Report of the 17th Session of the IOTC Working Party on Tropical Tunas

Montpellier, France, 23–28 October 2015

DISTRIBUTION:

Participants in the Session
Members of the Commission
Other interested Nations and International Organizations
FAO Fisheries Department
FAO Regional Fishery Officers

BIBLIOGRAPHIC ENTRY

IOTC–WPTT17 2015. Report of the 17th Session of the IOTC Working Party on Tropical Tunas. Montpellier, France, 23–28 October 2015. *IOTC–2015–WPTT17–R[E]: 102 pp.*

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

The designations employed and the presentation of material in this publication and its lists do not imply the expression of any opinion whatsoever on the part of the Indian Ocean Tuna Commission (IOTC) or the Food and Agriculture Organization (FAO) of the United Nations concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

This work is copyright. Fair dealing for study, research, news reporting, criticism or review is permitted. Selected passages, tables or diagrams may be reproduced for such purposes provided acknowledgment of the source is included. Major extracts or the entire document may not be reproduced by any process without the written permission of the Executive Secretary, IOTC.

The Indian Ocean Tuna Commission has exercised due care and skill in the preparation and compilation of the information and data set out in this publication. Notwithstanding, the Indian Ocean Tuna Commission, employees and advisers disclaim all liability, including liability for negligence, for any loss, damage, injury, expense or cost incurred by any person as a result of accessing, using or relying upon any of the information or data set out in this publication to the maximum extent permitted by law.

Contact details:

Indian Ocean Tuna Commission
Le Chantier Mall
PO Box 1011
Victoria, Mahé, Seychelles
Ph: +248 4225 494
Fax: +248 4224 364
Email: secretariat@iotc.org
Website: http://www.iotc.org

ACRONYMS

aFAD	anchored Fish aggregating device
ASPM	Age-Structured Production Model
B	Biomass (total)
BET	Bigeye tuna
B_{MSY}	Biomass which produces MSY
CE	Catch and effort
CI	Confidence Interval
CMM	Conservation and Management Measure (of the IOTC; Resolutions and Recommendations)
CPCs	Contracting parties and cooperating non-contracting parties
CPUE	Catch per unit of effort
current	Current period/time, i.e. $F_{current}$ means fishing mortality for the current assessment year.
EEZ	Exclusive Economic Zone
ENSO	El Niño–Southern Oscillation
EU	European Union
F	Fishing mortality; F_{2011} is the fishing mortality estimated in the year 2011
FAD	Fish aggregating device
F_{MSY}	Fishing mortality at MSY
GLM	Generalised linear model
HBF	Hooks between floats
IO	Indian Ocean
IOTC	Indian Ocean Tuna Commission
IWC	International Whaling Commission
K2SM	Kobe II Strategy Matrix
LL	Longline
M	Natural Mortality
MSC	Marine Stewardship Council
MSE	Management Strategy Evaluation
MSY	Maximum sustainable yield
n.a.	Not applicable
PS	Purse seine
q	Catchability
ROS	Regional Observer Scheme
SC	Scientific Committee, of the IOTC
SB	Spawning biomass (sometimes expressed as SSB)
SB_{MSY}	Spawning stock biomass which produces MSY (sometimes expressed as SSB_{MSY})
SKJ	Skipjack tuna
SS3	Stock Synthesis III
Taiwan,China	Taiwan, Province of China
VB	Von Bertalanffy (growth)
WPTT	Working Party on Tropical Tunas of the IOTC
YFT	Yellowfin tuna

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**).

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The 17th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Tropical Tunas (WPTT) was held in Montpellier, France, from 23–28 October 2015. The meeting was opened by the Chairperson, Dr M. Shiham Adam (Maldives) who welcomed participants and Vice-Chair, Dr Gorka Merino (EU,Spain). A total of 44 participants attended the Session (53 in 2014, 46 in 2013), including the invited expert, Dr Simon Hoyle (a consultant from New Zealand who received funding from the IOTC and ISSF), and the IOTC Stock Assessment consultant (for yellowfin tuna), Mr Adam Langley.

The following are a subset of the complete recommendations from the WPTT17 to the Scientific Committee, which are provided at Appendix X.

Report of the 2nd CPUE workshop on longline fisheries

WPTT17.02 (para. 111): **NOTING** that the Taiwan,China longline CPUE in southern regions is affected by the rapid recent growth of the oilfish fishery, and that this is a new fishery with substantially lower catchability for tunas, it is important for CPUE indices to adjust for this change in catchability. Thus, the WPTT **RECOMMENDED** that future tuna CPUE standardisations should use appropriate methods to identify effort targeted at oilfish and related species, and either remove it from the dataset, or include a categorical variable for targeting method in the standardisation. The oilfish data variable should be provided to data analysts producing the CPUE index.

WPTT17.03 (para. 112): The WPTT **NOTED** that differences between the Japan and Taiwan.China longline CPUE indices were examined and attributed to either low sampling coverage of logbook data (between 1982–2000) or misreporting across oceans (Atlantic and Indian oceans) for bigeye tuna catches between 2002–04 for Taiwan,China. The WPTT **RECOMMENDED** the 1) development of minimum criteria (e.g. 10% using a simple random stratified sample) for logbook coverage to use data in standardisation processes; and 2) identifying vessels through exploratory analysis that were misreporting, and excluding them from the dataset in the standardisation analysis.

WPTT17.04 (para. 113): The WPTT **RECOMMENDED** that:

- more credence should be given to CPUE indices based on operational data, since analyses of these data can take more factors into account, and analysts are better able to check the data for inconsistencies and errors.
- Taiwan,China fleets provide all available logbook data to data analysts, representing the best and most complete information possible. This stems from the fact that the dataset currently used by scientists from Taiwan,China is incomplete and not updated with logbooks that arrive after finalisation.
- that vessel identity information for the Japanese fleets for the period prior to 1979 should be obtained either from the original logbooks or from some other source, to the greatest extent possible to allow estimation of catchability change during this period and to permit cluster analysis using vessel level data. During this period there was significant technological change (e.g. deep freezers) and targeting changes (e.g. yellowfin tuna to bigeye tuna).
- examining operation level data across all longline fleets (Rep. of Korea, Japan and Taiwan,China) will give us a better idea of what is going on with the fishery and stock especially if some datasets have low sample sizes or effort in some years, and others have higher sample sizes and effort, so we have a representative sample covering the broadest areas in the Indian Ocean. This will also avoid having no information in certain strata if a fleet were not operating there, and avoid combining two indices in that case.

WPTT17.05 (para. 114): **NOTING** paragraph 113, the WPTT **RECOMMENDED** that continued work on joint analysis of operational catch and effort data from multiple fleets be undertaken, to further develop methods and to provide indices of abundance for IOTC stock assessments.

Review of the draft, and adoption of the Report of the 17th Session of the WPTT

WPTT17.08 (para. 164): The WPTT **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPTT17, provided at Appendix X, as well as the management advice provided in the draft resource stock status summary for each of the three tropical tuna species under the IOTC mandate, and the combined Kobe plot for the three species assigned a stock status in 2015 (Fig. 10):

- Bigeye tuna (*Thunnus obesus*) – Appendix VI
- Skipjack tuna (*Katsuwonus pelamis*) – Appendix VII
- Yellowfin tuna (*Thunnus albacares*) – Appendix VIII

