric ton of catch)	2	
Not available at all	8	

Key to colour coding

- Total score is 0 (or average score is 0-1)
- Total score is 2 (or average score is 1-3)
- Total score is 4 (or average score is 3-5)
- Total score is 6 (or average score is 5-7)
- Total score is 8 (or average score is 7-8)

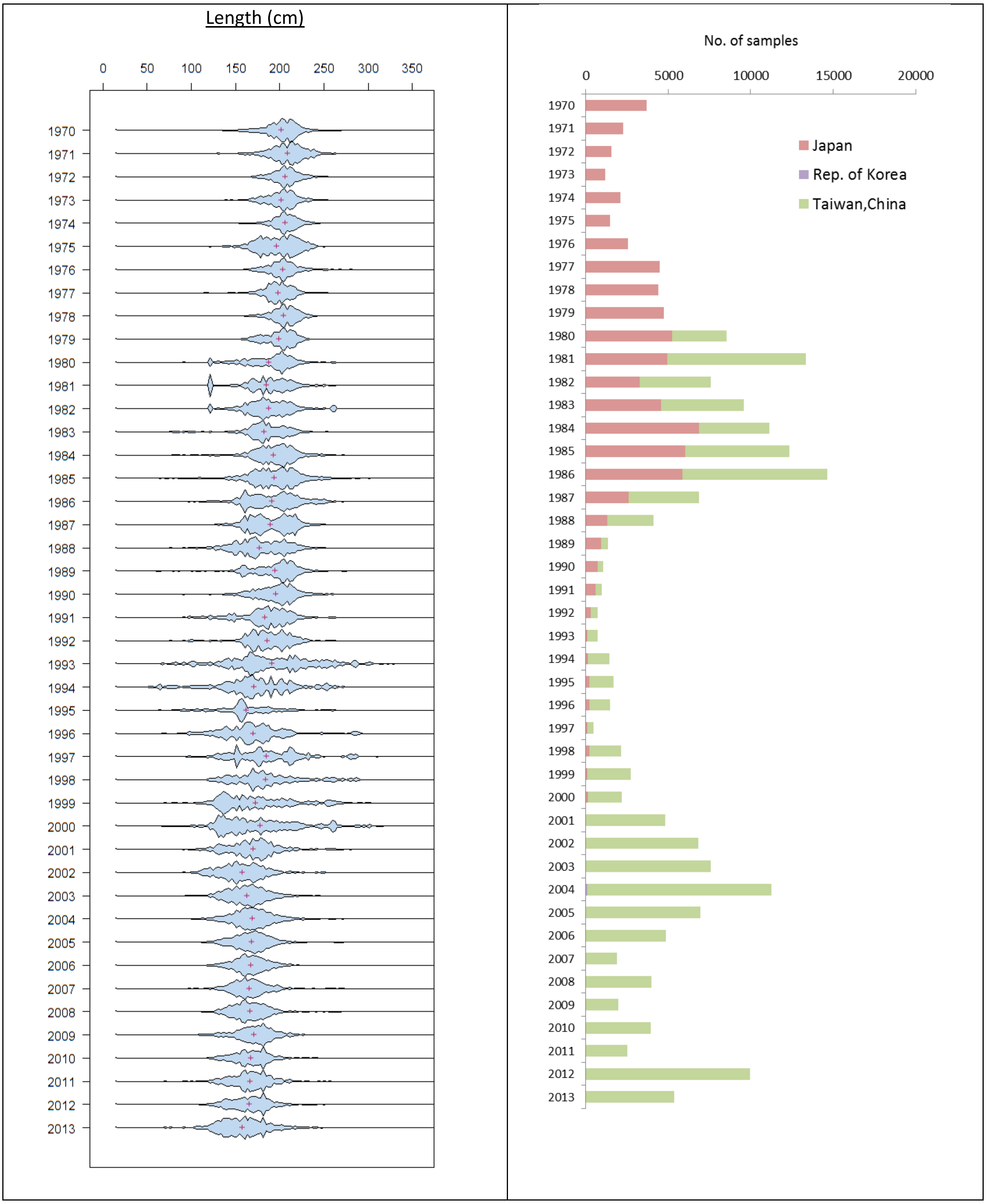


Fig. 7. Striped marlin: Longline catch-at-size length distributions (Data as of September 2014).

***Striped marlin:** Effort trends*

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2012 and 2013 are provided in Fig. 8, 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 2012 and 2013 are provided in Fig. 9.

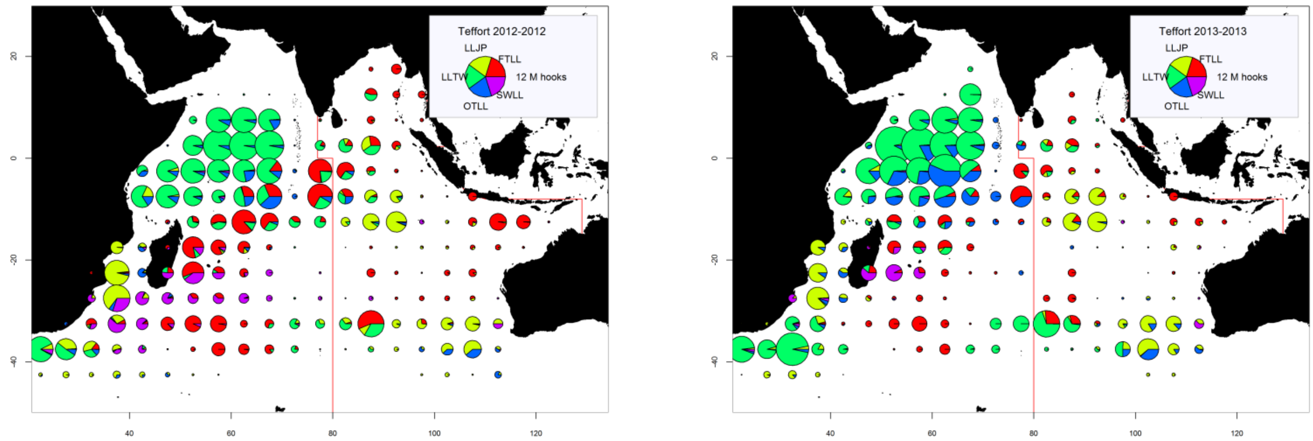


Fig. 8. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014). **LLJP** (light green): deep-freezing longliners from Japan LLTW (dark green): deep-freezing longliners from Taiwan,China; **SWLL** (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).

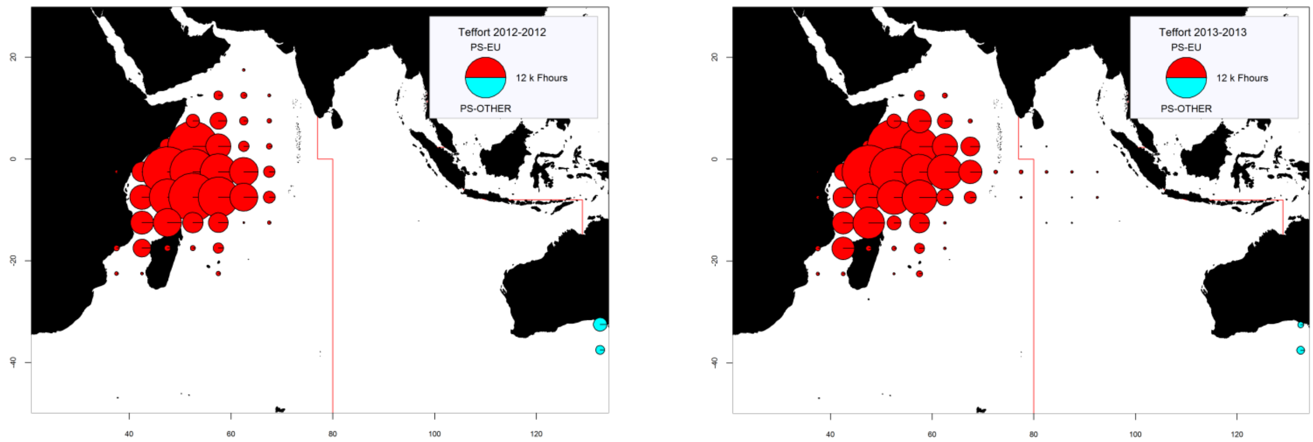


Fig. 9. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014). **PS-EU** (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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).

***Striped marlin:** Catch–per–unit–effort (CPUE) trends*

The sharp decline between 1952 and 1960 in the Japanese striped marlin CPUE series does not reflect the trend in abundance, although the gradual decline identified since 1960 until 2011 is more likely to represent actual declines in stock abundance (Fig. 10).

The catches and CPUE series estimated for striped marlin were very similar between the longline fleets of Japan and Taiwan,China although there were two peaks in the Taiwan,China data series. In particular the longline fleet data for Taiwan,China was highly variable and warranted further investigation and documentation.

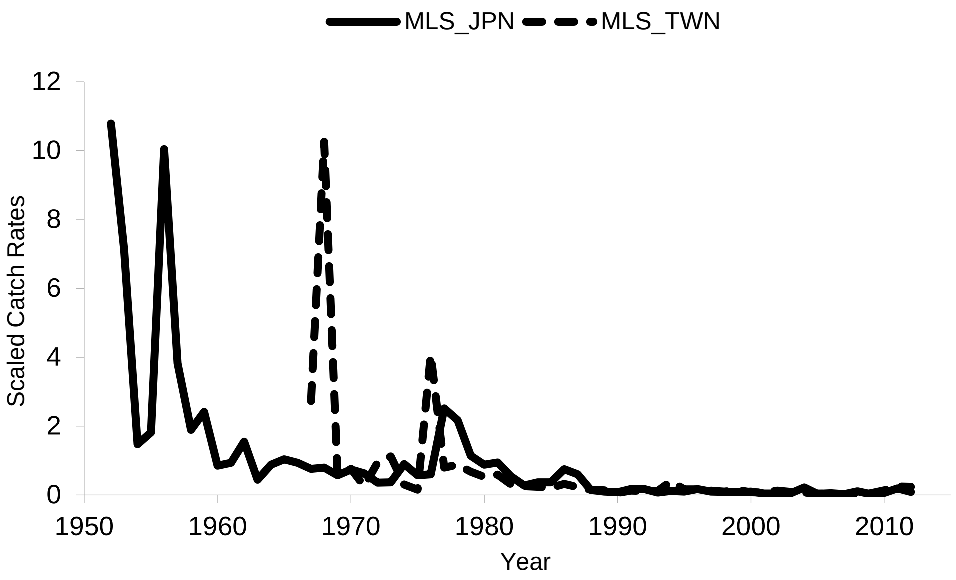


Fig. 10. Striped marlin: Standardised catch rates of striped marlin for Japan (JPN) and Taiwan,China (TWN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period.

Both Japan and Taiwan,China should undertake a historical review of their longline data and to document the changes in fleet dynamics for presentation and the next WPB meeting. The historical review should include as much explanatory information as possible regarding changes in fishing areas, species targeting, gear changes and other fleet characteristics to assist the WPB understand the current fluctuations observed in the data.

Of the striped marlin CPUE series available for assessment purposes, the separate Japan and Taiwan,China series were used in the stock assessment model for 2013 (Fig. 11).

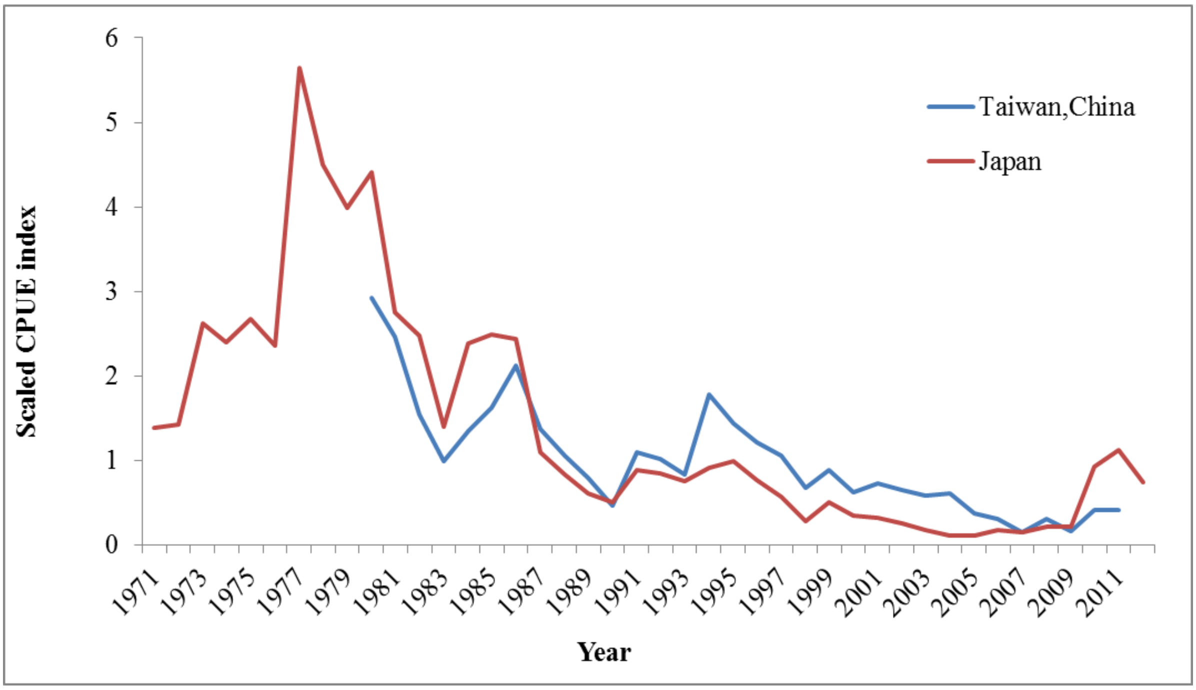


Fig. 11. Striped marlin: Comparison of the CPUE series for the longline fleets of Japan and Taiwan,China. Scaling was carried out using the average of the overlapped years.

STOCK ASSESSMENT

A range of quantitative modelling methods (ASPIC, Bayesian Production Model, and Stock Reduction Analysis) were applied to the striped marlin in 2013. The models explored did not perform well as far as the residual diagnostics, or other were concerned, denoting high uncertainties. However, these models showed similar stock trajectories, and based on the weight-of-evidence approach, the WPB agreed to use the results from the ASPIC model for stock status advice. Further work needs to be conducted in future years to improve these assessments.

The standardised CPUE series suggest that there was a sharp decline in the early 1980s, followed by slower decline since 1990. In 2013, an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicates the stock is currently subject to overfishing and that biomass is below the level which would produce MSY. Two other approaches examined in 2013 came to similar conclusions, namely a Bayesian State Space model, and a data poor stock assessment method, Stock Reduction Analysis using only catch data. The Kobe plot (Fig. 1) from the ASPIC model indicates that the stock has been subject to overfishing for some years, and that as a result, the stock biomass is well below the B_{MSY} level and shows little signs of rebuilding despite the declining effort trend. Thus, on the weight-of-evidence available to the WPB, the stock is determined to be **overfished** and **subject to overfishing** (Table 1, 5; Fig. 1).

TABLE 5. Striped marlin (*Tetrapturus audax*) key management quantities from the ASPIC stock assessment.

Management Quantity	Aggregate Indian Ocean
2013 catch estimate	4,429 t
Mean catch from 2009–2013	3,667 t
MSY (80% CI)	4,408 (3,539–4,578)
Data period used in assessment	1950–2011
F_{MSY} (80% CI)	–
B_{MSY} (80% CI) (1,000 t)	–
F_{2011}/F_{MSY} (80% CI)	1.28 (0.95–1.92)
B_{2011}/B_{MSY} (80% CI)	0.416 (0.2–0.42)
SB_{2011}/SB_{MSY} (80% CI)	–
B_{2011}/B_{1950} (80% CI)	0.18 (n.a.)
SB_{2011}/SB_{1950} (80% CI)	–
$B_{2011}/B_{1950,\ F=0}$ (80% CI)	–
$SB_{2011}/SB_{1950,\ F=0}$ (80% CI)	–

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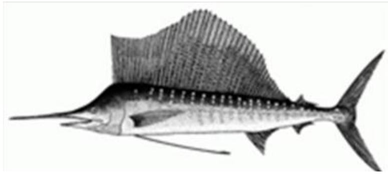
APPENDIX XX
EXECUTIVE SUMMARY: INDO-PACIFIC SAILFISH

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



Status of the Indian Ocean Indo-Pacific sailfish (SFA: *Istiophorus platypterus*) resource

TABLE 1. Indo-Pacific sailfish: Status of Indo-Pacific sailfish (*Istiophorus platypterus*) in the Indian Ocean.

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Catch 2013: Average catch 2009–2013:	29,750 t 28,087 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2013}/F_{MSY} (80% CI): B_{2013}/B_{MSY} (80% CI): B_{2013}/B_0 (80% CI):	27.84 (24.70–35.00) 0.27 (0.16–0.39) 95.2 (62.89–127.73) 1.19 (0.66–1.72) 1.12 (0.88–1.37) 0.56 (0.44–0.69)	

[1]Boundaries for the Indian Ocean = IOTC area of competence

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

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. Data poor methods for stock assessment using Stock reduction analysis (SRA) techniques indicate that the stock is not overfished and close to or exceeding maximum sustainable yield levels (Table 1). However, as this is the first time that the WPB used such a method on Indo-Pacific sailfish, further testing of how sensitive this technique is to model assumptions and available time series of catches needs to be undertaken before the WPB uses it to determine stock status. Thus, the stock status remains **uncertain**. Nonetheless in using the SRA method for comparative purposes with other stocks, the WPB considers that the use of the target reference points may be possible for the approach. The stock appears to show a continued increase in catch rates which is a cause of concern, indicating that fishing mortality levels may be becoming too high (Fig. 1). Aspects of the biology, productivity and fisheries for this species combined with the data poor status on which to base a more formal assessment are a cause for concern. Research emphasis on developing possible CPUE indicators and further exploration of stock assessment approaches for data poor fisheries are warranted. Given the limited data being reported for coastal gillnet fisheries, and the importance of sports fisheries for this species, efforts must be made to rectify these information gaps. Records of stock extirpation in the Gulf should also be examined to examine the degree of localised depletion in Indian Ocean coastal areas.

Outlook. The estimated increase in coastal gillnet catch and effort in recent years is a substantial cause for concern for the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is unknown.
- **Provisional reference points**: Although the Commission adopted interim reference points for swordfish in Resolution 13/10 *on interim target and limit reference points and a decision framework*, no such interim points have been established for I.P. sailfish.
- **Main fishing gear** (2010–13): Gillnet catches are currently estimated to comprise approximately 77% of the total estimated I.P. sailfish catch in the Indian Ocean.
- **Main fleets** (2010–13): I.R. Iran: 25%; Pakistan: 18%; India: 17%; Sri Lanka: 14%.

- **Improvements required**: Improvement in data collection and reporting, particularly for coastal gillnet and sports fisheries, is required to further assess the stock with a greater degree of certainty.

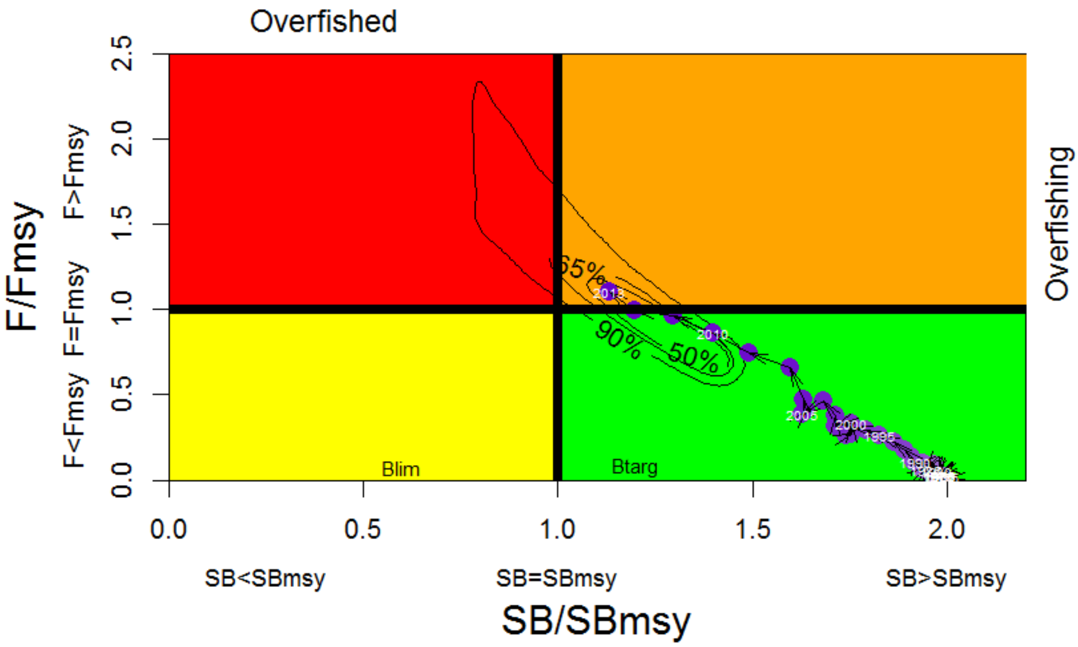


Fig. 1. Indo-Pacific sailfish: Stock reduction analysis (Catch MSY Method) of aggregated Indian Ocean assessment Kobe plot (contours are the 50, 65 and 90 percentiles of the 2013 estimate). Black lines indicate the trajectory of the point estimates (blue circles) for the B ratio and F ratio for each year 1950–2013.

TABLE 2. Indo-Pacific sailfish: Indian Ocean stock reduction analysis Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target reference points for nine constant catch projections (average catch level from 2011–2013 (20,087 t), ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years. These will be calculated during the next assessment of Indo-Pacific sailfish.

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2011–2013) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60% (12,052 t)	**70%** (14,061 t)	**80%** (16,070 t)	**90%** (18,078 t)	**100%** (20,087 t)	**110%** (22,096 t)	**120%** (24,104 t)	**130%** (26,113 t)	**140%** (28,121 t)
$B_{2016} < B_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$F_{2016} > F_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$B_{2023} < B_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$F_{2023} > F_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

APPENDIX I

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 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 13/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*
- Resolution 11/04 *on a regional observer scheme*
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Indo-Pacific sailfish: General

Indo-Pacific sailfish (*Istiophorus platypterus*) is a large oceanic apex predator that inhabits tropical and subtropical Indo-Pacific oceans (Fig. 2). Table 3 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.

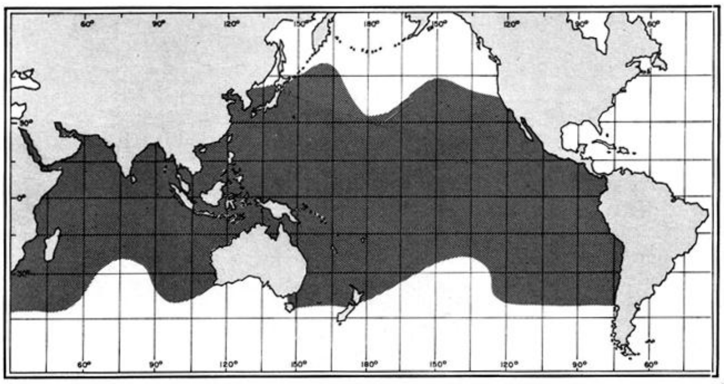


Fig. 1. Indo-Pacific sailfish: The worldwide distribution of Indo-Pacific sailfish (Source: Nakamura, 1984)

TABLE 3. Indo-Pacific sailfish: 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 burst swimming at speeds in excess of 110 km/h. The stock structure of Indo-Pacific sailfish in the Indian Oceans is uncertain: apparently there are local reproductively isolated stocks. At least one stock was reported in the Persian Gulf with no or very little intermixing with open Indian Ocean stocks. However outside of the Gulf no stock differentiation has been determined; 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. In subtropical waters of the southern hemisphere spawning is associated with warmer months: in Mozambique Channel and around Reunion Island high percentage of ripe females occurs in December.
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 LJFL, 50+ kg total weight; Males: 200 cm LJFL, 40+ kg total weight in the Indian Ocean. Recruitment into the fishery: varies by fishing method, apparently at age 0+ and size less than 100 cm LJFL for artisanal fleets. The average weight of fish caught in the Kenyan sports fishery is ~25 kg whole weight.

n.a. = not available. Sources: Nakamura 1985, Hoolihan 2003, 2004, 2006, Speare 2003, Hoolihan & Luo 2007, Sun et al. 2007, Froese & Pauly 2009, Ndegwa & Herrera 2011

Indo-Pacific sailfish: Catch trends

Indo-Pacific sailfish is caught mainly using gillnets (75%) with remaining catches recorded using troll and hand lines (20%), longlines (5%) or other gears (Table 4, Fig. 3). The average annual catch over recent years is estimated at around 29,000 t. In recent years, the countries attributed with the highest catches of Indo-Pacific sailfish are situated in the Arabian Sea (India, IR Iran, Sri Lanka and Pakistan). Smaller catches are reported for line fishers in Comoros and Mauritius and by Indonesia and other longline fleets. 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-1990’s (from around 5,000 t in the early 1990s to almost 30,000 t in 2011 and similar catch levels in the following years. The increases are largely due to the development of a gillnet/longline fishery in Sri Lanka (Fig. 4) and especially, the extension in the area of operation of IR Iran gillnet vessels to areas beyond the EEZ of IR Iran. In the case of IR Iran gillnets (Fig. 4), catches have increased from less than 1,000 t in the early 1990’s to over 7,700 t in 2011 and similar values in subsequent years.

Catches of Indo-Pacific sailfish using drifting longlines (Table 4) and other gears have also increased – to a lesser extent than catches from gillnet – from around 2,500 t to over 8,000 t in recent years. 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. 5).

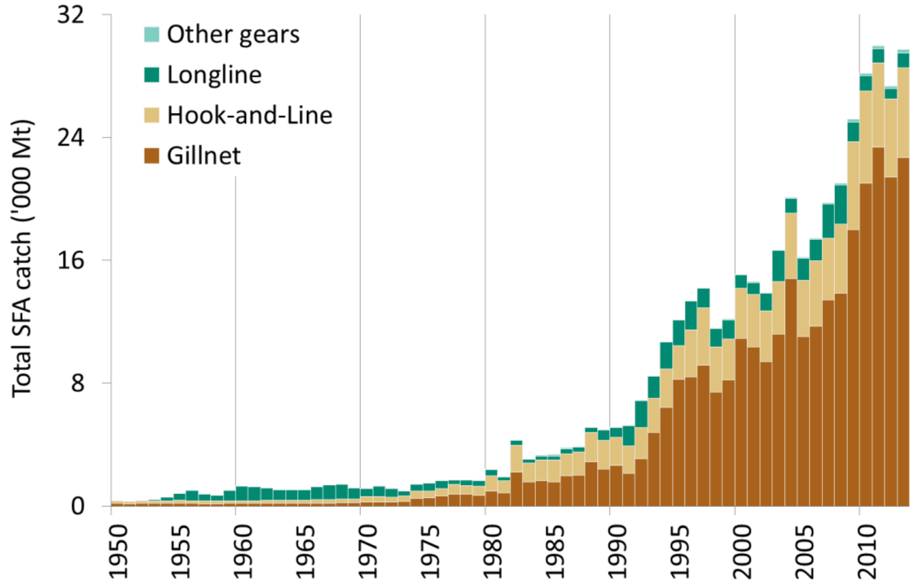


Fig. 2. Indo-Pacific sailfish. Catches of Indo-pacific sailfish by gear and year recorded in the IOTC Database (1950–2013).

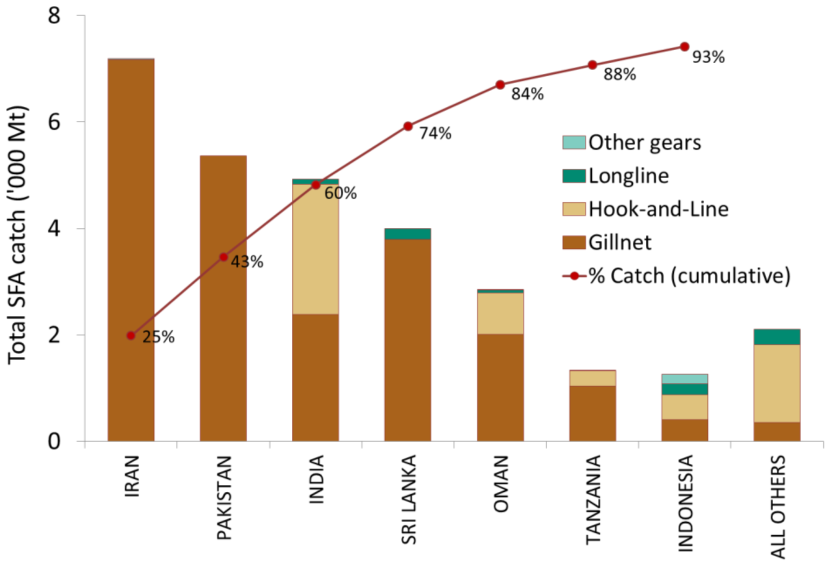


Fig. 3. Indo-Pacific sailfish: Average catches in the Indian Ocean over the period 2010–13, by country. Countries are ordered from left to right, according to the importance of catches of black marlin reported. The red line indicates the (cumulative) proportion of catches of Indo-Pacific sailfish for the countries concerned, over the total combined catches of this species reported from all countries and fisheries.

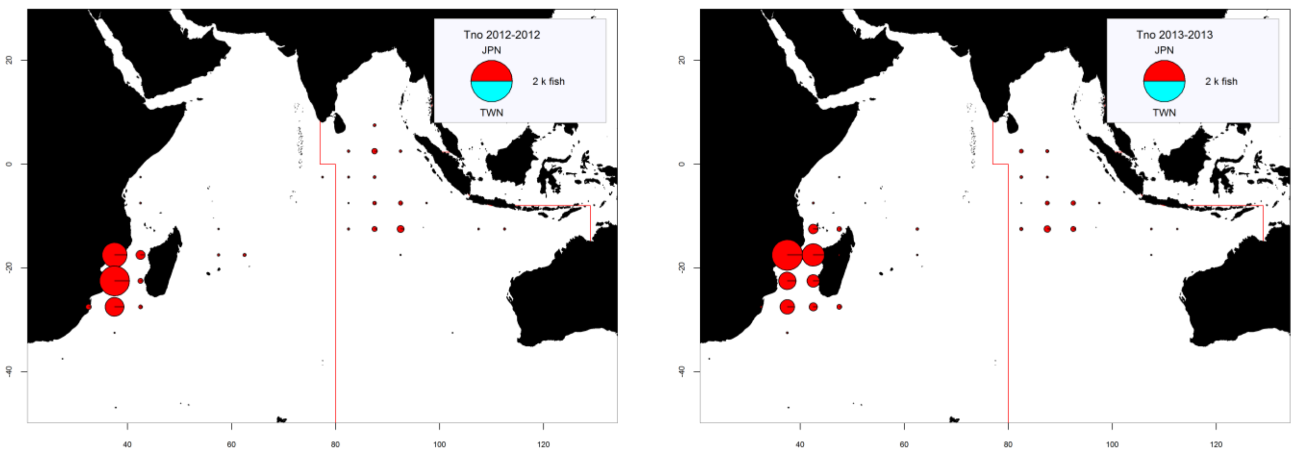


Fig. 4a-f. Indo-Pacific sailfish: Time-area catches (in number of fish) of Indo-Pacific sailfish as reported for the longline fisheries of Japan (JPN) for a) 2012 and b) 2013 by fleet.

TABLE 4. Indo-Pacific sailfish: Best scientific estimates of the catches of Indo-Pacific sailfish by type of fishery for the period 1950–2013 (in metric tons) (Data as of September 2014).

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LL	299	818	444	335	1,411	1,466	958	1,438	1,403	2,223	2,526	1,299	991	928	664	975
GN	165	181	507	1,809	6,056	12,470	14,798	11,047	11,712	13,415	13,862	17,994	21,028	23,385	21,413	22,699
HL	171	213	456	1,430	2,498	3,980	4,269	3,645	4,240	4,024	4,513	5,720	5,992	5,472	5,096	5,821
OT	-	-	3	44	42	85	63	84	88	95	134	171	172	181	178	255
Total	**634**	**1,212**	**1,410**	**3,618**	**10,007**	**18,000**	**20,088**	**16,215**	**17,443**	**19,758**	**21,034**	**25,183**	**28,184**	**29,965**	**27,351**	**29,750**

Indo-Pacific sailfish: 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: poorly known for most fisheries (Fig. 5a) due to:

- Catch reports often refer to total catches of all billfish species combined; catches by species are estimated by the IOTC Secretariat for some artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India and Pakistan) and industrial (longliners of Indonesia and Philippines) fisheries.
- Catches of Indo-Pacific sailfish reported for some fisheries may refer to the combined catches of more than one species of billfish, in particular marlins and shortbill spearfish (many coastal fisheries).
- Catches likely to be incomplete for some artisanal fisheries (e.g. 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.

Discards: unknown for most industrial fisheries, mainly longliners (for which they are presumed to be moderate-high).

Changes to the catch series: Catches of Indo-Pacific sailfish remain largely unchanged since the WPB meeting in 2013, and have been unaffected by revisions to the catch-by-species for IR Iran gillnet offshore fisheries, and also the revisions to the catch series in Indonesia.

Catch–per–unit–effort (CPUE) series (Fig. 5b): 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 IR 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) (Fig. 5c): Average fish weight can only be assessed for the longline fishery of Japan since 1970 and the gillnet/longline fishery of Sri Lanka since the late 1980s. 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 IOTC Secretariat by CPCs.

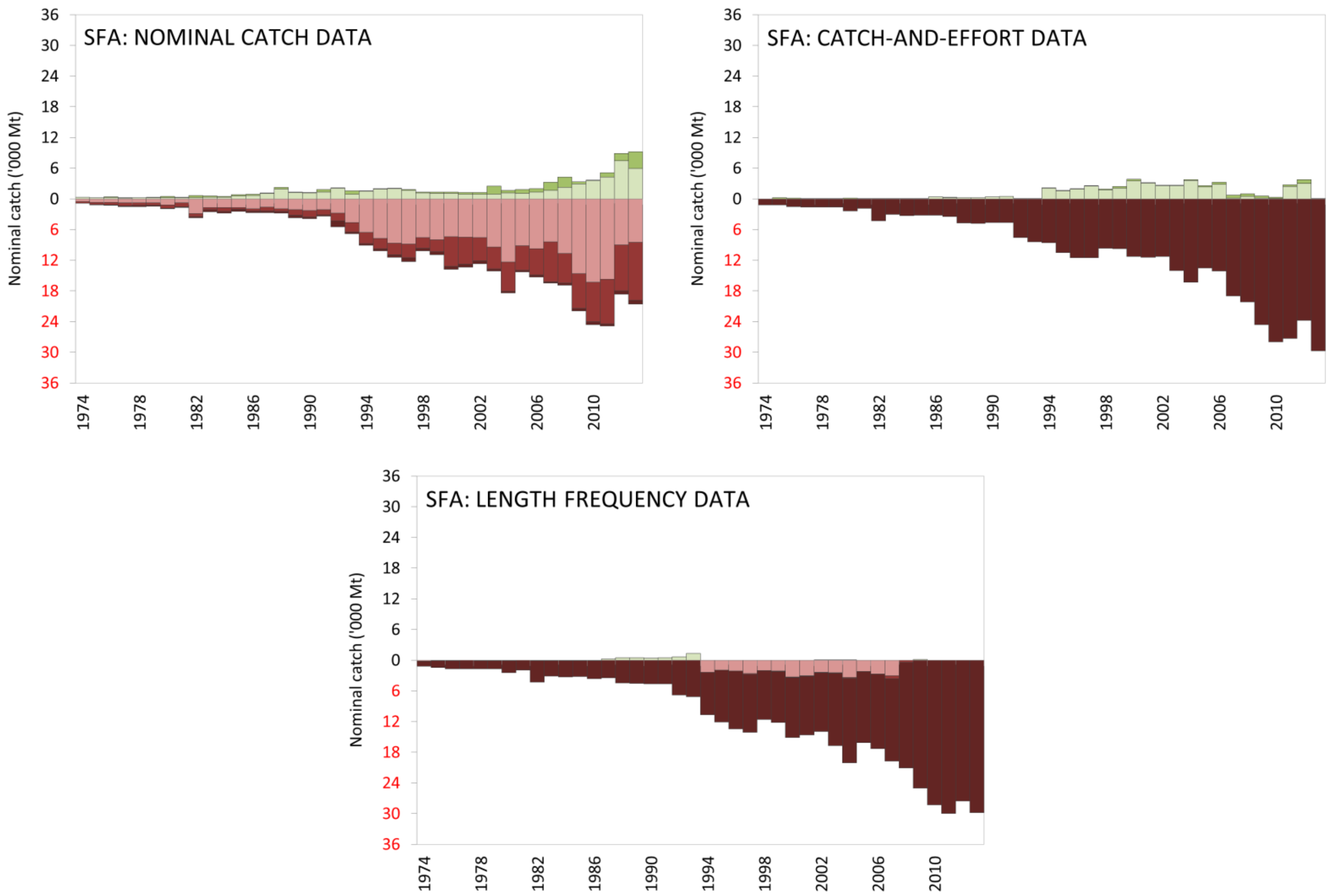


Fig. 5a–**c.** Indo-Pacific sailfish: data reporting coverage (1974–2013). a) nominal catch data; b) catch-and-effort data; c) length frequency data. Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available (Data as of September 2014).

Key to IOTC Scoring system

Nominal Catch	By species	By gear
Fully available	0	0
Partially available (part of the catch not reported by species/gear)*	2	2
Fully estimated (by the IOTC Secretariat)	4	4

*Catch assigned by species/gear by the IOTC Secretariat; or 15% or more of the catches remain under aggregates of species

Catch-and-Effort	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

Size frequency data	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 1 fish measured by metric ton of catch)	2	
Not available at all	8	

Key to colour coding

- Total score is 0 (or average score is 0-1)
- Total score is 2 (or average score is 1-3)
- Total score is 4 (or average score is 3-5)
- Total score is 6 (or average score is 5-7)
- Total score is 8 (or average score is 7-8)

Indo-Pacific sailfish: Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2012 and 2013 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 2012 and 2013 are provided in Fig. 7.

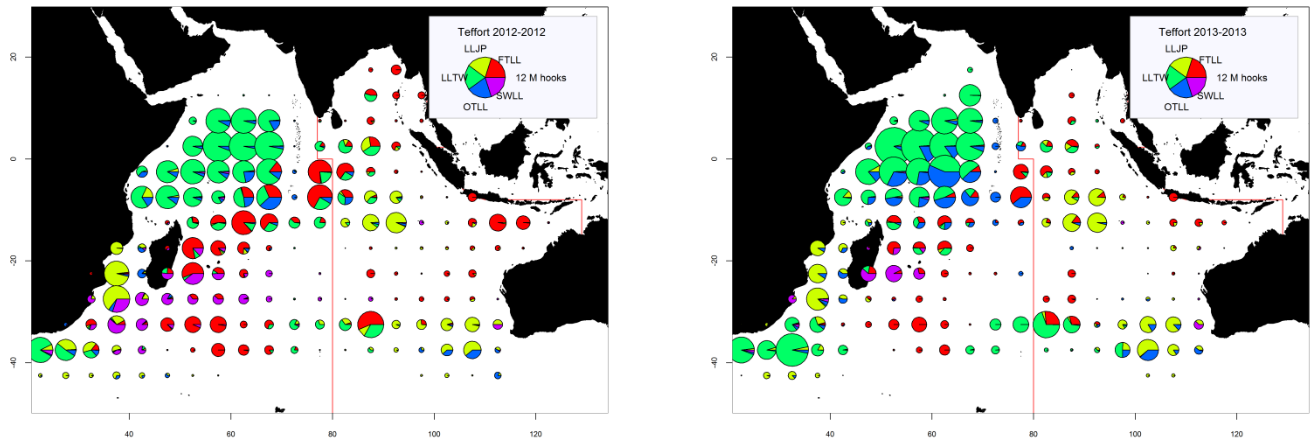


Fig. 6. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014). **LLJP** (light green): deep-freezing longliners from Japan LLTW (dark green): deep-freezing longliners from Taiwan,China. **SWLL** (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).

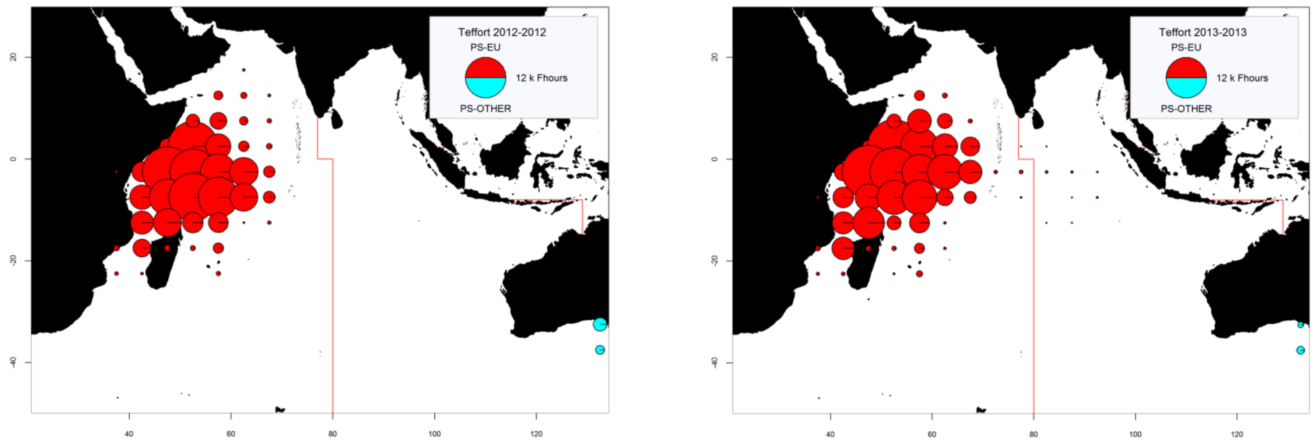


Fig. 7. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014). **PS-EU** (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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).

Indo-Pacific sailfish: Catch–per–unit–effort (CPUE) trends

Currently there is insufficient data to develop a CPUE series for Indo-Pacific sailfish caught in the IOTC area of competence. 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).

STOCK ASSESSMENT

The results of the stock assessment of Indo-Pacific sailfish in 2014 (Table 5) are based on very limited information and in particular are compromised by the uncertainty in the estimates of catches for this species, over the time series. As this was the first time that IP sailfish was the subject of an assessment, stock status should remain as 'uncertain' until further work is carried out by the WPB in 2015. Scientists from the U.A.E. may be able to provide the latest information from the I.P. sailfish fishery in the Gulf, as the most recent information submitted to the WPB some time ago suggested that the fishery may be collapsing or have collapsed. Any new information received should be submitted to the next WPB meeting as part of a general review of I.P. sailfish fisheries in the Indian Ocean.

TABLE 5. Indo-Pacific sailfish (*Istiophorus platypterus*): Key management quantities from the SRA approach used.

Management Quantity	**Indian Ocean**
2013 catch estimate	34,481 t
Mean catch from 2009–2013	32,414 t
MSY (1,000 t) (80% CI)	27.84 (24.70–35.00)
Data period used in assessment	1950–2013
F_{MSY} (80% CI)	0.27 (0.16–0.39)
B_{MSY} (1,000 t) (80% CI)	95.2 (62.89–127.73)
F_{2013}/F_{MSY} (80% CI)	1.19 (0.66–1.72)
B_{2013}/B_{MSY} (80% CI)	1.12 (0.88–1.37)
SB_{2013}/SB_{MSY} (80% CI)	n.a.
B_{2013}/B_{1950} (80% CI)	0.56 (0.44–0.69)
SB_{2013}/SB_{1950} (80% CI)	n.a.
$B_{2013}/B_{1950,\ F=0}$ (80% CI)	n.a.
$SB_{2012}/SB_{1950,\ F=0}$ (80% CI)	n.a.

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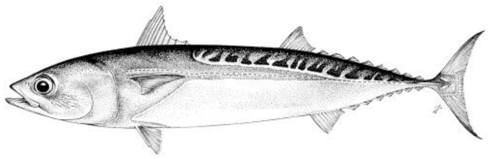
APPENDIX XXI
EXECUTIVE SUMMARY: BULLET TUNA

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



Status of the Indian Ocean bullet tuna (BLT: *Auxis rochei*) resource

TABLE 1. Bullet tuna: Status of bullet tuna (*Auxis rochei*) in the Indian Ocean

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Catch[2] 2013: Average catch[2] 2009–2013:	11,724 t 10,598 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2012}/F_{MSY} (80% CI): B_{2012}/B_{MSY} (80% CI): B_{2012}/B_0 (80% CI):	unknown unknown unknown unknown unknown unknown	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]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)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

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 status indicators can be used. Aspects of the fisheries for bullet tuna combined with the lack of data on which to base a more formal assessment, are a cause for considerable concern Stock status in relation to the Commission's B_{MSY} and F_{MSY} target reference points remains **uncertain** (Table 1), indicating that a precautionary approach to the management of bullet tuna should be applied.

Outlook. Total annual catches for bullet tuna over the past three years have ranged between 8,400 t and 15,000 t. There is insufficient information to evaluate the effect that this level of catch, or an increase in catch may have on the resource. Research emphasis on improving indicators and exploration of stock structure and stock assessment approaches for data poor fisheries should be considered a high priority for this species. The following should be noted:

- The Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- Species identification, data collection and reporting urgently need to be improved.
- Reconstruction of the catch history needs to occur before a reliable assessment can be attempted.
- Limit reference points: The Commission has not adopted limit reference points for any of the neritic tunas under its mandate.

APPENDIX I

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:

- Resolution 13/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence
- Resolution 14/05 concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information
- Resolution 12/11 *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 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Bullet tuna: 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. Bullet tuna: 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, Kahraman 2010, Widodo et al. 2012

Bullet tuna – Fisheries and catch trends

Bullet tuna is caught mainly by gillnet, handline, and trolling, across the broader Indian Ocean area (Table 3; Fig. 1). This species is also an important catch for coastal purse seiners. The catch estimates for bullet tuna were derived from very small amounts of information and are therefore highly uncertain[6].

[6] The uncertainty in the catch estimates has been assessed by the IOTC Secretariat and is based on the amount of processing required to account for the presence of conflicting catch reports, the level of aggregation of the catches by species and or gear, and the occurrence of non-reporting fisheries for which catches had to be estimated.

TABLE 3. Bullet tuna: Best scientific estimates of the catches of bullet tuna by type of fishery for the period 1950–2013 (in metric tonnes) (Data as of October 2014).

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Purse seine	-	2	28	278	552	655	603	625	650	581	908	1,055	1,368	630	1,618	971
Gillnet	41	153	296	531	1,222	1,741	1,699	1,631	1,872	1,692	2,236	2,587	3,338	2,706	4,410	3,426
Line	113	193	325	393	780	1,190	1,004	1,053	1,165	1,141	1,858	2,182	2,900	1,159	4,160	2,832
Other	5	13	44	242	755	1,322	1,239	1,188	1,465	1,908	1,638	2,022	2,728	3,885	4,517	4,494
Total	**159**	**362**	**693**	**1,444**	**3,309**	**4,907**	**4,545**	**4,496**	**5,152**	**5,324**	**6,640**	**7,847**	**10,334**	**8,380**	**14,706**	**11,724**

The catches provided in Table 3 are based on the information available at the IOTC Secretariat and the following observations on the catches cannot currently be verified. Estimated catches of bullet tuna reached around 2,000 t in the early 1990's, increasing markedly in the following years to reach a peak in 1997, at around 4,900 t. The catches decreased slightly in the following years and remained at values of between 3,500 t and 5,500 t until the late-2000's, increasing sharply again up to the 15,000 t recorded in 2012, the highest catch ever recorded for this species in the Indian Ocean (Table 3; Fig. 1).

In recent years the catches of bullet tuna estimated for the fisheries of India, Sri Lanka and Indonesia have represented over 90% of the total combined catches of this species from all fisheries in the Indian Ocean (Fig. 2).

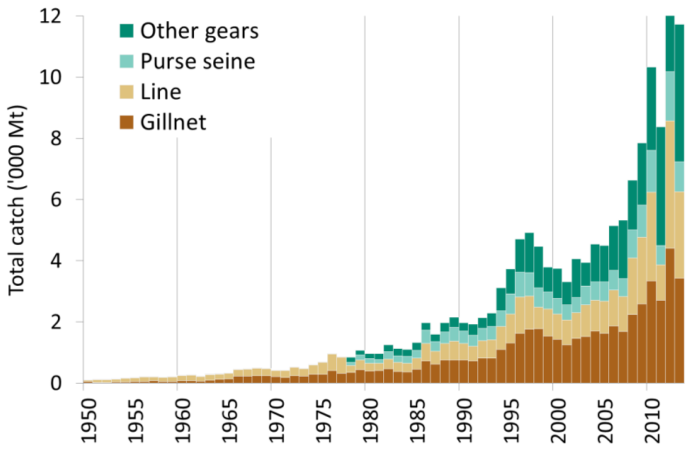


Fig. 1. Bullet tuna: Annual catches of bullet tuna by gear recorded in the IOTC Database (1950–2013) (Data as of October 2014).

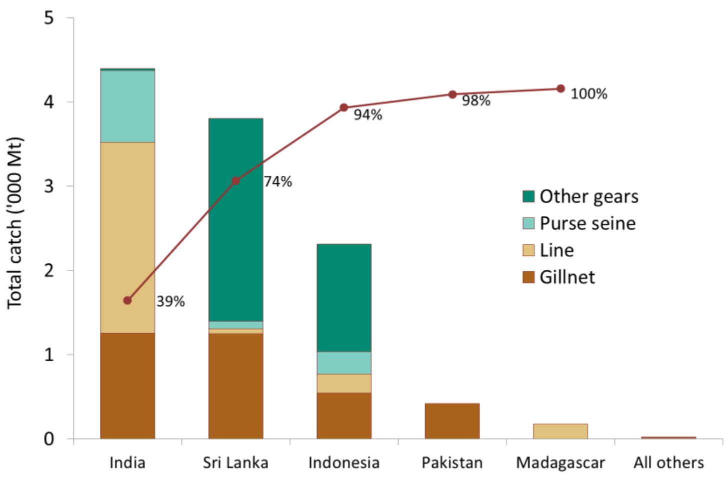


Fig. 2. Bullet tuna: average catches in the Indian Ocean over the period 2010–12, by country. Countries are ordered from left to right, according to the importance of catches of bullet tuna reported. The red line indicates the (cumulative) proportion of catches of bullet tuna for the countries concerned, over the total combined catches of bullet tuna reported from all countries and fisheries (Data as of October 2014).

Bullet tuna – Uncertainty of catches

Retained catches are highly uncertain for all fisheries (Fig. 3) due to:

- Aggregation: Bullet tunas are usually not reported by species, but are instead aggregated with frigate tunas or, less frequently, other small tuna species.
- Mislabelling: Bullet tunas are usually mislabelled as frigate tuna, with their catches reported under the latter species.
- Underreporting: 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 tunas in the IOTC database are thought to be highly uncertain and represent only a small fraction of the total catches of this species in the Indian Ocean.
- Discard levels are moderate for industrial purse seine fisheries. The EU recently reported discard levels of bullet tuna for its purse seine fleet, for 2003–07, estimated using observer data.
- Changes to the catch series: The catch series of bullet tuna has not changed substantially since the WPNT meeting in 2013.

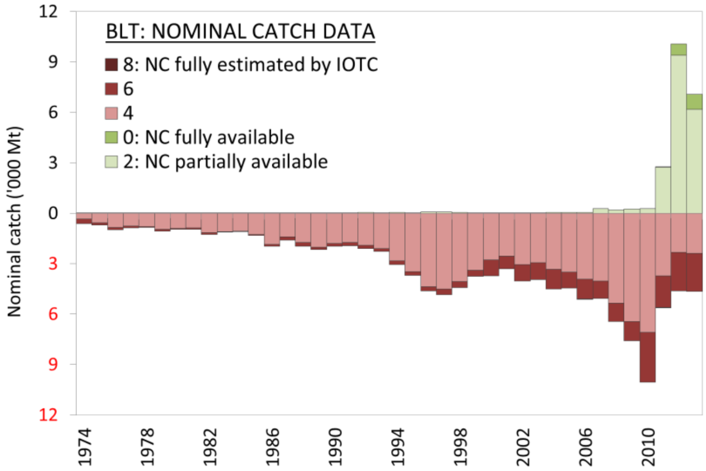


Fig. 3. Bullet tuna: nominal catch; uncertainty of annual catch estimates (1950–2013). Catches are assessed against IOTC reporting standards, where a score of 0 indicates catches that are fully reported according to IOTC standards; catches assigned a score of between 2 – 6 do not report catch data fully by gear and/or species (i.e., partially adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; catches with a score of 8 refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat) (Data as of October 2014).

Bullet tuna – Effort trends

Effort trends are unknown for bullet tuna in the Indian Ocean.

Bullet tuna – Catch–per–unit–effort (CPUE) trends

Catch-and-effort series are not available for most fisheries (Table 4) and, when available, they are usually considered to be of poor quality for the fisheries having reasonably long catch-and-effort data series, as is the case with the gillnet fisheries of Sri Lanka (Fig. 4).

TABLE. 4. Bullet tuna: Availability of catches and effort series, by fishery and year (1970–2013)[7]. Note that no catches and effort are available at all for 1950–78 and 2007 to present.

Gear-Fleet	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	00	02	04	06	08	10	12
PSS-Indonesia									■ –													
GILL-India					– ■																	
GILL-Indonesia								■ ■														
GILL-Sri Lanka								– ■	■ ■	■ ■	■ ■		■ ■	■ ■	■ ■	■ ■	■ ■	■ –				
LINE-India					– ■																	
LINE-Indonesia								– ■														
LINE-Sri Lanka									■ –													
LINE-Yemen																	– ■	■ ■	■ –			
OTHR-Indonesia								■ ■	– ■													
OTHR-Sri Lanka											– ■		■ ■	■ ■	■ ■	■ ■	■ ■	■ –				

[7] Note that the above list is not exhaustive, showing only the fisheries for which catches and effort are available in the IOTC database. Furthermore, when available catches and effort may not be available throughout the year existing only for short periods

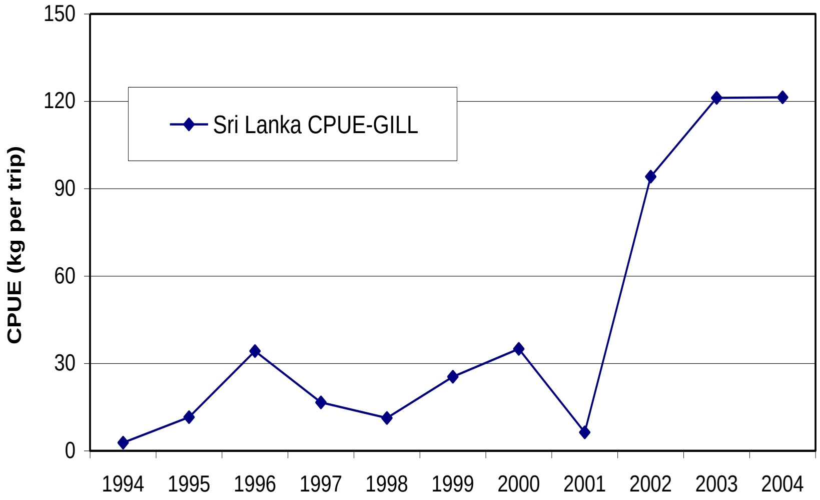
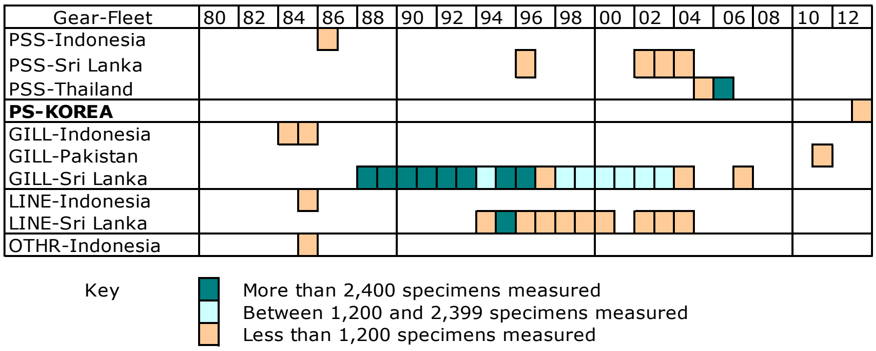


Fig. 4. Bullet tuna: Nominal CPUE series for the gillnet fishery of Sri Lanka derived from the available catches and effort data (1994–2004).

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

- 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 and 35 cm.
- 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 (Table 5).
- Catch-at-Size(age) data 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.

TABLE 5. Bullet tuna: Availability of length frequency data, by fishery and year (1980–2013)[8]. Note that no length frequency data are available at all for 1950–83.



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 6).

[8] Note that the above list is not exhaustive, showing only the fisheries for which size data are available in the IOTC database. Furthermore, when available size data may not be available throughout the year existing only for short periods

TABLE 6. Bullet tuna (*Auxis rochei*) key management quantities.

Management Quantity	**Aggregate Indian Ocean**
2013 catch estimate	11,724 t
Mean catch from 2009–2013	10,598 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{MSY} (80% CI)	–
B_{MSY} (80% CI)	–
F_{2012}/F_{MSY} (80% CI)	–
B_{2012}/B_{MSY} (80% CI)	–
SB_{2012}/SB_{MSY} (80% CI)	–
B_{2012}/B_0 (80% CI)	–
SB_{2012}/SB_0 (80% CI)	–
$B_{2012}/B_{0,\ F=0}$ (80% CI)	–
$SB_{2012}/SB_{0,\ F=0}$ (80% CI)	–

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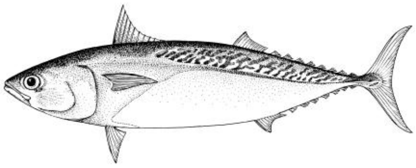
APPENDIX XXII
EXECUTIVE SUMMARY: FRIGATE TUNA

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



Status of the Indian Ocean frigate tuna (FRI: *Auxis thazard*) resource

TABLE 1. Frigate tuna: Status of frigate tuna (*Auxis thazard*) in the Indian Ocean

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Catch[2] 2013: Average catch[2] 2009–2013:	88,974 t 91,974 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2012}/F_{MSY} (80% CI): B_{2012}/B_{MSY} (80% CI): B_{2012}/B_0 (80% CI):	unknown unknown unknown unknown unknown unknown	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]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)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

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 status indicators can be used. Aspects of the fisheries for frigate tuna combined with the lack of data on which to base a more formal assessment are a cause for considerable concern. Stock status in relation to the Commission's B_{MSY} and F_{MSY} target reference points remains **uncertain** (Table 1), indicating that a precautionary approach to the management of frigate tuna should be applied.

Outlook. Total annual catches for frigate tuna have increased substantially in recent years with peak catches taken in 2010/11 (~99,500), although a decrease was recorded in 2012 (Table 1). There is insufficient information to evaluate the effect that this level of catch, or a further increase in catch may have on the resource. Research emphasis on improving indicators and exploration of stock structure and stock assessment approaches for data poor fisheries should be considered a high priority for this species. The following should be noted:

- The Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- Species identification, data collection and reporting urgently need to be improved.
- Reconstruction of the catch history needs to occur before a reliable assessment can be attempted.
- Limit reference points: The Commission has not adopted limit reference points for any of the neritic tunas under its mandate.

APPENDIX I

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:

- Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 14/05 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *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 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Frigate tuna: 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. Frigate tuna: 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 – Fisheries and catch trends

Frigate tuna is taken from across the Indian Ocean area using gillnets, handlines and trolling, and pole-and-lines (Table 3; Fig. 1). This species is also an important bycatch for industrial purse seine vessels and is the target of some ring net fisheries (recorded as purse seine in Table 3). The catch estimates for frigate tuna were derived from very small amounts of information and are therefore highly uncertain[9].

[9] The uncertainty in the catch estimates has been assessed by the IOTC Secretariat and is based on the amount of processing required to account for the presence of conflicting catch reports, the level of aggregation of the catches by species and or gear, and the occurrence of non-reporting fisheries for which catches had to be estimated.

TABLE 3. Frigate tuna: Best scientific estimates of the catches of frigate tuna by type of fishery for the period 1950–2013 (in metric tonnes) (Data as of October 2014).

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Purse seine	-	13	932	4,854	7,549	10,021	10,341	11,384	11,320	10,337	9,501	9,663	11,961	10,849	8,942	9,453
Gillnet	479	1,234	2,848	6,980	14,522	20,103	19,251	20,911	22,160	23,328	24,102	23,766	30,719	30,136	27,262	26,702
Line	1,270	2,413	4,420	7,423	13,751	27,188	25,692	29,977	27,797	31,814	31,067	34,918	37,728	37,349	34,995	35,618
Other	1,441	2,007	2,349	3,683	9,279	13,682	12,229	15,317	12,760	15,389	15,193	18,112	18,350	18,727	17,421	17,201
Total	**3,190**	**5,667**	**10,548**	**22,940**	**45,102**	**70,993**	**67,513**	**77,589**	**74,036**	**80,869**	**79,863**	**86,459**	**98,757**	**97,060**	**88,619**	**88,974**

The catches provided in Table 3 are based on the information available at the IOTC Secretariat and the following observations on the catches cannot currently be verified. Estimated catches have increased steadily since the late 1970's, reaching around 30,000 t in the late-1980's to between 55,000 and 60,000 t by the mid-1990's, and remaining at the same level in the following ten years. Since 2006 catches have increased, rising to nearly 100,000 t in 2010 and 2011, with current catches at around 89,000 t. The catches of frigate tuna have been higher in the east since the late 1990's, with three quarters of the catches of frigate tuna taken in the eastern Indian Ocean in recent years.

In recent years, over 90% of catches of frigate tuna have been concentrated in four countries: Indonesia (64%), Sri Lanka (11%), India (10%), and I.R. Iran (7%) (Table 3; Fig. 2).

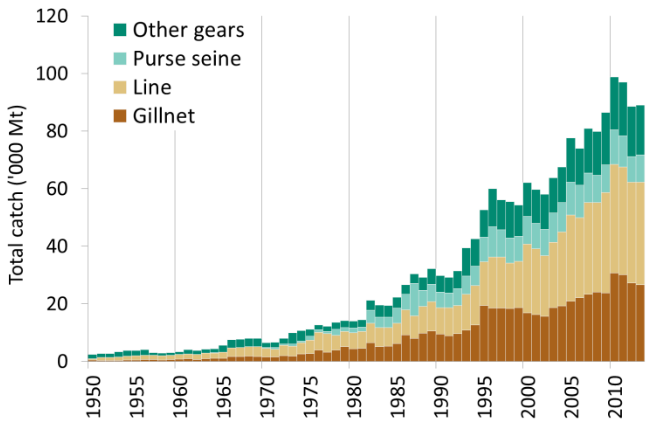


Fig. 1. Frigate tuna: Annual catches of frigate tuna by gear recorded in the IOTC Database (1950–2013) (Data as of October 2014).

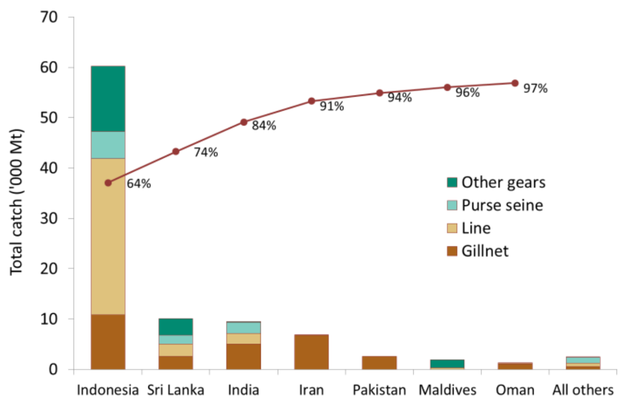


Fig. 2. Frigate tuna: average catches in the Indian Ocean over the period 2010–12, by country. Countries are ordered from left to right, according to the importance of catches of frigate tuna reported. The red line indicates the (cumulative) proportion of catches of frigate for the countries concerned, over the total combined catches of this species reported from all countries and fisheries (Data as of November 2014).

Frigate tuna – uncertainty of catches

Retained catches are highly 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. In the past, the IOTC Secretariat used the catches reported since 2005 to break the aggregates for 1950–2004, by gear and species. However, in a recent review by the IOTC Secretariat conducted by an independent consultant in 2012 he indicated that the catches of frigate tuna had been underestimated by Indonesia. While the new catches estimated for the frigate tuna in Indonesia remain uncertain, representing around 64% of the total catches of this species in the Indian Ocean in recent years (2010–12), the new figures are considered more reliable than those existing in the past.

- Artisanal fisheries of India and Sri Lanka: Although these countries report catches of frigate tuna until recently the catches have not been reported by gear. The catches of both countries were also reviewed by an independent consultant in 2012 and assigned by gear on the basis of official reports and information from various other alternative sources. The new catch series was previously presented to the WPNT in 2013, in which the new catches estimated for Sri Lanka are as much as three times higher than previous estimates. In recent years, the combined catches of frigate tuna for both countries have represented 21% of the total catches of this species in the Indian Ocean.
- Artisanal fisheries of Myanmar and Somalia: None of these countries have ever reported catches of frigate tuna to the IOTC Secretariat. Catch levels are unknown.
- Other artisanal fisheries: The catches of frigate tuna and bullet tuna are seldom reported by species and, when they are reported by species, usually refer to both species (due to misidentification, 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, and 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 2003–07, 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 2003–07, estimated using observer data.
- Changes to the catch series: The overall catch series of frigate tuna has not changed substantially since the WPNT meeting in 2012. The IOTC Secretariat is currently undertaking reviews of the catch series for Indonesia, Malaysia and Thailand which are likely revise the catch estimates for the next WPNT in 2015; however at present the total catches of frigate remain at similar levels when compared to previous estimates.

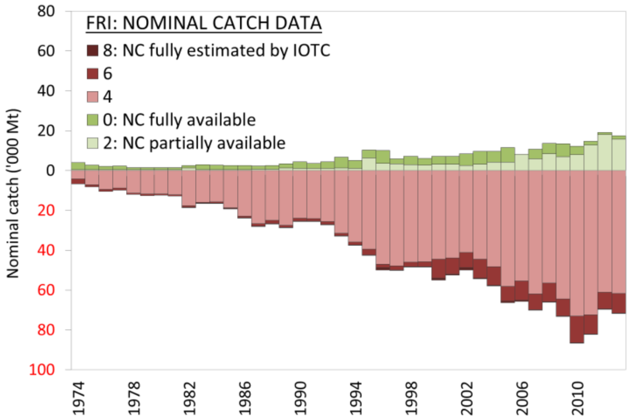


Fig. 3. Frigate tuna: nominal catch; uncertainty of annual catch estimates (1950–2013). Catches are assessed against IOTC reporting standards, where a score of 0 indicates catches that are fully reported according to IOTC standards; catches assigned a score of between 2 – 6 do not report catch data fully by gear and/or species (i.e., partially adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; catches with a score of 8 refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat) (Data as of October 2014).

Frigate tuna – Effort trends

Effort trends are unknown for frigate tuna in the Indian Ocean.

Frigate tuna – Catch–per–unit–effort (CPUE) trends

Catch-and-effort series are available from some fisheries but they are considered highly incomplete (Table 4). 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 hand 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.

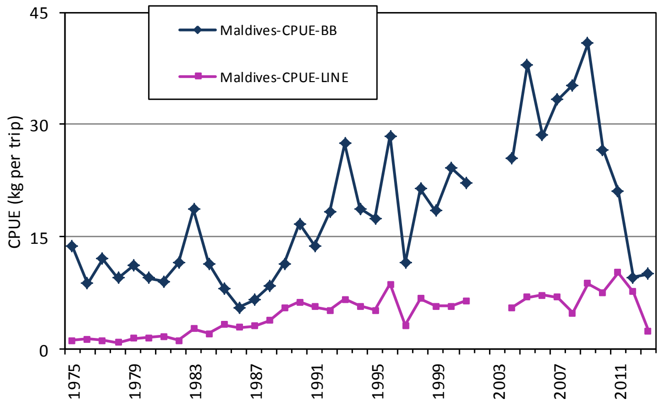
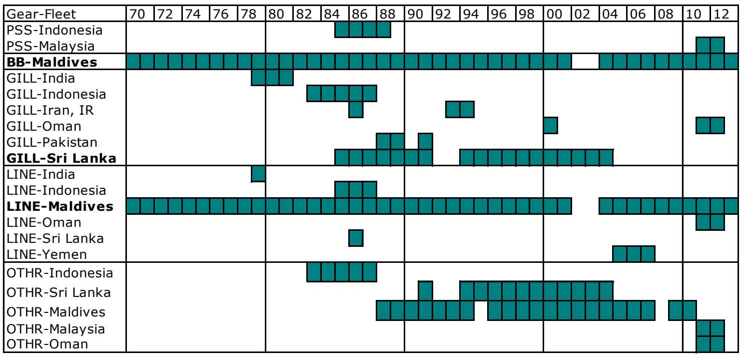


Fig. 4. Frigate tuna: Nominal CPUE series for the baitboat (BB using mechanized boats) and line (LINE, including handlines and trolling using mechanized boats) fisheries of Maldives derived from the available catches and effort data (1975–2013).

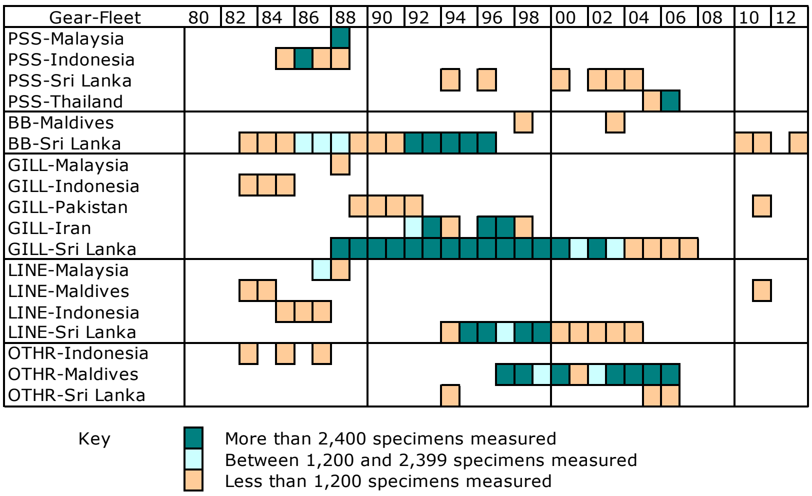
TABLE 4. Frigate tuna: Availability of catches and effort series, by fishery and year (1970–2013). Note that no catches and effort are available at all for 1950–69.



Frigate tuna – 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 and Maldivian pole-and-lines but the amount of specimens measured has been very low in recent years (Table 5). 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, the data collection did not continue in most countries after the end of the IPTP activities.

TABLE 5: Frigate tuna: Availability of length frequency data, by fishery and year (1980–2013). Note that no length frequency data are available at all for 1950–82.



- The size of frigate tunas taken by the Indian Ocean fisheries typically ranges between 20 and 50 cm depending on the type of gear used, season and location (Fig. 5). The fisheries operating in the Andaman Sea (coastal purse seines and troll lines) tend to catch frigate tuna of small to medium size (15–40 cm) while the gillnet, baitboat and other fisheries operating in the Indian Ocean catch usually larger specimens (25–50 cm).

- Catch-at-Size(Age) table: Catch-at-Size data are not available for the frigate tuna due to the paucity of size data available from most fleets (Table 5) and the uncertain status of the catches for this species (Fig. 3). Length distributions derived from the data available for gillnet fisheries are shown in Fig. 5. No data available for all other fisheries.Sex ratio data have not been provided to the Secretariat by CPCs.

Frigate tuna (Gillnet samples): size (in cm)

Frigate tuna (Gillnet): no. of samples (‘000)

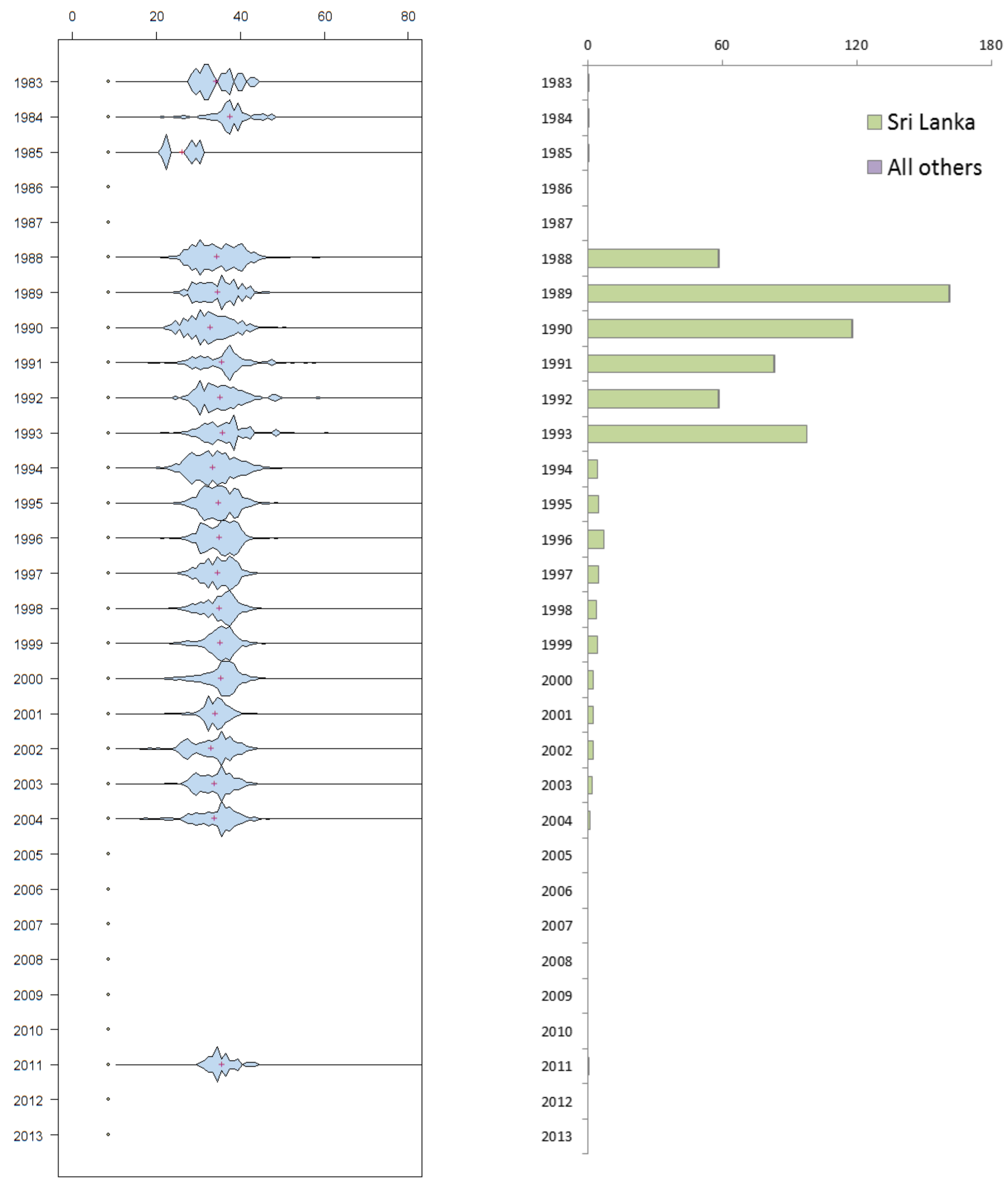


Fig. 5. Frigate tuna: Left - Frigate tuna (gillnet fisheries): Length frequency distributions (total amount of fish measured by 1cm length class) derived from data available at the IOTC Secretariat. Right - number of frigate tuna specimens (gillnet fisheries) sampled for lengths, by fleet and year.

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 6).

TABLE 6. Frigate tuna (*Auxis thazard*) key management quantities.

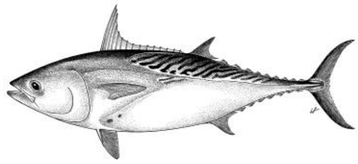
Management Quantity	Aggregate Indian Ocean
2012 catch estimate	88,974 t
Mean catch from 2008–2012	91,974 t
MSY (80% CI) (1,000 t)	unknown
Data period used in assessment	–
F_{MSY} (80% CI)	–
B_{MSY} (80% CI) (1,000 t)	–
F_{2012}/F_{MSY} (80% CI)	–
B_{2012}/B_{MSY} (80% CI)	–
SB_{2012}/SB_{MSY} (80% CI)	–
B_{2012}/B_0 (80% CI)	–
SB_{2012}/SB_0 (80% CI)	–
$B_{2012}/B_{0,\ F=0}$ (80% CI)	–
$SB_{2012}/SB_{0,\ F=0}$ (80% CI)	–

LITERATURE CITED

Froese R & Pauly DE, 2009. FishBase, version 02/2009, FishBase Consortium, www.fishbase.org.

APPENDIX XXIII
EXECUTIVE SUMMARY: KAWAKAWA

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



Status of the Indian Ocean kawakawa (KAW: *Euthynnus affinis*) resource

TABLE 1. Kawakawa: Status of kawakawa (*Euthynnus affinis*) in the Indian Ocean

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Catch[2] 2013: Average catch[2] 2009–2013:	168,954 t 150,387 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2012}/F_{MSY} (80% CI): B_{2012}/B_{MSY} (80% CI): B_{2012}/B_0 (80% CI):	144 (113–167) 0.51 (n.a.) 217 (168–152) 0.97 (0.62–1.61) 1.13 (0.64–1.4) 0.57 (0.32–0.7)	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]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 ($F_{year}/F_{MSY}\leq 1$)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. Analysis using a stock-reduction analysis (SRA) approach for a second year indicates that the stock is near optimal levels of F_{MSY}, and stock biomass is near the level that would produce MSY (B_{MSY}). Due to the quality of the data being used, the simplistic approach employed in 2014, combined with the rapid increase in kawakawa catch in recent years, measures need to be taken to slow the increase in catches in the IOTC area of competence. Based on the weight-of-evidence available to the WPNT, the kawakawa stock for the whole Indian Ocean is classified as **not overfished** and **not subject to overfishing** (Table 1, Fig. 1). A separate analysis done on a sub-population (north-west Indian Ocean region) in 2014 indicated that that stock may be experiencing overfishing, although spawning biomass is likely to be above the level to produce MSY. However, further analysis of the CPUE data should be undertaken in preparation for the next WPNT meeting so that more traditional approaches for assessing stock status are used.

Outlook. There remains considerable uncertainty about stock structure and about the total catches. Due to a lack of fishery data for several gears, only data poor assessment approaches can currently be used. 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. In the interim until more traditional approaches are developed the data-poor approaches will be used to assess stock status. The continued increase of annual catches for kawakawa is likely to have further increased the pressure on the Indian Ocean stock as a whole resource. Research emphasis on improving indicators and exploration of stock structure and stock assessment approaches for data poor fisheries should be undertaken. There is a high risk of exceeding MSY-based reference points by 2015 if catches are maintained at current (2012) levels (50% risk that $SB_{2015}<SB_{MSY}$, and 74% risk that $F_{2015}>F_{MSY}$) or a very high risk is catches are increase further (120% of 2012 levels) (98% risk that $SB_{2015}<SB_{MSY}$, and 100% risk that $F_{2015}>F_{MSY}$) (Table 2).

The following should be noted:

- The Maximum Sustainable Yield estimate for the whole Indian Ocean is estimated to be between 113,000 and 167,000 t.
- Reconstruction of the catch history needs to occur, as do annual catches submitted to the Secretariat.

- Improvement in data collection and reporting is required to assess the stock using more traditional stock assessment techniques.
- Given the rapid increase in kawakawa catch in recent years, some measures need to be taken to decrease the catches in the Indian Ocean (Table 2).
- Limit reference points: The Commission has not adopted limit reference points for any of the neritic tunas under its mandate.

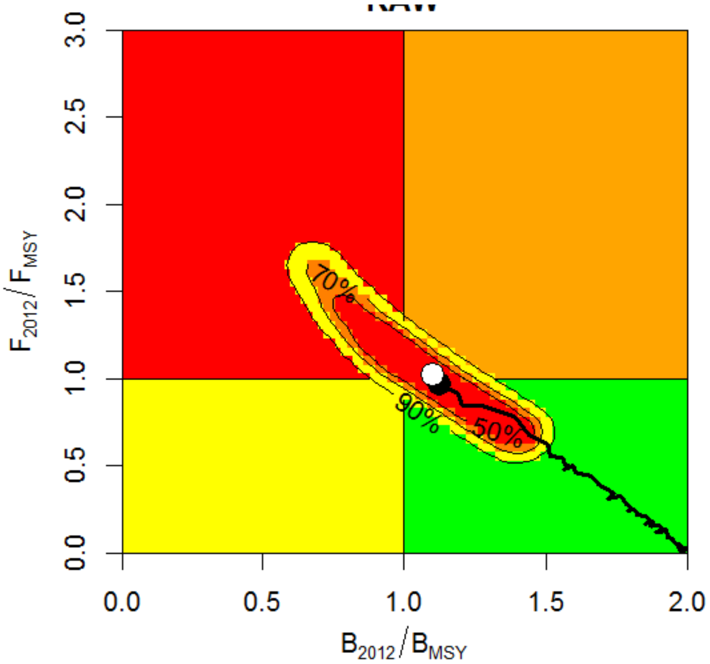


Fig. 1. Kawakawa: PFCRA Aggregated Indian Ocean assessment Kobe plot. The Kobe plot presents the trajectories for the range of plausible model options included in the formulation of the final management advice. The trajectory of the geometric mean of the plausible model options is also presented.

TABLE 2. Kawakawa: 2014 PFCRA Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of plausible models violating the MSY-based reference points for five constant catch projections (2012 catch level, -10%, -20%, -30% and +20%) projected for 3 and 10 years. Note: from the 2014 stock assessment using catch estimates at that time.

Reference point and projection timeframe	**Alternative catch projections (relative to 2012) and weighted probability (%) scenarios that violate reference point**								
	60% (93,610 t)	**70%** (109,212 t)	**80%** (124,813 t)	**90%** (140,415 t)	**100%** (156,017 t)	**110%** (161,619 t)	**120%** (187,220 t)	**130%** (202,822 t)	**140%** (218,424 t)
$B_{2015} < B_{MSY}$	n.a.	0%	4%	24%	50%	n.a.	98%	n.a.	n.a.
$F_{2015} > F_{MSY}$	n.a.	0%	0%	23%	74%	n.a.	100%	n.a.	n.a.
$B_{2022} < B_{MSY}$	n.a.	0%	12%	37%	77%	n.a.	100%	n.a.	n.a.
$F_{2022} > F_{MSY}$	n.a.	0%	6%	36%	80%	n.a.	100%	n.a.	n.a.

APPENDIX I

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:

- Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 14/05 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *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 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Kawakawa: General

Kawakawa (*Euthynnus affinis*) lives in open waters close to the shoreline and prefers waters temperatures ranging from 18° to 29°C. Table 3 outlines some key life history parameters relevant for management.

TABLE 3. Kawakawa: 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. Fish form the dominant prey item (76.7%). *Sardinella longiceps*, *Encrasicholina devisi*, *Decapterus* spp. and *Nemipterus* spp. are the major food items. No information is available on stock structure of kawakawa in Indian Ocean.
Longevity	9 years
Maturity (50%)	**Age**: n.a; females n.a. males n.a. **Size:** females and males ~38–50 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). Spawning is prolonged with peaks during June and October.
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, Abdussamad et al. 2012, Kaymaram & Darvishi 2012

Kawakawa – Fisheries and catch trends

Kawakawa is caught mainly by coastal purse seines, gillnets and, handlines and trolling (Table 4; Fig. 1); and may be also an important bycatch of the industrial purse seiners. The catch estimates for kawakawa were derived from very small amounts of information and are therefore highly uncertain[10].

[10] The uncertainty in the catch estimates has been assessed by the IOTC Secretariat and is based on the amount of processing required to account for the presence of conflicting catch reports, the level of aggregation of the catches by species and or gear, and the occurrence of non-reporting fisheries for which catches had to be estimated.

TABLE 4. Kawakawa: Best scientific estimates of the catches of kawakawa by type of fishery for the period 1950–2012 (in metric tonnes) (Data as of October 2014).

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Purse seine	100	385	2,228	11,365	21,393	28,613	27,811	32,393	34,785	32,586	32,441	37,051	34,788	40,298	42,323	45,115
Gillnet	2,179	4,098	9,187	16,666	29,742	50,538	45,728	47,845	53,050	56,393	65,293	63,698	57,864	69,646	74,501	80,098
Line	2,102	3,642	7,146	11,216	16,739	22,946	22,780	23,816	22,847	25,017	28,127	29,931	29,795	30,970	32,160	33,828
Other	295	719	1,357	2,690	5,129	7,829	7,511	8,447	8,066	9,629	9,015	10,129	9,938	9,948	9,941	9,913
Total	**4,676**	**8,844**	**19,919**	**41,937**	**73,003**	**109,926**	**103,830**	**112,501**	**118,748**	**123,625**	**134,876**	**140,808**	**132,385**	**150,862**	**158,925**	**168,954**

The catches provided in Table 5 are based on the information available at the IOTC Secretariat and the following observations on the catches cannot currently be verified. Annual estimates of catches for the kawakawa increased markedly from around 20,000 t in the mid-1970's to reach the 45,000 t mark in the mid-1980's and 169,000 t in 2013, the highest catches ever recorded for this species. In recent years the catches of kawakawa have been recorded at similar levels in in the two Indian Ocean basins.

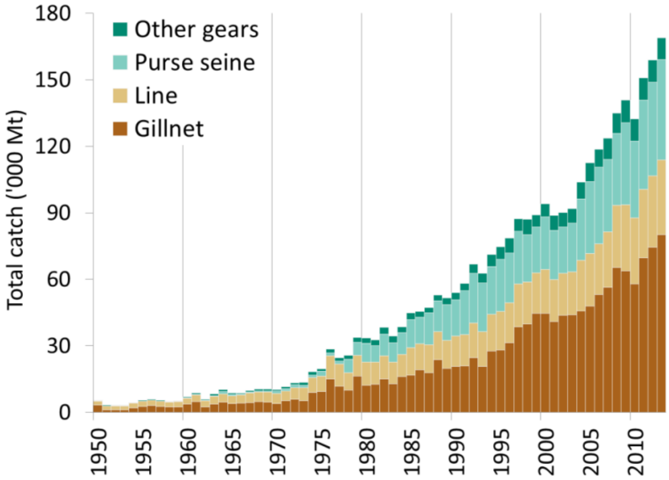


Fig. 1. Kawakawa: Annual catches of kawakawa by gear recorded in the IOTC database (1950–2013) (Data as of October 2014).