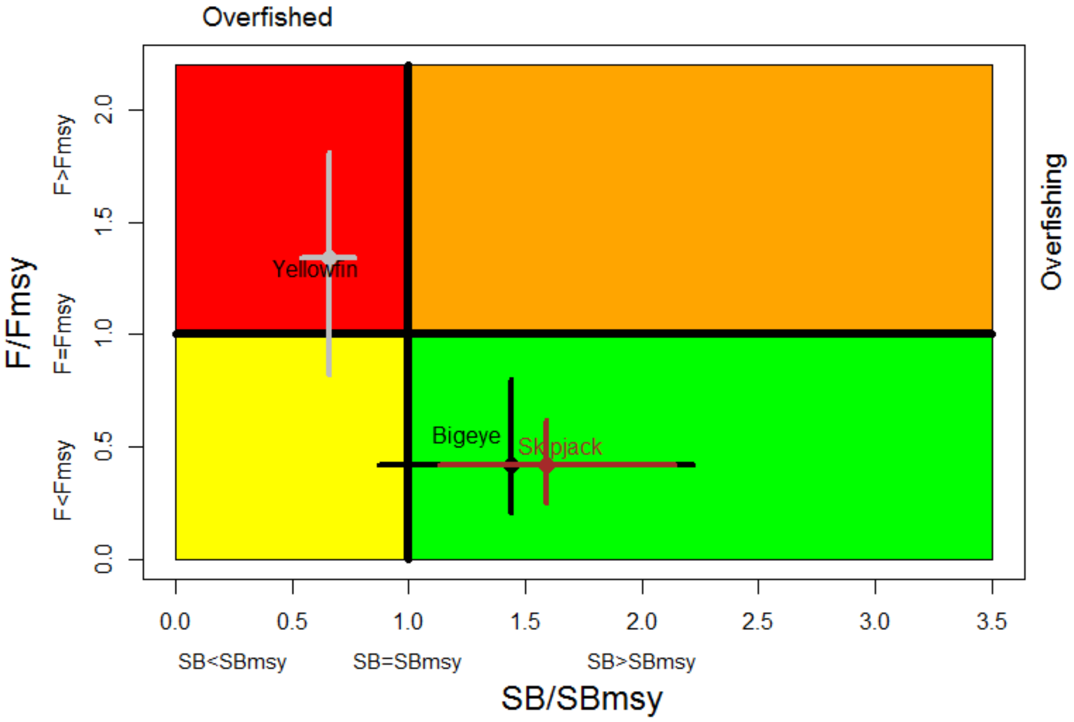


Fig. 10. Combined Kobe plot for bigeye tuna (black: 2013), skipjack tuna (brown: 2014) and yellowfin tuna (grey: 2015) showing the estimates of current stock size (SB) and current fishing mortality (F) in relation to optimal spawning stock size and optimal fishing mortality. Cross bars illustrate the 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.

Stock status

A summary of the stock status for tropical tuna species under the IOTC mandate is provided in Table 1.

Table 1. Status summary for species of tropical tuna under the IOTC mandate.

Stock	Indicators		2008	2009	2010	2011	2012	2013	2014	2015	Advice to the Commission
Bigeye tuna *Thunnus obesus*	Catch in 2014: Average catch 2010–2014: MSY (1000 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):	100,231 t 102,214 t 132 (98–207) n.a. (n.a.–n.a.) 474 (295–677) 0.42 (0.21–0.80) 1.44 (0.87–2.22) 0.40 (0.27–0.54)									No new stock assessment was carried out for bigeye tuna in 2014 or 2015, thus, stock status is determined on the basis of the 2013 assessment and other indicators presented in 2015. On the weight-of-evidence available in 2015, the bigeye tuna stock is determined to be **not overfished** and is **not subject to overfishing**. 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. <Click here for full stock status summary>
Skipjack tuna *Katsuwonus pelamis*	Catch in 2014: Average catch 2010–2014: MSY (1000 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):	402,229 t 432,467 t 684 (550–849) 0.65 (0.51–0.79) 875 (708–1,075) 0.42 (0.25–0.62) 1.59 (1.13–2.14) 0.58 (0.53–0.62)									No new stock assessment was carried out for skipjack tuna in 2015, thus, stock status is determined on the basis of the 2014 assessment and other indicators presented in 2015. On the weight-of-evidence available in 2015, the skipjack tuna stock is determined to be **not overfished** and is **not subject to overfishing**. 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. <Click here for full stock status summary>
Yellowfin tuna *Thunnus albacares*	Catch 2014: Average catch 2010–2014: MSY (1000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2014}/F_{MSY} (80% CI): SB_{2014}/SB_{MSY} (80% CI): SB_{2014}/SB_0 (80% CI):	430,327 t 373,824 t 421 (404–439) 0.165 (0.162–0.168) 1,217 (1,165–1,268) 1.34 (1.02–1.67) 0.66 (0.58–0.74) 0.23 (0.21–0.36)								**94% ****	In 2015, three models were applied to the yellowfin tuna stock, all of which give qualitatively similar results. Stock status is based on the Stock Synthesis III model formulation. On the weight-of-evidence available in 2015, the yellowfin tuna stock is determined to be **overfished** and **subject to overfishing.** The stock status determination changed in 2015 as a direct result of the large and unsustainable catches of yellowfin tuna taken over the last three (3) years, and the relatively low recruitment levels estimated by the model in recent years. The Commission does not currently have any Conservation and Management Measures in place, other than the FAD limitation measure (Resolution 15/08, which is yet to be evaluated) to

											regulate the fisheries for yellowfin tuna. Given the short term projected decline in stock status if catches are maintained or increased from 2014 levels, catches should be reduced in conformity with the decision framework described in Resolution 15/10. <Click here for full stock status summary>

* Not estimable accurately in SS-III as ascending limb missing from equilibrium yield curve.

** Estimated probability that the stock is in the respective quadrant of the Kobe plot (shown below), derived from the confidence intervals associated with the current stock status.

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

1. Opening of the Meeting

1. The 17th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Tropical Tunas (WPTT) was held in Montpellier, France, from 23–28 October 2015. The meeting was opened by the Chairperson, Dr M. Shiham Adam (Maldives) who welcomed participants and Vice-Chair, Dr Gorka Merino (EU,Spain). A total of 44 participants attended the Session (53 in 2014, 46 in 2013), including the invited expert, Dr Simon Hoyle (a consultant from New Zealand who received funding from the IOTC and ISSF), and the IOTC Stock Assessment consultant (for yellowfin tuna), Mr Adam Langley. The list of participants is provided at Appendix I.

2. Adoption of the Agenda and Arrangements for the Session

2. The WPTT **ADOPTED** the Agenda provided at Appendix II. The documents presented to the WPTT17 are listed in Appendix III.

3. The IOTC process: Outcomes, updates and progress

3.1 Outcomes of the 17th Session of the Scientific Committee

3. The WPTT **NOTED** paper IOTC–2015–WPTT17–03 which outlined the main outcomes of the 17th Session of the Scientific Committee (SC17), specifically related to the work of the WPTT, and **AGREED** to consider how best to progress these issues at the present meeting.

4. The WPTT **NOTED** that in 2014, the SC made a number of requests in relation to the WPTT16 report (noting that updates on Recommendations of the SC17 are dealt with under Agenda item 3.4 below). Those requests and the associated responses from the WPTT17 are provided below for reference.

- ***CPUE standardisations***
  - (Para. 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).* (para. 73 of the SC16 Report)
  - (Para. 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.* (para. 74 of the SC16 Report)

5. The WPTT **NOTED** the statement made by the participant from the Republic of Mauritius, which reiterates the position conveyed in the statements made by the Republic of Mauritius at the 19th Session of the Commission and contained in Report IOTC–2015–SC19–R at Appendix Va.

3.2 Outcomes of the 19th Session of the Commission

6. The WPTT **NOTED** paper IOTC–2015–WPTT17–04 which outlined the main outcomes of the 19th Session of the Commission, specifically related to the work of the WPTT and **AGREED** to consider how best to provide the Scientific Committee with the information it needs, in order to satisfy the Commission's requests, throughout the course of the current WPTT meeting.

7. The WPTT **NOTED** the 11 Conservation and Management Measures (CMMs) adopted at the 19th Session of the Commission (consisting of 11 Resolutions and 0 Recommendations) as listed below:

IOTC Resolutions

- Resolution 15/01 *On the recording of catch and effort data by fishing vessels in the IOTC area of competence*
- Resolution 15/02 *On mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs)*
- Resolution 15/03 *On the vessel monitoring system (VMS) programme*

- Resolution 15/04 *Concerning the IOTC record of vessels authorised to operate in the IOTC area of competence*
- Resolution 15/05 *On conservation measures for striped marlin, black marlin and blue marlin*
- Resolution 15/06 *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 15/07 *On the use of artificial lights to attract fish to drifting fish aggregating devices*
- Resolution 15/08 *Procedures on a fish aggregating devices (FADs) management plan, including a limitation on the number of FADs, 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*
- Resolution 15/09 *On a fish aggregating devices (FADs) working group*
- Resolution 15/10 *On target and limit reference points and a decision framework*
- Resolution 15/11 *On the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*

8. The WPTT **NOTED** that pursuant to Article IX.4 of the IOTC Agreement, the above mentioned Conservation and Management Measures became binding on Members, 120 days from the date of the notification communicated by the IOTC Secretariat in IOTC Circular 2015–049 (i.e. **10 September 2015**).

9. **NOTING** that the Commission also made a number of general comments and requests on the recommendations made by the Scientific Committee in 2014, which have relevance for the WPTT (details as follows: paragraph numbers refer to the report of the Commission (IOTC–2015–S19–R): the WPTT **AGREED** that any advice to the Commission would be provided in the relevant sections of this report, below.

   Para. 10. *The Commission **CONSIDERED** the list of recommendations made by the SC17 (Appendix VI) from its 2014 report (IOTC–2014–SC17–R) that related specifically to the Commission. The Commission **ENDORSED** the list of recommendations as its own, while taking into account the range of issues outlined in this Report (S19) and incorporated within Conservation and Management Measures adopted during the Session and as adopted for implementation as detailed in the approved annual budget and Program of Work. (para. 10 of the S19 report)*

   - ***Yellowfin tuna***
     - (Para. 24) *The Commission **NOTED** that although no new stock assessment was carried out for yellowfin tuna in 2014, previous estimates Maximum Sustainable Yield (MSY) for the whole Indian Ocean was 344,000 t with a range between 290,000–453,000 t. Management advice from the SC 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 (402,084 t).*
     - (Para 25) *The Commission **NOTED** that no proposals for yellowfin tuna Conservation and Management Measures were tabled for the Session.*
   - ***Meeting Participation Fund***
     - (Para. 37) *The Commission **NOTED** that the MPF was used to fund the participation of a reduced number of national scientists to the Working Parties in 2014 (49 in 2014; 58 in 2013; 42 in 2012), all of which were required to submit and present a working paper at the meeting.*
     - (Para. 38) *The Commission **NOTED** that at its 2014 meeting, the Scientific Committee had recommended that the Meeting Participation fund be maintained into the future and increased back to its original allocation of $200,000 per year (see recommendations SC17.34, para. 119). As per the IOTC Rules of Procedure (2014), the SC had reminded the IOTC Secretariat that the MPF budget should be spent at the ratio of 75:25 (science: non-science meetings) which would equate to US$150,000 science: US$50,000 non-science meeting.*
     - (Para. 39) *The Commission **AGREED** that the MPF budget remains important and therefore provisions according to the estimated needs will be integrated into the budget.*
   - ***Consultants***
     - (Para. 40) ***NOTING** the Scientific Committee's attempts to prioritise the various projects and consultancies which it had requested funding for in 2016, in particular, that the High priority projects were those which it felt must be undertaken in 2016, the Commission **REQUESTED** that only those High priority projects listed in the Scientific Committee budget be funded by the Commission's regular budget, with exceptions detailed in other areas of the S19 report.*

3.3 Review of Conservation and Management Measures relating to tropical tunas

10. The WPTT **NOTED** paper IOTC–2015–WPTT17–05 which aimed to encourage participants at the WPTT17 to review some of the existing Conservation and Management Measures (CMM) relevant tropical tunas, noting the CMMs contained in document IOTC–2015–WPTT17–04; and as necessary to 1) provide recommendations to the Scientific Committee on whether modifications may be required; and 2) recommend whether other CMMs may be required.

11. The WPTT **AGREED** that it would consider proposing modifications for improvement to the existing CMMs following discussions held throughout the current WPTT meeting.

3.4 Progress on the Recommendations of WPTT16

12. The WPTT **NOTED** paper IOTC–2015–WPTT17–06 which provided an update on the progress made in implementing the recommendations from the previous WPTT meeting which were endorsed by the Scientific Committee, and **AGREED** to provide alternative recommendations for the consideration and potential endorsement by participants as appropriate given any progress.

13. The WPTT **RECALLED** that any recommendations developed during a Session, must be carefully constructed so that each contains the following elements:
    - a specific action to be undertaken (deliverable);
    - clear responsibility for the action to be undertaken (i.e. a specific CPC of the IOTC, the IOTC Secretariat, another subsidiary body of the Commission or the Commission itself);
    - a desired time from for delivery of the action (i.e. by the next working party meeting, or other date);
    - if appropriate, an approximate budget for the activity, so that the IOTC Secretariat may be able to use it as a starting point for developing a proposal for the Commission's consideration.

4. NEW INFORMATION ON FISHERIES AND ASSOCIATED ENVIRONMENTAL DATA RELATING TO TROPICAL TUNAS

4.1 Review of the statistical data available for tropical tunas

14. The WPTT **NOTED** paper IOTC–2015–WPTT17–07 Rev_1 which summarised the standing of a range of data and statistics received by the IOTC Secretariat for tropical tuna, in accordance with IOTC Resolution 15/02 *Mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPC's)*, for the period 1950–2014. The paper also provided a range of fishery indicators, including catch and effort trends, for fisheries catching tropical tunas in the IOTC area of competence. It covers data on nominal catches, catch-and-effort, size-frequency and other data, in particular release and recapture (tagging) data. A summary of the supporting information for the WPTT is provided in Appendix IV.

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

16. The WPTT **AGREED** that all species specific discussion would be placed within the individual species sections below.

4.2 Review new information on fisheries and associated environmental data

Climate and oceanographic conditions

17. The WPTT **NOTED** paper IOTC–2015–WPTT17–09 which provided an outline of climate and oceanographic conditions in the Indian Ocean, including the following abstract provided by the author:

    "*Several descriptors of the ocean climate conditions are examined to depict the inter-annual trend and to track major changes that may affect the large pelagic ecosystem. We analyse climate indices (SOI, IOI, wind stress and rainfall), physical (SST, mixed layer depth) and biological (sea surface chlorophyll concentration) oceanographic variables, at the large (ocean basin) and regional scale (within specific areas that are relevant for tuna fisheries). The period considered is from September 1997 through August 2015. The ocean climate conditions seen in August 2015 reflect the early stage of development of a positive dipole mode, and further development in the wind, SST, Z20 and chlorophyll anomalies are foreseen during the fourth quarter 2015. The potential impact on purse seine and longline fisheries is discussed, based on two recent positive dipole events, a strong one in 1997-8 and a moderate one in 2006-07.*"

18. The WPTT **NOTED** that the Dipole Mode Index (DMI) can provide a better description of inter-annual variability than the Indian Oscillation Index (IOI), despite a significant correlation between the two indices. DMI is based on temperature anomalies and is a more direct indicator of the fish habitat, whereas other mechanisms may interfere when using the IOI.

19. The WPTT **NOTED** that the inter-annual patterns in ocean climate conditions (as depicted by Empirical Orthogonal Function analyses – EOF) may provide useful information for the selection of spatial units for standardisation of CPUE data. Specific areas where the oceanography fluctuates the most could be more informative than the 5x5 degree blocks that are currently used, as a fixed gridding cannot account for the oceanographic spatial variability.

Mauritius tropical tuna fishery

20. The WPTT **NOTED** paper IOTC–2015–WPTT17–10 which provided a review of the catch of tropical tunas from longline and purse seine vessels licensed in Mauritius, including the following abstract provided by the author:

    "*This paper provides a review of the tropical tuna fisheries as recorded by Mauritius, for the national vessels and foreign vessels that were licensed to fish in the Mauritius EEZ. Annual trends show an increase in the proportion of yellowfin and bigeye in the total catch from the national longliners vessels over the past four years from 14% in 2010 to 45% in 2014. Moreover, it is observed that at the height of winter in the month of July, the catch for both the species is quite low, but that during the summer months, there is a peak for bigeye in September whereas yellowfin peaks in December. Length frequency distribution of bigeye tuna revealed a distribution range from 81cm to 166cm with a majority (90.7%) of the catch consisting of large size fish measuring more than 100cm fork length. The fork length of yellowfin tuna ranged from 76cm to 171cm with most of the fish (77.7%) in the 100-134 cm range*." – see paper for full abstract.

21. **NOTING** that, due to lack of enumerators, tuna catches at anchored FADs around Mauritius are not yet reported to the IOTC, the WPTT **REQUESTED** that Mauritius to overcome this problem as soon as possible.

European Union tropical tuna fishery

22. The WPTT **NOTED** paper IOTC–2015–WPTT17–12 which provided statistics of the European Union and associated flags purse seine fishing fleet targeting tropical tunas in the Indian Ocean during 1981-2014, including the following abstract provided by the author:

    "*The European and associated flags purse seine fishing fleet was composed of a total of 39 distinct purse seiners and 15 support vessels in the Indian Ocean in 2014. The total capacity of the fleet has remained stable during 2009-2014 at about 46,000 t of fish hold volume. The nominal fishing effort of the fleet increased by about 10% in 2014 and reached more than 10,600 fishing days. In addition, the number of support vessels increased from 10 to 15 between 2010 and 2014. The total catch of the fleet in 2014 was more than 260,000 t and composed of 118,000 t (45%), 123,000 t (47%), and 20,000 t (8%) of yellowfin, skipjack, and bigeye, respectively. Catches on FAD-associated schools represented 80% of the total purse seine catch, amounting to about 210,000 t in 2014. YFT represented the bulk of total FSC catch (80%) which amounted to >50,000 t. Catch of SKJ per successful FAD-set increased in 2014 to 18.5 t set−1 in relation with an increase in their mean weight to 2.9 kg and catch of YFT per successful FSC set has remained stable at >30 t set−1 in the recent years.*" – see paper for full abstract.