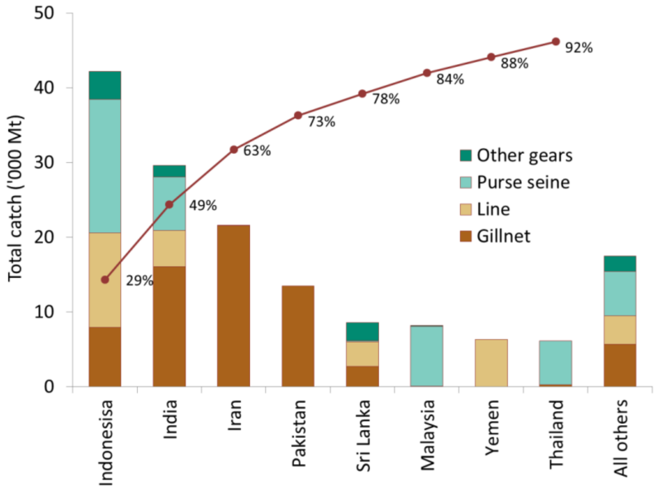


Fig. 2. Kawakawa: Average catches in the Indian Ocean over the period 2010–12, by country. Countries are ordered from left to right, according to the importance of catches of kawakawa reported. The red line indicates the (cumulative) proportion of catches of kawakawa for the countries concerned, over the total combined catches of this species reported from all countries and fisheries (Data as of October 2014).

In recent years nearly three quarters of the total catches of kawakawa are attributed to four countries (Indonesia (29%), India (20%), Iran (15%), and Pakistan (9%) (Fig. 2).

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. In the past, the IOTC Secretariat used the catches reported since 2005 to break the aggregates for 1950–2004, by gear and species. However, a review by the IOTC Secretariat conducted by an independent consultant in 2012 indicated that the catches of kawakawa had been overestimated by Indonesia. While the new catches estimated for kawakawa in Indonesia remain uncertain, representing around 29% of the total catches of this species in the Indian Ocean in 2010–12 (compared to around 38% in previous years, prior to the review of Indonesia's catch series), the new figures are considered more reliable than those previously recorded in the IOTC database.
- Artisanal fisheries of India: Although India reports catches of kawakawa they are not always reported by gear. The catches of kawakawa in India were also reviewed by the IOTC Secretariat in 2012 and assigned by gear on the basis of official reports and information from various other alternative sources. The catches of kawakawa in India have represented 20% of the total catches of this species in the Indian Ocean in 2010–12 (compared to around 17% in previous years, prior to the review of India's catch series).
- Artisanal fisheries of 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 (e.g., coastal purse seiners of Thailand, and until recently Malaysia).
- 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 2003–07, 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 2003–07, estimated using observer data.
- Changes to the catch series: The overall catch series of kawakawa has not changed substantially since the WPNT meeting in 2012. The IOTC Secretariat is currently undertaking reviews of the catch series for Indonesia, Malaysia and Thailand which are likely revise the catch estimates for the next WPNT in 2015; however at present the total catches of kawakawa remain at similar levels when compared to previous estimates.

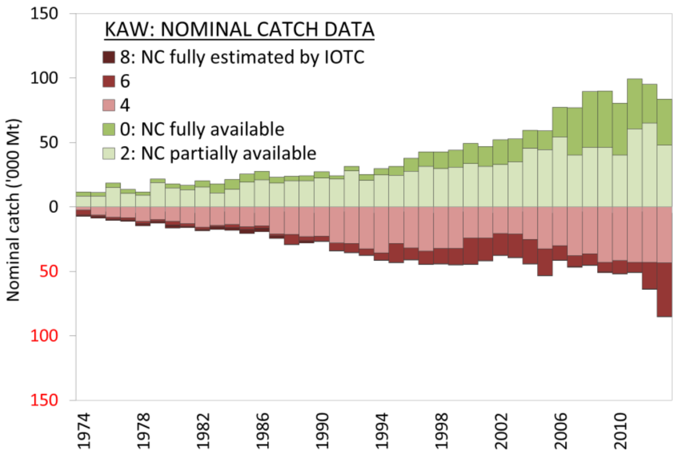


Fig. 3. Kawakawa: nominal catch; uncertainty of annual catch estimates (1950–2013). Catches are assessed against IOTC reporting standards, where a score of 0 indicates catches that are fully reported according to IOTC standards; catches assigned a score of between 2 – 6 do not report catch data fully by gear and/or species (i.e., partially adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; catches with a score of 8 refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat) (Data as of October 2014).

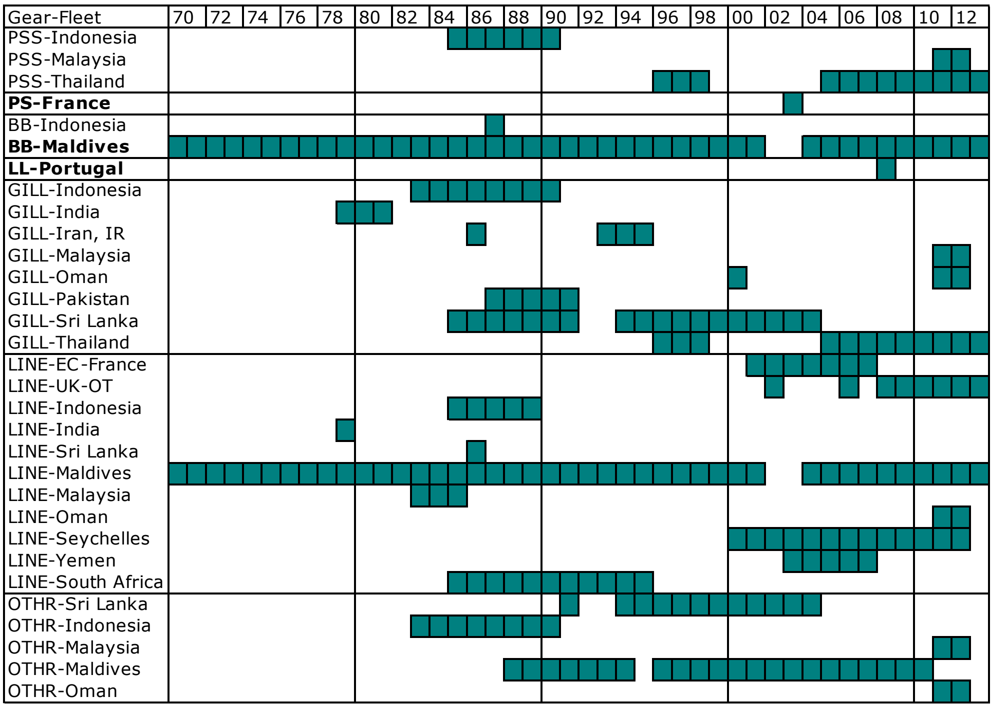
Kawakawa – Effort trends

Effort trends are unknown for kawakawa in the Indian Ocean.

Kawakawa – Catch–per–unit–effort (CPUE) trends

Catch-and-effort series are available from some fisheries but they are considered highly incomplete (Table 5). 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.

TABLE 5. Kawakawa: Availability of catches and effort series, by fishery and year (1970–2013). Note that no catches and effort are available at all for 1950–69.



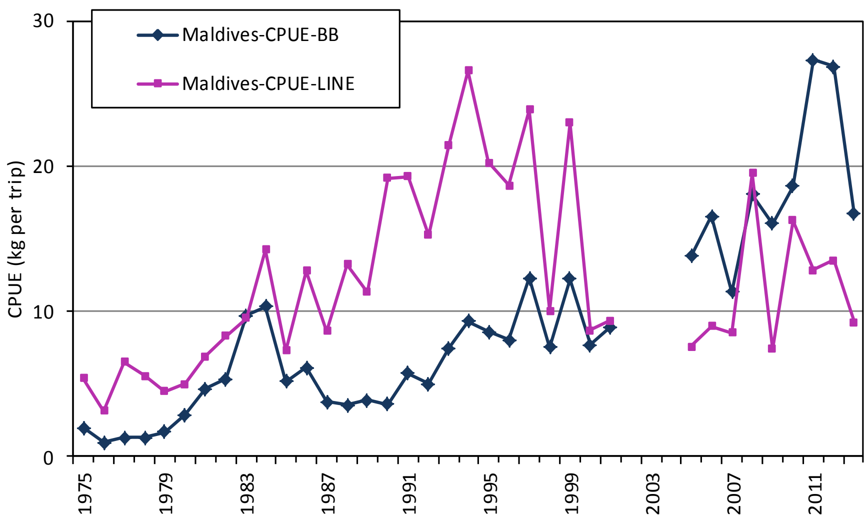


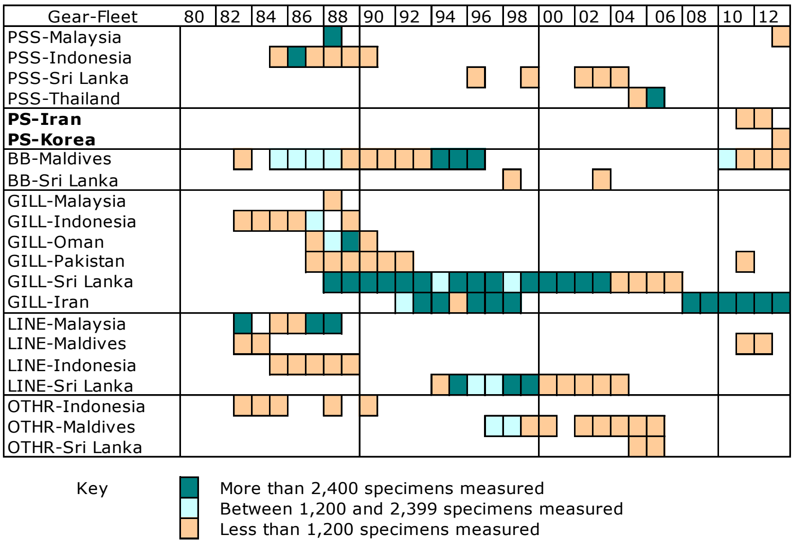
Fig. 4. Kawakawa: Nominal CPUE series for the baitboat (BB) and troll line (TROL) fisheries of Maldives (1975–2013) derived from the available catches and effort data.

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

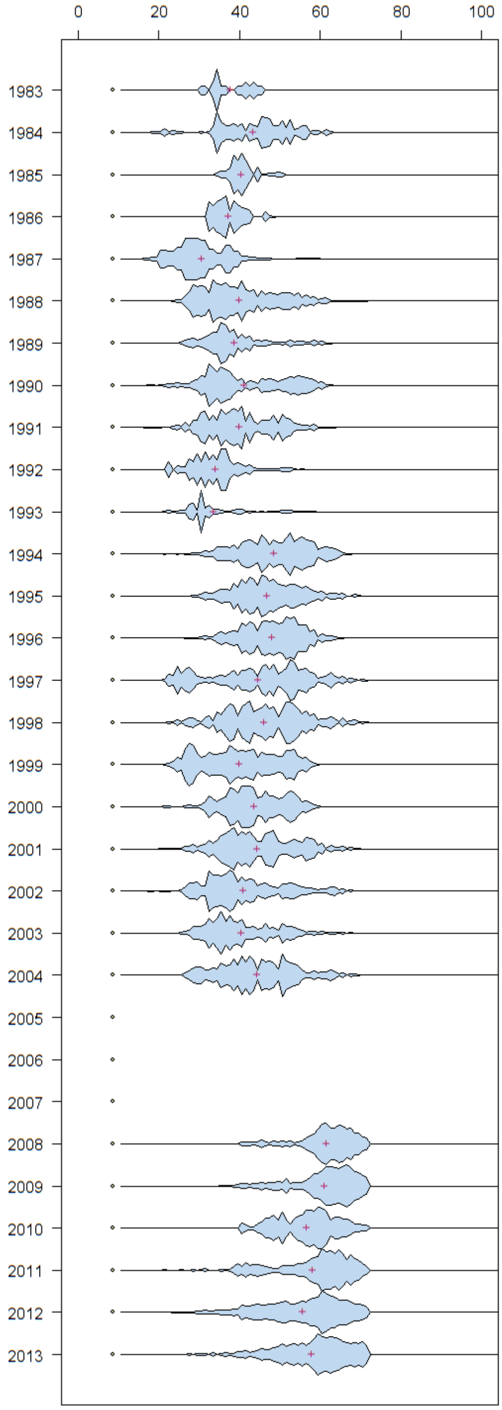
- The size of kawakawa taken by the Indian Ocean fisheries typically ranges between 20 and 60 cm depending on the type of gear used, season and location. The coastal purse seine fisheries operating in the Andaman Sea tend to catch kawakawa of small size (15–30 cm) while the gillnet, baitboat and other fisheries operating in the Indian Ocean catch usually larger specimens (25–55 cm).

- Trends in average weight can be assessed for Sri Lankan gillnets but the amount of specimens measured has been very low since the mid-1990s (Table 6; Fig. 5). 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, the data collection did not continue after the end of the IPTP activities. Since 1998 there has been some sampling of lengths from Iranian gillnets (collected from vessels operating in the Arabian Sea), although average lengths and distribution of lengths of samples are significantly larger than specimens reported by other fleets.
- Catch-at-Size(Age) data are not available for the kawakawa due to the paucity of size data available from most fleets (Table 3) and the uncertain status of the catches for this species (Fig. 3). Length distributions derived from the data available for gillnet fisheries are shown in Fig. 5. No data available for all other fisheries.
- Sex ratio data have not been provided to the IOTC Secretariat by CPCs.

TABLE 6. Kawakawa: Availability of length frequency data, by fishery and year (1980–2013). Note that no length frequency data are available at all for 1950–82.



Kawakawa (Gillnet samples): size (in cm)



Kawakawa (Gillnet): no. of samples ('000)

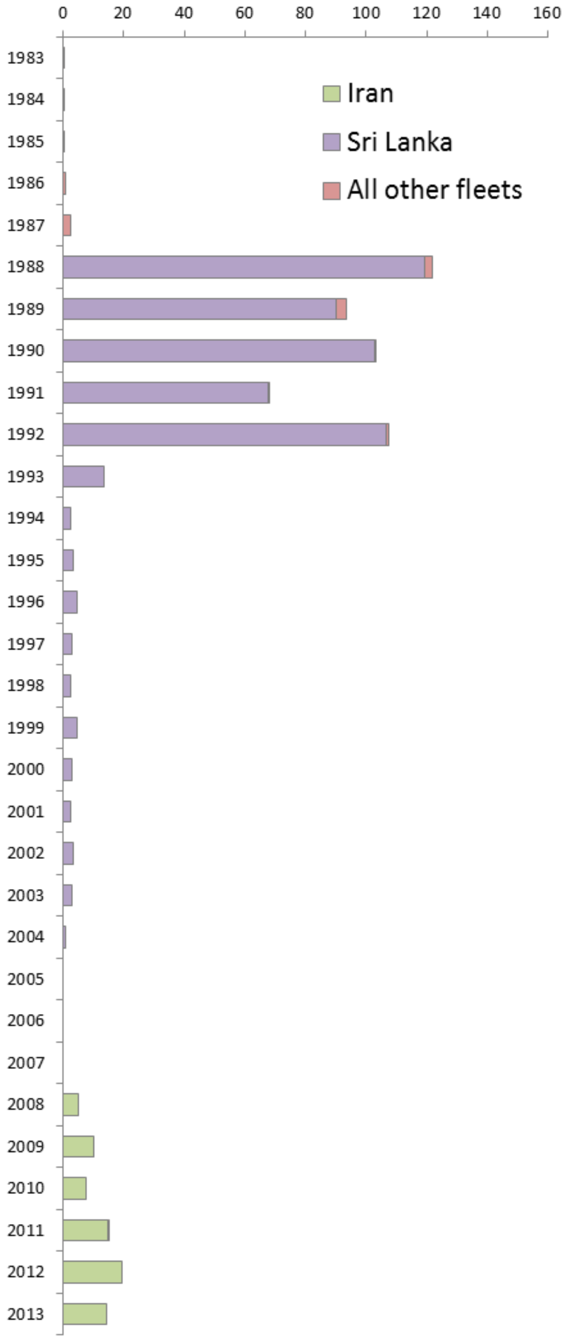


Fig. 5. Kawakawa: Left - Length frequency distributions for gillnet fisheries (total amount of fish measured by 1cm length class) derived from data available at the IOTC Secretariat. Right - number of kawakawa specimens sampled for lengths, by fleet (gillnet only).

STOCK ASSESSMENT

Two modelling methods, posterior-focused catch-based assessment method and catch-based stock reduction analysis (SRA) were applied to kawakawa in 2014. Surplus Production Model (SPM) was also applied to kawakawa CPUE data. However, this classical method had problems in convergence due to non-informative CPUE data so the results from the SPM Model were not included in the final report as it performed poorly and yielded unrealistic results.

The trajectories for both approaches were very similar and gave similar outcomes, and for reporting and stock status advice would use the PFCRA approach as it was statistically robust. Noting that the Commission adopted Resolution 12/01 *On the implementation of the precautionary approach*, which effectively means that in a situation of increased uncertainty (e.g. data poor situations), a more precautionary approach should be undertaken when developing advice and possible management actions, this approach, combined with the weight-of-evidence available (stock status indicators from data poor assessment approaches, species biology, fishery indicators), should be used to determine stock status for kawakawa (Table 7).

The stock status management advice for kawakawa should be based on the catch-based stock reduction method, combined with the known species and fishery attributes for status interpretation purposes (PFCRA). The approach presented is useful to assess stock status in the near term, while more traditional stock assessment approaches in the region are deferred until more data are collected and submitted in accordance with the IOTC data recording and reporting requirements for neritic tunas.

TABLE 7. Kawakawa (*Euthynnus affinis*) key management quantities from the PFCRA stock assessment.

Management Quantity	Aggregate Indian Ocean
2013 catch estimate	168,954 t
Mean catch from 2009–2013	150,387 t
MSY (80% CI) (1,000 t)	144 (113–167)
Data period used in assessment	1950–2012
F_{MSY} (80% CI)	0.51 (n.a.)
B_{MSY} (80% CI) (1,000 t)	217 (168–152)
F_{2012}/F_{MSY} (80% CI)	0.97 (0.62–1.61)
B_{2012}/B_{MSY} (80% CI)	1.13 (0.64–1.4)
SB_{2012}/SB_{MSY} (80% CI)	–
B_{2012}/B_0 (80% CI)	0.57 (0.32–0.7)
SB_{2012}/SB_0 (80% CI)	–
$B_{2012}/B_{0,\ F=0}$ (80% CI)	–
$SB_{2012}/SB_{0,\ F=0}$ (80% CI)	–

LITERATURE CITED

Abdussamad EM, Rohit P, Said Koya KP, Sivadas M (2012) Status and potential of neritic tunas exploited from Indian waters. IOTC–2012–WPNT02–10 Rev_1

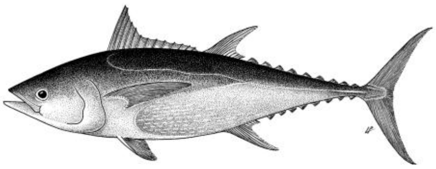
Kaymaram F, Darvishi M (2012) Growth and mortality parameters of *Euthynnus affinis* in the northern part of the Persian Gulf and Oman Sea. IOTC–2012–WPNT02–14 Rev_1

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 XXIV
EXECUTIVE SUMMARY: LONGTAIL TUNA

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



Status of the Indian Ocean longtail tuna (LOT: *Thunnus tonggol*) resource

TABLE 1. Longtail tuna: Status of longtail tuna (*Thunnus tonggol*) in the Indian Ocean

Area[1]	**Indicators**		**2014 stock status determination**
Indian Ocean	Catch[2] 2012: Average catch[2] 2008–2012:	160,532 t 139,971 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2012}/F_{MSY} (80% CI): B_{2012}/B_{MSY} (80% CI): B_{2012}/B_0 (80% CI):	120 (79–171) 0.39 (0.27–0.51) 255 (173–377) 1.23 (0.47–2.11) 1.05 (0.59–1.49) 0.53(0.30–0.75)	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]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)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. Stock Reduction Analysis techniques indicate that the stock is being exploited at a rate that exceed F_{MSY} in recent years (Fig. 1). Whether a four quadrant stock structure of catches in the Indian Ocean or a one stock assumption is used in the analysis, the conclusions remain the same. Another analysis conducted on the NWIO with a Surplus Production Model (ASPIC) also indicates that the stock is subject to overfishing. More traditional methods of stock assessment need to be conducted by developing indices of abundance using catch and effort series from I.R. Iran and Indonesia. Based on the weight-of-evidence available, including that estimated values of current biomass are near the estimated abundance to produce B_{MSY} in 2012, and that fishing mortality has exceeded F_{MSY} values in recent years, the stock is considered to be **not overfished**, but **subject to overfishing** (Table 1; Fig. 1).

Outlook. There remains considerable uncertainty about stock structure and about the total catches in the Indian Ocean. 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. 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. There is a continued high to very high risk of exceeding MSY-based reference points by 2015, even if catches are reduced to 90% of the current (2012) levels (67% risk that $SB_{2015}<SB_{MSY}$, and 93% risk that $F_{2015}>F_{MSY}$) (Table 2).

The following should be noted:

- The Maximum Sustainable Yield estimate of 120,000 t is likely being exceeded in recent years.
- Reconstruction of the catch history needs to occur, as do annual catches submitted to the IOTC Secretariat.
- Improvement in data collection and reporting is required to assess the stock using more traditional stock assessment techniques.
- Given the rapid increase in longtail tuna catch in recent years, some measures need to be taken to slow or reduce catches in the Indian Ocean (Table 2).

- Improvement in data collection and reporting is required to assess the stock status, primarily abundance index series from I.R. Iran, Oman and Indonesia.
- Limit reference points: The Commission has not adopted limit reference points for any of the neritic tunas under its mandate.

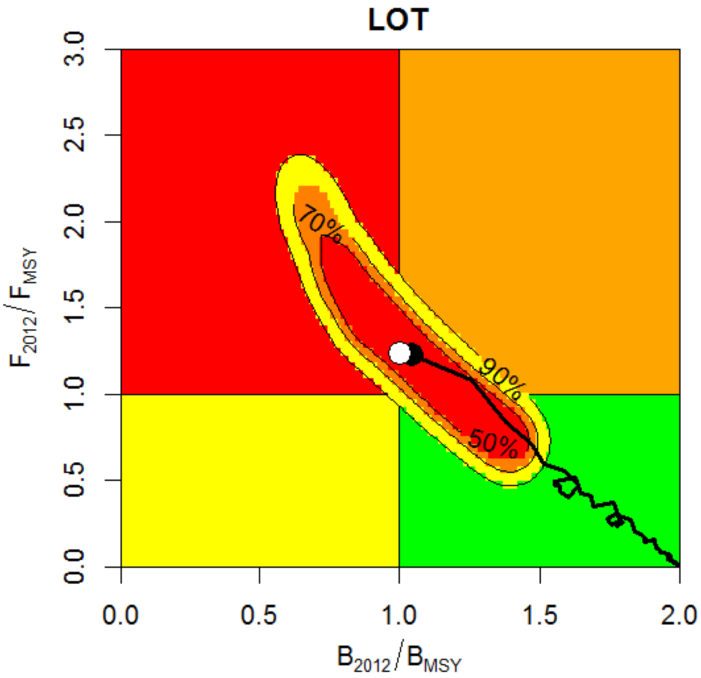


Fig. 1. Longtail tuna: PFCRA Aggregated Indian Ocean assessment Kobe plot. The Kobe plot presents the trajectories for the range of plausible model options included in the formulation of the final management advice. The trajectory of the geometric mean of the plausible model options is also presented.

TABLE 2. Longtail tuna: 2014 PFCRA Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of plausible models violating the MSY-based reference points for five constant catch projections (2012 catch level, ±10%, ±20%, ±30% and ±40%) projected for 3 and 10 years. Note: from the 2014 stock assessment using catch estimates at that time.

Reference point and projection timeframe	**Alternative catch projections (relative to 2012) and weighted probability (%) scenarios that violate reference point**								
	60% (96,319 t)	**70%** (112,372 t)	**80%** (128,425 t)	**90%** (144,479 t)	**100%** (160,532 t)	**110%** (176,585 t)	**120%** (187,220 t)	**130%** (208,692 t)	**140%** (224,745 t)
$B_{2015} < B_{MSY}$	n.a.	17%	37%	67%	87%	n.a.	96%	n.a.	n.a.
$F_{2015} > F_{MSY}$	n.a.	5%	53%	93%	100%	n.a.	100%	n.a.	n.a.
$B_{2022} < B_{MSY}$	n.a.	24%	56%	80%	95%	n.a.	100%	n.a.	n.a.
$F_{2022} > F_{MSY}$	n.a.	20%	60%	86%	100%	n.a.	100%	n.a.	n.a.

APPENDIX I

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:

- Resolution 13/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence
- Resolution 14/05 concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information
- Resolution 12/11 *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 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Longtail tuna: 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 3 outlines some key life history parameters relevant for management.

TABLE 3. Longtail tuna: 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: Chang et al. 2001, Froese & Pauly 2009, Griffiths et al. 2010a, b, Kaymaran et al. 2011

Longtail tuna – Fisheries and catch trends

Longtail tuna is caught mainly by using gillnets and, to a lesser extent, seine nets, and trolling (Table 4; Fig. 2). The catch estimates for longtail tuna were derived from small amounts of information and are therefore uncertain[11]. The catches provided in Table 4 are based on the information available at the IOTC Secretariat and the following observations on the catches cannot currently be verified. Estimated catches of longtail tuna increased steadily from the mid 1950's, reaching around 15,000 t in the mid-1970's, to over 35,000 t by the mid-1980's, and over 96,000 t in 2000. Catches dropped after 2000 to around 72,000 t by 2005 but have increased since then, with the highest catches ever recorded in 2011 at 166,000 t.

In recent years (2010–12), the countries attributed with the highest catches of longtail tuna are Iran (47%), Indonesia (15%), Pakistan (9%), Malaysia (9%) and, to a lesser extent, Oman, Yemen, India and Thailand (19%) (Fig. 3). I.R. Iran, in particular, has reported large increases in the catch of longtail tuna since 2009 where the increase in catches of

[11] The uncertainty in the catch estimates has been assessed by the Secretariat and is based on the amount of processing required to account for the presence of conflicting catch reports, the level of aggregation of the catches by species and or gear, and the occurrence of non-reporting fisheries for which catches had to be estimated.

longtail tuna have coincided with a decrease in catches of skipjack tuna as a consequence of increased gillnet effort in coastal waters and the Arabian Sea due to the threat of Somali piracy in the western tropical Indian Ocean.

TABLE 4. Longtail tuna: Best scientific estimates of the catches of longtail tuna by type of fishery for the period 1950–2012 (in metric tonnes) (Data as of May 2014).

Fishery	By decade (average)						By year (last ten years)									
	1950s	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Purse seine	44	204	1,306	5,381	10,937	17,718	19,551	13,313	12,390	16,131	23,835	18,877	20,649	16,538	20,595	21,767
Gillnet	2,593	5,849	8,983	24,872	39,423	58,205	54,974	46,212	43,455	51,570	59,905	67,508	83,300	101,251	118,288	110,825
Line	909	1,160	2,547	5,187	7,220	14,095	11,511	14,095	14,219	16,519	17,666	15,339	15,681	16,628	18,486	20,160
Other	0	0	125	1,091	1,993	3,577	2,527	2,912	2,661	3,370	5,103	5,928	5,221	6,507	8,527	7,779
Total	**3,546**	**7,213**	**12,961**	**36,530**	**59,573**	**93,595**	**88,562**	**76,532**	**72,725**	**87,590**	**106,509**	**107,653**	**124,851**	**140,923**	**165,896**	**160,532**

The size of longtail tunas taken by the Indian Ocean fisheries typically ranges between 20 and 100 cm depending on the type of gear used, season and location. The fisheries operating in the Andaman Sea (coastal purse seines and trolling) tend to catch longtail tuna of small size (20–45cm) while the gillnet fisheries of Iran and Pakistan (Arabian Sea) catch larger specimens (50–100cm).

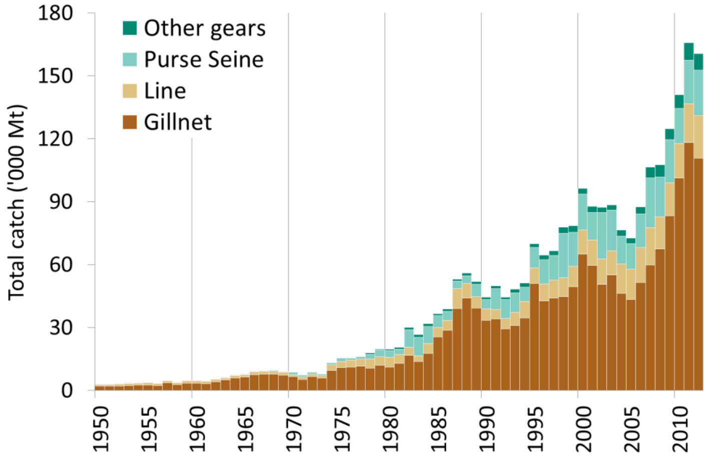


Fig. 2. Longtail tuna: Annual catches of longtail tuna by gear recorded in the IOTC Database (1950–2012).

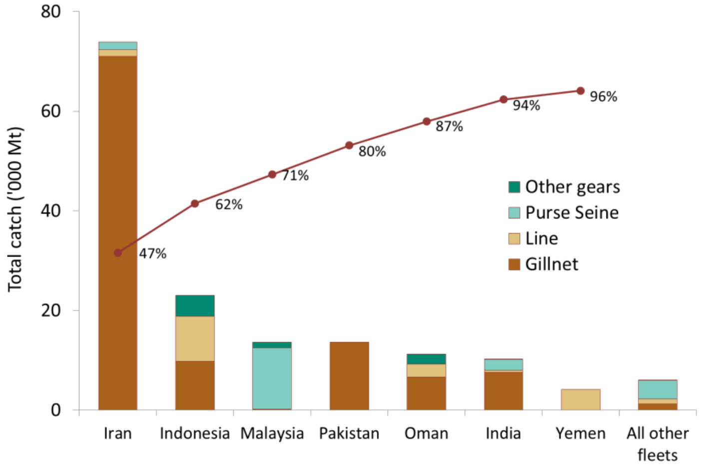


Fig. 3. Longtail tuna: Average catches in the Indian Ocean over the period 2010–12, by country. Countries are ordered from left to right, according to the importance of catches of longtail reported. The red line indicates the (cumulative) proportion of catches of longtail tuna for the countries concerned, over the total combined catches of this species reported from all countries and fisheries.

Longtail tuna: uncertainty of catches

Retained catches are uncertain (Fig. 4), 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. In the past, the IOTC Secretariat used the catches reported since 2005 to break the aggregates for 1950–2004, by gear and species. However, a recent review by the IOTC Secretariat conducted by an independent consultant in 2012 indicated that catches of longtail tuna had been severely overestimated by Indonesia. While the new catches estimated for the longtail tuna in Indonesia remain uncertain, representing around 15% (30% in the past) of the total catches of this species in the Indian Ocean in recent years (2009–11), the new figures are considered more reliable than those existing in the past.

- 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 assign the catches reported by Oman by gear. The catches of India were also reviewed by the independent consultant in 2012 and assigned by gear on the basis of official reports and information from various alternative sources. The catches of longtail tuna from Oman and India represent around 14% of the total catches of this species in recent years (2010–12).
- Artisanal fisheries of Myanmar and Somalia: None of these countries have ever reported catches of longtail tuna to the IOTC Secretariat. While catch levels are unknown they are unlikely to be substantial.
- Other artisanal fisheries: The IOTC Secretariat had to estimate catches of longtail tuna for the artisanal fisheries of Yemen (no data reported to the IOTC Secretariat) and until recently Malaysia (with catches of the main neritic tunas aggregated and reported as longtail).
- Discard levels are believed to be very low although they are unknown for most fisheries.
- Changes to the catch series: Although there have not been significant changes to the total catches of longtail tuna since the WPNT meeting in 2012, the IOTC Secretariat has conducted revisions to the catch series for some fleets, primarily Malaysia following an IOTC-OFCF data mining mission in January 2014. Indonesia is also subject to an on-going review of the catch-series by the IOTC Secretariat, and further improvements to the catch series for longtail in particular are expected for WPNT in 2015.

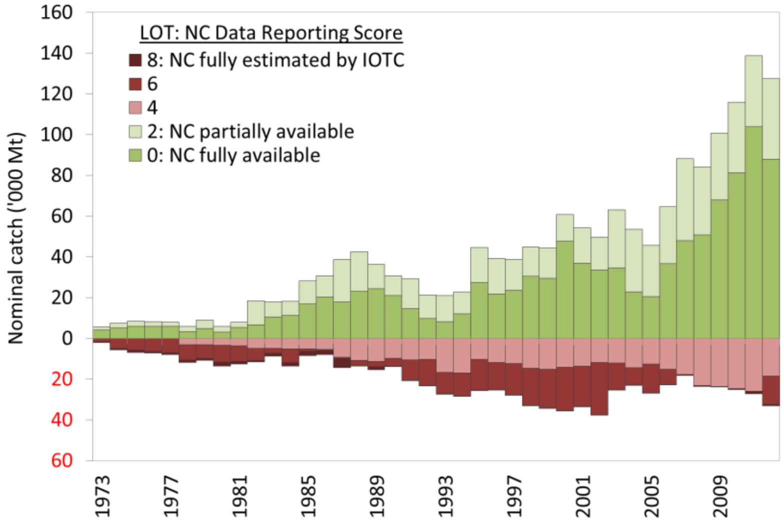


Fig. 4. Longtail tuna: Nominal catch; uncertainty of annual catch estimates (1950–2012). Catches are assessed against IOTC reporting standards, where a score of 0 indicates catches that are fully reported according to IOTC standards; catches assigned a score of between 2 – 6 do not report catch data fully by gear and/or species (i.e. partially adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; catches with a score of 8 refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat) (Data as of May 2014).

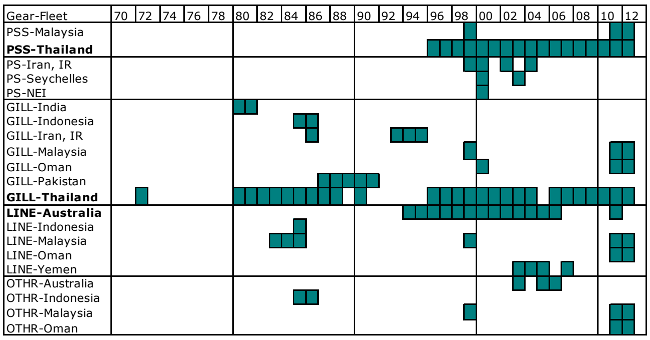
Longtail tuna – Effort trends

Effort trends are unknown for longtail tuna in the Indian Ocean.

Longtail tuna – Catch–per–unit–effort (CPUE) trends

Catch-and-effort series are available from some fisheries but they are considered highly incomplete (Table 5). In most cases catch-and-effort data are only available for short periods of time. Reasonably long catches and effort series (extending for more than 10 years) are only available for Thailand small purse seine vessels and gillnet vessels (Fig. 5).

TABLE 5. Longtail tuna: Availability of catches and effort series, by fishery and year (1970–2012)[12]. Note that no catches and effort are available at all for 1950–1971.



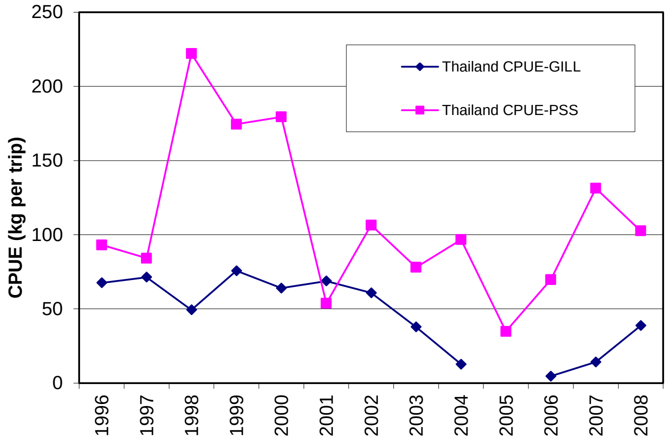


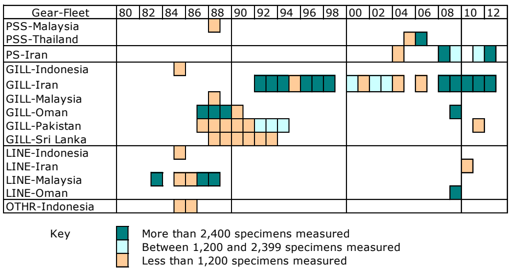
Fig. 5. Longtail tuna: Nominal CPUE series for gillnet (GILL) and coastal purse seine (PSS) fisheries of Thailand derived from the available catches and effort data (1996–2012).

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

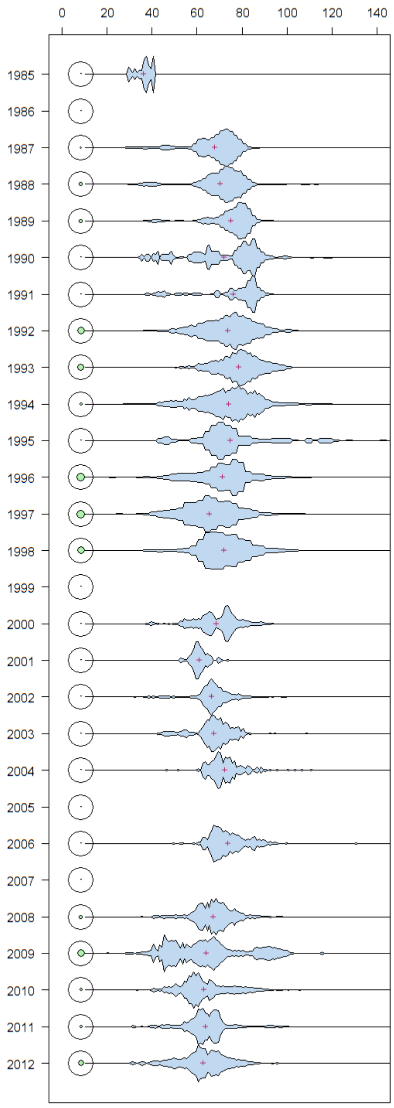
- The size of longtail tunas taken by the Indian Ocean fisheries typically ranges between 20 and 100 cm depending on the type of gear used, season and location (Fig. 6). The fisheries operating in the Andaman Sea (coastal purse seines and trolling) tend to catch longtail tuna of small size (20–45 cm) while the gillnet fisheries of Iran and Pakistan (Arabian Sea) catch larger specimens (50–100 cm).
- Catch-at-Size(Age) tables Catches-at-Size are not available for the longtail tuna due to the paucity of size data available from most fleets (Table 6) and the uncertain status of the catches for this species (Fig. 4). Length distributions derived from the data available for gillnet fisheries are shown in Fig. 6. No data available for all other fisheries.
- Sex ratio data have not been provided to the Secretariat by CPCs.
- Trends in average weight can only be assessed for Iranian gillnets but the amount of specimens measured has been very low for a number of years (i.e., below the minimum sampling standard of one fish per tonne of catch recommended by the IOTC Secretariat) (Table 6). 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, the data collection did not continue after the end of the IPTP activities.

[12] Note that the above list is not exhaustive, showing only the fisheries for which catches and effort are available in the IOTC database. Furthermore, catch-and-effort data are sometimes incomplete for a given year, existing only for short periods.

TABLE 6. Longtail tuna: Availability of length frequency data, by fishery and year (1980–2012)[13]. Note that no length frequency data are available at all for 1950–1982.



Longtail tuna (All samples): size (in cm)



Longtail tuna (Gillnet samples): size (in cm)

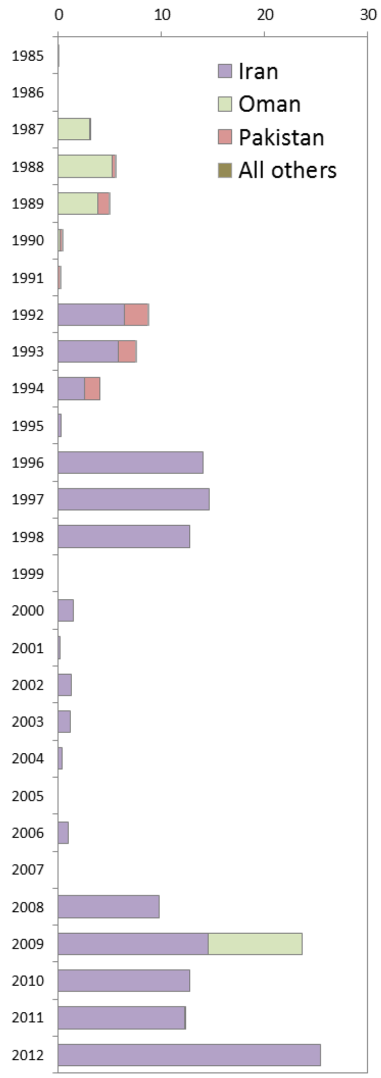


Fig. 6. Longtail tuna: Left - length frequency distributions for gillnet fisheries (total amount of fish measured by 1cm length class) derived from data available at the IOTC Secretariat. The black outline circles (to the left of each distribution) indicate the minimum sampling standard set by IOTC of one fish per metric tonne; the green proportional circles indicate the relative sampling coverage in each year (i.e., circles with areas greater than the minimum sampling standard indicate relatively high sampling coverage in a given year). Right - Number of longtail specimens sampled for lengths, by fleet (gillnet only).

[13] Note that the above list is not exhaustive, showing only the fisheries for which size data are available in the IOTC database. Furthermore, when available size data may not be available throughout the year existing only for short periods

STOCK ASSESSMENT

Three assessment approaches were applied to Longtail tuna in 2014, a traditional Stock Reduction Analysis technique, an alternative SRA technique (Posterior Focused Catch Reduction (PFCRA)) and a Surplus Production Model (ASPIC). The trajectories for all approaches were very similar and gave similar outcomes. For reporting and stock status advice the PFCRA approach was used as it was considered more statistically robust. Noting that the Commission adopted Resolution 12/01 *On the implementation of the precautionary approach*, which effectively means that in a situation of increased uncertainty (e.g. data poor situations), a more precautionary approach should be undertaken when developing advice and possible management actions, this approach, combined with the weight-of-evidence available (stock status indicators from data poor assessment approaches, species biology, fishery indicators), was used to determine stock status for longtail tuna (Table 7).

Stock status management advice for longtail tuna is based on the catch-based stock reduction method, combined with the known species and fishery attributes for status interpretation purposes. The approach presented is useful to assess stock status in the near term, while more traditional stock assessment approaches in the region are deferred until more data is collected and submitted in accordance with the IOTC data recording and reporting requirements for neritic tunas. More traditional methods of stock assessment need to be conducted by developing indices of abundance using catch and effort series from I.R. Iran and Indonesia.

TABLE 7. Longtail tuna (*Thunnus tonggol*) key management quantities from the PFCRA stock assessment.