EU,Spain purse seine fishery

23. The WPTT **NOTED** paper IOTC–2015–WPTT17–13 which provided statistics of the EU,Spain purse seine fleet in the Indian Ocean (1990–2014), including the following abstract provided by the author:

    "*Spanish Purse Seine vessels of the Spanish fleet operate in the West Indian Ocean in 2014. Total catches decreased a 9% in 2014 with respect to 2013, mainly due to the decrease in catches on FADs (11% less than in 2013). Catches on YTF free schools increase both in number (14% regarding 2013) and in the mean weitgh of the fish (12% kg more per fish than in 2013). Nominal effort measured in searching days and fishing days remain constant while the total number of sets decreased a 5% regarding 2013. The distribution area of catches and effort has been concentrated in less squares 1ºx1º explored (19% less than in 2013), excluding the North of Madagascar*."

24. The WPTT **NOTED** the change in species composition in FAD catches with more yellowfin tuna and less skipjack tuna overall.

Efficiency of purse seine vessels

25. The WPTT **NOTED** paper IOTC–2015–WPTT17–14 which provided an evaluation of the efficiency of tropical tuna purse seiners in the Indian Ocean: first steps towards a measure of fishing effort, including the following abstract provided by the author:

"*The evaluation of the fishing effort exerted by purse seiners on tropical tuna requires a constant monitoring of the changes in individual fishing power of purse seiners due to changes in vessel characteristics, fishing gears or fishing strategies. Also, since the 1990s, increasing numbers of drifting Fish Aggregating Devices have been used by this fleet. As dFADs contribute to a reduction of search times, traditional measures of fishing effort such as search time or fishing time are inappropriate. Here, using logbook data from the French and the Spanish purse seine fleets over 2003-2014, the effects of the characteristics of purse seiners (length overall, period of construction) and their use of support vessels on the efficiency of purse seiners are analyzed with Generalized Linear Models. 3 dimensions of the efficiency of purse seiners are analyzed at the scale of the month: the average catch per day, the average number of fishing sets per day and the average distance travelled per day.* – see paper for full abstract."

26. The WPTT **NOTED** that changes in vessel characteristics, fishing gears or fishing strategies can influence the effective fishing power of purse seine fishing vessels. Some effects could be quantified, e.g. the significant contribution of support vessels into catch per day (+45%) and number of fishing sets per day (+20%). Changes in fishing power can have important implications on intentions to control fishing capacity when using the number of vessels as a measure of fishing capacity.

27. **NOTING** the potential effects that fishing on FADs may have on fishing power, the WPTT **AGREED** that future extension of this work attempt to partition data between FAD and non-FAD sets in the analyses as well as to use the average catch by species in the analysis instead of pooling together all three species catch.

Tropical tuna habitat

28. The WPTT **NOTED** paper IOTC–2015–WPTT17–31 which detailed the preferred habitat of tropical tuna species in the Eastern Atlantic and Western Indian Oceans: a comparative analysis between FAD-associated and free-swimming schools, including the following abstract provided by the author:

"*An ecological niche modelling (ENM) approach was developed to describe the suitable habitat of skipjack (SKJ) and juvenile yellowfin (YFT) tuna in the Tropical Atlantic and West Indian Oceans. The environmental envelop of the potential habitat in each ocean was defined using occurrence data independently of the fishing mode and derived from purse seine fishing sets of the French fleet during 1997-2014. Daily satellite-derived chlorophyll-a content (CHL) and fronts (CHL gradient) were used as a proxy for food availability while circulation model derived-sea surface temperature, salinity, height anomaly, current and oxygen as well as the mixed layer depth contributed to identify the physical suitable conditions of each species. Only the cluster that showed no CHL front was excluded for the parameterization in order to enhance the favourable feeding habitat. In a second step, the distances of both the free swimming schools (FSC) and schools associated with dri*fting Fishing Aggregating Devices (FADs) to the closest potential habitat were computed and compared." – see paper for full abstract.

29. The WPTT **NOTED** the usefulness of this type of analysis, but considered that this analysis would benefit from combining both environmental (habitat) and fleet dynamics aspects to better interpret the seasonal movements and changes across the years. Such an approach does not consider the subsurface habitat which is essential to the movements and foraging activity of the adult component of bigeye tuna and yellowfin tuna, and cannot be inferred from the status of chlorophyll surface conditions as estimated by satellite measurements (as used in the study). Data from the EU,Spain and Seychelles fleets should be included as those fleets are an important component of the purse seine fishery and exploit a wider geographic range that the French fleet in the FAD fishery.

Evolution of fishing tactics

30. The WPTT **NOTED** paper IOTC–2015–WPTT17–32 Rev_1 which provided technological and fisher's evolution on fishing tactics and strategies on FADs vs. non-associated fisheries, including the following abstract provided by the author:

"*The relationship between catch per unit effort (CPUE) and abundance is central to stock assessment models and thus, changes in this relationship will ultimately result in changes in scientific diagnostic and associated management advice. In the lack of fishery-independent information in tuna fisheries, commercial data are traditionally used to compute CPUE and to derive spatio-temporal indices of abundance for stock assessments. Most of the tuna stock assessments rely upon CPUE data from longline fisheries with few CPUE series been developed and used for the purse seine fleet. While longline fleet has been decreasing over time, the tuna purse seine fishery has been expanding oceanwide currently accounting for around 75% of total tuna catch. Therefore, obtaining a standardized CPUE for the purse seine fleet and better understanding the factors that affect CPUE in purse seine fisheries is essential for their correct use in tuna stock assessment.*" – see paper for full abstract.

31. The WPTT **NOTED** the value of information on the evolution of fishing tactics for improving CPUE standardisations, but recognised the lack of quantitative metrics to incorporate this information at this stage.

32. The WPTT **NOTED** the importance of including the effect of skipper in CPUE standardisations, especially for free school sets. The availability of information collected on several new vessels having the same characteristics and equipment would allow the analysis of skipper effect on catch rates.

FAD number verification and best practices

33. The WPTT **NOTED** paper IOTC–2015–WPTT17–33 which provided a verification of the limitation of the number of FADs and best practices to reduce their impact on bycatch fauna, including the following abstract provided by the author:

“*In order to monitor the limitation of the number of FADs used and the level of application of these good practices, systems of verification are being implanted for the vessels of ANABAC and OPAGAC operating in the Indian Ocean – in the case of the control of the number of FADs – and for all their vessels in the case of the application of good practices. This verification is based on data transmission by buoy manufacturers and data processing through R, and on in-situ registration of the good practices by observers. The training for skippers and observers, as well as the first data of good practices observed in the Atlantic and Indian Ocean are also presented. These first results are overall encouraging, with a majority of vessels displaying a level of compliance superior to 80% for non-entangling FADs and reaching 100% for fauna release operations. In the case of boats with lower levels of compliance, significant progress could be observed in consecutive fishing trips*.” – see paper for full abstract.

34. The WPTT **ACKNOWLEDGED** the initiative to monitor the best practices on the use of non-entangling FADs and best practices to reduce mortality of FAD associated fish, as well as to verify the number of FADs/buoys active at sea as requested by Resolution 15/08. Efforts should be made to expand this type of monitoring/data collection from other FAD fisheries.

35. The WPTT **NOTED** that the requirement for FADs to be activated on board EU,Spain purse seine/supply vessels prior to deployment and the process of analysing data on the speed of FADs before deployment will assist with preventing infringements in exceeding the number of allowable FADs used.

Thailand tuna fisheries

36. The WPTT **NOTED** paper IOTC–2015–WPTT17–38 which provided an overview of tuna longline fishery in the east Indian Ocean, including the following abstract provided by the author:

“*Study on tuna from longline fishery in the East Indian Ocean was carried out during January to December, 2011. The data were collected from landing vessels in Phuket Province of Thailand by interview and port sampling. The landing vessels were from Taiwan, Belize, Malaysia, India and Indonesia and their lengths were 19-40 m lengths. They employed 1,300-1,500 hooks per vessel. The used baits were round scads and/or lived milkfish. Their fishing ground was in the latitude of 2°S to 12°N and longtitude of 77° to 95° 40´E. The high fishing period was during November to March and the low fishing period was during June to October . The total catch were 5,543,244 kg with the value of 766.8 million baht. The catch included tunas, billfishes and other miscellaneous bycatch for 4,318,743 kg (77.92 %), 92,351 kg (1.67%) and 1,132,150 kg (22.08%), respectively.”* – see paper for full abstract.

37. The WPTT **NOTED** the substantial increase in catch per trip from longline vessels landing catch in Phuket, Thailand in recent years. The most plausible reason for this increase is changes in fishing operations. The inclusion of transhipped catch from other vessels could have been another reason but, as catch from other vessels are marked, they are normally excluded in the calculation of the catch per trip.

38. The WPTT **NOTED** that a greater proportion of small fish was landed by longline vessels in Thailand than generally observed for longline vessels in other regions. This may indicate a different selectivity or potentially an issue with reporting.

I.R. Iran tropical tuna fisheries

39. The WPTT **NOTED** paper IOTC–2015–WPTT17–39 which provided an overview of the tropical tuna catch in I.R. Iran, including the following abstract provided by the author:

“*This paper gives a description of the trends of tuna and tuna-like catches, fishing effort, no. of active fishing vessels, type of fishery, size data and method used to determine tropical tuna catch in the Iranian Tuna fishery. This report also discusses the actions taken by Iran in recent years regarding the upgrading of data collection system and implementation of the recommendations of the working parties, the Scientific committee and the Commission in order to promote compliance. According to an IOTC evaluation, the level of compliance for Iran in 2010 was 11% compared to average compliance of 25% for member countries. During recent years Iran has carried out many efforts to enhance its compliance to 69% compared to an average of 58% for other countries. Although there are still problems in some areas, a lot* *of effort is being undertaken to remove those problems and build necessary infrastructures to fulfill all requirements.*"

40. The WPTT **NOTED** the value of sampling in the I.R. Iran region as it captures a size range of yellowfin tuna (75–90 cm) that are not represented well elsewhere in the Indian Ocean.

41. **NOTING** the limited amount of logbook data collected by I.R. Iran for the gillnet fishery and, the WPTT **REQUESTED** that efforts are made to expand the data collected from logbooks and observers from the gillnet fishery and to provide those data to the IOTC Secretariat.

42. The WPTT **NOTED** that recent declines in skipjack tuna catch by I.R. Iran vessels are most likely due to piracy, whereby vessels previously fishing in the south, have moved back into the Persian Gulf and Oman Sea where there are less skipjack tuna and more longtail tuna.

Seychelles auxiliary vessels: summary

43. The WPTT **NOTED** paper IOTC–2015–WPTT17–41 Rev_1 which provided an overview of the Seychelles auxiliary vessels in support of purse seine fishing in the Indian Ocean during 2005–14: summary of a decade of monitoring, including the following abstract provided by the author:

"*We used a large database of information collected from logbooks to provide an overview of the activities of the Seychelles auxiliary vessels used in support of the Seychelles purse seiners during 2005-2014. After a decrease in the number of support vessels linked to the piracy threat during 2010-2012, the effort of the fleet has increased in the recent years through the arrival of new vessels and increasing numbers of operations on a daily basis. In particular, the numbers of deployments of Fish Aggregating Devices (FADs), transfers of instrumented buoys and visits of floating objects have been steadily increasing over the recent years. Also, the engine power of the Seychelles support vessels has increased since the mid-2000s while their size has remained constant over the last decade. We argue that the time at sea of support vessels should be accounted for when deriving nominal catch rates from purse seine fisheries data. Information available from support vessels logbooks appears very valuable to describe the dynamics of FAD use and appreciate the component of purse seiner fishing strategy that takes place prior to the capture of tropical tunas.*"

Tuna vertical movement behaviour

44. The WPTT **NOTED** paper IOTC–2015–WPTT17–42 which provided a description of the vertical behaviour and habitat utilisation of yellowfin tuna and bigeye tuna in the South West Indian Ocean inferred from PSAT tagging data, including the following abstract provided by the author:

"*We present here preliminary results of PSATs tagging experiments conducted on bigeye tuna Thunnus obesus and yellowfin tuna Thunnus albacares in the South West Indian Ocean. We analyzed in this paper the vertical behavior and habitat use of the two tuna species. We found that bigeye and yellowfin tuna use distinct habitats during the day and night. At night, yellowfin tuna remain within the mixed layer while bigeye tuna moves around the thermocline. During the day, bigeye tuna reach colder and deeper layers between 300 and 600 m while yellowfin tuna stay around the thermocline.*"

45. The WPTT **NOTED** the objection made by the Participant from the Republic of Mauritius to the depiction of the Exclusive Economic Zone of the Republic of Mauritius in Figure 1 of Paper 42 and reiterated that the Chagos Archipelago and the Island of Tromelin form an integral part of the territory of the Republic of Mauritius.

46. **NOTING** that PSAT tagging data are fishery independent and are very useful to understand the local and ocean scale movements and habitat utilisation to design habitat-based models for CPUE standardisation, the WPTT **ENCOURAGED** that such experiments be continued with PSAT tags deployed on a larger number of individuals and regions of the Indian Ocean.

5. BIGEYE TUNA – REVIEW OF NEW INFORMATION ON STOCK STATUS

5.1 Review of the statistical data available for bigeye tuna

47. The WPTT **NOTED** paper IOTC–2015–WPTT17–07 Rev_1 which summarised the standing of a range of data and statistics received by the IOTC Secretariat for bigeye tuna, in accordance with IOTC Resolution 15/02 *Mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPC's)*, for the period 1950–2014. The paper also provided a range of fishery indicators, including catch and effort trends, for fisheries catching bigeye tuna in the IOTC area of competence. It covers data on nominal catches, catch-and-effort, size-frequency and other data, in particular release and recapture (tagging) data. A summary of the supporting information for the WPTT is provided in Appendix IVb.

48. The WPTT **NOTED** that, compared to other IOTC species (particularly neritic tunas) the overall quality of the data available for bigeye tuna is considered to be relatively good, given the majority of catches are accounted for by industrial fisheries which have good reporting systems. However, catches of bigeye tuna from coastal fisheries have increased in recent years and may be underestimated, in particular for driftnet gillnet fisheries, due to the lack of data or poor reporting of bigeye tuna catches for some coastal fisheries (e.g. Pakistan gillnets).

49. The WPTT **NOTED** the importance of Indonesia, which ranks number one in terms of recent catches of bigeye tuna in the Indian Ocean, and the lack of catch-and-effort, size data, and uncertainty in the total catches for the Indonesian fisheries. Indonesia has made good progress in data collection, with the support of the IOTC Secretariat, BOBLME and the IOTC-OFCF Project and other agencies, and will provide an update on capacity-building activities at the next WPDCS and WPTT meetings.

50. The WPTT **NOTED** that the uncertainty in total catches, particularly for most coastal fisheries, should be accounted in the stock assessments and that some modelling runs should be conducted based on alternative catch series that reflect the uncertainty in catches. This uncertainty is exacerbated by underestimation of the real bigeye tuna catches as small bigeye tuna are often misidentified as yellowfin tuna. The approach currently used to score the quality of data by the IOTC Secretariat is mainly focused on data reporting and timeliness. Collaborative work with CPCs needs to be undertaken to propose a set of indicators aimed at better reflecting the level of uncertainty in the data available at the IOTC Secretariat.

51. The WPTT **NOTED** that the current estimates of bigeye tuna in the European and associated flags purse seine fishery might mask some small-scale spatial variability and that further work should be conducted by the European Union to quantify the uncertainties associated with the current processing method and to refine the approach used to estimate the species composition of the catch.

52. **NOTING** the on-going issue regarding the accuracy of total catch estimates related to the capture and identification of juvenile bigeye tuna, the WPTT **REQUESTED** that CPCs catching large numbers of juvenile tuna improve the enumeration and classification of this species.

53. The WPTT **NOTED** that in the case of the Maldives and other coastal fisheries, juveniles of bigeye tuna often account for an appreciable amount of the total catch but are either not reported or assigned to an 'Other' species category. The work of the Maldives to improve the estimate of juvenile bigeye tuna was presented in paper IOTC–2014–WPTT16–26.

Length Frequency inter-sessional meeting guidelines

54. The WPTT **NOTED** that despite the progress made by Japan and Taiwan,China in resolving issues with the reliability of the size data for tropical tunas for longline vessels (e.g. low sampling rate, and discrepancies in catch, effort, and notably size data), a number of key matters remain to be resolved. All CPCs with longline fleets should work with the IOTC Secretariat to improve the transparency in the collection and processing of size data.

5.2 Review new information on the biology, ecology, stock structure, their fisheries and associated environmental data for bigeye tuna

55. The WPTT **NOTED** that as bigeye tuna was not the priority species at WPTT17, no papers were submitted for this agenda item in 2015.