Management Quantity	Aggregate Indian Ocean
2012 catch estimate	160,532 t
Mean catch from 2008–2012	139,971 t
MSY (1,000 t) (80% CI)	120 (79–171)
Data period used in assessment	1950–2012
F_{MSY} (80% CI)	0.39 (0.27–0.51)
B_{MSY} (80% CI) (1,000 t)	255 (173–377)
F_{2012}/F_{MSY} (80% CI)	1.23 (0.47–2.11)
B_{2012}/B_{MSY} (80% CI)	1.05 (0.59–1.49)
SB_{2012}/SB_{MSY} (80% CI)	–
B_{2012}/B_0 (80% CI)	0.53(0.30–0.75)
SB_{2012}/SB_0 (80% CI)	–
$B_{2012}/B_{0,\ F=0}$ (80% CI)	–
$SB_{2012}/SB_{0,\ F=0}$ (80% CI)	–

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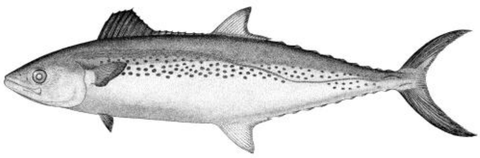
Kaymaram F, Darvishi M., Parafkandeh F, Ghasemi S,Talebzadeh SA (2011) Population dynamic parameters of *Thunnus tonggol* in the north of the Persian Gulf and Oman Sea. IOTC–2011–WPNT01–18.

APPENDIX XXV
EXECUTIVE SUMMARY: INDO-PACIFIC KING MACKEREL

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



Status of the Indian Ocean Indo-Pacific king mackerel (GUT: *Scomberomorus guttatus*) resource

TABLE 1. Indo-Pacific king mackerel: Status of Indo-Pacific king mackerel (*Scomberomorus guttatus*) in the Indian Ocean.

Area[1]	**Indicators**		**2014 stock status determination**
Indian Ocean	Catch[2] 2013: Average catch[2] 2009–2013:	44,363 t 45,447 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2012}/F_{MSY} (80% CI): B_{2012}/B_{MSY} (80% CI): B_{2012}/B_0 (80% CI):	unknown unknown unknown unknown unknown unknown	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]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)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

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. Aspects of the fisheries for Indo-Pacific king mackerel combined with the lack of data on which to base a more formal assessment are a cause for considerable concern. Stock status in relation to the Commission's B_{MSY} and F_{MSY} target reference points remains **uncertain** (Table 1), indicating that a precautionary approach to the management of Indo-Pacific king mackerel should be applied.

Outlook. Total annual catches for Indo-Pacific king mackerel have stabilised over the past five years at around 47,000 t. There is insufficient information to evaluate the effect that this level of catch, or an increase in catch may have on the resource. Research emphasis on improving indicators and exploration of stock structure and stock assessment approaches for data poor fisheries should be considered a high priority for this species. The following should be noted:

- The Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- Data collection and reporting urgently need to be improved.
- Reconstruction of the catch history needs to occur before a reliable assessment can be attempted.
- Limit reference points: The Commission has not adopted limit reference points for any of the neritic tunas under its mandate.

APPENDIX I

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:

- Resolution 13/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence
- Resolution 14/05 concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information
- Resolution 12/11 *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 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Indo-Pacific king mackerel: 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. Indo-Pacific king mackerel: 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 March 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 – Fisheries and catch trends

The Indo-Pacific king mackerel[14] is mostly caught by gillnet fisheries in the Indian Ocean but significant numbers are also caught trolling (Table 3, Fig. 1). The catch estimates for Indo-Pacific king mackerel were derived from very small amounts of information and are therefore highly uncertain[15].

[14] Hereinafter referred to as King mackerel.

[15] The uncertainty in the catch estimates has been assessed by the Secretariat and is based on the amount of processing required to account for the presence of conflicting catch reports, the level of aggregation of the catches by species and or gear, and the occurrence of non-reporting fisheries for which catches had to be estimated.

TABLE 3. Indo-Pacific king mackerel: Best scientific estimates of the catches of Indo-Pacific king mackerel by type of fishery for the period 1950–2013 (in metric tonnes) (Data as of October 2014).

Fishery	By decade (average)						By year (last ten years)									
	1950s	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Purse seine	0	0	34	584	772	938	786	768	720	1,109	1,239	1,605	1,116	1,236	1,089	1,166
Gillnet	4,213	6,747	13,532	16,555	21,251	23,345	21,837	20,031	20,744	27,278	31,074	31,887	25,975	28,046	27,336	28,710
Line	404	500	1,184	1,877	2,286	2,669	2,345	2,530	2,190	3,264	3,452	3,980	3,174	3,395	3,420	3,285
Other	13	21	48	3,879	5,103	9,352	8,159	8,334	8,208	10,872	11,929	15,733	11,543	12,336	11,003	11,201
Total	**4,630**	**7,268**	**14,798**	**22,895**	**29,411**	**36,304**	**33,127**	**31,663**	**31,862**	**42,523**	**47,694**	**53,206**	**41,808**	**45,012**	**42,847**	**44,363**

The catches provided in Table 3 are based on the information available at the IOTC Secretariat and the following observations on the catches cannot currently be verified. Estimated catches have increased steadily since the mid 1960's, reaching around 24,000 t in the late 1970's and over 30,000 t by the mid-1990's when catches remained stable until around 2006. Since the late-2000s catches have increased sharply, to over 40,000 t, with the highest catches recorded in 2009 at around 53,000 t.

In recent years, the countries attributed with the highest catches are India (36%) and Indonesia (31%) and, to a lesser extent, Iran and Myanmar (19%) (Fig. 2), which account for over 85% of the total catches of king mackerel. Catches of king mackerel in the eastern Indian Ocean have been higher in recent years.

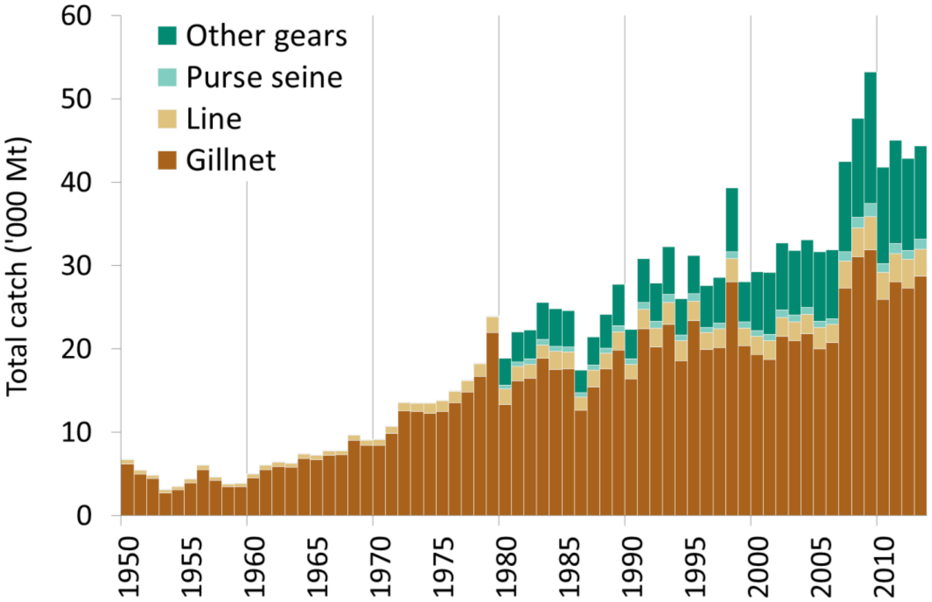


Fig. 1. Indo-Pacific king mackerel: Annual catches of Indo-Pacific king mackerel by gear recorded in the IOTC database (1950–2013) (Data as of October 2014).

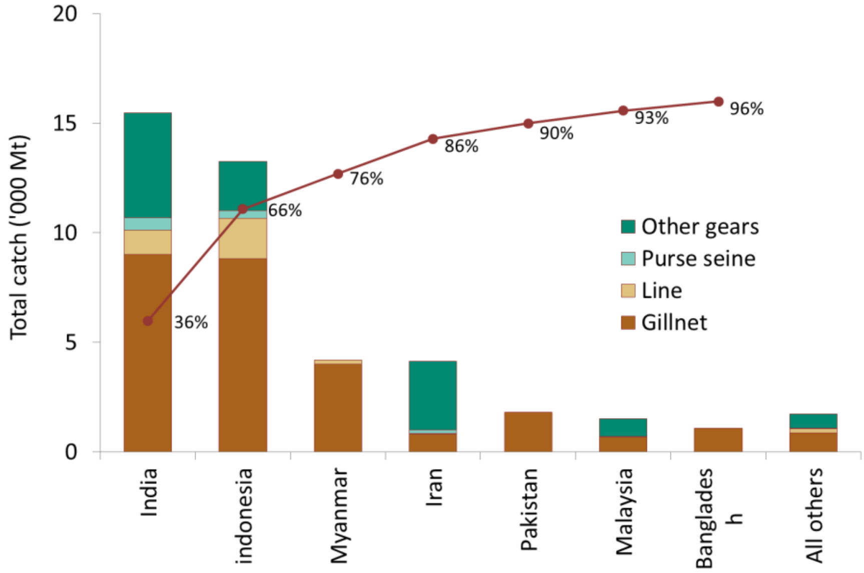


Fig. 2. Indo-Pacific king mackerel: Average catches in the Indian Ocean over the period 2010–12, by country. Countries are ordered from left to right, according to the importance of catches of Indo-Pacific king mackerel reported. The red line indicates the (cumulative) proportion of catches of Indo-Pacific king mackerel for the countries concerned, over the total combined catches of this species reported from all countries and fisheries (Data as of October 2014).

Indo-Pacific king mackerel – Uncertainty of catches

Retained catches are highly uncertain (Fig. 3) for all fisheries due to:

- Aggregation: Indo-Pacific king mackerels are usually not reported by species being aggregated with narrow-barred Spanish mackerel 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.
- Underreporting: 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 catches of Indo-Pacific king mackerel since the WPNT in 2013.

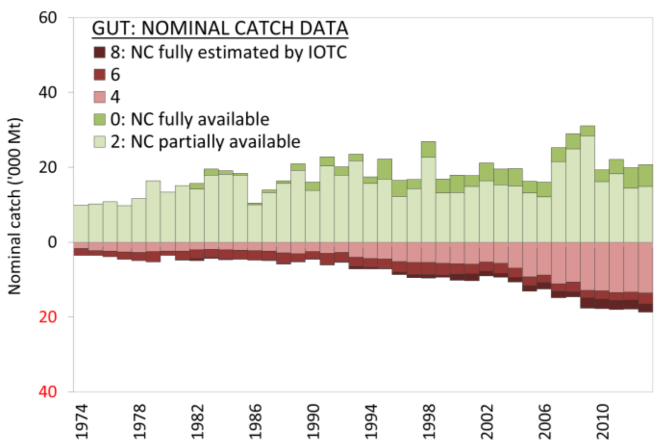


Fig. 3. Indo-Pacific king mackerel: uncertainty of annual catch estimates (1950–2013). Catches are assessed against IOTC reporting standards, where a score of 0 indicates catches that are fully reported according to IOTC standards; catches assigned a score of between 2 – 6 do not report catch data fully by gear and/or species (i.e., partially adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; catches with a score of 8 refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat) (Data as of October 2014).

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

Catch-and-effort series are not available for most fisheries and, when available, they refer to very short periods (Table 4). This makes it impossible to derive any meaningful CPUE from the existing data.

TABLE 4. Indo-Pacific king mackerel: Availability of catches and effort series, by fishery and year (1970–2012)[16]. Note that no catches and effort are available at all for 1950–85

Gear-Fleet	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	00	02	04	06	08	10	12
PSS-Indonesia									■													
LINE-South Africa																		■				
LINE-Yemen																			■			

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 Indo-Pacific 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 (Table 5).
- Catch-at-Size data are not available for the Indo-Pacific king mackerel due to the paucity of size data available from most fleets (Table 5) and the uncertain status of the catches for this species (Fig. 3).
- Sex ratio data have not been provided to the Secretariat by CPCs.

TABLE 5. Indo-Pacific king mackerel: Availability of length frequency data, by fishery and year (1980–2012)[17]. Note that no length frequency data are available at all for 1950–82).

Gear-Fleet	80	82	84	86	88	90	92	94	96	98	00	02	04	06	08	10	12
PSS-Thailand													□	□			
GILL-Sri Lanka					□□	□	□□										

Key
- ■ More than 2,400 specimens measured
- Between 1,200 and 2,399 specimens measured
- □ Less than 1,200 specimens measured

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 6).

TABLE 6. Indo-Pacific king mackerel (*Scomberomorus guttatus*) key management quantities.

Management Quantity	Aggregate Indian Ocean
2013 catch estimate	44,363 t
Mean catch from 2009–2013	45,447 t
MSY (80% CI) (1,000 t)	unknown
Data period used in assessment	–
F_{MSY} (80% CI)	–
B_{MSY} (80% CI) (1,000 t)	–
F_{2012}/F_{MSY} (80% CI)	–
B_{2012}/B_{MSY} (80% CI)	–
SB_{2012}/SB_{MSY} (80% CI)	–

[16] Note that the above list is not exhaustive, showing only the fisheries for which catches and effort are available in the IOTC database. Furthermore, when available catches and effort may not be available throughout the year existing only for short periods

[17] Note that the above list is not exhaustive, showing only the fisheries for which size data are available in the IOTC database. Furthermore, when available size data may not be available throughout the year existing only for short periods

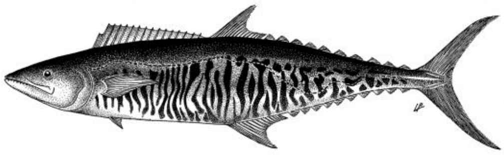
B_{2012}/B_0 (80% CI)	–
SB_{2012}/SB_0 (80% CI)	–
$B_{2012}/B_{0,\ F=0}$ (80% CI)	–
$SB_{2012}/SB_{0,\ F=0}$ (80% CI)	–

LITERATURE CITED

Froese R, Pauly DE (2009) FishBase, version 02/2009, FishBase Consortium, www.fishbase.org.

APPENDIX XXVI
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 (COM: *Scomberomorus commerson*) resource

TABLE 1. Narrow-barred Spanish mackerel: Status of narrow-barred Spanish mackerel (*Scomberomorus commerson*) in the Indian Ocean.

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Catch[2] 2013: Average catch[2] 2009–2013:	148,695 t 144,462 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2012}/F_{MSY} (80% CI): B_{2012}/B_{MSY} (80% CI): B_{2012}/B_0 (80% CI):	137(93–164) 0.47 (0.41–1.95) 229 (132–265) 0.92 (0.41–1.95) 1.17 (0.50–1.51) 0.59 (0.25–0.75)	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]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)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. Stock Reduction Analysis techniques indicate that the stock is being exploited at a rate that is near F_{MSY} in recent years, and the stock appears to be fully exploited. Northwest Indian Ocean (Gulf of Oman Sea countries) indicate that localised depletion may be occurring from an analysis done in 2013, and overfishing is occurring in this area, though the degree of connectivity with other stocks remains unknown. Stock structure issues remain to be clarified with this stock. Based on the weight-of-evidence available, including the two different SRA approaches pursued in 2014, the stock appears to be **not overfished** and **not subject to overfishing** (Table 1, Fig. 2).

Outlook. There remains considerable uncertainty about stock structure and the total catches. 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, and the stock is probably near full/optimal utilisation. 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. There is a high to very high risk of exceeding MSY-based reference points by 2015 if catches are maintained at current (2012) levels (72% risk that $SB_{2015}<SB_{MSY}$, and 90% risk that $F_{2015}>F_{MSY}$) or a very high risk is catches are increase further (120% of 2012 levels) (90% risk that $SB_{2015}<SB_{MSY}$, and 99% risk that $F_{2015}>F_{MSY}$) (Table 2).

The following should be noted:

- Maximum Sustainable Yield estimate for the whole Indian Ocean is 137,000 (range 93,000 t–64,000 t).
- Reconstruction of the catch history needs to occur, as do annual catches submitted to the Secretariat.
- Improvement in data collection and reporting is required to assess the stock using more traditional stock assessment techniques.

- Given the rapid increase in narrow-barred Spanish mackerel catch in recent years, some measures need to be taken to slow or reduce catches in the Indian Ocean (Table 2).
- Limit reference points: The Commission has not adopted limit reference points for any of the neritic tunas under its mandate.

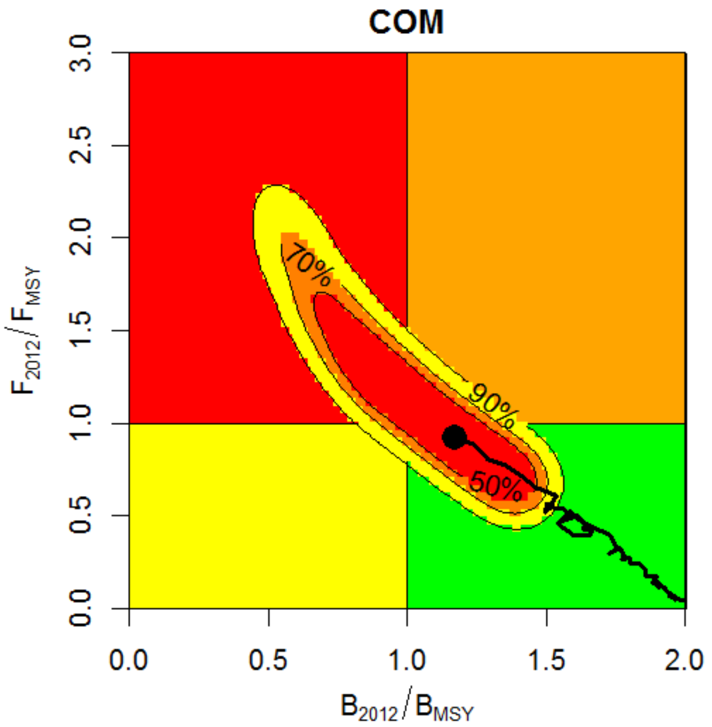


Fig. 1. Narrow-barred Spanish mackerel: PFCRA Aggregated Indian Ocean assessment Kobe plot. The Kobe plot presents the trajectories for the range of plausible model options included in the formulation of the final management advice. The trajectory of the geometric mean of the plausible model options is also presented.

TABLE 2. Narrow-barred Spanish mackerel: 2014 PFCRA Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of plausible models violating the MSY-based reference points for five constant catch projections (2012 catch level, ±10%, ±20%, ±30% and ±40%) projected for 3 and 10 years. Note: from the 2014 stock assessment using catch estimates at that time.

Reference point and projection timeframe	Alternative catch projections (relative to 2012) and weighted probability (%) scenarios that violate reference point								
	60% (85,999t)	**70%** (100,333 t)	**80%** (114,666 t)	**90%** (129,000 t)	**100%** (143,333 t)	**110%** (157,666 t)	**120%** (172,000 t)	**130%** (186,332 t)	**140%** (200,666 t)
$B_{2015} < B_{MSY}$	n.a.	6%	23%	46%	72%	n.a.	90%	n.a.	n.a.
$F_{2015} > F_{MSY}$	n.a.	0%	10%	54%	90%	n.a.	99%	n.a.	n.a.
$B_{2022} < B_{MSY}$	n.a.	9%	24%	52%	76%	n.a.	90%	n.a.	n.a.
$F_{2022} > F_{MSY}$	n.a.	4%	19%	53%	82%	n.a.	96%	n.a.	n.a.

APPENDIX I

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:

- Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 14/05 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*

- Resolution 12/11 *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 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Narrow-barred Spanish mackerel: 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 3 outlines some key life history parameters relevant for management.

TABLE 3. Narrow-barred Spanish mackerel. 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. They appear to undertake lengthy migrations, however, larger individuals may be resident which contributes to a metapopulation structure. 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**: 1.9 yrs for males and 2.1 yrs for females **Size:** 72.8 cm for males and 86.3 cm for females.
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. Spawning in the southern Arabian Gulf occurs in the spring and summer months between April and August.
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 – Fisheries and catch trends

Narrow-barred Spanish mackerel[18] 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 (Table 4, Fig. 2).

TABLE 4. Narrow-barred Spanish mackerel: Best scientific estimates of the catches of narrow-barred Spanish mackerel by type of fishery for the period 1950–2013 (in metric tonnes) (Data as of October 2014).

Fishery	**By decade (average)**						By year (last ten years)									
	1950s	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Purse seine	0	0	285	2,357	4,145	5,611	4,566	5,880	7,632	6,586	6,130	8,459	8,850	8,812	8,758	8,487
Gillnet	8,681	16,863	29,733	51,763	60,006	64,952	61,998	57,819	66,205	71,501	71,263	72,426	74,925	80,050	88,621	82,368
Line	2,581	3,300	7,106	14,467	14,741	19,453	17,398	19,191	19,846	21,293	23,065	25,847	25,550	27,435	31,769	31,941
Other	57	96	468	5,614	9,747	21,345	19,564	20,515	23,905	25,516	22,735	28,170	25,519	27,455	30,970	25,899
Total	**11,318**	**20,260**	**37,593**	**74,201**	**88,639**	**111,360**	**103,526**	**103,406**	**117,588**	**124,895**	**123,192**	**134,902**	**134,844**	**143,753**	**160,118**	**148,695**

The catch estimates for narrow-barred Spanish mackerel were derived from very small amounts of information and are therefore highly uncertain[19]. The catches provided in Table 4 are based on the information available at the IOTC

[18] Hereinafter referred to as Spanish mackerel

Secretariat and the following observations on the catches cannot currently be verified. The catches of narrow-barred Spanish mackerel increased from around 50,000 t the late-1970's to over 100,000 t by the late-1990's. The highest catches of narrow-barred Spanish mackerel were recorded in 2012, at over 160,000 t. Narrow-barred Spanish mackerel is caught in both Indian Ocean basins, with approximately equal proportions of catches recorded in the East and West Indian Ocean since the mid-2000s.

In recent years, the countries attributed with the highest catches of narrow-barred Spanish mackerel are Indonesia (29%) and India (23%) and, to a lesser extent, I.R. Iran, Myanmar, the UAE and Pakistan (25%) (Fig. 3).

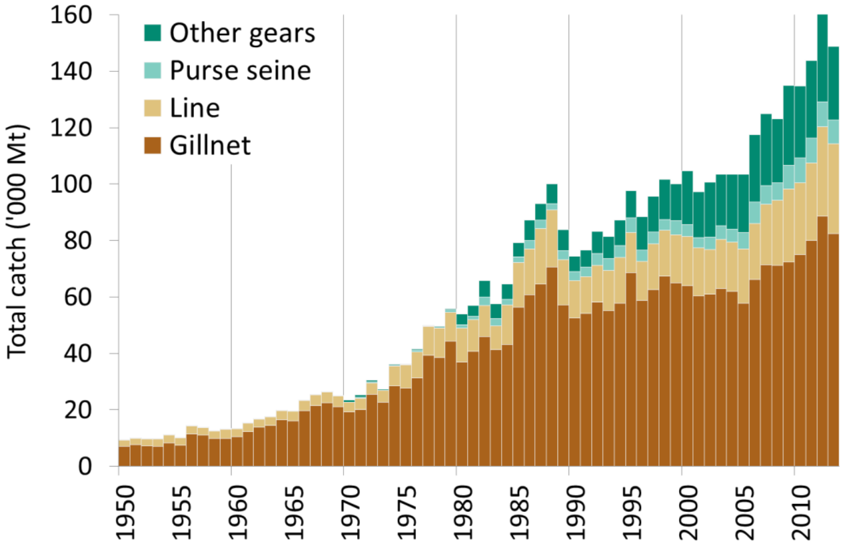


Fig. 2. Narrow-barred Spanish mackerel: Annual catches of narrow-barred Spanish mackerel by gear recorded in the IOTC database (1950–2013) (Data as of October 2014).

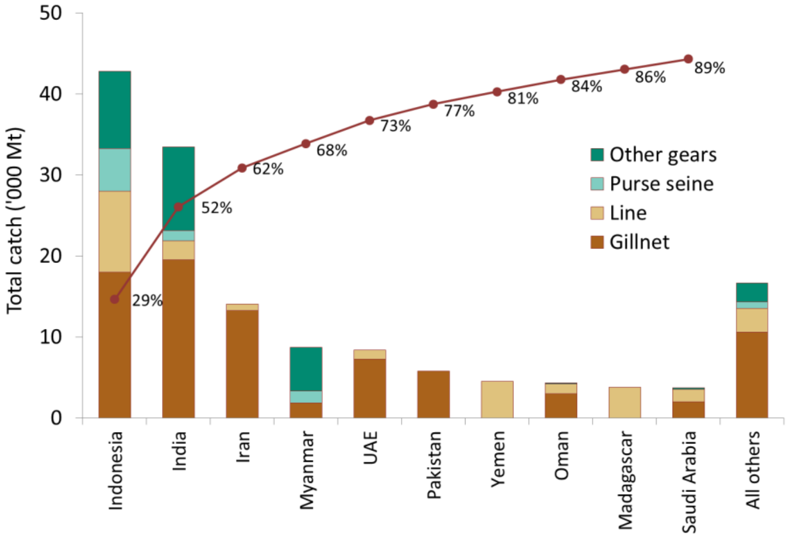


Fig. 3. Narrow-barred Spanish mackerel: Average catches in the Indian Ocean over the period 2010–12, by country. Countries are ordered from left to right, according to the importance of catches of narrow-barred Spanish mackerel reported. The red line indicates the (cumulative) proportion of catches narrow-barred Spanish mackerel for the countries concerned, over the total combined catches of this species reported from all countries and fisheries (Data as of October 2014).

Narrow-barred Spanish mackerel – uncertainty of catches

Retained catches are uncertain (Fig. 4), notably for the following fisheries:

[19] The uncertainty in the catch estimates has been assessed by the Secretariat and is based on the amount of processing required to account for the presence of conflicting catch reports, the level of aggregation of the catches by species and or gear, and the occurrence of non-reporting fisheries for which catches had to be estimated

- Artisanal fisheries of Indonesia and India: Indonesia and India have only recently reported catches of Spanish mackerel by gear, including catches by gear for the years 2005–08 and 2007–08, respectively. In the past, the IOTC Secretariat used the catches reported in recent years to break the aggregates for previous years, by gear and species. However, in a review conducted by the IOTC Secretariat by an independent consultant in 2012 the catches of narrow-barred Spanish mackerel were reassigned by gear. In recent years, the catches of narrow-barred Spanish mackerel estimated for Indonesia and India component represent around 50% of the total catches of this species in recent years.
- Artisanal fisheries of Madagascar: To date, Madagascar has not reported catches of narrow-barred Spanish mackerel to the IOTC. During 2012 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 tunas and tuna-like species had been combined under this name (the review used data from various sources including a reconstruction of the total marine fisheries catches of Madagascar (1950–2008), undertaken by the Sea Around Us Project). The new catches estimated are thought to be very uncertain.
- Artisanal fisheries of Somalia: Catch levels are unknown.
- Other artisanal fisheries UAE do not report catches of narrow-barred Spanish mackerel by gear. Although most of the catches are believed to be taken by gillnets, some narrow-barred Spanish mackerel may be also caught by using small surrounding nets, lines or other artisanal gears. In addition, Thailand 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: There have been no major revisions to the catch series of narrow-barred Spanish mackerel since the WPNT meeting in 2013.

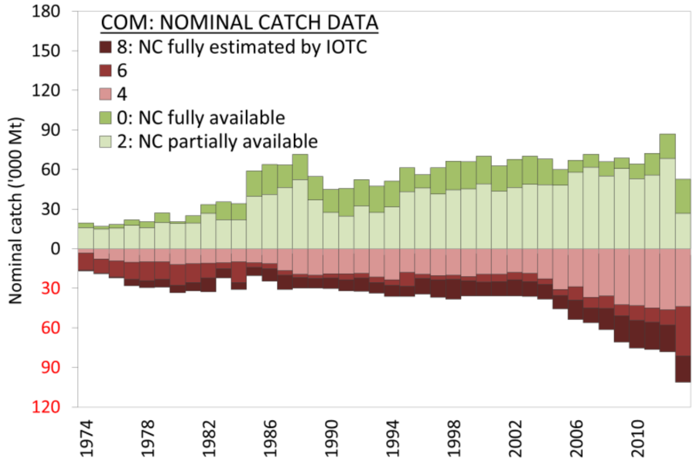


Fig. 4. Narrow-barred Spanish mackerel: Uncertainty of annual catch estimates (1950–2013). Catches are assessed against IOTC reporting standards, where a score of 0 indicates catches that are fully reported according to IOTC standards; catches assigned a score of between 2 – 6 do not report catch data fully by gear and/or species (i.e., partially adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; catches with a score of 8 refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat) (Data as of October 2014).

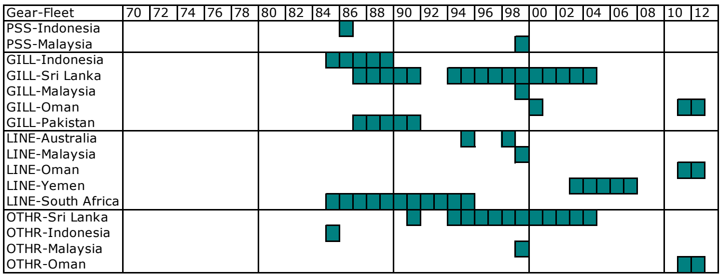
Narrow-barred Spanish mackerel – Effort trends

Effort trends are unknown for narrow-barred Spanish mackerel in the Indian Ocean.

Narrow-barred Spanish mackerel – Catch–per–unit–effort (CPUE) trends

Catch-and-effort series are available from some fisheries but they are considered highly incomplete (Table 5). 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. 5). The catches and effort recorded are, however, thought to be unrealistic due to the dramatic changes in CPUE recorded in 2003 and 2004.

TABLE 5. Narrow-barred Spanish mackerel: Availability of catches and effort series, by fishery and year (1970–2013). Note that no catches and effort are available at all for 1950–84.



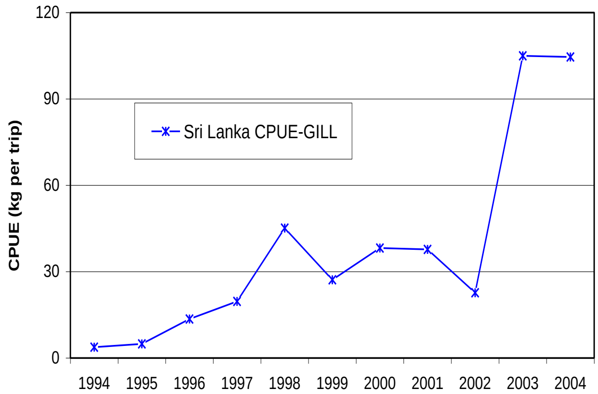
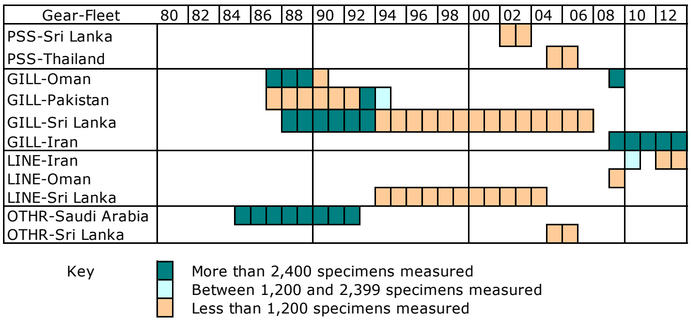


Fig. 5. Narrow-barred Spanish mackerel: Nominal CPUE series for the gillnet fishery of Sri Lanka derived from the available catches and effort data (1994–2004).

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 and 140 cm depending on the type of gear used, season and location (Fig. 6). The size of narrow-barred Spanish mackerel taken varies by location with 32–119 cm fish taken in the Eastern Peninsular Malaysia area, 17–139 cm fish taken in the East Malaysia area and 50–90 cm fish taken in the Gulf of Thailand. Similarly, narrow-barred 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 (from the late-1980s until the early 1990s), and Iranian gillnets from the late 2000s (Fig. 6, Table 6). 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 data are not available for the narrow-barred Spanish mackerel due to the paucity of size data available from most fleets (Table 6) and the uncertain status of the catches for this species (Fig. 4). Length distributions derived from the data available for gillnet fisheries are shown in Fig. 6. No data available for all other fisheries.

TABLE 6. Narrow-barred Spanish mackerel: Availability of length frequency data, by fishery and year (1980–2013)[20]. Note that no length frequency data are available at all for 1950–84.



[20] Note that the above list is not exhaustive, showing only the fisheries for which size data are available in the IOTC database. Furthermore, when available size data may not be available throughout the year existing only for short periods

Narrow-barred Spanish mackerel (Gillnet samples): size (in cm)

Narrow-barred Spanish mackerel (Gillnet): no. of samples ('000)

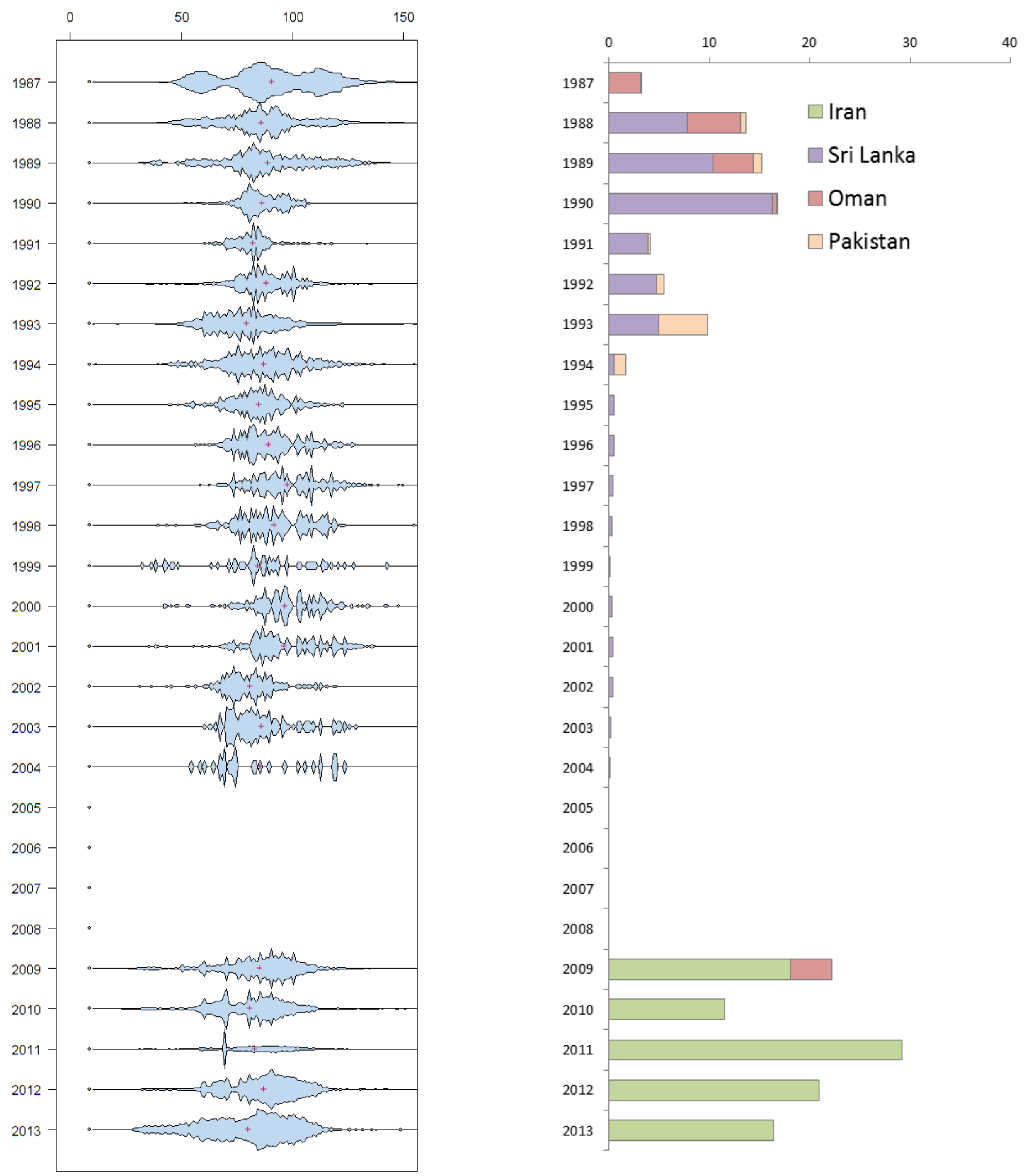


Fig. 6. Narrow-barred Spanish mackerel: Left - Narrow-barred Spanish mackerel: Length frequency distributions for gillnet fisheries (total amount of fish measured by 1cm length class) derived from data available at the IOTC Secretariat. Right - number of narrow-barred Spanish mackerel specimens sampled for lengths, by fleet (gillnet only).

STOCK ASSESSMENT

Two assessment approaches were applied to narrow-barred Spanish mackerel in 2014, a Stock Reduction Analysis technique and a Posterior Focused Catch Reduction (PFCRA) method. The trajectories for both approaches were very similar and gave similar outcomes, and for reporting and stock status advice the PFCRA approach is used, as it was statistically robust (Table 7).

Noting that the Commission adopted Resolution 12/01 On the implementation of the precautionary approach, which effectively means that in a situation of increased uncertainty (e.g. data poor situations), a more precautionary approach should be undertaken when developing advice and possible management actions, this approach, combined with the weight-of-evidence available (stock status indicators from data poor assessment approaches, species biology, fishery indicators), were used to determine stock status for narrow-barred Spanish mackerel.

The stock status management advice for narrow-barred Spanish mackerel is based on the catch-based stock reduction method, combined with the known species and fishery attributes for status interpretation purposes. The approach presented is useful to assess stock status in the near term, while more traditional stock assessment approaches in the region are deferred until more data is collected and submitted in accordance with the IOTC data recording and reporting requirements for neritic tunas.

TABLE 7. Narrow-barred Spanish mackerel (*Scomberomorus commerson*) key management quantities.

Management Quantity	**Aggregate Indian Ocean**
2013 catch estimate	148,695 t
Mean catch from 2009–2013	144,462 t
MSY (1,000 t) (80% CI)	137(93–164)
Data period used in assessment	–
F_{MSY} (80% CI)	0.47 (0.41–1.95)
B_{MSY} (1,000 t) (80% CI)	229 (132–265)
F_{2012}/F_{MSY} (80% CI)	0.92 (0.41–1.95)
B_{2012}/B_{MSY} (80% CI)	1.17 (0.50–1.51)
SB_{2012}/SB_{MSY} (80% CI)	–
B_{2012}/B_0 (80% CI)	0.59 (0.25–0.75)
SB_{2012}/SB_0 (80% CI)	–
$B_{2012}/B_{0,\,F=0}$ (80% CI)	–
$SB_{2012}/SB_{0,\,F=0}$ (80% CI)	–

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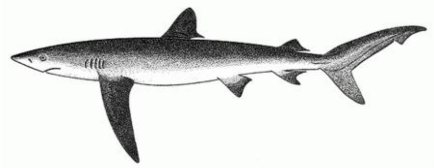
McPherson GR (1989) North-eastern Australian mackerel (*Scomberomorus*) fishery. In: Chavez EA, Ed). Proceedings of the workshop Australia-Mexico on marine sciences, Quintana Roo, Mexico, 6-17 July 1989. Quintana Roo, Mexico. pp. 341-348.

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 (BSH: *Prionace glauca*)

TABLE 1. Blue shark: Status of blue shark (*Prionace glauca*) in the Indian Ocean.

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Reported catch 2013: Not elsewhere included (nei) sharks[2]: Average reported catch 2009–2013: Not elsewhere included (nei) sharks[2]:	23,197 t 46,728 t 24,447 t 49,318 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2013}/F_{MSY} (80% CI): SB_{2013}/SB_{MSY} (80% CI): SB_{2013}/SB_0 (80% CI):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species.

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		

TABLE 2. Blue shark: IUCN threat status of blue shark (*Prionace glauca*) in the Indian Ocean.

Common name	Scientific name	IUCN threat status[21]		
		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, Stevens 2009

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about the relationship between abundance, CPUE series and total catches over the past decade (Table 1). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Blue sharks received a medium vulnerability ranking (No. 10) in the ERA rank for longline gear because it was estimated as the most productive shark species, but was also characterised by the second highest susceptibility to longline gear. Blue shark was estimated as not being susceptible thus not vulnerable to purse seine gear. The current IUCN threat status of 'Near Threatened' applies to blue sharks globally (Table 2). There is a paucity of information available on this species, but this has been improving in recent years. 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 (20–25 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. However, blue shark assessments in the Atlantic and Pacific oceans seem to indicate that blue shark stocks can sustain relatively high fishing pressure. 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 **uncertain** (Table 1).

[21] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

Outlook. Maintaining or increasing effort can 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 following should be noted:

- 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 ~ 24,447 t over the last five years, ~ 23,197 t in 2013, maintaining or increasing effort can result in declines in biomass, productivity and CPUE.
- Mechanisms need to be developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

APPENDIX I

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 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence* sets out the minimum logbook requirements for purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels over 24 metres length overall and those under 24 metres if they fish outside the EEZs of their flag States within the IOTC area of competence. As per this Resolution, catch of all sharks must be recorded (retained and discarded).
- Resolution 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries* prohibits, as an interim pilot measure, the retention onboard, transhipment, landing or storing any part or whole carcass of oceanic whitetip sharks (*Carcharhinus longimanus*) (and requests for all other species) by all vessels on the IOTC record of authorised vessels or authorised to fish for tuna or tuna-like species, with the exception of observers who are permitted to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs) from oceanic whitetip sharks that are dead at haulback and artisanal fisheries for the purpose of local consumption, and will conduct a review and an evaluation of the interim measure in 2016.
- 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.
- 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 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's)* indicated that the provisions, applicable to tuna and tuna-like species, are applicable to shark species.

Extracts from Resolutions 13/03, 13/06, 11/04 and 05/05

RESOLUTION 13/03 ON THE RECORDING OF CATCH AND EFFORT BY FISHING VESSELS IN THE IOTC AREA OF COMPETENCE

Para. 1. Each flag CPC shall ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system.

Para. 8 (start). The flag State and the States which receive this information shall provide all the data for any given year to the IOTC Secretariat by June 30th of the following year on an aggregated basis.

RESOLUTION 13/06 ON A SCIENTIFIC AND MANAGEMENT FRAMEWORK ON THE CONSERVATION OF SHARK SPECIES CAUGHT IN ASSOCIATION WITH IOTC MANAGED FISHERIES

Para. 8. CPCs, especially those targeting sharks, shall submit data for sharks, as required by IOTC data reporting procedures.

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

Para. 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

Resolution 10/02 MANDATORY STATISTICAL REQUIREMENTS FOR IOTC MEMBERS AND COOPERATING NON-CONTRACTING PARTIES (CPC'S)

Para. 3. The provisions, applicable to tuna and tuna-like species, shall also be applicable to the most commonly caught shark species and, where possible, to the less common shark species.

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

Para. 1. CPCs shall annually report data for catches of sharks, in accordance with IOTC data reporting procedures, including available historical data.

Para. 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.

FISHERIES INDICATORS

Blue shark: 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, great white sharks, and adult blue sharks. Fishing is a major contributor to adult mortality. Table 3 outlines some of the key life history traits of blue shark in the Indian Ocean.