5.3 Review of new information on the status of bigeye tuna

5.3.1 Nominal and standardised CPUE indices

Japan longline CPUE for bigeye tuna

56. The WPTT **NOTED** paper IOTC–2015–WPTT17–34 which provided the Japanese longline CPUE for bigeye tuna in the Indian Ocean standardised by GLM, including the following abstract provided by the author:

> "*Standardization of Japanese longline CPUE for bigeye tuna was conducted for 1960-2014 by using GLM (generalized linear model, log normal error structured). Methods of standardization are the same as or similar to those used at IOTC WPTT in 2014 or before. The effects of season (month or quarter), subarea or LT5LN5 (five degree latitude-longitude block), SST (sea surface temperature), NHF (number of hooks between floats) and material of main line, and several interactions between them were used for standardization. The trend of CPUE slightly differed by area, but high jump in 1977 and 1978, slight decrease after that, and increasing trend in the recent few years, but decrease in the latest year are seen as for each area.*"

57. The WPTT **WELCOMED** the updated catch rate standardisation for the Japan fleet in the Indian Ocean for bigeye tuna (Fig. 1).

58. The WPTT **AGREED** that the incorporation of the effect of sea surface temperature as polynomial effect would be useful and that this should be examined for presentation to the next WPTT meeting.

59. The WPTT **AGREED** that using operational data with vessel identifier including other distant water fishing nations to incorporate the changes of targeting should be incorporated in the CPUE analysis for the next stock assessment of bigeye tuna, in accordance with the recommendation by CPUE workshop in 2015. Only the difference of fishing gear seems not enough to detect target species.

60. The WPTT **RECALLED** the longstanding concern of a sharp increase in CPUE for both bigeye tuna and yellowfin tuna during the late 1970s which does not appear to represent an increase in abundance and that the reasons still remain unclear.

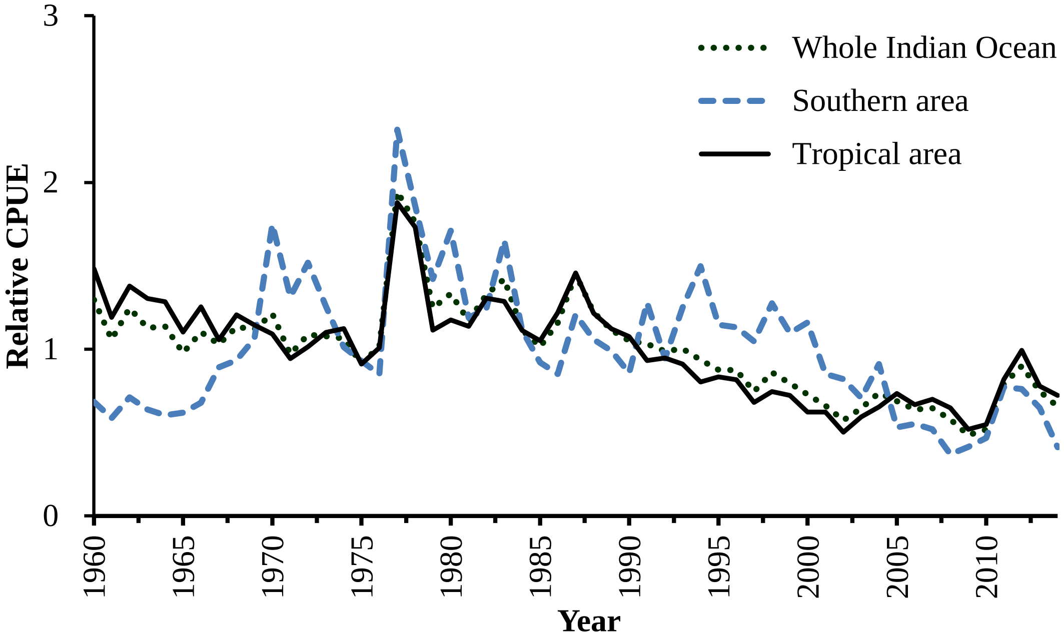


Fig. 1. Bigeye tuna: Comparison of the standardised longline CPUE series for Japan. Series have been rescaled relative to their respective means from 1960–2014.

61. The WPTT **NOTED** that it would be useful to harmonize the spatial structure of the bigeye tuna CPUE analysis (and stock assessments) with that of yellowfin tuna, in future analyses to facilitate management advice that might need to account for technical interactions in the tropical tuna fisheries.

5.3.2 Stock assessments

Bigeye tuna: Summary of stock assessment models in 2013 (no new assessments in 2014 or 2015)

62. **NOTING** that no new stock assessments were carried out on bigeye tuna in 2014 or 2015, the WPTT **RECALLED** that a range of quantitative modelling methods (ASAP, ASPM and SS3) were applied to bigeye tuna in 2013 and readers are requested to refer to the report of the 15th Session for details (IOTC–2013–WPTT15–R).

Parameters for future analyses: Bigeye tuna CPUE standardisation and stock assessments

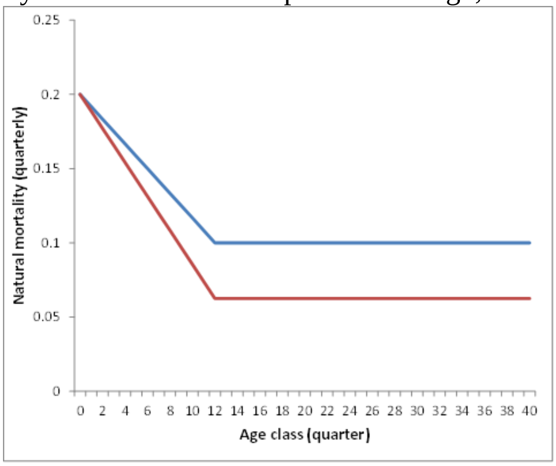
63. The WPTT **RECALLED** that in order to obtain comparable CPUE standardisations, the analyses should be conducted with similar parameters and resolutions when the stock is next assessed. The improved methods recommended by the CPUE workshop should also be applied. Table 2 provides a set of parameters that shall give guidelines for the standardisation of CPUE.

Table 2. Bigeye tuna: Parameters for the standardisation of CPUE series in 2016.

CPUE standardisation parameters	CPUE standardisations for consistency
Area	By region
CE Resolution	Aggregated data
GLM Factors	Year, Quarter, 5 degree squares, HBF, vessel, environmental + interactions
Model	lognormal + constant
Updated standardisation methods	
Area	By region
CE Resolution	Operational data
Data preparation	Cluster analysis or related approaches to select data or add cluster parameters
GLM Factors	Year, Quarter, 5 degree squares, SST (as appropriate) and gear effects, vessel effect
Model	Delta lognormal, negative binomial, zero inflated

64. The WPTT **RECALLED** that the model parameters contained in Table 3 could be considered appropriate for future bigeye tuna stock assessments preliminary base case analysis, with appropriate sensitivity runs.

Table 3. Bigeye tuna: Model parameters for use in future base case and sensitivity stock assessment runs.

Biological parameters	Value for assessments
Sex ratio	1:1
Age (longevity)	15 years
Natural mortality	Age specific, quarterly M. 2 alternative M options base high, sensitivity low). 
Growth formula	VB log K 2-stanza growth (Eveson et al. 2012 IOTC–2012–WPTT14–23) or appropriate re-analysis based on more recent data
Weight-length allometry	$W=aL^b$ with $a= 3.661^{-05}$ and $b=2.901$ common to sex
Maturity	Length-specific (50% mature at length 110 cm) – or age-based equivalent
Fecundity	Proportional to the spawning biomass
Stock-recruitment	B&H, h=0.8 (plus sensitivity e.g. 0.7 and 0.9), sigma_R=0.6
Other parameters	
Spatial structure	As in previous assessment, or harmonize with yellowfin tuna spatial structure if possible
Fisheries	12 (Longline (5); Baitboat (pole-and-line); Purse seine free school (2); Purse seine log school (2); Other (2))
Abundance indices	Japan longline whole Indian Ocean (alternative option with 1% p.a. increase in catchability); or following the advice of the CPUE workshop
Selectivity	Age based, fishery specific

5.3.3 Selection of Stock Status indicators for bigeye tuna

65. The WPTT **AGREED** that as no new stock assessment was carried out for bigeye tuna in 2014 or 2015, management advice should be based on the range of results from the SS3 model in 2013, as well as the updated CPUE series presented at the WPTT16 and WPTT17 meetings.

5.4 Development of management advice on the status of bigeye tuna & update of the bigeye tuna Executive Summary for the consideration of the Scientific Committee

66. The WPTT **ADOPTED** the management advice developed for bigeye tuna (*Thunnus obesus*), as provided in the draft resource stock status summary and **REQUESTED** that the IOTC Secretariat update the draft stock status summary for bigeye tuna with the latest 2014 catch data (if necessary), and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration:
    - Bigeye tuna (*Thunnus obesus*) – Appendix VI

5.5 Bigeye tuna Management Strategy Evaluation process update

67. The WPTT **NOTED** paper IOTC–2015–WPTT17–36 and the WPM06 Report (IOTC–2015–WPM06–R), which provided an update on the bigeye tuna and yellowfin tuna management strategy evaluation development framework. The discussion is detailed in Section 7.5 below.