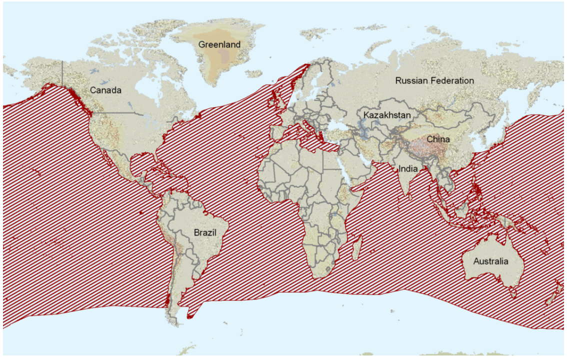


Fig. 1. Blue shark: The worldwide distribution of the blue shark (source: www.iucnredlist.org).

TABLE 3. Blue shark: 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 waters south of 20°S and temperate waters appear to be nursery grounds 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.
Maturity (50%)	Age: Sexual maturity is attained at about 4–7 years for males and 5–7 years for females. Size: Females mature at 194 cm TL and males at 201 cm TL. In the Atlantic 182–218 cm TL for males; 173–221 cm TL for females. In the South Pacific: 229–235 cm TL for males and 205–229 cm TL 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 (25–55) • 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, Francis & Duffy 2005, Mejuto & Garcia-Cortes 2006, IOTC 2007, Matsunaga 2007, Nakano & Stevens 2008, Rabehagosoa et al. 2009, Romanov & Romanova 2009, Anon 2010, Romano & Campana 2011, Jolly et al. 013.

Blue shark: 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 substantial 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 et al. 2006, Clarke 2008) 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 (Table 4). Specimen size seems to be a significant factor, with larger specimens having a higher survival at-haulback (Coelho et al. 2011).

TABLE 4. Blue shark: 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
At vessel mortality	unknown	13 to 51 %	0 to 31%	unknown	unknown	unknown
Post release	unknown	19% (Atlantic)		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, Coelho et al. (2011), Coelho et al. (2013a).

Blue shark: Catch trends

The catch estimates for blue shark (Table 5) are highly uncertain as is their utility in terms of minimum catch estimates. Five CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, I.R. Iran and Sri Lanka) while thirteen CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Rep. of Korea, Indonesia, Mozambique, Malaysia, Oman, Seychelles, Mauritius, Philippines, UK-territories, Vanuatu). For CPCs reporting longline data by species (i.e. Australia, EU (Spain, Portugal, United Kingdom) and South Africa), 71% of the catch of sharks by longliners, all targeting swordfish, were blue sharks.

TABLE 5. Blue shark: Catch estimates for blue shark in the Indian Ocean for 2011 to 2013.

Catch		2011	2012	2013
Most recent catch (reported)	Blue shark	26,361 t	21,901 t	23,197 t
	nei-sharks	53,658 t	42,793 t	46,728 t
Mean catch (reported) over the last 5 years (2009–2013)	Blue shark		24,204 t	24,447 t
	nei-sharks		48,708 t	49,318 t

Nei-sharks: sharks not elsewhere included

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 2013 thirteen countries reported catches of blue sharks in the IOTC region.

Blue shark: Nominal and standardised CPUE Trends

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 nominal CPUE while mean weight of blue shark in this time series are relatively stable (Romanov et al. 2008).

Trends in the Japanese CPUE series obtained from fishery observer data (Fig. 2) suggest an increase in the CPUE from1991–1999, followed by a decrease until 2004 and a more stable period with several oscillations in more recent years (Kanaiwa et al., 2014).The standardised CPUE of blue shark catches by the Portuguese longline fleet in the Indian Ocean obtained from logbook data show a general decreasing trend between 2000 and 2013 (Fig. 2, Coelho et al. 2014). The standardised CPUE of blue shark catches by the Taiwan,China longline fleet in the Indian Ocean obtained from fishery observer data shows a general increasing trend between 2004 and 2012 (Fig. 2, Tsai and Liu 2014).

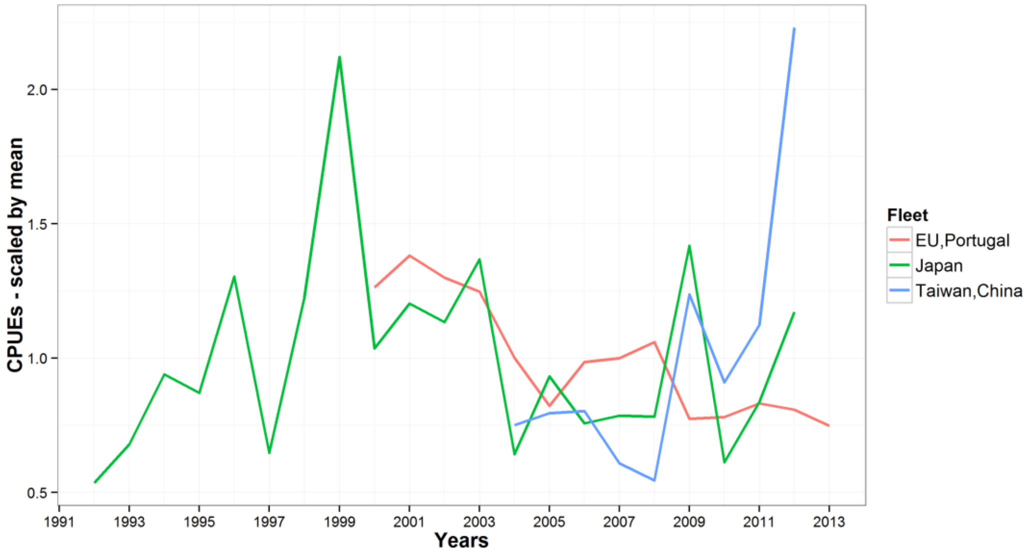


Fig. 2. Blue shark: Comparison of the blue shark standardised CPUE series for the longline fleets of Japan, Taiwan,China and EU,Portugal.

Blue shark: Average weight in the catch by fisheries

Data not available.

Blue shark: 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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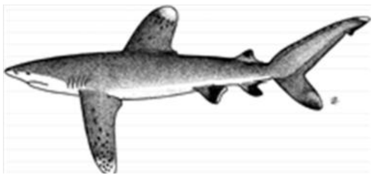
APPENDIX XXVIII
EXECUTIVE SUMMARY: OCEANIC WHITETIP SHARK

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



Status of the Indian Ocean oceanic whitetip shark (OCS: *Carcharhinus longimanus*)

TABLE 1. Oceanic whitetip shark: Status of oceanic whitetip shark (*Carcharhinus longimanus*) in the Indian Ocean.

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Reported catch 2013: Not elsewhere included (nei) sharks[2]: Average reported catch 2009–2013: Not elsewhere included (nei) sharks[2]:	230 t 46,728 t 317 t 49,318 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2013}/F_{MSY} (80% CI): SB_{2013}/SB_{MSY} (80% CI): SB_{2013}/SB_0 (80% CI):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species.

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		

NOTE: IOTC Resolution 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries*, prohibits retention onboard, transhipping, landing or storing any part or whole carcass of oceanic whitetip sharks.

TABLE 2. Oceanic whitetip shark: IUCN threat status of oceanic whitetip shark (*Carcharhinus longimanus*) in the Indian Ocean.

Common name	Scientific name	IUCN threat status[22]		
		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, Baum et al. 2006
CITES - In March 2013, CITES agreed to include oceanic whitetip shark to Appendix II to provide further protections prohibiting the international trade; which will become effective on September 14, 2014.

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about the relationship between abundance, standardised CPUE series and total catches over the past decade (Table 1). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Oceanic whitetip shark received a high vulnerability ranking (No. 5) in the ERA rank for longline gear because it was estimated as one of the least productive shark species, and was also characterised by a high susceptibility to longline gear. Oceanic whitetip shark

[22] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

was estimated as being the most vulnerable shark species to purse seine gear, as it was characterised as having a relatively low productive rate, and high susceptibility. The current IUCN threat status of 'Vulnerable' applies to oceanic whitetip sharks globally (Table 2). 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. 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 likely vulnerable to overfishing. Despite the lack of data, there is anecdotal information suggesting that oceanic whitetip shark abundance has declined over recent decades. Available standardised CPUE indices from Japan and EU,Spain indicate conflicting trends as discussed in the full Executive Summary for oceanic whitetip sharks. 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 **uncertain** (Table 1).

Outlook. Maintaining or increasing effort with associated fishing mortality can 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 oceanic whitetip sharks will decline in these areas in the near future, and may result in localised depletion. The following should be noted:

- The two primary sources of data that drive the assessment, total catches and CPUE are lacking or uncertain and should be investigated further as a priority.
- Noting that current catches (probably largely underestimated) are estimated at an average ~317 t over the last five years, ~230 t in 2013, maintaining or increasing effort with an associated fishing mortality can result in further declines in biomass, productivity and CPUE.
- Mechanisms need to be developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

APPENDIX I

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 shark in the Indian Ocean are currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence* sets out the minimum logbook requirements for purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels over 24 metres length overall and those under 24 metres if they fish outside the EEZs of their flag States within the IOTC area of competence. As per this Resolution, catch of all sharks must be recorded (retained and discarded).
- Resolution 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries* prohibits, as an interim pilot measure, the retention onboard, transhipment, landing or storing any part or whole carcass of oceanic whitetip sharks (*Carcharhinus longimanus*) (and requests for all other species) by all vessels on the IOTC record of authorised vessels or authorised to fish for tuna or tuna-like species, with the exception of observers who are permitted to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs) from oceanic whitetip sharks that are dead at haulback and artisanal fisheries for the purpose of local consumption, and will conduct a review and an evaluation of the interim measure in 2016.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on 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.
- 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 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's)* indicated that the provisions, applicable to tuna and tuna-like species, are applicable to shark species.

Extracts from Resolutions 13/03, 13/06, 11/04 and 05/05

RESOLUTION 13/03 ON THE RECORDING OF CATCH AND EFFORT BY FISHING VESSELS IN THE IOTC AREA OF COMPETENCE

Para. 1. Each flag CPC shall ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system.

Para. 8 (start). The flag State and the States which receive this information shall provide all the data for any given year to the IOTC Secretariat by June 30th of the following year on an aggregated basis.

RESOLUTION 13/06 ON A SCIENTIFIC AND MANAGEMENT FRAMEWORK ON THE CONSERVATION OF SHARK SPECIES CAUGHT IN ASSOCIATION WITH IOTC MANAGED FISHERIES

Para. 3. CPCs shall to prohibit, as an interim pilot measure, to retain onboard, tranship, land or store any part or whole carcass of oceanic whitetip sharks with the exception of paragraph 7.

Para. 8. CPCs, especially those targeting sharks, shall submit data for sharks, as required by IOTC data reporting procedures.

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

Para. 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

Resolution 10/02 MANDATORY STATISTICAL REQUIREMENTS FOR IOTC MEMBERS AND COOPERATING NON-CONTRACTING PARTIES (CPC'S)

Para. 3. The provisions, applicable to tuna and tuna-like species, shall also be applicable to the most commonly caught shark species and, where possible, to the less common shark species.

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

Para. 1. CPCs shall annually report data for catches of sharks, in accordance with IOTC data reporting procedures, including available historical data.

Para. 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.

FISHERIES INDICATORS

Oceanic whitetip shark: 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 3 outlines some of the key life history traits of oceanic whitetip shark in the Indian Ocean.

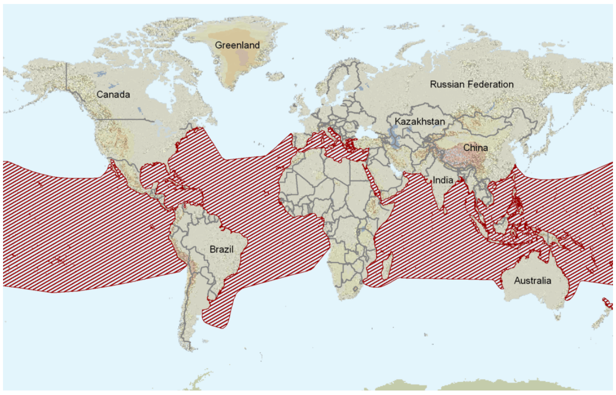


Fig. 1. Oceanic whitetip shark: The worldwide distribution of the oceanic whitetip shark (source: www.iucnredlist.org).

TABLE 3. Oceanic whitetip shark: 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, however, long distance movement has been observed for oceanic whitetip sharks ranging from the Mozambique Channel to the Somali Basin and the Southern Indian Ocean. Area of overlap with IOTC management area = high.
Longevity	Maximum age observed was 17 years.
Maturity (50%)	In the eastern Indian Ocean both males and females mature at around 190-200 cm TL. Similarly, 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 160-196 cm TL for males and 181-203 cm TL for females.
Reproduction	Oceanic whitetip sharks are placental viviparous. Litter sizes range from 1–15 pups in the Pacific Ocean (mean=6.2) and the Indian Ocean (mean = 12), with larger sharks producing more offspring. Each pup is approximately 50-65 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: Bass et al. 1973, Mejuto et al. 2005, White 2007, Romanov & Romanova 2009, Coelho et al. 2009, Filamalter et al. 2012.

Oceanic whitetip shark: 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) (Table 4).

There is little information on the fisheries prior to the early 1970s, 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.

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 4. Oceanic whitetip shark: 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

Oceanic whitetip shark: Catch trends

The catch estimates for oceanic whitetip shark (Table 5) are uncertain as is their utility in terms of minimum catch estimates. Five CPCs have reported detailed data on shark landings (i.e. Australia, EU (Spain, Portugal and United Kingdom), I.R. Iran, South Africa, and Sri Lanka) while thirteen CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Rep. of Korea, Indonesia, Mozambique, Malaysia, Oman, Seychelles, Mauritius, Philippines, UK-territories, Vanuatu). For CPCs having longline fisheries targeting swordfish that report catches of sharks by species (i.e. Australia, EU (Spain, Portugal, United Kingdom), Madagascar, and South Africa), 0.9% of the catch of sharks by longliners, all targeting swordfish, were oceanic whitetip sharks, and for CPCs reporting gillnet data by species, I.R. Iran reported 1% of the catches of shark as oceanic whitetip sharks for the period 2011–13.

TABLE 5. Oceanic whitetip shark: Catch estimates for oceanic whitetip shark in the Indian Ocean for 2011 to 2013.

Catch		**2011**	**2012**	**2013**
Most recent catch (reported)	Oceanic whitetip shark	251 t	412 t	230 t
	nei-sharks	53,658 t	42,793 t	46,728 t
Mean catch (reported) over the last 5 years (2009–2013)	Oceanic whitetip shark		292 t	317 t
	nei-sharks		48,708 t	49,318 t

Nei-sharks: sharks not elsewhere included

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 2013 six countries reported catches of oceanic whitetip sharks in the IOTC region. A recent project estimated possible oceanic white tip shark catches for fleets/countries based on the ratio of shark catch over target species by metier (Murua et al. 2013). This estimation was done using target species nominal catch IOTC database and assuming that target catches are declared correctly. The estimated figure by this study highlighted that the possible underestimation of oceanic white tip shark in IOTC database is considerable (i.e. the estimated catch is around 20 times higher than the declared in the IOTC database). Although this figure needs to be further investigated, it gives a global figure of possible underreporting level of oceanic white tip in the area.

Oceanic whitetip shark: Nominal and standardised CPUE Trends

Statistics not available at the IOTC Secretariat.

Historical research data shows overall decline in nominal CPUE and mean weight of oceanic whitetip shark (Romanov et al. 2008). 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 & Varghese 2009).

Trends in the Japanese standardised CPUE series (2003–2011) suggest that the longline vulnerable biomass has decreased (Fig. 2; Yokawa & Semba 2012). The authors stated that the early CPUE (2000–02) were not reliable due to the data problems. The updated results are in line with those presented to the WPEB07, although there are some differences on the initial years of the data series, which were due to an improvement on the filtering process. .

Trends in the EU,Spain standardised CPUE series (1998–2011) suggest that the longline vulnerable biomass declined until 2007 and has been variable since (Fig. 2; Ramos-Cartelle et al. 2012).

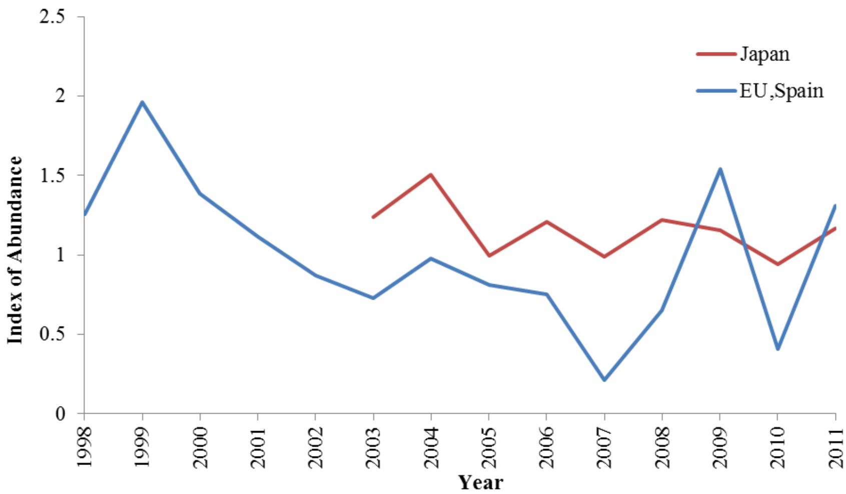


Fig. 2. Oceanic whitetip shark: Comparison of the oceanic whitetip shark standardised CPUE series for the longline fleets of Japan and EU,Spain.

Oceanic whitetip shark: Average weight in the catch by fisheries

Data not available.

Oceanic whitetip shark: 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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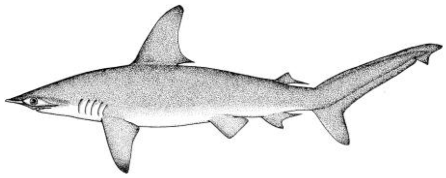
APPENDIX XXIX
EXECUTIVE SUMMARY: SCALLOPED HAMMERHEAD SHARK

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



Status of the Indian Ocean Scalloped Hammerhead Shark (SPL: *Sphyrna lewini*)

TABLE 1. Status of scalloped hammerhead shark (*Sphyrna lewini*) in the Indian Ocean.

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Reported catch 2013: Not elsewhere included (nei) sharks[2]: Average reported catch 2009–2013: Not elsewhere included (nei) sharks[2]:	128 t 46,728 t 91 t 49,318 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2013}/F_{MSY} (80% CI): SB_{2013}/SB_{MSY} (80% CI): SB_{2013}/SB_0 (80% CI):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species.

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)		
Not assessed/Uncertain		

TABLE 2. IUCN threat status of scalloped hammerhead shark (*Sphyrna lewini*) in the Indian Ocean.

Common name	**Scientific name**	**IUCN threat status**[23]		
		Global status	**WIO**	**EIO**
Scalloped hammerhead	*Sphyrna lewini*	Endangered	Endangered	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
Sources: IUCN 2007, Baum 2007

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. The current IUCN threat status of 'Endangered' applies to scalloped hammerhead sharks globally and specifically for the western Indian Ocean (Table 2). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Scalloped hammerhead shark received a low vulnerability ranking (No. 14) in the ERA rank for longline gear because it was estimated as one of the least productive shark species, but was also characterised by a lower susceptibility to longline gear. Scalloped hammerhead shark was estimated as the sixth most vulnerable shark species in the ERA ranking for purse seine gear, but with lower levels of vulnerability compared to longline gear, because the susceptibility was lower for purse seine gear. There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. 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

[23] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

overfishing. 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 **uncertain** (Table 1).

Outlook. Maintaining or increasing effort can result in 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. The following should be noted:

- One of the primary sources 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 ~91 t over the last five years, ~128 t in 2013, maintaining or increasing effort can result in declines in biomass and productivity.
- Mechanisms need to be developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

APPENDIX I

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 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence* sets out the minimum logbook requirements for purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels over 24 metres length overall and those under 24 metres if they fish outside the EEZs of their flag States within the IOTC area of competence. As per this Resolution, catch of all sharks must be recorded (retained and discarded).
- Resolution 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries* prohibits, as an interim pilot measure, the retention onboard, transhipment, landing or storing any part or whole carcass of oceanic whitetip sharks (*Carcharhinus longimanus*) (and requests for all other species) by all vessels on the IOTC record of authorised vessels or authorised to fish for tuna or tuna-like species, with the exception of observers who are permitted to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs) from oceanic whitetip sharks that are dead at haulback and artisanal fisheries for the purpose of local consumption, and will conduct a review and an evaluation of the interim measure in 2016.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on 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.
- 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 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's)* indicated that the provisions, applicable to tuna and tuna-like species, are applicable to shark species.

Extracts from Resolutions 13/03, 13/06, 11/04 and 05/05

RESOLUTION 13/03 ON THE RECORDING OF CATCH AND EFFORT BY FISHING VESSELS IN THE IOTC AREA OF COMPETENCE

Para. 1. Each flag CPC shall ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system.

Para. 8 (start). The flag State and the States which receive this information shall provide all the data for any given year to the IOTC Secretariat by June 30th of the following year on an aggregated basis.

RESOLUTION 13/06 ON A SCIENTIFIC AND MANAGEMENT FRAMEWORK ON THE CONSERVATION OF SHARK SPECIES CAUGHT IN ASSOCIATION WITH IOTC MANAGED FISHERIES

Para. 8. CPCs, especially those targeting sharks, shall submit data for sharks, as required by IOTC data reporting procedures.

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

Para. 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

Resolution 10/02 MANDATORY STATISTICAL REQUIREMENTS FOR IOTC MEMBERS AND COOPERATING NON-CONTRACTING PARTIES (CPC'S)

Para. 3. The provisions, applicable to tuna and tuna-like species, shall also be applicable to the most commonly caught shark species and, where possible, to the less common shark species.

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

Para. 1. CPCs shall annually report data for catches of sharks, in accordance with IOTC data reporting procedures, including available historical data.

Para. 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.

FISHERIES INDICATORS

Scalloped hammerhead shark: 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. Their aggregating habit makes large schools highly vulnerable to fishing. Large CPUEs can be recorded even when stocks are severely depleted (Baum et al. 2007). An assessment of population rebound potential of 26 shark species in the Pacific Ocean ranked *Sphyrna lewini* as one of the species with the poorest ability to recover from increased mortality (Smith et al. 1998). Scalloped hammerhead sharks feeds on pelagic fishes, rays and occasionally other sharks, squids, lobsters, shrimps and crabs. Table 3 outlines some of the key life history traits of scalloped hammerhead shark in the Indian Ocean.

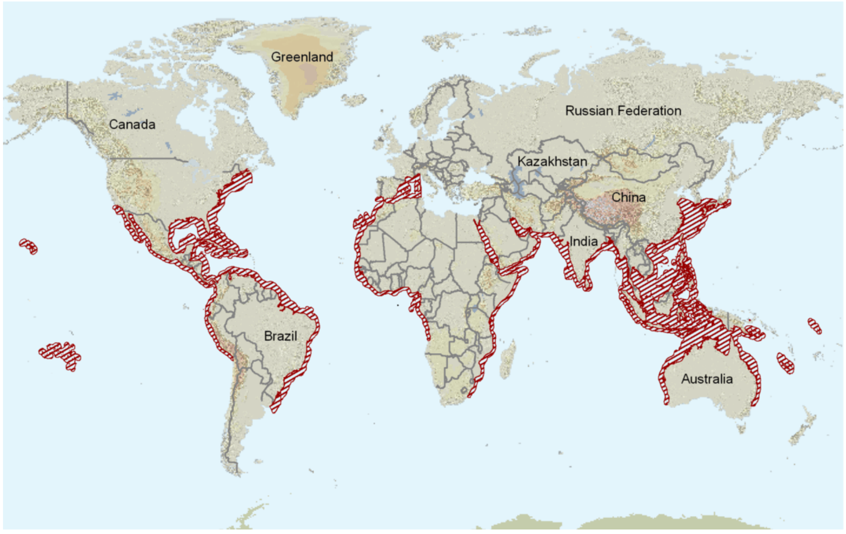


Fig. 1. Scalloped hammerhead shark: The worldwide distribution of the scalloped hammerhead shark (source: www.iucnredlist.org).[24]

[24] Map of distribution in the Indian Ocean is not correctly represent species distribution, which is much wider, including Madagascar, Seychelles – whole Mascarene shoals and islands chain (E. Romanov pers com) and to Maldives (Randall and Anderson 1993).

TABLE 3. Scalloped hammerhead shark: 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.
Growth and 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 Indian Ocean mature at around 140-165 cm TL. Females mature at about 200-220 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 13–41 pups, varying by area. The reproductive cycle is annual and the gestation period is 9–10 months. The nursery areas are in shallow coastal waters. • Fecundity: medium (<41 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 & Lyle 1989, De Bruyn et al. 2005, White et al. 2008, Jorgensen et al. 2009, Kembaren et al. 2013.

Scalloped hammerhead shark: Fisheries

Scalloped hammerhead sharks are often targeted or taken as an incidental bycatch by some semi-industrial, artisanal and recreational fisheries and often for industrial fisheries (pelagic longline tuna and swordfish fisheries and purse seine fishery) (Table 4). There is little information on the fisheries prior to the early 1970s, 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 IUCN assessment for each of the major geographic regions where the scalloped hammerhead occurs (Baum et al. 2007), suggests a 64% decline in abundance over the study period, based largely on the observations by De Bruyn et al. (2005) and Dudley & Simpfendorfer (2006) which indicate that in localised areas of the western Indian Ocean catch-per-unit-effort of *Sphyrna lewini* declined significantly from 1978–2003 in shark net catches off the beaches of Kwa-Zulu Natal, South Africa. It observed that *Sphyrna lewini* is captured throughout much of its range in the Indian Ocean, including illegal targeting of the species in several areas. Landings reported to FAO by Oman, surveys of landings sites in Oman and interviews with fishers also suggest that catches of *Sphyrna lewini* have declined substantially (IUCN 2007, Baum op. cit. 2007). The species faces heavy fishing pressure in the region, and similar declines in abundance are also inferred in other areas of its range. Papers presented at IOTC WPEB in 2013 show harvesting of scalloped hammerhead neonates and juvenile pups in the artisanal fisheries of both Kenya and Indonesia.

The practice of shark finning is considered to be regularly occurring and on the increase for this species (Clarke et al. 2006, Clarke 2008, Holmes et al. 2009) and the bycatch/release injury rate is unknown but probably high.

TABLE 4. 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

Scalloped hammerhead shark: Catch trends

The catch estimates for scalloped hammerhead (Table 5) are highly uncertain as is their utility in terms of minimum catch estimates. Five CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), I.R. Iran, South Africa, and Sri Lanka) while thirteen CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Rep. of Korea, Indonesia, Malaysia, Oman, Seychelles, Mauritius, Philippines, UK-territories, Vanuatu).

TABLE 5. Catch estimates for scalloped hammerhead shark* in the Indian Ocean for 2011 to 2013.

Catch		**2011**	**2012**	**2013**
Most recent catch (reported)	Scalloped hammerhead shark	90 t	80 t	128 t
	nei-sharks	53,658 t	42,793 t	46,728 t
Mean catch (reported) over the last 5 years (2009–2013)	Scalloped hammerhead shark		74 t	91 t
	nei-sharks		48,708 t	49,318 t

* catches likely to be misidentified with the smooth hammerhead shark (*S. zygaena*) which is an oceanic species. Nei-sharks: sharks not elsewhere included.

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 2012 two countries reported catches of scalloped hammerhead sharks in the IOTC region.

A recent project estimated possible hammerhead shark catches for fleets/countries based on the ratio of shark catch over target species by metier (Murua et al 2013). The estimation was done using target species nominal catch from the IOTC database and assuming that target catches have been accurately declared. The estimated catch from this study highlighted that the possible underestimation of oceanic whitetip shark in the IOTC database is considerable (i.e. the estimated catch is around 80 times higher than the declared/report and contained in the IOTC database). Although this figure needs to be further investigated, it gives a global figure of the level of underreporting for oceanic whitetip in shark in the Indian Ocean.

Scalloped hammerhead shark: 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 nominal catch rates over the period 1984–2006 (John & Varghese 2009). Nominal CPUE in South African protective net shows steady decline from 1978.

Scalloped hammerhead shark: Average weight in the catch by fisheries

Data not available.

Scalloped hammerhead shark: 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.

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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 (SMA: *Isurus oxyrinchus*)

TABLE 1. Shortfin mako shark: Status of shortfin mako shark (*Isurus oxyrinchus*) in the Indian Ocean.

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Reported catch 2013: Not elsewhere included (nei) sharks[2]: Average reported catch 2009–2013: Not elsewhere included (nei) sharks[2]:	1,572 t 46,728 t 1,364 t 49,318 t	**Uncertain**
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2013}/F_{MSY} (80% CI): SB_{2013}/SB_{MSY} (80% CI): SB_{2013}/SB_0 (80% CI):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species.

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		

TABLE 2. Shortfin mako shark: IUCN threat status of shortfin mako shark (*Isurus oxyrinchus*) in the Indian Ocean.

Common name	Scientific name	IUCN threat status[25]		
		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, Cailliet 2009

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about the relationship between abundance, the standardised CPUE series, and total catches over the past decade (Table 1). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Shortfin mako sharks received the highest vulnerability ranking (No. 1) in the ERA rank for longline gear because it was characterised as one of the least productive shark species, and with a high susceptibility to longline gear. Shortfin mako shark was estimated as the third most vulnerable shark species in the ERA ranking for purse seine gear, but with lower levels of vulnerability compared to longline gear, because the susceptibility was lower for purse seine gear. The current IUCN threat status of 'Vulnerable' applies to shortfin mako sharks globally (Table 2). Trends in the Japanese standardised CPUE series from its longline fleet suggest that the biomass has declined from 1994 to 2003, and has been increasing since then. Trends in EU,Portugal longline standardised CPUE series suggest that the biomass has declined from 1999 to 2004, and has been increasing since then. There is a paucity of information available on this species, but this situation has been improving in recent years. Shortfin mako sharks are commonly taken by a range of fisheries in the Indian Ocean.

[25] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

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 can be vulnerable to overfishing. There is no quantitative stock assessment currently available for shortfin mako shark in the Indian Ocean therefore the stock status is **uncertain**.

Outlook. Maintaining or increasing effort can 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 shortfin mako shark will decline in these areas in the near future, and may result in localised depletion. The following should be noted:

- The two primary sources of data that drive the assessment, total catches and CPUE are uncertain and should be investigated further as a priority.
- Noting that current reported catches are estimated (probably largely underestimated) at an average ~1,364 t over the last five years, ~1,572 t in 2013, maintaining or increasing effort can result in declines in biomass, productivity and CPUE.
- Mechanisms need to be developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

APPENDIX I

SUPPORTING INFORMATION

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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 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence* sets out the minimum logbook requirements for purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels over 24 metres length overall and those under 24 metres if they fish outside the EEZs of their flag States within the IOTC area of competence. As per this Resolution, catch of all sharks must be recorded (retained and discarded).
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Extracts from Resolutions 13/03, 13/06, 11/04 and 05/05

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Para. 1. Each flag CPC shall ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system.

Para. 8 (start). The flag State and the States which receive this information shall provide all the data for any given year to the IOTC Secretariat by June 30th of the following year on an aggregated basis.

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Para. 3. The provisions, applicable to tuna and tuna-like species, shall also be applicable to the most commonly caught shark species and, where possible, to the less common shark species.

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Para. 1. CPCs shall annually report data for catches of sharks, in accordance with IOTC data reporting procedures, including available historical data.

Para. 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.

FISHERIES INDICATORS

Shortfin mako shark: 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 3 outlines some of the key life history traits of shortfin mako shark in the Indian Ocean.

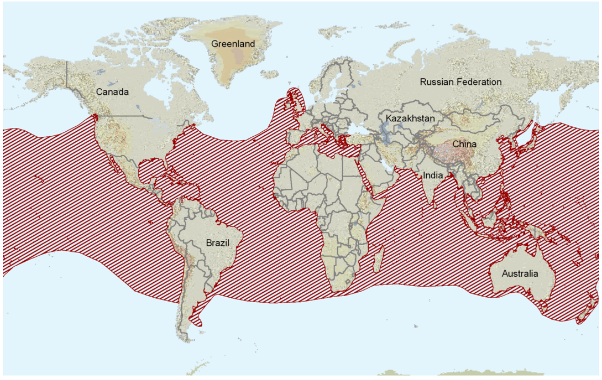

Fig. 1. Shortfin mako shark: The worldwide distribution of the shortfin mako shark (source: www.iucnredlist.org).

TABLE 3. Shortfin mako shark: 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%)	In the western South Indian Ocean, individuals were estimated to mature at about 250 cm FL or 15 years for females and 190 cm FL or 7 years for males. In other oceans sexual maturity is estimated to be reached at 18-19 years or 290-300 cm TL for females and 8 years or about 200 cm TL for males in the western North Atlantic and 19-21 years or 207-290 cm TL for females and 7-9 years or 180-190 cm TL for males in the western South Pacific. 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 9 to 14 pups, 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. • 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 South African waters females reached 311.3 cm FL (not aged) compared with 299 cm for males (17 years). In the tropical 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 * $FL^{2.76544}$. In South Africa von Bertalanffy growth model parameters were estimated as L_0=90.4 cm, L_∞=285.4 cm, and k=0.113y^{-1}. New-born pups are around 70 cm (TL).

Sources: Bass et al. 1973, Mollet et al. 2000, Mejuto et al. 2005, White 2007, Romanov & Romanova 2009, Groeneveld et al. 2014

Shortfin mako shark: 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) (Table 4). 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 1970s, 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.

Preliminary estimations of at-vessel haulback mortality showed that 56% of the shortfin mako shark specimens captured in longline fisheries targeting swordfish in the Indian Ocean are dead at the time of haulback (Table 4). The effects of size on the mortality rates have not been studied in the Indian Ocean, but were significant in the Atlantic Ocean with larger specimens having higher changes of surviving after capture (at-haulback) (Coelho et al. 2012).

TABLE 4. Shortfin mako shark: 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
At-vessel mortality	unknown	13 to 56 %	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

Shortfin mako shark: Catch trends

The catch estimates for shortfin mako shark (Table 5) are highly uncertain as is their utility in terms of minimum catch estimates. Five CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), I.R. Iran, South Africa, and Sri Lanka while thirteen CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Indonesia, Japan, Rep. of Korea, Malaysia, Mozambique, Oman, Seychelles, Mauritius, Philippines, UK-territories, Vanuatu). For CPCs reporting longline data by species (i.e. Australia,EU (Spain, Portugal, United Kingdom) and South Africa), 11.4% of the catch of sharks by longliners, all targeting swordfish, were shortfin mako sharks.

TABLE 5. Shortfin mako shark: Catch estimates for shortfin mako shark in the Indian Ocean for 2011 to 2013.

Catch		2011	2012	2013
Most recent catch (report)	Shortfin mako shark	1,489 t	1,426 t	1,572 t
	nei-sharks	53,658 t	42,793 t	46,728 t
Mean catch (reported) over the last 5 years (2009–2013)	Shortfin mako shark		1,300 t	1,364 t
	nei-sharks		48,708 t	49,318 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 2013, ten countries reported catches of shortfin mako sharks in the IOTC region.

Shortfin mako shark: Nominal and standardised CPUE Trends

Statistics not available at the IOTC Secretariat.

Historical data shows an overall decline in nominal CPUE and mean weight of mako sharks (Romanov et al. 2008). Nominal CPUE in South African protection net has been fluctuating without any trend (Holmes et al. 2009). The standardised CPUE series of shortfin mako catches by the Portuguese longline fleet in the Indian Ocean showed some significant variability between 1999–2012, with a declining trend from 1999 to 2004 and an increasing trend in more recent years until 2012 (Fig. 2; Coelho et al. 2013).

The Japanese standardised CPUE series (Fig. 2) suggest that the biomass declined from 1994 to 2003, and increased until 2010 with substantial fluctuations. (Kimoto et al. 2011).

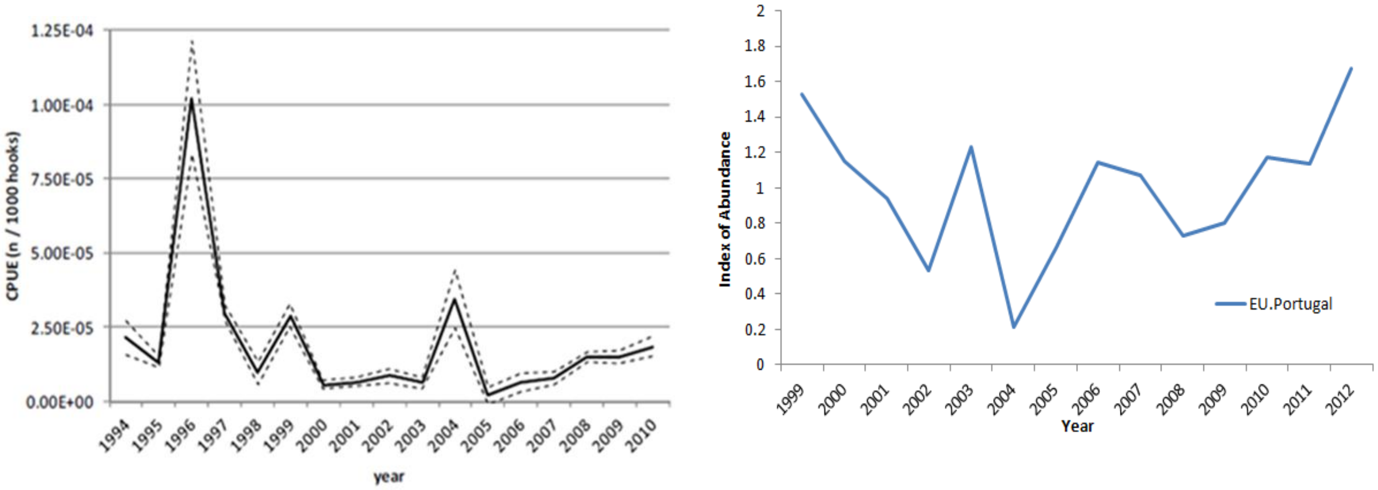

Fig. 2. Shortfin mako shark: Standardised longline CPUE series for shortfin mako shark in the Indian Ocean for the Japanese fleet (1994–2010) (left) and the EU,Portugal fleets (1999–2012) (right).

Shortfin mako shark: Average weight in the catch by fisheries

Data not available.

Shortfin mako shark: 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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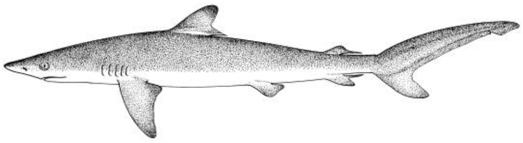
APPENDIX XXXI
EXECUTIVE SUMMARY: SILKY SHARK

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



Status of the Indian Ocean silky shark (FAL: *Carcharhinus falciformis*)

TABLE 1. Silky shark: Status of silky shark (*Carcharhinus falciformis*) in the Indian Ocean.

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Reported catch 2013: Not elsewhere included (nei) sharks[2]: Average reported catch 2009–2013: Not elsewhere included (nei) sharks[2]:	3,573 t 46,728 t 3,843 t 49,318 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2013}/F_{MSY} (80% CI): SB_{2013}/SB_{MSY} (80% CI): SB_{2013}/SB_0 (80% CI):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species.

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		

TABLE 2. Silky shark: IUCN threat status of silky shark (*Carcharhinus falciformis*) in the Indian Ocean.

Common name	Scientific name	IUCN threat status[26]		
		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, 2012

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about the relationship between abundance and the nominal CPUE series from the main longline fleets, and about the total catches over the past decade (Table 1). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Silky shark received a high vulnerability ranking (No. 4) in the ERA rank for longline gear because it was estimated as one of the least productive shark species, and with a high susceptibility to longline gear. Silky shark was estimated as the second most vulnerable shark species in the ERA ranking for purse seine gear, due to its low productivity and high susceptibility for purse seine gear. The current IUCN threat status of 'Near Threatened' applies to silky sharks in the western and eastern Indian Ocean and globally (Table 2). There is a paucity of information available on this species but several recent studies have been carried out for this species in the recent years. 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 can be vulnerable to overfishing. Despite the lack of data, there is some anecdotal information suggesting that silky shark abundance has declined over recent decades, including from Indian longline research surveys, which is described in the full Executive Summary for silky shark sharks. There is no

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quantitative stock assessment or basic fishery indicators currently available for silky shark in the Indian Ocean therefore the stock status is **uncertain**.

Outlook. Maintaining or increasing effort can 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 following should be noted:

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FISHERIES INDICATORS

Silky sharks: 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 3 outlines some of the key life history traits of silky shark in the Indian Ocean.

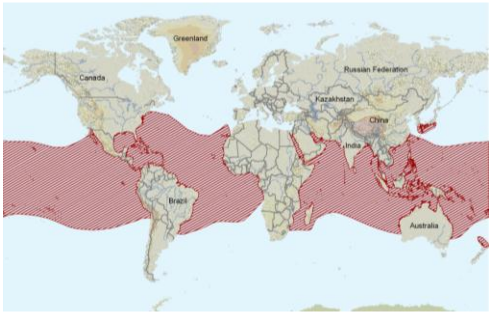

Fig. 1. The worldwide distribution of the silky shark (source: www.iucnredlist.org).

TABLE 3. Silky shark: 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 can reach 350 cm long. In the Pacific area it was estimated to be around 25 years. 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 Indian Ocean it has been estimated to be around 15 years for females and 13 years for males. 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: 215 cm TL for females; 207 cm TL for males in the Eastern Indian Ocean. 239 cm TL for males; 216 cm TL for females in Aldabra atoll. In South Africa: 240cm TL for males and 248-260cm 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 around 350 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 Africa. Length–weight relationship for both sexes combined in the Indian Ocean is TW=0.160*10-4 * $FL^{2.91497}$.

Sources: Strasburg 1958, Bass et al. 1973, Stevens 1984, Anderson & Ahmed 1993, Compagno & Niem 1998, Smith et al. 1998, Mejuto et al. 2005, Matsunaga 2007, Romanov & Romanova 2009, Hall et al. 2012

Silky sharks: 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) (Table 4). 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 et al. 2006, Clarke 2008) and the bycatch/release injury rate is unknown but probably high.

TABLE 4. Silky shark: 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	81% (85% brailed individuals, 18% meshed individuals).	unknown	unknown	unknown	unknown	unknown

Sources: Romanov 2002, 2008, Ariz et al. 2006, Peterson et al. 2008, Romanov et al. 2008, Poisson 2014

Silky sharks: Catch trends

The nominal catches for silky shark reported to the IOTC Secretariat are highly uncertain as is their utility in terms of minimum catch estimates (Table 5). Five CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), I.R. Iran, South Africa, and Sri Lanka) while thirteen CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Indonesia, Japan, Rep. of Korea, Malaysia, Mozambique, Oman, Philippines, Seychelles, Mauritius, UK-territories, Vanuatu). For CPCs reporting longline data by species (i.e. Australia, EU (Spain, Portugal), United Kingdom and South Africa), 0.1% of the catch of sharks by longliners, all targeting swordfish, were silky sharks, and for CPCs reporting gillnet data by species, I.R. Iran 25% and Sri Lanka 11% of the catches of shark were silky sharks.

TABLE 5. Silky shark: Catch estimates for silky shark in the Indian Ocean for 2011 to 2013.

Catch		2011	2012	2013
Most recent catch (reported)	Silky shark	4,490 t	4,177 t	3,573 t
	nei-sharks	53,658 t	42,793 t	46,728 t
Mean catch (reported) over the last 5 years (2009–2013)	Silky shark		3,443 t	3,843 t
	nei-sharks		48,708 t	49,318 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 2013, six countries reported catches of silky sharks in the IOTC region.

A recent project estimated possible silky shark catches for fleets/countries based on the ratio of shark catch over target species by metier (Murua et al 2013). The estimation was done using target species nominal catch from the IOTC database and assuming that target catches have been accurately declared. The estimated catch from this study highlighted that the possible underestimation of silky shark in the IOTC database is considerable (i.e. the estimated catch is around 10 times higher than the declared/report and contained in the IOTC database). Another study estimated the amount of silky shark entanglement in the nets underneath FADs is much higher than previously thought, in a range between 480,000 and 960,000 individuals per year, assuming a presence of between 3,750 and 7,500 active

FADs (Filmater et al. 2013). The authors also acknowledged that solutions exist to mitigate the problem excluding meshed materials in the subsurface structure of the FAD as the European purse seine fleet is being implementing currently and it is agreed by IOTC Commission with the Resolution 13/08 *Procedures on a fish aggregating devices (FADs) management plan*, including more detailed specifications of catch reporting from FAD sets, and the development of improved FAD designs to reduce the incidence of entanglement of non-target species.

Silky sharks: Nominal and standardised CPUE Trends

Data not available at the IOTC Secretariat. However, Maldivian shark fishermen have reported significant declines in silky shark abundance (Anderson 2009). In addition, Indian longline research surveys, in which silky sharks contributed 7% of catch, demonstrate declining nominal 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 2005.

Silky sharks: Average weight in the catch by fisheries

Data not available.

Silky sharks: 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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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 (BTH: *Alopias superciliosus*)

TABLE 1. Bigeye thresher shark: Status bigeye thresher shark (*Alopias superciliosus*) in the Indian Ocean.

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Reported catch 2013: Not elsewhere included (nei) sharks[2]: Average reported catch 2009–2013: Not elsewhere included (nei) sharks[2]:	0 t 46,728 t 75 t 49,318 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2013}/F_{MSY} (80% CI): SB_{2013}/SB_{MSY} (80% CI): SB_{2013}/SB_0 (80% CI):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species.

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		

TABLE 2. Bigeye thresher shark: IUCN threat status of bigeye thresher shark (*Alopias superciliosus*) in the Indian Ocean.

Common name	Scientific name	IUCN threat status[27]		
		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, Amorim et al. 2009

NOTE: IOTC Resolution 12/09 *On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence*, prohibits retention onboard, transhipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family Alopiidae[28].

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty in the stock status due to lack of information necessary for assessment or for the development of other indicators of the stock (Table 1). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Bigeye thresher shark received a high vulnerability ranking (No. 2) in the ERA rank for longline gear because it was characterised as one of the least productive shark species, and highly susceptible to longline gear. Despite its low productivity, bigeye thresher shark has a low vulnerability ranking to purse seine gear due to its low susceptibility for this particular gear. The current IUCN threat status of 'Vulnerable' applies to bigeye thresher shark globally (Table 2). There is a paucity

[27] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only
[28] Scientific observers shall be allowed to collect biological samples from thresher sharks that are dead at haulback, provided that the samples are part of the research project approved by the Scientific Committee (or the Working Party on Ecosystems and Bycatch).

of information available on this species and this situation is not expected to improve in the short to medium term. 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 9–3 years, and have few offspring (2–4 pups every year), the bigeye thresher shark is vulnerable to overfishing. 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 **uncertain**.

Outlook. Current longline fishing effort is directed to other species, however bigeye thresher sharks is a common bycatch in 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 may be largely ineffective for species conservation. Maintaining or increasing effort, with associated fishing mortality, can result in declines in biomass, productivity and CPUE. However there are few data to estimate CPUE trends, in view of IOTC Resolution 12/09 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 following should be noted:

- Two important sources of data that inform the assessment, total catches and CPUE are highly uncertain or not available, and should be investigated further as a priority.
- Noting that current catches (probably largely underestimated) are estimated at an average ~97 t over the last five years, ~0 t in 2013, maintaining or increasing effort can result in declines in biomass, productivity and CPUE.
- Mechanisms need to be developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

APPENDIX I

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 are currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence* sets out the minimum logbook requirements for purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels over 24 metres length overall and those under 24 metres if they fish outside the EEZs of their flag States within the IOTC area of competence. As per this Resolution, catch of all sharks must be recorded (retained and discarded).
- Resolution 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries* prohibits, as an interim pilot measure, the retention onboard, transhipment, landing or storing any part or whole carcass of oceanic whitetip sharks (*Carcharhinus longimanus*) (and requests for all other species) by all vessels on the IOTC record of authorised vessels or authorised to fish for tuna or tuna-like species, with the exception of observers who are permitted to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs) from oceanic whitetip sharks that are dead at haulback and artisanal fisheries for the purpose of local consumption, and will conduct a review and an evaluation of the interim measure in 2016.
- Resolution 12/09 *On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence* prohibits 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 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.
- Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's)* indicated that the provisions, applicable to tuna and tuna-like species, are applicable to shark species.
- 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.

Extracts from Resolutions 13/03, 13/06, 12/09, 11/04 and 05/05

RESOLUTION 13/03 ON THE RECORDING OF CATCH AND EFFORT BY FISHING VESSELS IN THE IOTC AREA OF COMPETENCE

Para. 1. Each flag CPC shall ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system.

Para. 8 (start). The flag State and the States which receive this information shall provide all the data for any given year to the IOTC Secretariat by June 30th of the following year on an aggregated basis.

RESOLUTION 13/06 ON A SCIENTIFIC AND MANAGEMENT FRAMEWORK ON THE CONSERVATION OF SHARK SPECIES CAUGHT IN ASSOCIATION WITH IOTC MANAGED FISHERIES

Para. 8. CPCs, especially those targeting sharks, shall submit data for sharks, as required by IOTC data reporting procedures.

RESOLUTION 12/09 ON THE CONSERVATION OF THRESHER SHARKS (FAMILY ALOPIIDAE) CAUGHT IN ASSOCIATION WITH FISHERIES IN THE IOTC AREA OF COMPETENCE

Para. 2 Fishing Vessels flying the flag of an IOTC Member or Cooperating non-Contracting Party (CPCs) are prohibited 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, with the exception of paragraph 7.

Para. 3 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.

Para. 4 CPCs shall encourage their fishers to record and report 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

Para. 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

Resolution 10/02 MANDATORY STATISTICAL REQUIREMENTS FOR IOTC MEMBERS AND COOPERATING NON-CONTRACTING PARTIES (CPC'S)

Para. 3. The provisions, applicable to tuna and tuna-like species, shall also be applicable to the most commonly caught shark species and, where possible, to the less common shark species.

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

Para. 1. CPCs shall annually report data for catches of sharks, in accordance with IOTC data reporting procedures, including available historical data.

Para. 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.

FISHERIES INDICATORS

Bigeye thresher shark: 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 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 the continental slopes (Compagno 2001). Bigeye thresher can be found near the surface, and has even been recorded in the intertidal zone, but it is most commonly found at depths greater than 100m, often reaching 500 m and has even been recorded at a depth of 723 m (Compagno 2001, Nakano et al. 2003). There is currently no information on the predation of bigeye thresher sharks, however they may be preyed upon by makos, white sharks, and killer whales. Fishing is the major contributor to adult mortality. This species uses its long tail to attack prey (Compagno 2001, Aalbers et al. 2010). Table 3 outlines some of the key life history traits of bigeye thresher sharks in the Indian Ocean.

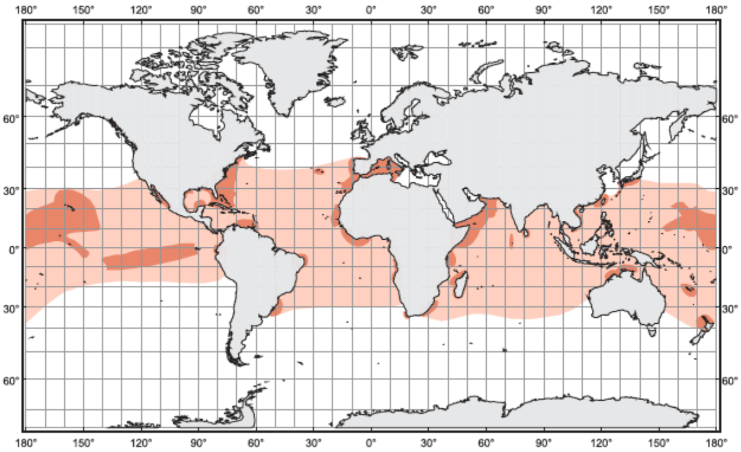

Fig. 1. Bigeye thresher shark: The worldwide distribution of the bigeye thresher shark (source: FAO).

TABLE 3. Bigeye thresher shark: 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.
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)
Reproduction	Bigeye thresher shark is an aplacental viviparous with oophagy species. • Fecundity: very low (2–4) •, Size at birth 130-150 cm TL • 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, or 0.002–0.009.
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: Chen et al. 1997, Lui et al. 1998, Compagno 2001, Nakano et al. 2003, Weng & Block 2004, Amorim et al. 2007, White 2007, Cortés 2008, Dulvy et al. 2008, Smith et al. 2008, Stevens et al. 2010, Fernandez-Carvalho et al. 2011, Fernandez-Carvalho et al. in press

Bigeye thresher shark: 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) (Table 4). Typically, the size range elected by the fisheries is between 140–210 cm FL or 40-120 kg (Romanov pers comm). In Australia thresher sharks used to be targeted by 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 1970s. 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 IOTC Resolution 12/09. The practice of shark finning is considered to be regularly occurring and on the increase for this species (Clarke et al. 2006, Clarke 2008). The post-release mortality is unknown but probably high. In longline fisheries bigeye thresher sharks are often hooked by the tail (Compagno 2001, Romanov pers comm) and die soon afterward. Therefore they are usually discarded dead if not retained. In most cases discarded sharks are not recorded in fisheries logbooks. Therefore the current measures (notably Resolution 12/09) 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 4. Bigeye thresher shark: 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.

Bigeye thresher shark: Catch trends

The catch estimates for bigeye thresher shark are highly uncertain, as is their utility in terms of minimum catch estimates (Table 5). Five CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), I.R. Iran, South Africa, and Sri Lanka) while thirteen CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Indonesia, Japan, Rep. of Korea, Malaysia, Mozambique, Oman, Philippines, Seychelles, Mauritius, UK-territories, Vanuatu).

TABLE 5. Bigeye thresher shark: Catch estimates for bigeye thresher shark in the Indian Ocean for 2011 to 2013.

Catch		**2011**	**2012**	**2013**
Most recent catch (reported)	bigeye thresher	5 t	465 t	0 t
	nei-sharks	53,658 t	42,793 t	46,728 t
Mean catch (reported) over the last 5 years (2009–2013)	bigeye thresher		98 t	75 t
	nei-sharks		48,708 t	49,318 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 2012, one country reported catches of bigeye thresher sharks in the IOTC area of competence.

A recent project estimated possible thresher shark catches for fleets/countries based on the ratio of shark catch over target species by metier (Murua et al 2013). The estimation was done using target species nominal catch from the IOTC database and assuming that target catches have been accurately declared. The estimated catch from this study highlighted that the possible underestimation of thresher shark in the IOTC database is considerable (i.e. the estimated catch is around 70 times higher than the declared/report and contained in the IOTC database).

Bigeye thresher shark: 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 nominal CPUE and mean weight of thresher sharks (Romanov pers comm).

Bigeye thresher shark: Average weight in the catch by fisheries

Data not available.

Bigeye thresher shark: 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
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Status of the Indian Ocean pelagic thresher shark (PTH: *Alopias pelagicus*)

TABLE 1. Pelagic thresher shark: Status pelagic thresher shark (*Alopias pelagicus*) in the Indian Ocean.

Area[1]	**Indicators**		**2014 stock status determination**
Indian Ocean	Reported catch 2013: Not elsewhere included (nei) sharks[2]: Average reported catch 2009–2013: Not elsewhere included (nei) sharks[2]:	0 t 46,728 t 75 t 49,318 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2013}/F_{MSY} (80% CI): SB_{2013}/SB_{MSY} (80% CI): SB_{2013}/SB_0 (80% CI):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species.

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)		
Not assessed/Uncertain		

TABLE 2. Pelagic thresher shark: IUCN threat status of pelagic thresher shark (*Alopias pelagicus*) in the Indian Ocean.

Common name	**Scientific name**	**IUCN threat status**[29]		
		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, Reardon et al. 2009

NOTE: IOTC Resolution 12/09 *On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence*, prohibits retention onboard, transhipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family Alopiidae[30].

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. 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 (Table 1). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Pelagic thresher shark received a high vulnerability ranking (No. 3) in the ERA rank for longline gear because it was characterised as one of the least productive shark species, and with a high susceptibility to longline gear. Despite its low productivity, pelagic thresher shark has a low vulnerability ranking to purse seine gear due to its low susceptibility for this

[29] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only
[30] Scientific observers shall be allowed to collect biological samples from thresher sharks that are dead at haulback, provided that the samples are part of the research project approved by the Scientific Committee (or the Working Party on Ecosystems and Bycatch).

particular gear. The current IUCN threat status of 'Vulnerable' applies to pelagic thresher shark globally (Table 2). There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. 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. 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 **uncertain.**

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 may be largely ineffective for species conservation. Maintaining or increasing effort can result in declines in biomass, productivity and CPUE. However there are few data to estimate 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 following should be noted:

- Two important sources of data that inform the assessment, total catches and CPUE are uncertain or unavailable, and should be investigated further as a priority.
- Noting that current catches (probably largely underestimated) are estimated at an average ~75 t over the last five years ~0 t in 2013, maintaining or increasing effort can result in declines in biomass, productivity and CPUE.
- Mechanisms need to be developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

APPENDIX I

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 are currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence* sets out the minimum logbook requirements for purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels over 24 metres length overall and those under 24 metres if they fish outside the EEZs of their flag States within the IOTC area of competence. As per this Resolution, catch of all sharks must be recorded (retained and discarded).
- Resolution 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries* prohibits, as an interim pilot measure, the retention onboard, transhipment, landing or storing any part or whole carcass of oceanic whitetip sharks (*Carcharhinus longimanus*) (and requests for all other species) by all vessels on the IOTC record of authorised vessels or authorised to fish for tuna or tuna-like species, with the exception of observers who are permitted to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs) from oceanic whitetip sharks that are dead at haulback and artisanal fisheries for the purpose of local consumption, and will conduct a review and an evaluation of the interim measure in 2016.
- Resolution 12/09 *On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence* prohibits 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 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.
- Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's)* indicated that the provisions, applicable to tuna and tuna-like species, are applicable to shark species.
- 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.

Extracts from Resolutions 13/03, 13/06, 12/09, 11/04 and 05/05

RESOLUTION 13/03 ON THE RECORDING OF CATCH AND EFFORT BY FISHING VESSELS IN THE IOTC AREA OF COMPETENCE

Para. 1. Each flag CPC shall ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system.

Para. 8 (start). The flag State and the States which receive this information shall provide all the data for any given year to the IOTC Secretariat by June 30th of the following year on an aggregated basis.

RESOLUTION 13/06 ON A SCIENTIFIC AND MANAGEMENT FRAMEWORK ON THE CONSERVATION OF SHARK SPECIES CAUGHT IN ASSOCIATION WITH IOTC MANAGED FISHERIES

Para. 8. CPCs, especially those targeting sharks, shall submit data for sharks, as required by IOTC data reporting procedures**.**

RESOLUTION 12/09 ON THE CONSERVATION OF THRESHER SHARKS (FAMILY ALOPIIDAE) CAUGHT IN ASSOCIATION WITH FISHERIES IN THE IOTC AREA OF COMPETENCE

Para. 2 Fishing Vessels flying the flag of an IOTC Member or Cooperating non-Contracting Party (CPCs) are prohibited 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, with the exception of paragraph 7.

Para. 3 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.

Para. 4 CPCs shall encourage their fishers to record and report 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

Para. 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

Resolution 10/02 MANDATORY STATISTICAL REQUIREMENTS FOR IOTC MEMBERS AND COOPERATING NON-CONTRACTING PARTIES (CPC'S)

Para. 3. The provisions, applicable to tuna and tuna-like species, shall also be applicable to the most commonly caught shark species and, where possible, to the less common shark species.

RESOLUTION 05/05 CONCERNING THE CONSERVATION OF SHARKS CAUGHT IN ASSOCIATION WITH FISHERIES MANAGED BY IOTC

Para. 1. CPCs shall annually report data for catches of sharks, in accordance with IOTC data reporting procedures, including available historical data.

Para. 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.

FISHERIES INDICATORS

Pelagic thresher shark: General

The Pelagic thresher shark (*Alopias pelagicus*) is commonly found in pelagic coastal and oceanic waters throughout the tropical Indo-Pacific (Fig. 1). This species is often confused with common thresher shark (*Alopias vulpinus*), which is a predominantly temperate species and often misidentified. In fact most tropical records of common thresher sharks in the Indo-Pacific are considered to be misidentified pelagic threshers. Due to identification issues, the actual distribution and biology of pelagic and common thresher sharks are poorly known. The pelagic thresher is thought to be highly migratory and epipelagic, found in surface waters to depths of 300 m (Compagno 2001). It aggregates around seamounts and continental slopes (Compagno 2001). There is little information on the predation of pelagic thresher sharks, however being the smallest species among thresher sharks it may well 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 uses its long tail to attack prey (Compagno 2001, Aalbers et al. 2010). Table 3 outlines some of the key life history traits of pelagic thresher shark in the Indian Ocean.

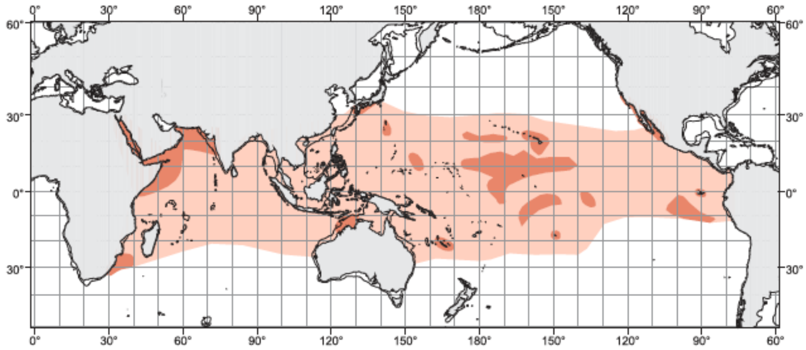

Fig. 1. Pelagic thresher shark: The worldwide distribution of the pelagic thresher shark (source: FAO).

TABLE 3. Pelagic thresher shark: 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) 240-275 (TL) and females at 280-290 cm TL.
Reproduction	Pelagic thresher shark is an ovoviviparous species, without a placental attachment. • Fecundity: very low (2) •, Size at birth: 130-140 cm TL • 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
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: Lui et al. 1998, Compagno 2001, Reardon et al. 2004, White 2007, Dulvy et al. 2008

Pelagic thresher shark: Fisheries

Pelagic thresher shark are often targeted by some recreational, semi-industrial and artisanal fisheries and are also taken as bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries) (Table 4). The typical size of pelagic thresher caught ranges from 120–190 cm FL or 20–90 kg (Romanov pers comm). In Australia thresher sharks used to be targeted by 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 1970s. 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 IOTC Resolution 12/09. The practice of shark finning is considered to be regularly occurring and on the increase for this species (Clarke et al. 2006, Clarke 2008). The bycatch/release mortality rate is unknown but probably high. In longline fisheries pelagic thresher sharks are often hooked by the tail (Compagno 2001) and die soon afterward. Therefore they are usually discarded dead if not retained. In most cases discarded sharks are not recorded in fisheries logbooks. Therefore the current IOTC measures (notably Resolution 12/09) 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. The common confusion between the common and pelagic thresher sharks creates difficulties for data enumerators and means there is a high degree of uncertainty associated with the species-specific data reported.

TABLE 4. Pelagic thresher shark: 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

Pelagic thresher shark: Catch trends

The catch estimates for pelagic thresher shark (Table 5) are uncertain as is their utility in terms of minimum catch estimates. Five our CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), I.R. Iran. South Africa, and Sri Lanka) while thirteen CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Indonesia, Japan, Rep. of Korea, Malaysia, Mozambique, Oman, Philippines, Seychelles, Mauritius, UK-territories, Vanuatu).

TABLE 5. Pelagic thresher shark: Catch estimates for pelagic thresher shark in the Indian Ocean for 2011 to 2013.

Catch		2011	2012	2013
Most recent catch (reported)	pelagic thresher	17 t	328 t	0 t
	nei-sharks	53,658 t	42,793 t	46,728 t
Mean catch (reported) over the last 5 years (2009–2013)	pelagic thresher		76 t	75 t
	nei-sharks		48,708 t	49,318 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 2012, one country reported catches of pelagic thresher sharks in the IOTC region.

A recent project estimated possible thresher shark catches for fleets/countries based on the ratio of shark catch over target species by metier (Murua et al 2013). The estimation was done using target species nominal catch from the IOTC database and assuming that target catches have been accurately declared. The estimated catch from this study highlighted that the possible underestimation of thresher shark in the IOTC database is considerable (i.e. the estimated catch is around 70 times higher than the declared/report and contained in the IOTC database).

Pelagic thresher shark: 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 nominal CPUE and mean weight of thresher sharks (Romanov pers com).

Pelagic thresher shark: Average weight in the catch by fisheries

Data not available.

Pelagic thresher shark: 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
EXECUTIVE SUMMARY: MARINE TURTLES

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
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Status of marine turtles in the Indian Ocean

TABLE 1. Marine turtles: 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[31]
Flatback turtle	*Natator depressus*	Data deficient
Green turtle	*Chelonia mydas*	Endangered
Hawksbill turtle	*Eretmochelys imbricata*	Critically Endangered
Leatherback turtle	*Dermochelys coriacea*	Vulnerable
Loggerhead turtle	*Caretta caretta*	Endangered
Olive Ridley turtle	*Lepidochelys olivacea*	Vulnerable

Sources: Marine Turtle Specialist Group 1996, Red List Standards & Petitions Subcommittee 1996, Sarti Martinez (Marine Turtle Specialist Group) 2000, Seminoff 2004, Abreu-Grobois & Plotkin 2008, Mortimer et al. 2008, IUCN 2014

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 is likely to be substantial as shown by the Ecological Risk Assessment undertaken in 2012/13, and an order of magnitude higher than longline and purse seine gears for which mitigation measures are in place.

Outlook. Resolution 12/04 *On the conservation of marine turtles* includes an annual evaluation requirement (para. 17) by the Scientific Committee. However, given the lack of reporting of marine turtle interactions by CPCs to date, such an evaluation cannot not be undertaken. Unless IOTC CPCs become compliant with the data collection and reporting requirements for marine turtles, the WPEB and the SC 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 following should be noted:

- The available evidence indicates considerable risk to 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 interactions are known to be a severe underestimate: 39 interactions reported in 2010 by 3 CPCs.
- The Ecological Risk Assessment conducted by Nel et al. (2013) concluded that, from the limited data received on longlining and purse seining, the former posed the greater apparent risk to marine turtles. The ERA estimated that ~3,500 marine turtles are caught by longliners annually, followed by ~250 turtles p.a. in purse seine operations. Two separate approaches to estimate gillnet impacts on marine turtles, based on very limited data, calculated that 52,425 turtles p.a. or 11,400–47,500 turtles p.a. are caught in gillnets (with a mean of the two methods being 29,488 turtles p.a.). Anecdotal/published studies reported values

[31] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

of >5000–16,000 marine turtles p.a. for each of India, Sri Lanka and Madagascar. Of these reports, green turtles are under the greatest pressure from gillnet fishing, constituting 50–88% of catches for Madagascar. Loggerhead, hawksbill and olive Ridley turtles are caught in varying proportions depending on the region.
- Maintaining or increasing fishing 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 Committee to ensure CPCs comply with their data collection and reporting requirements for marine turtles.

APPENDIX I

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 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 12/04 *on the conservation of 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 24 m and vessel under 24 m fishing outside their EEZ. The requirement under Resolution 11/04 in conjunction with the reporting requirements under Resolution 12/04, means that all CPCs should be reporting marine turtle interactions as part of their annual report to the Scientific Committee.

Extracts from Resolutions 11/04 and 12//04

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

Para. 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;

RESOLUTION 12/04 ON MARINE TURTLES

Para. 3. CPCs shall collect (including through logbooks and observer programs) and provide to the IOTC Secretariat no later than 30 June of the following year in accordance with Resolution 10/02 (or any subsequent revision), all data on their vessels' interactions with marine turtles. The data shall include the level of logbook or observer coverage and an estimation of total mortality of marine turtles incidentally caught in their fisheries.

Para. 7. CPCs with gillnet vessels that fish for species covered by the IOTC Agreement shall:

a) require that operators of such vessels record all incidents involving marine turtles during fishing operations in their logbooks[1] and report such incidents to the appropriate authorities of the CPC.

Para. 8. CPCs with longline vessels that fish for species covered by the IOTC Agreement shall:

…

c) require that operators of such vessels record all incidents involving marine turtles during fishing operations in their logbooks[1] and report such incidents to the appropriate authorities of the CPC

Para. 9. CPCs with purse seine vessels that fish for species covered by the IOTC Agreement shall:

…

c) require that operators of such vessels record all incidents involving marine turtles during fishing operations in their logbooks[1] and report such incidents to the appropriate authorities of the CPC

[1] This information should include where possible, details on species, location of capture, conditions, actions taken on board and location of release.

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.

Flatback turtle

The flatback turtle (*Natator depressus*) 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 2 outlines some of the key life history traits of flatback turtles.

TABLE 2. Biology of the flatback turtle (*Natator depressus*).

Parameter	Description
Range and stock structure	Flatback 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, one to four times a season (mean = 2.8), 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: Mortimer 1984, FAO 1990; Limpus 2007

Green turtle

The green turtle (*Chelonia mydas*) 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 20th centuries 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 3 outlines some of the key life history traits of green turtles.

TABLE 3. 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: open beaches (for nesting), convergence zones in the open ocean (oceanic stage juveniles), and benthic feeding grounds in coastal areas (neritic stage juveniles and adults). 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. Nesting seasons can change throughout the year (i.e. winter vs summer) according to the nesting site locations in the Indian Ocean.
Size (length and weight)	The largest of all the hard-shelled marine turtles, growing up to 1.2 m long and weighing 130–160 kg.

Sources: Mortimer 1984, FAO 1990, Dalleau et al. 2012

Hawksbill turtle

The hawksbill turtle (*Eretmochelys imbricata*) 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 4 outlines some of the key life history traits of hawksbill turtles.

TABLE 4. Biology of the hawksbill turtle (*Eretmochelys imbricata*).

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. Nesting generally takes place during the warmest months of the year.
Size (length and weight)	In the Indian Ocean, adults weigh 45 to 70 kg, but can grow to as large as 90 kg.

Sources: Mortimer 1984, FAO 1990

Leatherback turtle

The leatherback turtle (*Dermochelys coriacea*) 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 5 outlines some of the key life history traits of leatherback turtles.

TABLE 5. Biology of the leatherback turtle (*Dermochelys coriacea*).

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, South Mozambique, 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 at around 15 years
Spawning season	Females lay clutches of approximately 100 eggs on sandy, tropical beaches. They nest 6–8 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, Nel 2012

Loggerhead turtle

The loggerhead turtle (*Caretta caretta*) is globally distributed and the species is known to be heavily impacted by longline fisheries worldwide. The hatchlings and juveniles are pelagic, living in the open ocean and have the ability to undertake long trans-hemispheric migrations from the south to the north Indian Ocean. Adults forage in coastal areas or near shallow sea mounts. Key nesting sites in the Indian Ocean are found in Oman, South Africa and West Australia. Table 6 outlines some of the key life history traits of loggerhead turtles.

TABLE 6. Biology of the loggerhead turtle (*Caretta caretta*).

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. Adults are capable of migrating long distances between nesting beaches and foraging areas and late stage juveniles have also been shown to undertake extensive migrations. 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, three to four times 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, Lewison et al., 2004, Dalleau et al. 2013, Hamann et al. 2013

Olive Ridley turtle

The olive Ridley turtle (*Lepidochelys olivacea*) 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 7 outlines some of the key life history traits of olive Ridley turtles.

TABLE 7. Biology of the olive Ridley turtle (*Lepidochelys olivacea*).

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. Arribadas occur at the beginning of each year in Indian, from January to March.
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: Mortimer 1984, FAO 1990

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, China, the EU, Japan, the Republic of Korea and South Africa reporting levels of marine turtle interactions to date (Table 8). 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 2008–2013 to the IOTC.

CPCs		**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Sources/notes**
Australia		4	7	1	0	1	0	Observer data:IOTC-2014-SC17-NR01
Belize		0	0	0				
China		0	0	0	0	0	0	Observer data: submitted reports (2010, 2012,2013) and IOTC-2014-SC17-NR03_Rev1
Taiwan,China		32	84	4	4	14	7	Observer data: letter to the Secretariat (2012-2013), Report for SC16 (2008-2011)
Comoros								
European Union*	LL	16 (ESP)	0 (ESP)	0 (ESP)	0 (ESP) 2(PRT) 4(FRA)	0 (ESP) 7(PRT) 4(FRA)	27 (ESP) 17(PRT) 2(UK) 4(FRA)	ESP,PRT(2013),UK: Observer data (IOTC-2014-SC17-NR06) PRT (2011-2012) & EU,FRA: submitted observer data
	PS	250 (SD=157)	250 (SD=157)	250 (SD=157)	250 (SD=157)	3(EU, France)	159	Average number of observed interactions extrapolated to total fleet. 2008-2011:EU,France,

							EU,Spain and France,OT (IOTC-2012-WPEB08-35_Rev_1; IOTC-2012-SC15-NR07). NB: Approximately 77% of turtles are released alive. 2012: unextrapolated submitted observer data 2013: extrapolated observer data. EU,France and France,OT (Discard form and IOTC-2014-SC17-NR07 and NR06).
Eritrea							
France (territories)[32]	See EU purse seine fleet				4 (OT, France)	as EU PS	See EU Purse Seine
Guinea							
India							
Indonesia	51 & 71 caught during 2 observer trips					6+25	Observer data IOTC-2014-SC17-NR10
Iran, Islamic Republic of				2	24		Port-sampling data IOTC-2013-WPEB09-40
Japan			14	0	2	1	Observer data: submitted trip data (2010-2012) and IOTC-2014-SC17-NR12
Kenya							
Korea, Republic of		36	0		0	1	Observer data: IOTC-2014-SC17-NR14
Madagascar					4kg	0	Observer data: IOTC-2014-SC17-NR15
Malaysia					0		
Maldives, Republic of		0	0	0	0	93	*"observed annul catches"* 2009-2012: IOTC-2014-SC17-NR17 2013: discard form
Mauritius					0		
Mozambique					0		No interactions reported in letter to IOTC Secretariat (2012). Observer data
Oman, Sultanate of							
Pakistan							
Philippines	0	0	0		0	0	*"no reported interactions"* IOTC-2014-SC17-NR22
Seychelles						0	"*…not reported any interactions with marine turtles via logbook"*. IOTC-2014-SC17-NR23
Sierra Leone							
Somalia							
Sri Lanka						25	Sample data: IOTC-2014-WPEB10-27
Sudan							
Tanzania							*"There is no information so far with regards to interaction between sea*

[32] Extrapolated PS data reported were provided aggregated for EU and France OT. In 2012 no extrapolations were available so observer data reported separately for EU.FRA and FRA(OT) are shown.

							turtles and long line fishery” IOTC-2014-SC17-NR28
Thailand							
United Kingdom (OT)	0	0	0	0	0	0	Discard forms for the recreational fishery
Vanuatu			0				
Yemen							
Cooperating Non-Contracting Parties							
Djibouti							
Senegal							No fishing activity since 2007
South Africa	15	13	24	14	4	95	Discard forms (includes foreign fleets)

Green = CPC reported level of marine turtle interactions; Red = CPC did not report level marine turtle interactions

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[33]. 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,France has 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,Spain has 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. Data collected through observer programs from 1995 to 2011 on purse seine fishing operations suggested that the purse-seine fishery has a low impact on marine turtles with an estimated 240 (SD=157) individuals incidentally captured annually[34]. This study suggested that drifting FADs, considered a critical conservation issue for this fishery, may play a key role in the aggregation of juvenile turtles and could be improved by avoiding entangling devices such as nets. Nevertheless, initial results suggest that this is not the main source of incidental captures of marine turtles in this fishery.

Longline

There is limited information on the interactions of longline fleets in the IOTC with marine turtles and and it is not known if this fishing activity represents a serious threat, as is the case in most other regions of the world.

The South African longline fleets have reported that marine turtle bycatch mainly comprises predominantly leatherback turtles, with lesser amounts of loggerhead, hawksbill and green turtles[35]. 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 Palangre Réunionnais[36] examined marine turtle bycatch on 5,885 longline sets in the vicinity of Reunion Island (19-25° S, 48-54° E). The fishery caught 47 leatherback, 30 hawksbill, 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 a survey covering the whole Indian EEZ using four longline vessels from 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: 0.302 marine turtles per 1000 hooks in the Bay of Bengal area, 0.068 marine turtles per

[33] IOTC-2008-WPEB-08

[34] Bourjea et al. 2014

[35] IOTC-2006-WPBy-15

[36] 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

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, quantitative 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 a 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[37] 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, Rep. 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[38].
- Loggerhead turtle – 2009 status review under the U.S. endangered species act[39].
- Loggerhead turtle – 2013 Assessment of the conservation status of the loggerhead turtle in the Indian Ocean and South-East Asia. IOSEA Species Assessment: Volume II.
- Leatherback turtle – Assessment of the conservation status of the leatherback turtle in the Indian Ocean and South-East Asia (IOSEA Marine Turtle MoU, 2006)[40].
- Leatherback turtle – 2012 Assessment of the conservation status of the leatherback turtle in the Indian Ocean and South-East Asia – 2012 update. IOSEA Marine Turtle MoU Secretariat report

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[37](www.ioseaturtles.org/report.php)

[38]http://www.iucnredlist.org/documents/attach/8005.pdf

[39]http://www.nmfs.noaa.gov/pr/pdfs/statusreviews/loggerheadturtle2009.pdf

[40]http://www.ioseaturtles.org/content.php?page=Leatherback%20Assessment

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APPENDIX XXXV
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**[41]
Albatross		
Atlantic Yellow-nosed Albatross	*Thalassarche chlororynchos*	Endangered
Black-browed albatross	*Thalassarche melanophrys*	Near Threatened
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
Grey-headed albatross	*Thalassarche chrysostoma*	Endangered
Petrels		
Cape/Pintado petrel	*Daption capense*	Least Concern
Great-winged petrel	*Pterodroma macroptera*	Least Concern
Grey petrel	*Procellaria cinerea*	Near Threatened
Southern giant petrel	*Macronectes giganteus*	Least Concern
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), the Agreement on the Conservation of Albatrosses and Petrels (ACAP), 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, for albatrosses and large petrels, fisheries bycatch is generally considered to be the primary threat. 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 incidental catches rates have been recorded in the absence of a suite of proven incidental catches mitigation measures.

Outlook. Resolution 10/06 *On Reducing the Incidental Bycatch of Seabirds in Longline Fisheries* was superseded by Resolution 12/06 on 1 July 2014, which includes an evaluation requirement (para. 8) by the Scientific Committee in time for the 2016 meeting of the Commission. The level of compliance with 12/06 and the frequency of use of each of

[41] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

the 3 measures (because vessels can chose two out of three possible options) are currently unknown. Methods to evaluate the effectiveness of the incidental catches mitigation measures prescribed in Res 12/06 need to be developed. Observer reports and logbook data should be analysed to support assessments of the effectiveness of mitigation measures used and relative impacts on seabird mortality rates. Information regarding seabird interactions reported in National Reports should be stratified by season, broad area, and in the form of catch per unit effort. Unless IOTC CPCs become compliant with the data collection, Regional Observer Programme and reporting requirements for seabirds, the WPEB will continue to be unable to address this issue. The following should be noted:

- The available evidence indicates considerable risk from longline fishing to the status of seabirds in the Indian Ocean, where the best practice seabird incidental catches mitigation measures outlined in Resolution 12/06 are not implemented.
- CPCs that have not fully implemented the provisions of the IOTC Regional Observer Scheme outlined in paragraph 2 of Resolution 11/04 shall report seabird incidental catches through logbooks, including details of species, if possible.
- Appropriate mechanisms should be developed by the Compliance Committee to assess levels of compliance by CPCs with the Regional Observer Programme requirements and the mandatory measures described in Res 12/06.

APPENDIX I

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 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence* came into force on 14 November 2013. Annex II requires CPCs whose observer programmes do not meet the required 5% coverage of fishing effort (based on number of operations/sets) to record the number of seabirds caught per operation.
- Resolution 12/06 *On reducing the incidental bycatch of seabirds in longline fisheries*, came into force on 1 July, 2014, and requires all longline vessels in the area south of 25 degrees South latitude, to use simultaneously at least two of the following three mitigation measures:
    - Night setting with minimum deck lighting
    - Bird-scaring lines (Tori Lines)
    - Line weighting.
- The specifications and minimum requirements for each of these measures is described in Resolution 12/06.
- Resolution 12/06 supersedes Resolution 10/06 *On Reducing the Incidental Bycatch of Seabirds in Longline Fisheries.*

  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.
- 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 incidental catches on, at least, 5% of the fishing operations of vessels over 24m and vessel under 24m fishing outside their EEZ. The requirement under Resolution 11/04, in conjunction with the reporting requirements under Resolution 12/06, means that all CPCs should be reporting seabird interactions as part of their annual report to the Scientific Committee.

RESOLUTION 12/06 ON REDUCING BYCATCH OF SEABIRDS IN LONGLINE FISHERIES

1. CPCs shall record data on seabird incidental bycatch by species, notably through scientific observers in accordance with Resolution 11/04 and report these annually.
2. CPCs that have not fully implemented the provisions of the IOTC Regional Observer Scheme outlined in paragraph 2 of Resolution 11/04 shall report seabird incidental bycatch through logbooks, including details of species, if possible.
3. CPCs shall provide to the Commission, as part of their annual reports, information on how they are implementing this measure.

RESOLUTION 11/04 ON A REGIONAL OBSERVER SCHEME

10. Observers shall:

a) Record and report fishing activities, verify positions of the vessel;

b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency;

c) Record the gear type, mesh size and attachments employed by the master;

d) Collect information to enable the cross-checking of entries made to the logbooks (species composition and quantities, live and processed weight and location, where available); and

e) Carry out such scientific work (for example, collecting samples), as requested by the IOTC Scientific Committee..

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.

CONSERVATION AND MANAGEMENT MEASURES IN OTHER REGIONS

Evidence from areas where seabird incidental catches was formerly high but has been substantially 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 bait is 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 incidental catches, 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. To date, the research also suggests no negative effect of line-weighting on target catches (Melvin et al. 2010, Gianuca et al., 2013, Jiménez et al 2013, Robertson et al. 2013). In addition, experience from CCAMLR and elsewhere has indicated a number of additional factors contribute to successful reduction of seabird incidental catches (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 incidental catches data and evaluate the effectiveness of incidental catches 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 incidental catches may even bring benefits to fishing operations, for example by reducing the loss of bait to seabirds. 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 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 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 incidental catches (or incidental catches risk), currently defined in the South Atlantic as of 25˚S, longline fishing vessels are required to use two of the three measures, consistent with IOTC Resolution 12/06.

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. Eighteen 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 incidental catches 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 vulnerable to incidental catches which are not identified in this Executive Summary.

Worldwide, 15 of the 22 species of albatross are listed by the IUCN as globally threatened, with incidental catches in fisheries identified as the key threat to the majority of these species (Robertson & Gales 1998). Impacts of longline fisheries on seabird populations have been demonstrated (e.g. Weimerskirch & Jouventin 1987, Croxall et al. 1990, Weimerskirch et al. 1997, 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 lower incidental catch of seabirds, however data remain limited. The Convention on Migratory Species (CMS) has recently completed a global review of incidental catches levels in gillnet fisheries (Waugh et al. 2013), and the findings of this report are relevant to seabird incidental catches in gillnet fisheries operating in the IOTC. A complementary study estimated that at least 400,000 birds die in gillnets each year (Žydelis et al. 2013), highlighting the importance of further investigation of the impact of IOTC gillnet fisheries on seabirds.

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 incidental catches 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[42]. In addition, all but one[43] 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 incidental catches, risk of incidental catches 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 incidental catches 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 incidental catches (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 & 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

[42] Amsterdam, black-browed, grey-headed, Indian yellow-nosed, light-mantled, sooty and wandering albatrosses

[43] Atlantic yellow-nosed albatross (*Thalassarche chlororhynchos)*

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.

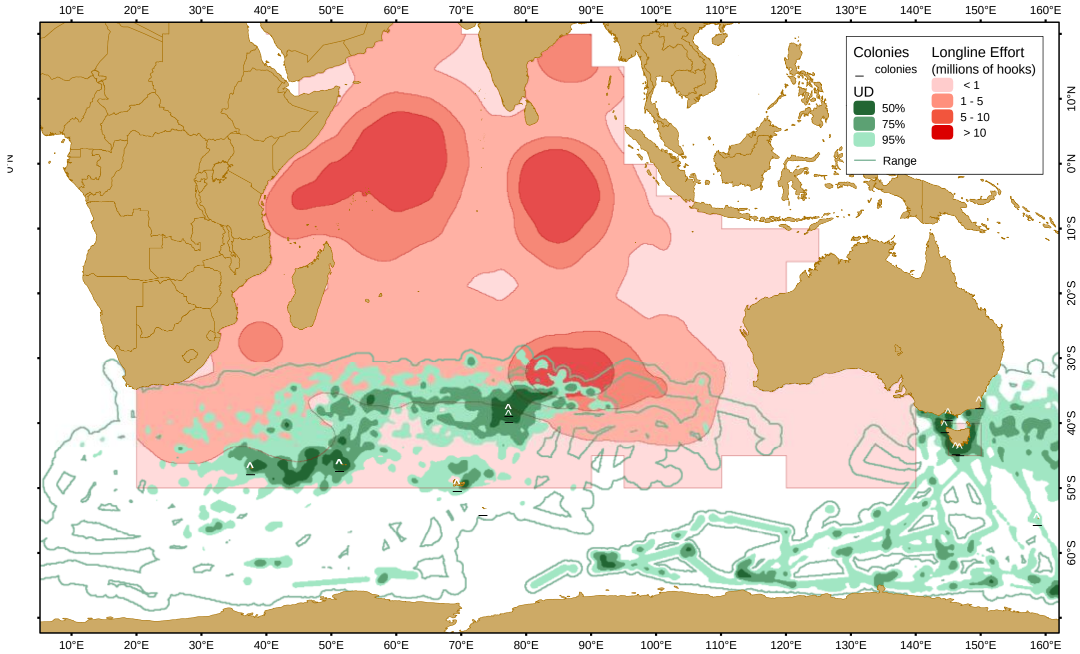

Fig. 1. Distribution of breeding albatrosses, petrels and shearwaters in the Indian Ocean (see Table 2 for a list of species included), and overlap with IOTC longline fishing effort for all gear types and fleets (average annual number of hooks set per 5° grid square from 2002 to 2005).

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 incidental catches 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 incidental catches 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 2008–2013 to the IOTC.