6. Skipjack Tuna – Review of New Information on Stock Status

6.1 Review of the statistical data available for skipjack tuna

68. The WPTT **NOTED** paper IOTC–2015–WPTT17–07 Rev_1 which summarised the standing of a range of data and statistics received by the IOTC Secretariat for skipjack tuna, in accordance with IOTC Resolution 15/02 *Mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPC's)*, for the period 1950–2014. The paper also provided a range of fishery indicators, including catch and effort trends, for fisheries catching skipjack tuna in the IOTC area of competence. It covers data on nominal catches, catch-and-effort, size-frequency and other data, in particular release and recapture (tagging) data. A summary of the supporting information for the WPTT is provided in Appendix IVc.

69. The WPTT **EXPRESSED** concern about substantial drops in catch rates, reported in recent years by the European Union purse seine vessels fishing on free-swimming schools (since 2009, and by the Maldivian pole-and-line since 2006 – although total skipjack tuna catches have increased in 2013 and 2014 (relative to 2012) mostly for purse seine vessel FAD associated schools and gillnet vessels. While part of the decrease in catch could be explained by the presence of piracy activities, the nature of the decline warrants further investigation and it was stressed that there was a need to closely monitor the fisheries involved in the future.

70. The WPTT **NOTED** that since 2010 approximately 60% of the catches of skipjack tuna have been taken by artisanal and/or semi-industrial fisheries (mainly gillnet and trolling fisheries) and that those catches are not reported accurately to IOTC Secretariat. The proportion of catches accounted for by coastal or artisanal fisheries has been increasing in recent years, relative to catches from industrial and semi-industrial fisheries such as purse seine and pole-and-line, and that this may lead to a decrease in the availability and quality of data available to the IOTC Secretariat. Those countries with gillnet fleets in particular catching skipjack tuna should work to develop a sampling scheme to collect such fishery data and submit to IOTC Secretariat.

71. **NOTING** the decline in skipjack tuna catches reported by the Maldives pole-and-line fleet since the mid-2000s, the WPTT **REQUESTED** that the Maldives, in collaboration with the IOTC Secretariat, assess the extent to which the changes in catches of skipjack tuna are related to the improvements in the data collection and introduction of logbooks, as compared to changes in the fishery (e.g. a shift from pole-and-line targeting skipjack tuna to handlines targeting yellowfin tuna).

6.2 Review new information on the biology, ecology, stock structure, their fisheries and associated environmental data for skipjack tuna

72. The WPTT **NOTED** that as skipjack tuna was not the priority species at WPTT17, no papers were submitted for this agenda item in 2015.

6.3 Review of new information on the status of skipjack tuna

6.3.1 Nominal and standardised CPUE indices

73. The WPTT **NOTED** that as skipjack tuna was not the priority species at WPTT17, no papers were submitted for this agenda item in 2015.

Parameters for future analyses: Skipjack tuna CPUE standardisation and stock assessments

74. The WPTT **RECALLED** its previous agreement that in order to obtain comparable CPUE standardisations, the analyses shall be conducted with similar parameters and resolutions. Table 4 provides a set of parameters,

discussed during the WPTT16 that shall give guidelines, if available, for the standardisation of CPUE, to be used as indices of abundance for the next scheduled stock assessment of skipjack tuna.

Table 4. Skipjack tuna: A set of parameters for the standardisation of CPUE series in preparation for the next WPTT meeting.

CPUE standardisation parameters	Value for next CPUE standardisation
Area	*To be defined (possible eastern and western Indian Ocean.* Explore core area(s)
CE Resolution	Operational data
GLM Factors	Year, Quarter, Area, vessel characteristics, environmental + interactions, number of FADs and species composition
Model	negative binomial, zero-inflated or delta-lognormal models

75. The WPTT **RECALLED** that the model parameters contained in Table 5 could be considered appropriate for future skipjack tuna stock assessments preliminary base case analysis, with appropriate sensitivity runs.

Table 5. Skipjack tuna: Model parameters agree to by the WPTT for use in future base case stock assessment runs.

Biological parameters	Value for assessments
Stock structure	1 and 2 areas
Sex ratio	1:1
Age (longevity)	7+ years
Natural mortality	M=0.8 (/year) constant over ages (or estimated within the model to be 1.48 age 0-1,1.13 age 1-2, 1.13 age 2-3, 0.83 for 3-4 and older)
Growth formula	VB log K 2-stanza growth (Everson et al. 2015)*
Weight-length allometry	$W=aL^b$ with $a= 5.32*10^{-6}$ and $b=3.34958$ common to sex
Maturity	Length-specific (50% mature at length 38 cm, fully mature at 44 cm)
Fecundity	Proportional to the spawning biomass
Stock-recruitment	B&H, h=0.8 (plus sensitivity e.g. 0.7 and 0.9), sigma_R=0.6
Other parameters	
Fisheries	4 (Maldives PL, Purse Seine FS, Purse Seine LS, Other)
Abundance indices	PSFS/PSLS combined, Maldives PL
Selectivity	Fishery specific. Cubic splines

* Eveson J P, Million J, Sardenne F & Le Croizier G (2015) Estimating growth of tropical tunas in the Indian Ocean using tag-recapture data and otolith-based age estimates. Fisheries Research: Indian Ocean Tuna Tagging Programme special issue.

6.3.2 Stock assessments

76. The WPTT **NOTED** that as skipjack tuna was not the priority species at WPTT17, no papers were submitted for this agenda item in 2015.

6.3.3 Selection of Stock Status indicators for skipjack tuna

77. The WPTT **AGREED** that the advice on the status of skipjack tuna in 2015 would be derived from the grid agreed using an integrated statistical assessment method from 2014. In 2014, 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.

6.4 Development of management advice for skipjack tuna & update of skipjack tuna Executive Summary for the consideration of the Scientific Committee

78. The WPTT **ADOPTED** the management advice developed for skipjack tuna as provided in the draft resource stock status summary and **REQUESTED** that the IOTC Secretariat update the draft stock status summary for

skipjack tuna with the latest 2014 catch data (if necessary), and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration:

- Skipjack tuna (*Katsuwonus pelamis*) – Appendix VII.

6.5 Skipjack tuna Management Strategy Evaluation process update

79. The WPTT **NOTED** paper IOTC–2015–WPTT17–35 which detailed the operating model for Indian Ocean skipjack tuna, including the following abstract provided by the authors:
"*A simulation model of the Indian Ocean skipjack tuna fishery was developed for the evaluation of alternative fisheries management procedures. The model partitions the population by region, age, and size and the fishery by region and gear (purse seine, pole-and-line, gill net, others). Prior probability distributions and sensitivity ranges are defined for model parameters for use in conditioning and robustness testing. Performance statistics are defined and linked to broader management objectives. Three contrasting classes of management procedure (MP) are provided as examples: BRule (a generic harvest control rule based on an estimate of stock status), FRange (a MP which adjusts effort when fishing mortality is outside a target range) and IRate (a MP which recommends a total allowable catch using a CPUE-based biomass index).*"

80. The WPTT **NOTED** the refinements to the model made over the past year, including the division of the western region into two separate regions, refinements to the parameterisation of movement, and the use of a two-stanza growth model.

81. The WPTT **ENDORSED** the current formulation of the skipjack tuna Operating Model (taking into account modifications agreed upon during the WPM06 held immediately before the WPTT17, and the timeline established in Resolution 15/10) and **AGREED** that its use on an initial set of evaluations of management procedures should be presented during the next Scientific Committee meeting for its consideration.

82. The WPTT **RECOMMENDED** that the Scientific Committee consider endorsing the skipjack tuna Operating Model for evaluating management procedures, as stipulated in Resolution 15/10.

7. YELLOWFIN TUNA – REVIEW OF NEW INFORMATION ON STOCK STATUS

7.1 Review of the statistical data available for yellowfin tuna

83. The WPTT **NOTED** paper IOTC–2015–WPTT17–07 Rev_1 which summarised the standing of a range of data and statistics received by the IOTC Secretariat for yellowfin tuna, in accordance with IOTC Resolution 15/02 *Mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPC's)*, for the period 1950–2014. The paper also provided a range of fishery indicators, including catch and effort trends, for fisheries catching yellowfin tuna in the IOTC area of competence. It covers data on nominal catches, catch-and-effort, size-frequency and other data, in particular release and recapture (tagging) data. A summary of the supporting information for the WPTT is provided in Appendix IVd.

84. The WPTT **NOTED** that according to the information within the IOTC database, some longline fleets, in particular the Taiwan,China longline fleet, have resumed fishing in the western central tropical area since January 2012, although longline fishing effort in the area remains significantly below the levels before the onset of piracy (i.e. compared to the early-mid 2000s). However, longline vessels flagged to Japan continue to be almost completely absent from the area since July 2009.