	2008	2009	2010	2011	2012	2013	Sources/notes
CPCs							
Australia	0	2	0	0	0	0	Observer data:IOTC-2014-SC17-NR01
Belize	0	0	0				
China			0	0	0	0	Observer data submitted. Observers noted *"some interaction around haul".*
Taiwan,China	6	52	214	4	42	87	Observer data: Report for SC16 (2008-2011) letter to the Secretariat (2012-2013)
Comoros							No longline activity
European Union*	4 (ESP)	0 (ESP)	0 (ESP)	0 (ESP)	0 (ESP) 2(FRA)	13 (ESP) 26 (PRT) 0 (UK)	ESP,PRT&UK: Observer data (IOTC-2014-SC17-NR06) EU,France: submitted observer data
Eritrea							
Guinea							
India				0		0	*"no reported instances of sea bird interaction"* IOTC-2014-SC17-NR09
Indonesia	42			0	8		Observer data; IOTC-2014-SC17-NR10
Iran, Islamic Republic of							No longline activity
Japan			10	214	28	2	Observer data: submitted data (2010-2012) and IOTC-2014-SC17-NR12
Kenya							No active LL fleet 2011-2013
Korea, Republic of		94	72		90	48	Observer data (2009-2011): IOTC-2014-SC17-NR14and discard forms (2012-2013)
Madagascar							Longline activities north of 25°S
Malaysia				0	0	0	*"no report of seabird interaction";* IOTC-2014-SC17-NR16
Maldives, Republic of		0	0	0	0		*"observed annul catches"* IOTC-2014-SC17-NR17
Mauritius	0	0	0	0	0	0	*"No interaction with seabirds was recorded"* IOTC-2014-SC17-NR18
Mozambique				0	0		Letter to IOTC Secretariat reporting nil interactions (2011-2012). Observer data in 2012. No fleet activity in 2013
Oman, Sultanate of							
Pakistan							No longline activity
Philippines	0	0	0		0		
Seychelles				0		0	*"The logbook has been upgraded to record interactions and to date no*

							interaction have been reported". IOTC-2014-SC17-NR23
Sierra Leone							
Somalia							
Sri Lanka						0	Survey data: IOTC-2014-WPEB10-30
Sudan							
Tanzania						0	*"There was no incidence of sea bird interaction"*: IOTC-2014-SC17-NR28
Thailand				0			IOTC-2012-SC15-NR28_Rev_2
United Kingdom (OT)	0	0	0[44]				No longline activity since 2010
Vanuatu							
Yemen							
Cooperating Non-contracting Party							
Djibouti							
Senegal							No fishing activity since 2007
South Africa	157	467	162	373	123	144	Discard forms (includes foreign fleets)

Green = CPC reported level of seabird interactions; Red = CPC did not report level of seabird interactions

Longline

Observer data from longline fisheries occurring north of 20˚S is very sparse (Gauffier 2007). While seabird incidental catches 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, incidental catches at significant levels could be occurring but not, or almost never being observed.

Other 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 & 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. See reference above to recent global reviews of seabird incidental catches in gillnet fisheries.

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 & 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).

[44] Licenced vessels fishing inside UK(OT)

- 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 XXXVI
2014 UPDATE ON THE IMPLEMENTATION OF THE IOTC REGIONAL OBSERVER SCHEME

CPCs	Active Vessels LOA≥24m or High Seas vessels[45]				Progress	List of observers submitted	Number of observer reports provided[46]				
	LL	PS	GN	BB			2010	2011	2012	2013	2014
MEMBERS											
Australia	4	5			Australia has implemented an observer programme for the longline fleet	**YES: 21**	**2(O)**	**1(O)**	**3(O)**	**No**	**2(O)**
Belize	3				Belize is planning to launch an observer programme in 2104.	**No**	**No**	**No**	**No**	**No**	**No**
China	36				China has an observer programme and has started submitting data in 2010.	**YES: 2**	**1(O)**	**No**	**1(O)**	1(O)	**No**
–Taiwan,China	272					**YES: 54**	**No**	**No**	**No**	**No**	**No**
Comoros					Comoros does not have vessels ≥ 24m. Two observers were trained under the IOC Regional Monitoring Project, and 5 by SWIOFP.	**YES: 7**	N/A	N/A	N/A	N/A	N/A
Eritrea	No information received				No information received by the Secretariat.	**No**	**No**	**No**	**No**	**No**	**No**
European Union	48	22			EU has an observer programme on-board its purse seine and longline fleets. To date, no information has been received from EU,Spain and EU,UK.	Partial: **EU,France: 52** **EU,Portugal: 4** **EU,Spain : No** **EU,UK : No**	**No**	EU, France: 13**(O)** EU, Portugal: 1**(O)**	EU, France: 13**(O)** EU, Portugal: 1**(O)**	EU, France: 15**(O)** EU, Portugal: 1**(O)**	EU, France: 18(O) EU, Portugal: 1**(O)**
France(OT)		5			France(OT) has reported observer data since 2011		**No**	9(O)	7(O)	7(O)	**N/A**
Guinea					No information received by the Secretariat.	**No**	**No**	**No**	**No**	**No**	**No**
India					India has not yet developed an observer programme.	**No**	**No**	**No**	**No**	**No**	**No**
Indonesia	1238				Indonesia has 13 registered IOTC observers	**YES:13**	**No**	**No**	**No**	**No**	**No**
Iran, Isl. Rep. of		4	1224		No information received by the Secretariat.	**No**	**No**	**No**	**No**	**No**	**No**
Japan	73				Japan started its observer programme on the 1st of July 2010, and currently deploys 19 observers in the Indian Ocean.	**YES: 19**	**6(E)**	**8(E)**	**14(E)**	**No**	**No**
Kenya					Kenya is developing an observer programme and 5 observers have been trained by SWIOFP.	**YES: 5**	**No**	**No**	**No**	**No**	**No**
Korea, Rep. of	9	4			Korea has had an observer programme since 2002 with 3 observers deployed in the Indian Ocean.	**YES: 29**	**2(O)**	**No**	**2(O)**	**3(O)**	**No**

[45] The number of active vessels is given for 2013.
[46] Year in which the observed trip has started (E: Electronic; O: Other)

CPCs	Active Vessels LOA≥24m or High Seas vessels[45]				Progress	List of observers submitted	Number of observer reports provided[46]				
	LL	PS	GN	BB			2010	2011	2012	2013	2014
Madagascar	8				Madagascar is developing an observer programme. Five and three observers have been trained through SWIOFP and IOC respectively.	YES: 7	No	No	5(O)	No	No
Malaysia	5				Malaysia is developing plans for the implementation of an observer programme.	No	No	No	No	No	No
Maldives	7			311	Maldivian vessel landings are monitored by field samplers at landing sites. Maldives is currently developing an at-sea observer programme .	YES: 4	No	No	No	No	No
Mauritius		2			Mauritius is developing an observer programme. Five observers have been trained through SWIOFP and three through the IOC.	YES: 8	No	No	No	No	No
Mozambique					Mozambique has an observer programme and has submitted one trip report, but has not had any active vessels ≥24m since 2012.	YES: 11	No	No	1(O)	N/A	N/A
Oman	5				No information received by the Secretariat.	No	No	No	No	No	No
Pakistan					No information received by the Secretariat.	No	No	No	No	No	No
Philippines	9				No information received by the Secretariat.	No	No	No	No	No	No
Seychelles	32	7			Seychelles is developing an observer programme. Four observers have been trained through SWIOFP and three through the IOC.	YES: 7	No	No	No	No	No
Sierra Leone	No information received				No information received by the Secretariat.	No	No	No	No	No	No
Somalia	No information received				No information received by the Secretariat.	No	N/A	N/A	N/A	N/A	0
Sri Lanka	7	8	2226		Sri Lanka has begun a pilot observer initiative.	No	No	No	No	No	No
Sudan	No information received				No information received by the Secretariat.	No	No	No	No	No	No
Tanzania, United Rep.of	5				Tanzania does not currently have an observer programme in place.	No	No	No	No	No	No
Thailand	5				No information received by the Secretariat.	No	No	No	No	No	No
United Kingdom					The UK does not have any active vessels in the Indian Ocean.	N/A	N/A	N/A	N/A	N/A	N/A
Vanuatu	3				Vanuatu does not currently have an observer programme in place.	No	No	No	No	No	No
Yemen	No information received				No information received by the Secretariat.	No	No	No	No	No	No
COOPERATING NON-CONTRACTING PARTIES											
Djibouti					No information received by the Secretariat.	No	No	No	No	No	No
Senegal					Senegal has not had any active vessels in the Indian Ocean since 2007.	N/A	N/A	N/A	N/A	N/A	N/A

CPCs	Active Vessels LOA≥24m or High Seas vessels[45]				Progress	List of observers submitted	Number of observer reports provided[46]				
	LL	PS	GN	BB			2010	2011	2012	2013	2014
South Africa	10			5	South Africa currently only operates an observer programme for foreign vessels operating within the EEZ.	**YES: 16**	**No**	**13(O)[47]**	**10(O)[8]**	**13(O) [8]**	**No**

[47] Reports from South African observers onboard foreign vessels operating in the EEZ of South Africa.

APPENDIX XXXVII

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				
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 Parties 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 & Ongoing**: 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.	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. Other sources and cooperative arrangements will continue (e.g. IOTC-OFCF Project) or might be available in the future (e.g. SWIOFC, COI, etc.). The Secretariat continues to collaborate with these initiatives.	Review annually at IOTC WP and SC meetings.	High

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*	**Partially 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. Implementation by CPCs has been limited to date. The Secretariat will commence training workshops in 2015 in several key CPCs requesting assistance (i.e. IR Iran and Sri Lanka).	Review annually at IOTC WP and SC meetings.	High
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, 2010 and 2011. However, no meeting is being scheduled for 2012 as the SC felt that this WP meeting should only be held when there are specific tasks to be considered.	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, in collaboration with others (i.e. OFCF, COI, BOBLME) has supported sampling programmes and other means of data collection since 2002. The Secretariat continues to work with CPCs to improve their data collection programs.	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 is currently being implemented. In 2013 and 2014, data poor approaches to determining stock status was applied to a range of billfish and neritic tuna species. The SC will consider in 2014, options to rank stock status determination using a 'tier' approach, which will assist in the interpretation of the level of uncertainty present in assessment methods applied.	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, which was Adopted by the Commission in 2012 as Resolution 12/02.	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 & Ongoing**: Guidelines for the presentation of stock assessment papers were revised and agreed to by the Scientific Committee in 2010 and 2012. The SC will again revise the guidelines in 2014, as a result of the Commission adoption Recommendation 14/07 *To standardise the presentation of scientific information in the annual Scientific Committee report and in Working Party reports.* The SC actively encourages national scientists to publish in peer reviewed journals, as is the case following the Tuna tagging Symposium held in 2012.	Review annually at IOTC WP and SC meetings.	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 and 2011, 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 reviewed 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*	**Partially completed & 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, 2011 and 2012 Scientific Committee reports included Kobe Matrices for stock assessments where available. The format of the Working Party reports and the resultant Executive Summaries continues to be refined to improve readability and content. The Commission adopted Recommendation 14/07 *To standardise the presentation of scientific information in the annual Scientific Committee report and in Working Party reports*, and this has been applied to all WP meeting reports in 2014.	Review annually at IOTC WP and SC meetings.	Medium
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 2014 meeting of the Working Party on Methods will again focus on this process.	Progress at 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. A second fishing capacity study was conducted in 2013.	See Recommendation 33, which has been agreed as the priority path in this regard.	Medium

APPENDIX XXXVIII
PROGRAM OF WORK (2015–2019) FOR THE SCIENTIFIC COMMITTEE AND ITS SUBSIDIARY BODIES

Working Party on Billfish (WPB)

(Extracts from IOTC–2014–WPB12–R: Appendix XIII, Table 2)

WPB: High priority topics, by project for billfish in the Indian Ocean

Topic	Sub-topic and project	Priority
Stock structure (connectivity)	Research to describe the population structure and connectivity of billfish (swordfish and striped marlin) within the Indian Ocean (and adjacent Pacific and Atlantic waters as appropriate) ➢ Next Generation Sequencing (NGS) to determine the degree of shared stocks for billfish (highest priority species: swordfish and striped marlin) in the Indian Ocean with the southern Atlantic Ocean and Pacific Ocean, as appropriate. ➢ Nuclear markers (i.e. microsatellite) to determine the degree of shared stocks for billfish (highest priority species: striped marlin) in the Indian Ocean with the southern Atlantic Ocean and Pacific Ocean, as appropriate. ➢ Tagging studies (P-SAT)	High
Biological and ecological information (parameters for stock assessment)	Age and growth research ➢ CPCs to provide further research reports on billfish biology, namely age and growth studies including through the use of fish otolith or other hard parts, either from data collected through observer programs or other research programs.	High
	Age-at-Maturity ➢ Quantitative biological studies are necessary for billfish throughout their range to determine key biological parameters including age/size-at-maturity and fecundity-at-age/length relationships, which will be fed into future stock assessments.	High
	Spawning time and locations ➢ Collect gonad samples from billfish to confirm the spawning time and location of the spawning area that are presently hypothesized for each billfish species	High
Historical data review	Changes in fleet dynamics ➢ Japan and Taiwan,China to undertake an historical review of their longline fleets and to document the changes in fleet dynamics. The historical review should include as much explanatory information as possible regarding changes in fishing areas, species targeting, gear changes and other fleet characteristics to assist the WPB understand the current fluctuations observed in the data.	High
	Species identification ➢ The quality of the data available at the IOTC Secretariat on marlins (by species) is likely to be compromised by species miss-identification. Thus, CPCs should review their historical data in order to identify, report and correct (if possible) potential identification problems that are detrimental to any analysis of the status of the stocks.	High
Sports/recreational fisheries	Fishery trends ➢ The catch and effort data for sports/recreational fisheries targeting marlins and sailfish in the Indian Ocean should be submitted to the IOTC Secretariat to assist in future assessments for these species. CPCs with active sports/recreational fisheries targeting marlins and sailfish should undertake a comprehensive analysis for provision to the WPB.	High
CPUE	Develop and/or revise standardised CPUE series for each billfish species and	High

standardisation	major fisheries/fleets for the Indian Ocean ➢ Swordfish: Priority LL fleets: Taiwan,China, EU(Spain, Portugal, France), Japan, Indonesia ➢ Striped marlin: Priority fleets: Japan, Taiwan,China ➢ Black marlin: Priority fleets: Taiwan,China ➢ Blue marlin: Priority fleets: Taiwan,China ➢ IP Sailfish: Priority fleets: Priority LL fleets: EU(Spain, Portugal, France), Japan, Indonesia; Priority GN fleets: I.R. Iran and Sir Lanka	
Stock assessment / Stock indicators	Develop and compare multiple assessment approaches to determining stock status for billfish	High
	Develop and investigate new methods for data poor stocks (marlins and IP sailfish)	High
Target and Limit reference points	To advise the Commission, by end of 2016 at the latest on Target Reference Points (TRPs) and Limit Reference Points (LRPs). ➢ Used when assessing billfish stock status and when establishing the Kobe plot and Kobe matrices	High
Management measure options	To advise the Commission, by end of 2016 at the latest, on potential management measures having been examined through the Management Strategy Evaluation (MSE) process. ➢ These management measures will therefore have to ensure the achievement of the conservation and optimal utilisation of stocks as laid down in article V of the Agreement for the establishment of the IOTC and more particularly to ensure that, in as short a period as possible and no later than 2020, (i) the fishing mortality rate does not exceed the fishing mortality rate allowing the stock to deliver MSY and (ii) the spawning biomass is maintained at or above its MSY level.	High

Working Party on Neritic Tunas (WPNT)

(Extracts from IOTC–2014–WPNT04–R: Appendix VI, Table 2)

WPNT: High priority topics, by project for neritic tuna species in the Indian Ocean

Stock structure (connectivity)	Genetic research to determine the connectivity of neritic tunas throughout their distributions ➢ Determine the degree of shared stocks for all neritic tunas under the IOTC mandate in the Indian Ocean, so as to better equip the SC in providing management advice based on unit stocks delineated by geographic distribution and connectivity. ➢ Genetic research to determine the connectivity of neritic tunas throughout their distributions: Table 2b should be used as a starting point for research project development to delineate potential stock structure for neritic tunas in the Indian Ocean. ➢ The IOTC Secretariat to coordinate a review of the available literature on neritic tuna stock structure across the Indian Ocean to assess the data already available such as the location of spawning grounds to identify potential sub-stocks. The report shall be provided to the WPNT05 meeting in 2015.	High
Biological information (parameters for stock assessment)	Age and growth research; Age-at-Maturity ➢ Quantitative biological studies are necessary for all neritic tunas throughout their range to determine key biological parameters including age-at-maturity and fecundity-at-age/length relationships, age-length keys, age and growth, which will be fed into future stock assessments.	High
Ecological information	Review of literature on life history parameters to assess stock structure on morphometric data ➢ IOTC Secretariat: Fishery Officer (Science) to undertake a literature review of all available population parameters for kawakawa, longtail tuna and narrow-barred Spanish mackerel, to support further stock assessment of these species in 2015. Summary paper to be made available 30 days before the WPNT05 meeting.	High
CPUE standardisation	Develop standardised CPUE series for each neritic tuna species for the Indian Ocean ➢ There is an urgent need to develop standardised CPUE series for each neritic tuna species for the Indian Ocean as a whole, by sub-region, by fleet, as appropriate.	High
Stock assessment / Stock indicators	Develop alternative approaches to determining stock status via and indicator based assessment ➢ The Weight-of-Evidence approach should be used to determine stock status, by building layers of partial evidence, such as CPUE indices combined with catch data, life-history parameters and yield-per recruit metrics, as well as the use of data poor assessment approaches. ➢ An examination of a four quadrant Indian Ocean stock structure (NE, SE, NW, SW) using the algorithms presented on Stock Reduction Analysis techniques should be undertaken for consideration at the next WPNT meeting for longtail tuna and kawakawa. ➢ The following data should be collated and made available for collaborative analysis: 1) catch and effort by species and gear by landing site; 2) operational data: stratify this by vessel, month, and year for the development as an indicator of CPUE over time; and 3) operational data: collate other information on fishing technique (i.e. area fished, gear specifics, depth, environmental condition (near shore, open ocean, etc.) and vessel size (length/horsepower).	High

Working Party on Temperate Tunas (WPTmT)

(Extracts from IOTC–2014–WPTmT05–R: Appendix VII, Table 2)

WPTmT: High priority topics, by project for albacore in the Indian Ocean

Topic	Sub-topic and project	Priority	Est. budget and/or potential source	Timing				
				2015	2016	2017	2018	2019
1. Stock structure (connectivity and diversity)	1.1 Genetic research to determine the connectivity of albacore throughout its distribution and the effective population size.	High	1.3 m Euro: European Union					
	1.1.1 Determine albacore stock structure, migratory range and movement rates in the Indian Ocean.		TBD	■	■	■	■	
	1.1.2 Determine the degree of shared stocks for albacore in the Indian Ocean with the southern Atlantic Ocean.		Ifremer	■	■			
	1.1.3 Population genetic analyses to decipher inter- and intraspecific evolutionary relationships, levels of gene flow (genetic exchange rate), genetic divergence, and effective population sizes.		TBD	■	■	■	■	■
2. Biological information (parameters for stock assessment)	2.1 Age and growth research (collaborative research to estimate ages across research facilities; stratification of sampling across fishery and stock)	High	CPCs directly					
	2.1.1 China and other CPCs to provide further research reports on albacore biology, including through the use of fish otolith studies, either from data collected through observer programs or other research programs, at the next WPTmT meeting.		CPCs directly	■	■			
	2.1.2 Growth curve analysis: Uncertainty about the growth curve is a primary source of uncertainty in the stock assessment. Depending on the shape of the growth curve, it is likely that only limited information about total mortality can be obtained from catch-at-size data. As an additional information source, data on the age structure of the catch may be very informative about total mortality and may considerably reduce uncertainty in the assessment. Research needs to be undertaken to investigate the potential and the best approaches to be used. MSE process to look at improvement in precision of estimates given different amounts		CPCs directly	■	■	■		

		of age structure data, depending on fishery, growth curve, and effective sample sizes.			
		2.2 Natural mortality (M)	High		
		2.2.1 Examine the impacts of a range of M values on stock assessments, from constant rates of 0.2, 0.3. and 0.4 over time, to M values which change with age, from 0.4 to 0.2.		CPCs directly	
		2.2.2 Review evidence of currently available estimates are realistic, and whether more recent data is available on this key parameter.		CPCs directly	
		2.3 Age-at-Maturity	High		
		2.3.1 Quantitative biological studies are necessary for albacore throughout its range to determine key biological parameters including age-at-maturity and fecundity-at-age/length relationships, age-length keys, age and growth, which will be fed into future stock assessments.		CPCs directly	
3.	Ecological information	3.1 Spawning time and locations	High		
		3.1.1 Collect gonad samples from albacore to confirm the spawning time and location of the spawning area that are presently hypothesised for albacore.		CPCs directly	
4.	CPUE standardisation	4.1 Develop standardised CPUE series for each albacore fishery for the Indian Ocean, with the aim of developing a single CPUE series for stock assessment purposes (either a combined or single fleet series approved by the WPTmT).	High	CPUE Workshop (TBD)	
		4.1.1 Changes in species targeting is the most important issue to address in CPUE standardisations.		CPCs directly	
		4.1.2 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.		CPCs directly	
		4.1.3 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-lognormal models). Adding a small constant to the lognormal model may be fine if there are few zero's, but may not be appropriate for areas with many zero		CPCs directly	

	catches (e.g. north of 10oS). Sensitivity to the choice of constant should be tested.				
	4.1.4 The appropriate inclusion of environmental variables in CPUE standardisation is an ongoing research topic. 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.		CPCs directly		
	4.1.5 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.		CPCs directly		
5. Stock assessment / Stock indicators	5.1 Develop and compare multiple assessment approaches to determining stock status for albacore (SS3, ASPIC etc).	High			
	5.1.1 A consultant be hired to assist in building capacity among the WPTmT participants by supplementing the skill set available within IOTC CPCs to further develop the SS3 model. An indicative budget is provided below: Estimated budget (US$) required to hire a consultant to further develop the SS3 stock assessment model on albacore tuna in 2016 and 2018.		US$26,000 in 2016 and 2018 IOTC Regular Budget	*	*

Description	Unit price	Units required	2016 Total (US$)	2018 Total (US$)
SS3 Stock assessment for albacore (fees)	550	40	22,000	22,000
SS3 Stock assessment for albacore (travel)	4,000	1	4,000	4,000
		Total estimate	**26,000**	**26,000**

6. Target and Limit reference points	6.1 To advise the Commission, by end of 2014 at the latest on Target Reference Points (TRPs) and Limit Reference Points (LRPs).	High			
	6.1.1 Assessment of the interim reference points as well as alternatives: Used when assessing the albacore stock status and when establishing the Kobe plot and Kobe matrices. Agreed to pass this task temporarily to WPM.				

7.	Management measure options	7.1 To advise the Commission, by end of 2014 at the latest, on potential management measures having been examined through the Management Strategy Evaluation (MSE) process. Agreed to pass this task temporarily to WPM.		

Working Party on Tropical Tunas (WPTT)

(Extracts from IOTC–2014–WPTT16–R: Appendix IX, Table 2)

WPTT: High priority topics, by project for tropical tunas in the Indian Ocean

Topic	Sub-topic and project	Priority
Stock structure (connectivity)	Research to describe the population structure and connectivity of billfish within the Indian Ocean (and adjacent Pacific and Atlantic waters as appropriate) ➢ Next Generation Sequencing (NGS) to determine tropical tuna stock structure, and migratory range. Determine the degree of shared stocks for tropical tunas in the Indian Ocean with the Pacific Ocean. ➢ Tagging movements and analysis to incorporate in stock assessments	High
Biological information (parameters for stock assessment)	Age and growth research ➢ CPCs to provide further research reports on tropical tuna biology, namely age and growth studies including using through the use of fish otoliths, either from data collected through observer programs or other research programs.	High
	Age-at-Maturity ➢ Quantitative biological studies are necessary for tropical tunas throughout their range to determine key biological parameters including age/size-at-maturity and fecundity-at-age/length relationships, which will be fed into future stock assessments.	High
Ecological information	Spawning time and locations ➢ Collect gonad samples from tropical tunas to confirm the spawning time and location of the spawning area that are presently hypothesized for each tropical tuna species	High
Historical data review	Changes in fleet dynamics need to be documented by fleet. ➢ Priority fleets: Japan and Taiwan,China LL ➢ FAD issues to be analysed for incorporation in CPUE series.	 High High
CPUE standardisation	Develop standardised CPUE series for each tropical tuna fleet/fishery for the Indian Ocean There is an urgent need to investigate the CPUE issues as detailed for bigeye tuna, skipjack tuna and yellowfin tuna in the WPTT15 report, and for these to be a high priority research activity for the tropical tuna resources in the Indian Ocean. That standardised CPUE index for juvenile yellowfin tuna and bigeye tuna caught by the EU purse seiner fleets, be estimated and submitted to the WPTT before the next round of stock assessments of tropical tunas. The standardisation of purse seine CPUE be made where possible using the operational data on the fishery. Develop and/or revise standardised CPUE series for each tropical tuna species and fishery for the Indian Ocean ➢ Bigeye tuna: High priority fleets: High (2016) ➢ Skipjack tuna: High priority fleets: High (2017) ➢ Yellowfin tuna: High priority fleets: High (2015)	High
Stock assessment / Stock indicators	Develop and compare multiple assessment approaches to determining stock status for tropical tunas	High
Target and Limit reference points	To advise the Commission, by end of 2016 at the latest on Target Reference Points (TRPs) and Limit Reference Points (LRPs). ➢ Used when assessing tropical tuna stock status and when establishing the Kobe plot and Kobe matrices	High
Management measure options	To advise the Commission, by end of 2016 at the latest, on potential management measures having been examined through the Management Strategy Evaluation (MSE) process.	High

- These management measures will therefore have to ensure the achievement of the conservation and optimal utilisation of stocks as laid down in article V of the Agreement for the establishment of the IOTC and more particularly to ensure that, in as short a period as possible (i) the fishing mortality rate does not exceed the fishing mortality rate allowing the stock to deliver MSY and (ii) the spawning biomass is maintained at or above its MSY level.

Working Party on Ecosystems and Bycatch (WPEB)

(Extracts from IOTC–2014–WPEB10–R: Appendix XVIII, Table 2)

WPEB: High priority topics, by project for bycatch in the Indian Ocean

Table 2. High priority topics, by project for bycatch in the Indian Ocean.

Topic	Sub-topic and Project	Priority
SHARKS		
Fisheries and data collection	Historical data mining for the key species and IOTC fleets (e.g. as artisanal gillnet and longline coastal fisheries) and implementation of Regional Observer Schemes, including: • Capacity building of fisheries observers (including the provision of ID guides, training, etc.); • Define observer scheme (including minimum requirements) for fleets which are believed to have large catches on pelagic sharks (i.e. various longline and gillnet coastal fisheries) and where those statistics are mostly absent; • Historical data mining for the key species, including the collection of information about catch, effort and spatial distribution of those fleets; • Integration of data mining with observer programs to reconstruct species composition and catches of sharks.	High
Biology and ecology	Develop basic biology and ecology studies to fill essential knowledge gaps on the key IOTC shark species, including: • Age and growth studies for the blue (BSH), shortfin mako (SMA) and oceanic whitetip (OCS) sharks; • Stock delimitation identification (i.e., tagging and genetics[48]) for the blue (BSH), shortfin mako (SMA) and oceanic whitetip (OCS) sharks; • Migration and habitat use, including identification of hotspots and investigate associated environmental conditions affecting the sharks distribution, and making use of conventional and electronic tagging, for blue (BSH), shortfin mako (SMA) and oceanic whitetip (OCS) sharks; • Post-release mortality (electronic tagging), to assess the efficiency of management resolutions on no retention species (i.e. oceanic whitetip (OCS) and threshers sharks), shortfn mako sharks SMA) ranked as the most vulnerable species to longline fisheries.	High
Mitigation measures	Develop studies on shark mitigation measures (operational, technological aspects and best practices), including: • Longline selectivity, to assess the effects of hooks styles, bait types and trace materials on shark catch rates, hooking-mortality, bite-offs and fishing yield (socio-economics); • Gillnet selectivity, to assess the effect of mesh size, hanging ratio and net twine on sharks catches composition (i.e. species and size), and fishing yield (socio-economics); • Post-release mortality of whale sharks in purse-seine fisheries, to assess the efficiency of the best practice currently set in place; • Develop guidelines and protocols for safe handling and release of sharks caught on longlines and gillnets fisheries.	High
CPUE standardisation	Develop standardised CPUE series for each key shark species and fishery in the Indian Ocean • (High priority fleets: TWN-CHN LL, EU,Spain LL, Japan LL; Indonesia LL)	High
Stock assessment / Stock indicators	Develop and compare multiple assessment approaches to determining stock status for key shark species	High
Marine turtles	Review of bycatch mitigation measures Res. 12/04 (para. 11) The IOTC Scientific Committee shall request the IOTC Working Party on Ecosystems and Bycatch to: a) Develop recommendations on appropriate mitigation measures for gillnet, longline and purse seine fisheries in the IOTC area; b) Develop regional standards covering data collection, data exchange and training;	High

[48] Genetic studies might be integrated in a single study including other IOTC tuna and tuna-like species.

	c) Develop improved FAD designs to reduce the incidence of entanglement of marine turtles, including the use of biodegradable materials. The recommendations of the IOTC Working Party on Ecosystems and Bycatch shall be provided to the IOTC Scientific Committee for consideration at its annual session in 2012. In developing its recommendations, the IOTC Working Party on Ecosystems and Bycatch shall examine and take into account the information provided by CPCs in accordance with paragraph 10 of this measure, other research available on the effectiveness of various mitigation methods in the IOTC area, mitigation measures and guidelines adopted by other relevant organizations and, in particular, those of the Western and Central Pacific Fisheries Commission. The IOTC Working Party on Ecosystems and Bycatch will specifically consider the effects of circle hooks on target species catch rates, marine turtle mortalities and other bycatch species.	
	Res. 12/04 (para. 17) The IOTC Scientific Committee shall annually review the information reported by CPCs pursuant to this measure and, as necessary, provide recommendations to the Commission on ways to strengthen efforts to reduce marine turtle interactions with IOTC fisheries.	High
Seabirds	Review of bycatch mitigation measures: Res. 12/06 (para. 8) The IOTC Scientific Committee, based notably on the work of the WPEB and information from CPCs, will analyse the impact of this Resolution on seabird bycatch no later than for the 2016 meeting of the Commission. It shall advise the Commission on any modifications that are required, based on experience to date of the operation of the Resolution and/or further international studies, research or advice on best practice on the issue, in order to make the Resolution more effective.	High
Discards	Review proposal on retention of non-targeted species: The Commission requested that the Scientific Committee review proposal IOTC–2014–S18–PropL Rev_1, and to make recommendations on the benefits of retaining non-targeted species catches, other than those prohibited via IOTC Resolutions, for consideration at the 19th Session of the Commission. (S18 Report, para. 143). Noting the lack of expertise and resources at the WPEB and the short timeframe to fulfill this task, the SC RECOMMENDED that a consultant be hired to conduct this work and present the results at the next WPEB meeting. The following tasks, necessary to address this issue, should be considered for the terms of reference, taking into account all species that are usually discarded on all major gears (i.e., purse-seines, longlines and gillnets), and fisheries that take place on the high seas and in coastal countries EEZs: i) Estimate species-specific quantities of discards to assess the importance and potential of this new product supply, integrating data available at the Secretariat from the regional observer programs; ii) Assess the species-specific percentage of discards that is captured dead versus alive, as well as the post-release mortality of species that are discarded alive, in order to estimate what will be the added fishing mortality to the populations, based on the best current information; iii) Assess the feasibility of full retention, taking into account the specificities of the fleets that operate with different gears and their fishing practices (e.g., transhipment, onboard storage capacity). iv) Assess the capacity of the landing port facilities to handle and process this catch. v) Assess the socio-economic impacts of retaining non-target species, including the feasibility to market those species that are usually not retained by those gears; vi) Assess the benefits in terms of improving the catch statistics through port-sampling programmes; vii) Evaluate the impacts of full retention on the conditions of work and data quality collected by onboard scientific observers, making sure that there is a strict distinction between scientific observer tasks and compliance issues.	High

WPEB: Proposed timeline for the development of the high priority research projects.

		Year 1 - 2015				Year 2 - 2016				Year 3 - 2017				Year 4 - 2018				Year 5 - 2019			
Project	**Task**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Fisheries and data collection	Capacity building of fisheries observers (including the provision of ID guides, training, etc.)																				
	Define observer scheme (including minimum requirements) for fleets which are believed to have large catches on pelagic sharks (i.e. various longline and gillnet coastal fisheries) and where those statistics are mostly absent																				
	Historical data mining for the key species, including the collection of information about catch, effort and spatial distribution of those fleets																				
	Integration of data mining with observer programs to reconstruct species composition and catches of sharks																				
	Reporting to the IOTC WPEB and IOTC SC																				
Biology and ecology	Age and growth studies for the blue (BSH), shortfin mako (SMA) and oceanic whitetip (OCS) sharks	BSH				BSH+SMA+OCS				SMA+OCS				OCS							
	Stock delimitation identification (i.e., tagging and genetics*) for the blue (BSH), shortfin mako (SMA) and oceanic whitetip (OCS) sharks	BSH				BSH+SMA+OCS				SMA+OCS				OCS							
	Migration and habitat use, including identification of hotspots and investigate associated environmental conditions affecting the sharks distribution, and making use of conventional and electronic tagging, for blue (BSH), shortfin mako (SMA) and oceanic whitetip (OCS) sharks			BSH		BSH+SMA				BSH+SMA+OCS				SMA+OCS							
	Post-release mortality (electronic tagging), to assess the efficiency of management resolutions on no retention species (i.e. oceanic whitetip (OCS) and threshers sharks) and shotfin mako (SMA) the most vulnerable species on longline fisheries	SMA				THR				OCS											
	Reporting to the IOTC WPEB and IOTC SC																				

Mitigation measures	Longline selectivity, to assess the effects of hooks styles, bait types and trace materials on shark catch rates, hooking-mortality, bite-offs and fishing yield (socio-economics)
	Gillnet selectivity, to assess the effect of mesh size, hanging ratio and net twine on sharks catches composition (i.e. species and size)
	Post-release mortality of whale sharks in purse-seine fisheries, to assess the efficiency of the best practice currently set in place
	Develop guidelines and protocols for safe handling and release of sharks caught on longlines and gillnets fisheries
	Reporting to the IOTC WPEB and IOTC SC

* Genetic studies might be integrated in a single study including other IOTC tuna and tuna-like species.

Working Party on Data Collection and Statistics (WPDCS)

(Extracts from IOTC–2014–WPDCS10–R: Appendix VII)

The following is the Draft List of Priorities for the Development of a Program of Work by the IOTC WPDCS (2015–2019) and is based on the specific requests of the Commission and Scientific Committee. The Draft List of Priorities is presented in Table A, noting that the Programme of Work and timeline for implementation would be developed by the SC once it has agreed to the priority projects across all of its Working Parties:

Table A. High priority topics, by project for data collection and statistics in the Indian Ocean.

Topic	Sub-topic and project	Rank
Data Collection Standards ROS	Artisanal Fisheries: ➢ Develop minima data requirements for the routine collection of data at the landing place, through sampling by enumerators ➢ Develop General Guidelines for data collection from artisanal fisheries; including development of a set of indicators to be used to assess the quality of data collection and management systems for artisanal fisheries ➢ Develop/Amend Fisheries specific data collection protocols, by country, where necessary ➢ Assist implementation of pilot sampling activities in countries/fisheries not/insufficiently sampled in the past; priority to be given to the following fisheries: 1. Coastal fisheries of Indonesia 2. Coastal fisheries of India 3. Coastal fisheries of Pakistan 4. Coastal fisheries of Sri Lanka 5. Coastal fisheries of Yemen 6. Coastal fisheries of Madagascar 7. Coastal fisheries of Comoros 8. Coastal fisheries of Tanzania 9. Coastal fisheries of Thailand 10. Coastal fisheries of Malaysia	1
	Industrial fisheries: ➢ Develop General Guidelines for data collection by at-sea observers; including development of a set of indicators to be used to assess the quality of data collection and management systems for industrial fisheries ➢ Organize a Regional Workshop on the Implementation of the IOTC Regional Observer Scheme (all IOTC CPCs having industrial fisheries) ➢ Develop/Amend fisheries specific at-sea observer data collection protocols, by country, where necessary ➢ Assist implementation of at-sea observer programmes in countries/fisheries not/insufficiently monitored in the past; including: • Evaluation of existing observer programmes and arrangements • Coordination of country/fishery specific Training Sessions and Workshops on the ROS • Assistance to data management and reporting Priority to be given to the following fisheries: 1. Iran (driftnet; purse seine) 2. Sri Lanka (purse seine; drifting gillnet & longline) 3. Indonesia (longline) 4. Pakistan (driftnet) 5. India (longline) 6. Mauritius (purse seine; longline) 7. Malaysia (longline)	
Review Size Data Longline Fisheries	Assistance to historical review of length frequency data for longline fisheries, in particular longliners from Taiwan,China and Japan.	2

Topic	Sub-topic and project	Rank
Compliance with IOTC Data Requirements	Data Support Missions ➢ Identification of indicators to assess performance of IOTC CPCs against IOTC Data Requirements; evaluation of performance of IOTC CPCs with those Requirements; development of plans of action to address the issues identified, including timeframe of implementation and follow-up activities required. Priority to be given to the following fisheries: 1. Iran 2. India 3. Pakistan 4. Yemen 5. Madagascar 6. Mozambique 7. Mauritius 8. Sri Lanka 9. Indonesia	3
Assistance to Implementation of logbook systems and data collection on FADs	Assist developing coastal IOTC CPCs in the implementation of logbook systems on industrial vessels under their flag, in particular: development of logbooks and guidelines for its completion, including provisions for FADs, as per IOTC Resolution 13/08; training of local staff; assistance to data management and reporting. Priority to be given to the following fisheries: 1. Iran (driftnet; purse seine) 2. Sri Lanka (purse seine; drifting gillnet & longline) 3. Indonesia (longline) 4. Pakistan (driftnet) 5. India (longline) 6. Mauritius (purse seine; longline) 7. Malaysia (longline)	4
Implementation Data Collection Sport Fisheries	Produce a catalogue of sport fisheries in the Indian Ocean; facilitate collection and reporting of data from sport clubs; training of local staff.	5
IOTC Data Summary	Development of Web Based online querying procedures for nominal catch, fishing craft, and catch-and-effort data.	6

Working Party on Methods (WPM)

(Extracts from IOTC–2014–WPM05–R: Appendix IV)

The Program of Work consists of the following, noting that a timeline for implementation would be developed by the SC once it has agreed to the priority projects across all of its Working Parties. The aim of this Program of Work is for a first full set of simulations to be presented at SC18 in 2015.

Topic	Subtopic	Days	Allocated	Budget (US$)	Start	End
Albacore	Refinement of OM structure and parameterisation	120	30	72,000	Feb 2015	Mar 2015
	Refinement of OM conditioning				Feb 2015	Mar 2015
	Definition and implementation of alternative MPs				Feb 2015	Apr 2015
	Complete set of simulation runs & results				Jun 2015	Sep 2015
	Internal peer review of OM & MPs	10		8,000	May 2015	
	External peer review	5		4,000	Nov 2015	
Skipjack tuna	Refinement of OM structure and parameterisation	120		96,000	Feb 2015	Apr 2015
	Refinement of OM conditioning				Feb 2015	Apr 2015
	Further development of MPs				Feb 2015	Apr 2015
	Run evaluations and produce summaries of results				Jun 2015	Sep 2015
	Internal peer review of OM & MPs	10		8,000	May 2015	
	External peer review	5		4,000	Nov 2015	
Bigeye tuna and yellowfin tuna	Initial OM	360	360		May 2015	
	Conditioning and OM set up				Dec 2015	
	Generic MP tests				May 2016	
	Final Model with MP’s				Dec 2016	
Presentation	Exploration of tools for effective presentation of MSE results					
	Implementation and adaptation of those tools for IOTC needs	10		8,000	Feb 2015	Mar 2015

Note that Resolution 14/03 has certain hard deadlines and to achieve them this work needs to be completed. These are noted below.

From Resolution 14/03:

> *Para. 2 (Point 2): “These Science and Management Dialogue Workshops shall be held in 2015, 2016 and 2017, as needed, prior to the respective Commission Annual Sessions”*
>
> *Para. 4: The effectiveness of the Science and Management Dialogue Workshops shall be reviewed no later than at the Annual Session of the Commission in 2018.*

APPENDIX XXXIX
SCHEDULE OF STOCK ASSESSMENTS FOR IOTC SPECIES AND SPECIES OF INTEREST FROM 2015–2019, AND FOR OTHER WORKING PARTY PRIORITIES

Species	**2015**	**2016**	**2017**	**2018**	**2019**
Working Party on Billfish					
Black marlin		**Full assessment***		**Full assessment***	
Blue marlin		**Full assessment***			**Full assessment***
Striped marlin	**Full assessment***		**Full assessment***		**Full assessment***
Swordfish	Indicators	Indicators	**Full assessment**		
Indo-Pacific sailfish	**Full assessment***			**Full assessment***	
Working Party on Neritic Tunas					
Bullet tuna	Indicators	Indicators	Indicators	**Full assessment***	Indicators
Frigate tuna	Indicators	Indicators	Indicators	**Full assessment***	Indicators
Kawakawa	**Full assessment***	Indicators	**Full assessment***	Indicators	Indicators
Longtail tuna	**Full assessment***	Indicators	**Full assessment***	Indicators	Indicators
Indo-Pacific king mackerel	**Full assessment***	Indicators	Indicators	**Full assessment***	Indicators
Narrow-barred Spanish mackerel	**Full assessment***	Indicators	Indicators	**Full assessment***	Indicators
Working Party on Temperate Tunas					
Albacore	–	**Full assessment**	–	**Full assessment**	–
Working Party on Tropical Tunas					
Bigeye tuna	Indicators	**Full assessment**	Indicators	Indicators	**Full assessment**
Skipjack tuna	Indicators	Indicators	**Full assessment**	Indicators	Indicators
Yellowfin tuna	**Full assessment**	Indicators	Indicators	**Full assessment**	Indicators
Working Party on Ecosystems and Bycatch					
Blue shark	**Full assessment**		Indicators	Revisit ERA	**Full assessment**
Oceanic whitetip shark	**–**	Indicators; Review of measures in Res. 13/06	**Full assessment***	Revisit ERA	**–**
Scalloped hammerhead shark	**–**	Indicators	**–**	Revisit ERA	Indicators
Shortfin mako shark	**–**	Indicators	**–**	Revisit ERA	**–**
Silky shark	Indicators	–	**–**	Revisit ERA	Indicators
Bigeye thresher shark	**–**	–	Indicators	Revisit ERA	**–**
Pelagic thresher shark	**–**	Indicators	**–**	Revisit ERA	**–**
Marine turtles	Review of mitigation measures in 12/04	–	Revisit ERA	–	Review of mitigation measures in 12/04
Seabirds	Review of mitigation measures in 12/06	–	Review of mitigation measures in 12/06	–	Review of mitigation measures in 12/06
Marine Mammals	**–**	–	**–**	–	**–**
Working Party on Methods					
Management Strategy Evaluation	Extension of the MSE process to tropical tunas: ALB, SKJ. Commence work on YFT and BET	Complete work on ALB, SKJ, YFT and BET	TBD	TBD	TBD

*Including data poor stock assessment methods; Note: the assessment schedule may be changed dependant on the annual review of fishery indicators, or SC and Commission requests. ALB: albacore; BET: bigeye tuna; YFT: yellowfin tuna; SKJ: skipjack tuna.

APPENDIX XL
RULES OF PROCEDURE FOR THE SELECTION OF INVITED EXPERTS AND HIRED CONSULTANTS TO ATTEND IOTC WORKING PARTY MEETINGS

Definition of an Invited expert
Invited Expert are **NOT** consultants, as they are **unpaid**, other than for return **economy** airfares and DSA to attend a meeting.

Hired Consultants are **paid**, including for return **economy** airfares and DSA to attend a meeting.

The role of an Invited Expert or Hired Consultant and the guiding principles for their selection are as follows:

Duties (Invited Expert): (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;

Duties (Hired Consultant): (i) to carry out tasks identified by the Working Party (WP), according to Terms of Reference proposed by the WP and approved by the SC 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/hired consultant must have recognized experience and skill in the subjects for which they are tasked;

Independence: The invited expert/hired consultant'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/hired consultant shall be selected based in their personal capacity without representing any CPCs and/or stakeholder. Participation of experts/consultant based in IOTC developing coastal states shall be encouraged. Invited Experts/Hired Consultant should not be:

- directly involved with current IOTC stock assessments or CPUE standardizations.
- from a CPC where a scientist is presenting a stock assessment or CPUE standardization.

Confidentiality: Invited Experts/Hired Consultant shall not divulge any information, including data considered confidential by the Commission, as defined in IOTC Resolution 98/02.

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	<u>Selection panel</u>, **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	–

Process and timeline for the selection of a Hired Consultant

STEP	Action Item	Responsibility	Due date
1	Chair of the Working Party (WP) (or Vice-Chair if Chair not available) to present the proposed terms of reference (including timeline, tasks and deliverables to be provided by the Hired Consultant) to the SC for consideration and approval.	Chair of the WP (or Vice-Chair)	No later than 15 days prior to the commencement of the SC meeting.
2	Secretariat to advertise a call for tender among the IOTC Commissioner's and Science contact lists, and the web site.	IOTC Secretariat	Within 14 days after the approval by the SC (Step 1 above)
3	Selection panel, **consisting of the Chair** (or Vice-Chair if Chair not available) **of the SC, the Chair and Vice-Chair of the Working Party, in consultation with the Executive Secretary** or his/her delegate to determine the most appropriate Consultant for the meeting and taking into consideration budgetary constraints as may be advised by the IOTC Secretariat. Potential Hired Consultant to be contacted by the Chair (or Vice-Chair if Chair not available) of the SC to confirm availability.	Selection panel	Within 14 days after the deadline for applications
4	Chair of the Working Party (or Vice-Chair) to advise the IOTC Science contact list of the successful Hired Consultant, and request the IOTC Secretariat to commence the contract process. The IOTC Secretariat will also inform the IOTC Commissioner's and Science contact lists of the selected Hired Consultant.	Chair of WP or alternate & IOTC Secretariat	Within 2 days of the selection meeting.
5	Working Party meeting.	Participants	–

APPENDIX XLI
SCHEDULE OF IOTC SCIENCE MEETINGS IN 2015 AND 2016

Meeting	2015		2016	
	Date	**Location**	**Date**	**Location**
Working Party on **Data Collection and Statistics**	22–24 May (3d)	Tanzania	25–27 November (3d)	Victoria, Seychelles
Working Party on **Neritic Tunas**	26–29 May (4d)	Tanzania	24–27 May (4d)	Kenya
Working Party on **Billfish**	1–5 September (5d)	Algarve, Portugal	1–5 September (5d)	TBD
Working Party on **Ecosystems and Bycatch**	7–11 September (5d)	Algarve, Portugal	7–11 September (5d)	TBD
Working Party on **Methods**	19–21 October (3d)	Montpellier, France	15–17 October (3d)	TBD
Working Party on **Tropical Tunas**	23–28 October (6d)	Montpellier, France	19–24 October (6d)	TBD
Working Party on **Temperate Tunas**	Nil	Nil	25–28 July (4d)	TBD
Scientific Committee	24–28 November (5d)	Indonesia ‘or’ Victoria, Seychelles	29 November–2 December (5d)	Victoria, Seychelles

APPENDIX XLII
PROPOSED IOTC SCIENCE BUDGET FOR 2015 AND 2016

(Note: this does not include recommendations for which a budget was approved for 2014, which were rolled over into 2015 by the IOTC Secretariat)

	Description	Paragraph	2015 total (US$)	2016 total (US$)	Priority
IOTC Meeting Participation Fund (Science):					
1	That the MPF be maintained into the future and increased back to its original allocation of $200,000 per year (US$200,000). As per the IOTC Rules of Procedure (2014): • 75%: Shall be allocated to facilitating the attendance of developing Contracting Party scientists to the Scientific Committee and its Working Parties. • 25%: No more than 25% of the expenditures of the Fund in one year is used to fund attendance to non-scientific meetings (Rule XVI, para. 5)	118 & 119	150,000	150,000	**High**
MPF (Science): Sub-Total estimated budget proposed at SC17			**150,000**	**150,000**	
Consultants (Science):					
	Working Party on Neritic Tunas (WPNT)				
2	Neritic tuna data poor stock assessment and capacity building (fees)	177 & 183	6,750	6,750	Low
3	Neritic tuna data poor stock assessment and capacity building (travel)	177 & 183	5,000	5,000	Low
	Working Party on Billfish (WPB)	177 & 183			
4	Billfish data poor stock assessment (fees)	177 & 183	6,750	6,750	Med
5	Billfish data poor stock assessment (travel)	177 & 183	5,000	5,000	Med
	Working Party on Ecosystems and Bycatch (WPEB)	177 & 183			
6	Shark stock assessment (fees)	177 & 183	9,000	9,000	**High**
7	Shark stock assessment (travel)	177 & 183	5,000	5,000	**High**
8	Evaluation of the discards ban proposal	41, 177 & 183	–	15,750	Med
	Working Party on Tropical Tunas (WPTT)	177 & 183			
9	Tropical tuna stock assessment (fees)	177 & 183	15,750	15,750	**High**
10	Tropical tuna stock assessment (travel)	177 & 183	5,000	5,000	**High**
	Working Party on Temperate Tunas (WPTmT)	177 & 183			
11	Temperate tuna stock assessment (fees)	177 & 183	–	15,750	**High**
12	Temperate tuna stock assessment (travel)	177 & 183	–	5,000	**High**
	Working Party on Methods (WPM)	177 & 183			
13	External peer review of the albacore MSE	177 & 183	4,500	–	Med
14	External peer review of the skipjack tuna MSE	110, 177 & 183	4,500	–	Med
	CPUE Workshop/s				
15	CPUE workshop among key longline fleets targeting tropical tunas	73 & 177	50,000	–	**High**
16	CPUE development based on purse seine species composition for skipjack tuna	74 & 177	25,000	–	Med
Consultants: Total estimated budget proposed at SC17			**142,250**	**94,750**	

APPENDIX XLIII
CONSOLIDATED SET OF RECOMMENDATIONS OF THE SEVENTEENTH SESSION OF THE SCIENTIFIC COMMITTEE (8–12 DECEMBER 2014) TO THE COMMISSION

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

Tuna – Highly migratory species

SC17.01 (para. 145) 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, and the combined Kobe plot for the three species assigned a stock status in 2014 (Fig. 4):

- Albacore (*Thunnus alalunga*) – Appendix XII
- Bigeye tuna (*Thunnus obesus*) – Appendix XIII
- Skipjack tuna (*Katsuwonus pelamis*) – Appendix XIV
- Yellowfin tuna (*Thunnus albacares*) – Appendix XV

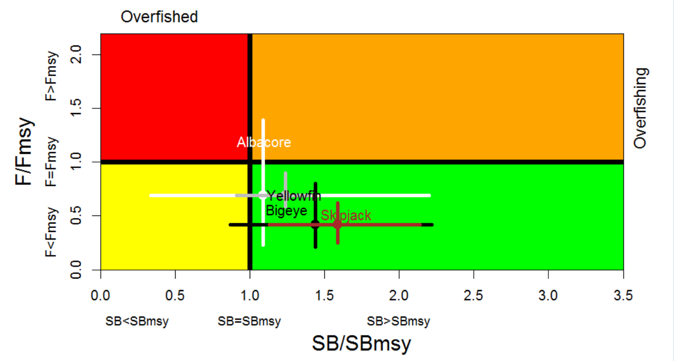

Fig. 4. Combined Kobe plot for bigeye tuna (black: 2013), skipjack tuna (brown: 2014), yellowfin tuna (grey: 2012) and albacore (white: 2014) showing the estimates of current stock size (SB) and current fishing mortality (F) in relation to the interim target spawning stock size and interim target fishing mortality. Cross bars illustrate the range of uncertainty from the model runs. Note that for skipjack tuna, the estimates are highly uncertain as FMSY is poorly estimated, and as suggested for stock status advice it is better to use B_0 as a biomass reference point and C(t) relative to CMSY as a fishing mortality reference point.

Billfish

SC17.02 (para. 147) The SC **RECOMMENDED** that the Commission note the management advice developed for each billfish species under the IOTC mandate, as provided in the Executive Summary for each species, and the combined Kobe plot for the three species assigned a stock status in 2014 (Fig. 5):

- Swordfish (*Xiphias gladius*) – Appendix XVI
- Black marlin (*Makaira indica*) – Appendix XVII
- Blue marlin (*Makaira nigricans*) – Appendix XVIII
- Striped marlin (*Tetrapturus audax*) – Appendix XIX
- Indo-Pacific sailfish (*Istiophorus platypterus*) – Appendix XX

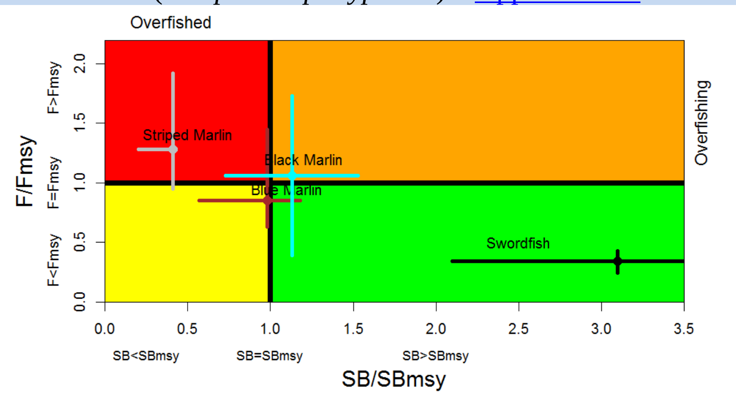

Fig. 5. Combined Kobe plot for swordfish (black: 2014), black marlin (light blue: 2014), blue marlin (brown: 2013) and striped marlin (grey: 2013) showing the estimates of current stock size (SB or B, species assessment dependent) and current fishing mortality (F) in relation to the interim target spawning stock size and interim target fishing mortality. Cross bars illustrate the range of uncertainty from the model runs.

Tuna and seerfish – Neritic species

SC17.03 (para. 148) The SC **RECOMMENDED** that the Commission note the management advice developed for each neritic tuna (and mackerel) species under the IOTC mandate, as provided in the Executive Summary for each species, and the combined Kobe plot for the three species assigned a stock status in 2014 (Fig. 6):

- Bullet tuna (*Auxis rochei*) – Appendix XXI
- Frigate tuna (*Auxis thazard*) – Appendix XXII
- Kawakawa (*Euthynnus affinis*) – Appendix XXIII
- Longtail tuna (*Thunnus tonggol*) – Appendix XXIV
- Indo-Pacific king mackerel (*Scomberomorus guttatus*) – Appendix XXV
- Narrow-barred Spanish mackerel (*Scomberomorus commerson*) – Appendix XXVI

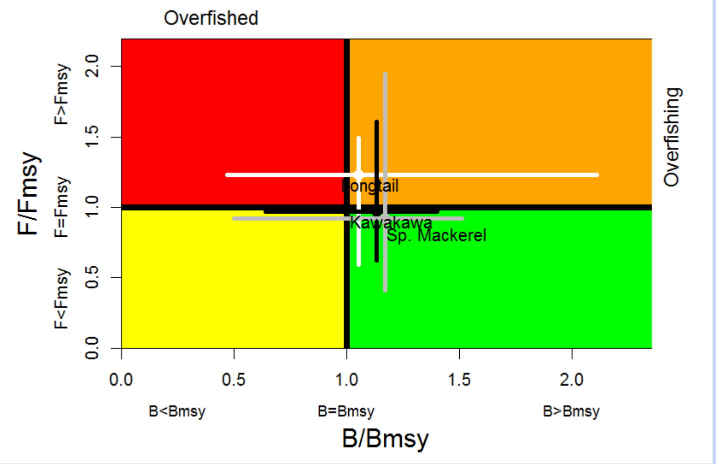

Fig. 6. Combined Kobe plot for kawakawa (black: 2014), longtail tuna (white: 2014) and narrow-barred Spanish mackerel (grey: 2014), showing the estimates of current stock size (B) and current fishing mortality (F) in relation to interim target spawning stock size and interim target fishing mortality. Cross bars illustrate the range of uncertainty from the model runs.

Status of Marine Turtles, Seabirds and Sharks in the Indian Ocean

Sharks

SC17.04 (para. 149) 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 shark (*Prionace glauca*) – Appendix XXVII
- Oceanic whitetip shark (*Carcharhinus longimanus*) – Appendix XXVIII
- Scalloped hammerhead shark (*Sphyrna lewini*) – Appendix XXIX
- Shortfin mako shark (*Isurus oxyrinchus*) – Appendix XXX
- Silky shark (*Carcharhinus falciformis*) – Appendix XXXI
- Bigeye thresher shark (*Alopias superciliosus*) – Appendix XXXII
- Pelagic thresher shark (*Alopias pelagicus*) – Appendix XXXIII

Marine turtles

SC17.05 (para. 150) 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 XXXIV

Seabirds

SC17.06 (para. 151) 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 XXXV

GENERAL RECOMMENDATIONS TO THE COMMISSION

National Reports from CPCs

SC17.07 (para. 24) **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 providing the reports by all CPCs, the SC **RECOMMENDED** that the Commission note that in 2014, 26 reports were provided by CPCs, down from 28 in 2013 (26 in 2012, 25 in 2011, 15 in 2010 and 14 in 2009) (Table 2).

SC17.08 (para. 26) The SC **RECOMMENDED** that the Commission note the lack of compliance by several CPCs in 2014, that did not submit a National Report in 2014, noting that the Commission agreed that the submission of the reports to the SC is mandatory (Table 2).

Report of the 12th Session of the Working Party on Billfish (WPB12)

Shortbill spearfish

SC17.09 (para. 36) **NOTING** that one of the Indian Ocean billfish species (shortbill spearfish, *Tetrapturus angustirostris*) is currently not listed among the species managed by IOTC, and considering the ocean-wide distribution of this species, its highly-migratory nature, and that it is a common bycatch in IOTC managed fisheries, the SC **RECOMMENDED** that the Commission include it in the list of species to be managed by the IOTC.

Report of the 10th Session of the Working Party on Ecosystems and Bycatch (WPEB10)

Evaluating benefits of retaining non-target species

SC17.10 (para. 41) **NOTING** the lack of expertise and resources within the WPEB and the short timeframe to fulfill this task, the SC **RECOMMENDED** that a consultant be hired to conduct this work and present the results at the next WPEB meeting. The following tasks, necessary to address this issue, should be considered for the terms of reference, taking into account all species that are usually discarded on all major gears (i.e., purse seines, longlines and gillnets), and fisheries that take place on the high seas and in coastal countries EEZs:

i) Estimate species-specific quantities of discards to assess the importance and potential of this new product supply, integrating data available at the IOTC Secretariat from the regional observer schemes;
ii) Assess the species-specific percentage of discards that is captured dead versus alive, as well as the post-release mortality of species that are discarded alive, in order to estimate what will be the added fishing mortality to the populations, based on the best current information;
iii) Assess the feasibility of full retention, taking into account the specificities of the fleets that operate with different gears and their fishing practices (e.g., transhipment, onboard storage capacity);
iv) Assess the capacity of the landing port facilities to handle and process this catch;
v) Assess the socio-economic impacts of retaining non-target species, including the feasibility to market those species that are usually not retained by those gears;
vi) Assess the benefits in terms of improving the catch statistics through port-sampling programs;
vii) Evaluate the impacts of full retention on the conditions of work and data quality collected by onboard scientific observers, making sure that there is a strict distinction between scientific observer tasks and compliance issues.

Sharks and rays: Review of data needs and way forward for the evaluation of shark stocks - catch data reconstruction

SC17.11 (para. 43) The SC **RECOMMENDED** that a short inter-sessional meeting is conducted with a small group of scientists to work mainly on blue shark catch data reconstruction to be used for stock assessment in 2015. Ideally, and to reduce costs, all participants should fund their own participation at a venue to be decided, or work electronically.

Review of new information on the status of sharks and rays

SC17.12 (para. 44) **NOTING** that the information on retained catches and discards of sharks contained in the IOTC database remains very incomplete for most fleets despite their mandatory reporting status, and that catch-and-effort as well as size data are essential to assess the status of shark stocks, the SC **RECOMMENDED** that all CPCs collect and report catches of sharks (including historical data), catch-and-effort and length frequency data on sharks, as per IOTC Resolutions, so that more detailed analysis can be undertaken for the next WPEB meeting.

Shark Ecological Risk Assessment: review of current knowledge and potential management implications

SC17.13 (para. 45) The SC reiterated its **RECOMMENDATION** from 2013, that the Commission note the list of the 10 most vulnerable shark species to longline gear (Table 3) and purse seine gear (Table 4) in the Indian Ocean, as determined by a productivity susceptibility analysis, compared to the list of shark species/groups required to be recorded for each gear, contained in Resolution 13/03 o*n the recording of catch and effort by fishing vessels in the IOTC area of competence*. At the next revision to Resolution 13/03, the Commission may wish to add the missing species/groups of sharks and rays.

SC17.14 (para. 46) The SC reiterated its **RECOMMENDATION** from 2013, that, in line with Recommendation 12/15 on the best available science, the list of shark species (or groups of species) for longline gear under Resolution 13/03 (Table 3) should be supplemented with the silky shark (*Carcharhinus falciformis*), which was estimated to be at risk in longline fisheries by the ERA conducted in 2012 (ranked as the 4th most vulnerable species to longline gear). The SC **REQUESTED** the Commission to define the most appropriate means of collecting this additional information.

TABLE 3. List of the 10 most vulnerable shark species to longline gear compared to the list of shark species/groups required to be recorded in logbooks, as listed in Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*.

PSA vulnerability ranking	Most susceptible shark species to longline gear	FAO Code	Shark species currently listed in IOTC Resolution 13/03 for longline gear: mandatory recording	FAO Code
1	Shortfin mako (*Isurus oxyrinchus*)	SMA	Blue shark (*Prionace glauca*)	BSH
2	Bigeye thresher (*Alopias superciliosus*)	BTH	Mako sharks (*Isurus* spp.)	MAK
3	Pelagic thresher (*Alopias pelagicus*)	PTH	Porbeagle shark (*Lamna nasus*)	POR
4	Silky shark (*Carcharhinus falciformis*)	FAL	Hammerhead sharks (*Sphyrna* spp.)	SPN
5	Oceanic whitetip shark (*Carcharhinus longimanus*)	OCS	Other sharks	SKH
6	Smooth hammerhead (*Sphyrna zygaena*)	SPZ	Thresher sharks (*Alopias* spp.)	THR
7	Porbeagle (*Lamna nasus*)	POR	Oceanic whitetip shark (*Carcharhinus longimanus*)	OCS
8	Longfin mako (*Isurus paucus*)	LMA		
9	Great hammerhead (*Sphyrna mokarran*)	SPM		
10	Blue shark (*Prionace glauca*)	BSH		

SC17.15 (para. 47) The SC reiterated its **RECOMMENDATION** form 2013, that, in line with Recommendation 12/15 on the best available science, the list of shark species (or groups of species) for purse seine gear under Resolution 13/03 (Table 4) should be supplemented with the silky shark (*Carcharhinus falciformis*), mako sharks (*Isurus* spp.), hammerhead sharks (*Sphyrna* spp.), pelagic stingray (*Pteroplatytrygon violacea*), dusky shark (*Carcharhinus obscurus*), tiger shark (*Galeocerdo cuvier*), which were estimated to be at risk in purse seine fisheries by the ERA conducted in 2012. The SC **REQUESTED** the Commission to define the most appropriate means of collecting this additional information.

TABLE 4. List of the 10 most vulnerable shark species to purse seine gear compared to the list of shark species/groups required to be recorded in logbooks, as listed in Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*.

PSA vulnerability ranking	Most susceptible shark species to purse seine gear	FAO Code	Shark species listed in IOTC Resolution 13/03 for purse seine gear: Mandatory recording	FAO Code
1	Oceanic whitetip shark (*Carcharhinus longimanus*)	OCS	Whale sharks (*Rhincodon typus*)	RHN
2	Silky shark (*Carcharhinus falciformis*)	FAL	Thresher sharks (*Alopias* spp.)	THR
3	Shortfin mako (*Isurus oxyrinchus*)	SMA	Oceanic whitetip shark (*Carcharhinus longimanus*)	OCS
4	Great hammerhead (*Sphyrna mokarran*)	SPM		
5	Pelagic stingray (*Pteroplatytrygon violacea)*	PLS		
6	Scalloped hammerhead (*Sphyrna lewini*)	SPL		
7	Smooth hammerhead (*Sphyrna zygaena*)	SPZ		
8	Longfin mako (*Isurus paucus*)	LMA		
9	Dusky shark (*Carcharhinus obscurus*)	DUS		
10	Tiger shark (*Galeocerdo cuvier*)	TIG		

Best practice guidelines for the safe release and handling of encircled whale sharks

SC17.16 (para. 48) The SC reiterated its **RECOMMENDATION** from 2013, that the following *Guidelines for the safe release and handling of encircled whale* sharks, should be added as an additional page in the IOTC shark identification guides:

The methods listed below depend on the condition of the particular purse seine set, e.g. the size and orientation of the encircled animal, size of fish in the purse seine set and operation style.

- Cutting the net when the whale shark is at the surface and separated from the tuna and when the operation presents no danger for the crew;
- Standing the animal on the net and rolling it outside the bunt. A rope placed under the animal and attached to the float line could help rolling the whale shark out of the net;
- Brailing sharks (only for small individual less than 2–3 meters).

The crew should never:

- Pull up the shark by its tail;
- Tow the shark by its tail.

SC17.17 (para. 49) The SC reiterated its **RECOMMENDATION** from 2013, that the Commission allocates funds in its 2015 budget, to produce and print the IOTC best practice guidelines for the safe release and handling of encircled whale sharks, and for these to be incorporated into the existing IOTC "*Shark and ray identification in Indian Ocean pelagic fisheries*", identification cards.

Shark fin to body weight ratio and wire leaders/traces

SC17.18 (para. 50) **NOTING** that the Commission, at its 18th Session considered a range of proposals on sharks which included matters relevant to the shark fin to body weight ratio and wire leaders/traces, the SC **RECALLED** its previous advice to the Commission as follows:

- 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.

- On the basis of information presented to the SC 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.

Marine Turtles: Review of Resolution 12/04 on the conservation of marine turtles

SC17.19 (para. 52) The SC reiterated its **RECOMMENDATION** from 2013, that at the next revision of IOTC Resolution 12/04 *on the conservation of marine turtles*, the measure is strengthened to ensure that where possible, CPCs report annually on the total estimated level of incidental catches of marine turtles, by species, as provided at Table 5.

TABLE 5. Marine turtle species reported as caught in fisheries within the IOTC area of competence.

Common name	Scientific name
Flatback turtle	*Natator depressus*
Green turtle	*Chelonia mydas*
Hawksbill turtle	*Eretmochelys imbricata*
Leatherback turtle	*Dermochelys coriacea*
Loggerhead turtle	*Caretta caretta*
Olive ridley turtle	*Lepidochelys olivacea*

Marine mammals: Development of technical advice for marine mammals

SC17.20 (para. 53) The SC reiterated its **RECOMMENDATION** from 2013, that depredation events be incorporated into Resolution 13/03 at its next revision, so that interactions may be quantified at a range of spatial scales. Depredation events should also be quantified by the regional observer scheme.

Best practice guidelines for the safe release and handling of encircled cetaceans

SC17.21 (para. 54) The SC reiterated its **RECOMMENDATION** from 2013, that the Commission allocates funds in its 2015 and 2016 budgets, to produce and print the IOTC best practice guidelines for the safe release and handling of encircled cetaceans. The guidelines could be incorporated into a set of IOTC cetacean identification cards: "*Cetacean identification for Indian Ocean fisheries*".

Status of development and implementation of National Plans of Action for seabirds and sharks, and implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations

SC17.22 (para. 58) The SC **RECOMMENDED** that the Commission note the current status of development and implementation of National Plans of Action (NPOAs) for sharks and seabirds, and the implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations, by each CPC as provided at Appendix VI, recalling that the IPOA-Seabirds and IPOA-Sharks were adopted by the FAO in 1999 and 2000, respectively, and required the development of NPOAs. Despite the time that has elapsed since then, very few CPCs have developed NPOAs, or even carried out assessments to ascertain if the development of a Plan is warranted. Currently only 12 of the 35 IOTC CPCs have an NPOA-Sharks (8 more in development), while only 6 CPCs have an NPOA-Seabirds (2 more in development). A single CPC has determined than an NPOA-Sharks is not needed, and 5 have similarly determined than an NPOA-Seabirds is not needed. Currently only 6 of the 35 IOTC CPCs have implemented the FAO guidelines to reduce marine turtle mortality in fishing operations (2 more in progress), and one CPC (France (OT)) will implement a full NPOA in 2015.

Report of the 16th Session of the Working Party on Tropical Tunas (WPTT16)

Fish aggregating devices

SC17.23 (para. 71) The SC **RECOMMENDED** that an ad hoc working group on FADs, drifting and anchored, be created to assess the consequences of the increasing number and technological developments of FADs in tuna fisheries and their ecosystems, in order to inform and advise on future FAD-related management options. This ad hoc working group would be of multi-sectorial nature, involving various stakeholders such as scientists, fishery managers, fishing industry representatives, administrators and fishers. The Terms of reference for this working group are provided at Appendix VIII.

Report of the 10th Session of the Working Party on Data Collection and Statistics (WPDCS10)

Resolution 10/02 Mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties

SC17.24 (para. 86) The SC **RECOMMENDED** that the Commission makes the following amendments to IOTC Resolution 10/02:

- Adopting the following definitions in order to clarify the type of fisheries, area and species covered by Resolution 10/02:
  - **Longline fisheries:** Fisheries undertaken by vessels in the IOTC Record of Authorized Vessels that use longline gear.
  - **Surface fisheries:** All fisheries undertaken by vessels in the IOTC Record of Authorized Vessels other than longline fisheries; in particular purse seine, pole-and-line, and gillnet fisheries.
  - **Coastal fisheries:** Fisheries other than longline or surface, as defined above, also called artisanal fisheries.
  - **IOTC area of competence**: as described in Annex A of the IOTC Agreement.
  - **Species:** refers to all species under the IOTC mandate as described in Annex B of the IOTC Agreement, and the most commonly caught elasmobranch species, as defined by the Commission in IOTC Resolution 13/03 or any subsequent revisions of this Resolution.
  - **Support vessels:** Any types of vessels that operate in support of the fishing activities of purse seine vessels.
- Specify the requirements for Nominal Catch data, including:
  - Changing the term Nominal by Total;
  - Change the time-period resolution of Total catch data from Year to Quarter, in order to be able to assess the seasonality of fisheries, in particular those that do not report catch-and-effort data;
  - Request separate reports for retained catches (in live weight) and discards (in live weight or number), as per the above Resolution.

- Specify the requirements for Catch and effort data, including:
  - Surface fisheries: Extend the requirements to report catch and effort data by type of fishing mode, drifting or anchored FADs, to fisheries other than the purse seine fisheries that use FADs; and ensure that the effort units reported are consistent with those requested in Resolution 13/03 or any subsequent revisions to such Resolution;
  - Coastal fisheries: Specify the time-period to be used to report this information, preferably Month.
- Harmonise the type of data resolution that is requested for coastal fisheries, in particular for catch-and-effort and size data; for data to be reported by month and landing area.
- Specify that Size Frequency data shall be reported according to the procedures described in the IOTC Guidelines for the Reporting of Fisheries Statistics (instead of those set out by the IOTC Scientific Committee, as recorded in the present Resolution).
- Specify the requirements for data on supply vessels, including:
  - Change the term Supply to Support (Support Vessels);
  - Indicate that data on the activities of support vessels shall be reported by the flag country of the vessels that receive the assistance of the support vessel (and not by the flag country or other parties);
  - Request the name of the purse seiners that receive assistance from each support vessel.

Review of Estimates of Input Fishing Capacity

SC17.25 (para. 88) **NOTING** that while there are currently forms available for the reporting of fishing capacity in the IOTC area of competence, the majority of CPCs do not report this information for its coastal fisheries, the SC **RECOMMENDED** that the Commission consider making reporting mandatory if an estimate of total fishing capacity is required.

Resolution 11/04 On a regional observer scheme

SC17.26 (para. 90) **NOTING** that the objective of the Regional Observer Scheme contained in Resolution 11/04, and the rules contained in Resolution 12/02 *On data confidentiality policy and procedures* makes no reference to the data collected not being used for compliance purposes, the SC **RECOMMENDED** that at the next revision of Resolution 11/04, it be clearly stated that the data collected within the Regionl Observer Scheme shall not be used for compliance purposes.

Report of the 5th Session of the Working Party on Methods (WPM05)

Limit reference points

SC17.27 (para. 103) The SC **RECOMMENDED** the Commission consider an alternative approach to identify biomass limit reference points, such as those based on biomass depletion levels, when the MSY-based reference points are difficult to estimate. In cases where MSY-based reference points can be robustly estimated, limit reference points may be based around MSY.

SC17.28 (para. 104) The SC **RECOMMENDED** that in cases where MSY-based reference points cannot be robustly estimated, biomass limit reference points be set at 20% of unfished levels ($B_{LIM} = 0.2B_0$).

Target reference points

SC17.29 (para. 105) **NOTING** that the interim target reference points contained in Resolution 13/10 are also MSY-based and subject to the same difficulties with robust estimation, the SC **RECOMMENDED** that the Commission consider that stock biomass depletion levels equivalent to B_{MSY} are expected to lie in the range of 30% to 40% of unfished levels ($0.3B_0$ to $0.4B_0$), when MSY-based levels cannot be accurately estimated. The Commission may wish to consider a value of $0.4B_0$ or higher, if a precautionary buffer against reaching a biomass limit is desirable.

SC17.30 (para. 106) **NOTING** that the approach described in para. 105 is similar to what is currently taking place in other RFMOs such as WCPFC, the SC **RECOMMENDED** that the use of this type of reference point is adopted by the Commission. In considering target reference points, guidance will be required from the Commission on tolerable risks of exceeding limit reference points.

Fishing Mortality Equivalents

SC17.31 (para. 107) The SC **RECOMMENDED** that with respect to fishing mortality (F) reference points, for consistency between the definitions of overfished and overfishing, the Commission should consider using those F values that correspond to the biomass reference points. For example, given a biomass limit of

0.2B_0, a consistent F limit reference point would be $F_{B20\%}$, the fishing mortality rate that reduces the biomass to 20% of unfished levels.

Skipjack tuna MSE update

SC17.32 (para. 110) The SC **NOTED** that the consultancy that has been used to develop the simulation tools and initial evaluations of some candidate Management Procedures has run to completion. Additional work is required to support the Commission's desire to implement management approaches that can achieve its objectives. In this regard, the SC **RECOMMENDED** that the Commission fully fund the work needed to support its requirement to achieve its objectives in particular facilitating the implementation of Resolution 12/01.

Summary discussion of matters common to Working Parties (capacity building activities – stock assessment course; connecting science and management, etc.)

Meeting participation fund

SC17.33 (para. 118) **NOTING** that the MPF was used to fund the participation of a reduced number of national scientists to the Working Parties in 2014, 49 national scientists to the Working Party meetings and the SC in 2014 (58 in 2013; 42 in 2012), all of which were required to submit and present a working paper at the meeting, the SC **RECOMMENDED** that the Commission consider the following:

- 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 now incorporated into the IOTC Rules of Procedure (2014), was established for the purposes of supporting scientists and representatives from IOTC Contracting Parties who are developing States to attend and contribute to the work of the Commission, the Scientific Committee and its Working Parties.
- The Commission has made the following directives to the IOTC Secretariat:
  a) The Commission had directed the IOTC Secretariat (via Resolution 10/05 and now via the IOTC Rules of Procedure (2014)) to ensure that: (para. 88 of the S18 Report)
     i. the MPF be utilised, as a first priority, to support the participation of scientists from developing Contracting Parties in scientific meetings of the IOTC, including Working Parties, rather than non-science meetings.
     ii. the MPF will be allocated in such a way that no more than 25% of the expenditures of the Fund in one year is used to fund attendance to non-scientific meetings.
     iii. thus, 75% of the annual MPF shall be allocated to facilitating the attendance of developing Contracting Party scientists to the Scientific Committee and its Working Parties.
  b) The Commission had directed the IOTC Secretariat that any cost savings made on the annual IOTC budget, shall also be used to further supplement the $60,000 currently budgeted for the MPF.
- In accordance with para. 89 of the S18 Report, the IOTC Secretariat is actively seeking extra budgetary funding sources to supplement the MPF budget from individual Contracting Parties as well as other interested groups. However, the SC was informed by the IOTC Secretariat that other sources should actively be sought by interested candidates, including the UNFSA meeting fund, as well as through their own domestic budgetary processes.

SC17.34 (para. 119) The SC strongly **RECOMMENDED** that this fund be maintained into the future and increased back to its original allocation of $200,000 per year.

SC17.35 (para. 123) The SC **RECOMMENDED** that the MPF rules of procedure be modified, so that a Draft working document, rather than an abstract, be submitted to the relevant Working Party MPF Selection Panel 45 days before the meeting, so that the Panel may review the full paper rather than just the abstract, and provide guidance on areas for improvement and the suitability of the application to receive funding using the MPF. The justification of this request is based upon the reduced funds available and the need to maximise benefits. The SC **AGREED** that until such time as the Commission revises the IOTC Rules of Procedure the MPF selection panels may choose to follow this proposal.

Capacity building activities

SC17.36 (para. 126) The SC **AGREED** that, while external funding is helping the work of the Commission, funds allocated by the Commission to capacity building are still too low, considering the range of issues identified by the SC and its Working Parties, and **RECOMMENDED** that the Commission consider allocating more funds to these activities in the future.

SC17.37 (para. 127) The SC **RECOMMENDED** that the Commission further increase the IOTC Capacity Building budget line so that capacity building workshops/training can be carried out in 2015, 2016 and future years on the collection, reporting and analyses of catch and effort data for IOTC species, with a special focus on neritic tuna and tuna-like species. Where appropriate these training sessions shall include information that explains the entire IOTC process from data collection to analysis and how the information collected is used by the Commission to develop Conservation and Management Measures.

IOTC species identification cards

SC17.38 (para. 129) **NOTING** the recent online survey distributed by the IOTC Secretariat, the SC strongly **RECOMMENDED** that the IOTC Secretariat ensure that hard copies of the identification cards continue to be printed as many CPCs scientific observers, both on board and port, still do not have smart phone technology/hardware access and need to have hard copies on board. At this point in time, electronic formats, including 'applications or apps' are only suitable for larger scale vessels, and even in the case of EU purse seine vessels, the use of hard copies is relied upon due to on board fish processing and handling conditions, as well as weather conditions.

Identification cards: Tuna and tuna-like species

SC17.39 (para. 130) **NOTING** the excellent work undertaken by the IOTC Secretariat and other experts to develop and finalise the cards for the *Identification of tuna and tuna-like species in the Indian Ocean fisheries*, the SC **RECOMMENDED** that the cards be translated, in priority order to the following languages, according to the proportion of total catches of neritic tuna species reported by country, and that the IOTC Secretariat utilise funds from both the IOTC budget, as well as external funding sources to translate and print in hard copy, the identification cards. Funds were approved by the Commission in the 2014 budget for this purpose, however the IOTC Secretariat indicated the funds are yet to be received from Members. Number in brackets represents the recent proportion of the total neritic tuna catch in the IOTC area of competence:

1) Bahasa-Indonesian (Indonesia 29%) and Malaysian (Malaysia 4%)
2) Persian (Farsi-I.R. Iran 20%) and Arabic (Oman 3%)
3) Hindi (India 18%) and Sinhala (Sri Lanka 5%)
4) Urdu (Pakistan 7%)

Identification cards: Marine turtles, seabirds and sharks

SC17.40 (para. 132) **NOTING** that funds were approved by the Commission in the 2014 budget to translate and print hard copies of the marine turtle, seabird and shark identification cards, but this was only partially done as the IOTC Secretariat indicated the funds are yet to be received from Members, the SC **RECOMMENDED** that the translation and printing occur as soon as the necessary contributions are received.

Chairs and Vice-Chairs of the SC and its subsidiary bodies

SC17.41 (para. 136) The SC **RECOMMENDED** that the Commission note and endorse the Chairs and Vice-Chairs for the SC and its subsidiary bodies for the coming years, as provided in Appendix XI.

Proposed revisions to Resolution 11/04 on a regional observer scheme

SC17.42 (para. 159) **RECALLING** the objectives of Resolution 11/04 *on a regional observer scheme* as follows: "Para 1: The objective of the IOTC Observer Scheme shall be to collect verified catch data and other scientific data related to the fisheries for tuna and tuna-like species in the IOTC area of competence" and **NOTING** that the objective of the ROS contained in Resolution 11/04, and the rules contained in Resolution 12/02 *On data confidentiality policy and procedures* makes no reference to the data collected not being used for compliance purposes, the SC **RECOMMENDED** that at the next revision of Resolution 11/04, it be clearly stated that the data collected shall not be used for compliance purposes.

Electronic Monitoring

SC17.43 (para. 166) **NOTING** that electronic monitoring (including video) has been trialled and successfully implemented in many fisheries worldwide (e.g. Australia, European Union, USA, New Zealand), with the aim of supplementing scientific observers on board vessels; and given the current difficulties cited as reasons for not deploying scientific observers under the IOTC Regional Observer Scheme (ROS) on board large-scale gillnet vessels operating in the Indian Ocean; the SC **RECOMMENDED** that the Commission considers assigning the IOTC Secretariat, in consultation with interested IOTC scientisits, to develop a project on electronic monitoring in the IOTC area of competence. This would allow an evalution of the efficacy of electronic monitoring in the collection of information on catch, discards and fishing effort as a means to supplement scientific observer coverage for large-scale gillnet vessels. The trial will include an evaluation of the main challenges of using electronic monitoring data such as the accurate identification of IOTC and bycatch species, weight and size of catches and the time taken to process the footage and extract the required data. The concept note/proposal shall also include a clear indication that the IOTC data confidentiality policy (Resolution 12/02) will need to be modified to ensure any data/information collected is for the sole purpose of scientific analysis and not for compliance purposes. The concept note should include a detailed budget and be communicated to a range of potential funding organisations.

Evaluation of closed areas as management options

SC17.44 (para. 170) The SC reiterated its previous **RECOMMENDATION** with respect to bigeye tuna, skipjack tuna and yellowfin tuna stocks, that the Commission note that the previous IOTC closure is likely to be ineffective, as fishing effort will be redirected to other fishing grounds in the Indian Ocean and it considered that this recommendation also related to the wider network of closures including UK(OT) MPA. Papers IOTC–2013–SC16–INF11 and IOTC–2011–SC14–40, which examined the effect of IOTC closure and the effect of the UK(OT) MPA as well as a partial Maldives closure on the status of yellowfin tuna, concluded that if displacement of effort occurred to areas outside the closures then there would be no effect. An effect was only observed if it was assumed that all effort that would have occurred in those areas was entirely removed from the fishery. Thus any positive impacts of closed areas would likely be offset by effort reallocation.

SC17.45 (para. 172) The SC **RECOMMENDED** that the Commission specify the level of reduction or the long term management objectives to be achieved with any time area closure/s and/or alternative measures which it adopts in the future, as these will, in turn, guide and facilitate the analysis by the SC and its subsidiary bodies.

Progress on the Implementation of the Recommendations of the Performance Review Panel

SC17.46 (para. 174) 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 XXXVII.

Invited Experts

SC17.47 (para. 181) The SC **RECOMMENDED** that at least one 'Invited Expert' be brought to each of the science Working Parties in 2015 and in each subsequent year, so as to further increase the capacity of the Working Paties to undertake the work detailed in the Program of Work (Appendix XL). The IOTC regular budget shall include travel funds (flights, DSA) for this purpose. The Invited Expert for each meeting will continue to be selected based on the process adopted by the Scientific Committtee and provided at Appendix XL.

Consultants

SC17.48 (para. 183) **NOTING** the highly beneficial and relevant work done by IOTC stock assessment consultants in 2014 and in previous years, the SC **RECOMMENDED** that engagement by consultants be continued for each coming year based on the Program of Work (Appendix XXXVIII), to supplement the skill set available within the IOTC Secretariat and CPCs. An indicative budget is provided at Table 6.

TABLE 6. Estimated budget required to hire a consultant to carry out stock assessments on tuna and tuna-like species under the IOTC mandate, sharks frequenly caught by IOTC fisheries, and capacity building, in 2015 and 2016.

Description	Unit price	Units required	2015 Total (US$)	2016 Total (US$)	Priority
WPNT					
Neritic tuna data poor stock assessment and capacity building (fees)	450	15	6,750	6,750	Low
Neritic tuna data poor stock assessment and capacity building (travel)	5,000	1	5,000	5,000	Low
WPB					
Billfish data poor stock assessment (fees)	450	15	6,750	6,750	Med
Billfish data poor stock assessment (travel)	5,000	1	5,000	5,000	Med
WPEB					
Shark stock assessment (fees)	450	20	9,000	9,000	High
Shark stock assessment (travel)	5,000	1	5,000	5,000	High
Evaluation of the discards ban proposal	450	35	Nil	15,750	Med
WPTT					
Tropical tuna stock assessment (fees)	450	35	15,750	15,750	High

Tropical tuna stock assessment (travel)	5,000	1	5,000	5,000	High
WPTmT					
Temperate tuna stock assessment (fees)	450	35	Nil	15,750	High
Temperate tuna stock assessment (travel)	5,000	1	Nil	5,000	High
WPM					
External peer review of the albacore MSE	450	10	4,500	Nil	Med
External peer review of the skipjack tuna MSE	450	10	4,500	Nil	Med
TOTAL			**67,250**	**94,754**	

Schedule of meetings for 2015 and 2016

SC17.49 (para. 185) The SC **RECOMMENDED** that the Commission endorse the schedule of Working Party and Scientific Committee meetings for 2015 and 2016 provided at Appendix XLI.

Discussion of the Science to Management dialogue

SC17.50 (para. 190) The SC **NOTED** the substantial progress being made by the Working Party on Methods to develop management strategy evaluation frameworks, and that for this work to progress there is a need for clear guidance to the SC on fishery management objectives and on tolerable risks associated with breaching the limits. In this regard, the SC **RECOMMENDED** that these issues be given a high priority for broad discussion by the CPCs during the Science and Management Dialogue Workshops under Resolution 14/03 and that the Chair of the Commission consider inclusion of their discussion in the Commission meeting.

Review of the Draft, and Adoption of the Report of the 17th Session of the Scientific Committee

SC17.51 (para. 194) The SC **RECOMMENDED** that the Commission consider the additional science budget for 2015–16, (Appendix XLII) and the consolidated set of recommendations arising from SC17, provided at Appendix XLIII.