85. **NOTING** that drops in total effort and area coverage may reduce the ability of the WPTT to produce accurate CPUE estimates for some fleets and/or years, the WPTT **AGREED** that the movement of fleets back into the area vacated due to piracy activities should be closely monitored and reported at the SC and the next WPTT meeting.

86. The WPTT **NOTED** that, due to the on-going uncertainties in the size-frequency data for Taiwan,China, samples for this fleet from 2002 have been removed from the yellowfin tuna stock assessment for the first time.

87. The WPTT **NOTED** that catch-and-effort and size data for yellowfin tuna (and for other tropical tuna species) is either unavailable or is not reported to IOTC standards for some fisheries including many coastal fisheries and gillnet and fresh-tuna longline vessels operating on the high seas, which account for over half of total catches in recent years.

7.2 Review new information on the biology, ecology, stock structure, their fisheries and associated environmental data for yellowfin tuna

Sex ratio of yellowfin tuna and bigeye tuna: Indonesia

88. The WPTT **NOTED** paper IOTC–2015–WPTT17–16 which provided an analysis of sex ratio by length class of yellowfin tuna and bigeye tuna caught by Indonesian longliners in the eastern Indian Ocean, including the following abstract provided by the author:

    "*This paper present the sex ratio results corresponding to yellowfin tuna-YFT (Thunnus albacares, Bonaterre 1788) and bigeye tuna-BET (Thunnus obesus, Lowe 1839) obtained by scientific observer program courtesy of Research Institute for Tuna Fisheries (RITF). Data collection was conducted from August 2005 to December 2014 following Indonesian longliners based in Benoa, Palabuhanratu, and Padang fishing port. Chi square analysis also used to determine sex ratio. YFT size ranging from 30 and 179 cmFL, however 81,19% of them had been eligible to be captured. While 69,21% of BET had been eligible with size ranged from 30 to 192 cmFL. Sex ratio of (F:M) 1:1,45 was observed for YFT and 1:1,32 for BET respectively indicated that male was dominant than female. Correlation between sex ratio and length proved to be significant with different pattern for YFT and BET. However, both of those correlation could be described as linear regression equation*."

89. The WPTT **ACKNOWLEDGED** the interest and the usefulness of the results shown in this study and suggested the authors consider increasing the bin sizes as a means to confirm the results.

90. The WPTT **NOTED** that the results confirm the findings from previous studies undertaken for other areas with regards to the predominance of male individuals in large size yellowfin tuna catches.

Maldives Yellowfin tuna fishery

91. The WPTT **NOTED** paper IOTC–2015–WPTT17–17 which provided a review of yellowfin tuna fisheries in the Maldives, including the following abstract provided by the author:

    "*Catches of yellowfin tuna (Thunnus albacares) in the Maldives used to be essentially from pole-and-line gear. Juveniles (<60 cm FL) are caught in mixed and conspecific schools, which represent about 15-20% of the pole-and-line component along with skipjack (Katsuwonus pelamis). Trolling and handline methods used to catch small numbers of surface-dwelling large yellowfin (> 80 cm FL) prior to late 1990s. A specific fishery targeting large yellowfin started in late 1990s growing rapidly into what is referred to as a "handline large yellowfin" fishery. The fishery is geared toward the lucrative fresh fish export market. Pole-and-line fishers operating in the north and central regions of the Maldives can switch to handline fishing opportunistically. Total catch and catch rates of yellowfin tuna have shown an increase in the recent years. Total catches of yellowfin in the Maldives stood around 45,000 – 50,000 MT during last three years (2012-2014), of which about 60% were from handline and the remaining from pole-and-line*." – see paper for full abstract.

92. The WPTT **NOTED** that some tuna fishing vessels operate both hand line (HL) and pole-and-line (PL). It was clarified that the logbook information allowed the separation of the effort for each gear.

93. The WPTT **NOTED** that the current data collection system (which dates from 2011) addresses many of the problems with the data found in the past.

94. The WPTT **NOTED** that the reported catch information could be underestimated as the total catch is reported as gutted weight because the fish is gutted before unloading in the HL fishery. Maldives should investigate this issue and, if necessary, to correct the reported yellowfin tuna catches using IOTC yellowfin tuna total weight – gutted weight relationships.

Yellowfin tuna FAD-association

95. The WPTT **NOTED** paper IOTC–2015–WPTT17–18 which provided a preliminary evaluation of differences in habitat quality between FADs-associated and unassociated schools of yellowfin tuna, including the following abstract provided by the author:

    "*The use of drifting fish aggregation advices (FADs) by tuna purse seine fleets has greatly expedited tuna catches since the 1990s. The large increase in the number of FADs calls for studies to evaluate potential ecological impacts on the entire life cycle of tunas. The effects of FADs on habitat selection should be a research priority since altered life history traits could be the consequence of inappropriate habitat selection. We evaluated the quality of available habitat for free swimming schools and drifting-FAD-associated schools for yellowfin tuna (Thunnus albacares) in the Western and Central Pacific Ocean (WCPO). We quantified the habitat quality with an Integrated Habitat Index (IHI) developed using a quantile regression model based on available environmental variables. The preliminary results showed that the free swimming schools tended to have higher 95% Confidence Intervals (CIs) of IHI values* *compared to the FAD associated schools (0.2933-0.3608 versus 0.1037-0.1181), suggesting that they encountered higher quality habitat.*" – see paper for full abstract.

96. **NOTING** that this approach and the relationship with the concept of "ecological trap", would benefit from further explorations with environmental variables, the WPTT **ENCOURAGED** the use of operational data for further analysis in order to investigate the impact of the use of FADs.

97. The WPTT **NOTED** that sampling at different times of the day for the free swimming school and FAD associated schools, may mean that the condition factors observed are not comparable. Comparing different sizes and, thus, different life-history with different metabolic and energetic needs from free and FAD schools could affect the results of the study. The use of similar size for improving the analysis is encouraged.

Yellowfin tuna diet

98. The WPTT **NOTED** paper IOTC–2015–WPTT17–19 which examined the opportunistic dietary nature of yellowfin tuna: Occurrence of polythene and plastic debris in the stomach, including the following abstract provided by the author:

"*A total number of 112 stomachs of Yellowfin tuna (Thunnus albacares) were analyzed. The total length range of the observed yellowfin tuna was 40-150 cm with the mean length being 107.5 cm and weight range being 10-86.5 kg. The diet of yellowfin tuna around Sri Lanka comprised of a variety of food items such as fish (51.75 %), squids (34.5%), crabs (4.5%), shrimps (7.5%) and debris (1.75%). The great diversity in the food composition was represented mainly by some families of teleost fishes, then cephalopods and crustaceans, which indicate that they are non-selective feeders and that feeding depends on prey availability rather than selectivity. The present study reports the ingestion of debris such as plastic and polythene by yellowfin tuna (Thunnus albacares) in the Indian Ocean.*"

99. The WPTT **NOTED** the importance of tracking the time between catch and the gutting of the fish, which will permit a better understanding of gut contents analysis.

Yellowfin tuna purse seine caught spatio-temporal distribution

100. The WPTT **NOTED** paper IOTC–2015–WPTT17–21 which provided a temporal and spatial patterns in the catch ratio of adult yellowfin for the West Indian purse seine fishery (1984–2014), including the following abstract provided by the author:

"*Time series of catch at size from the Indian Ocean European purse seine fisheries are used to investigate the trend and spatial characteristics of the ratio of adult yellowfin (YFT) in the catch during 1984-2014… The size at first maturity L50 is the threshold used to define the spawning stock, and two extreme estimates of L50 are tested in the study, at 76 and 112 cm. At the scale of the whole fished area, combining free and object-associated schools, we observe an overall decline of the spawners' ratios, independently of the catch level. Two major dips are seen in the series, likely to result from different causes. The first dip developed during the intense 1997-98 El Niño which affected catches and occurrence of free-swimming schools. The second dip which happened between 2008 and 2011 is likely due to a change in fishing tactics and strategies at the climax of the Somalian piracy.*" – see paper for full abstract.

101. The WPTT **NOTED** that other works also concluded that the main spawning area is located between 0º–10ºS during December-March and indicated that a second spawning season with lower intensity occur during June–July.

102. The WPTT **NOTED** that the work describing the spawning habitat of yellowfin tuna was restricted by the fishery distribution of the purse seine fleet and **AGREED** that this type of work be expanded to other gears/areas as to provide a better understanding of the spawning habitat and spawning season/area of yellowfin tuna throughout the Indian Ocean. However, the main limitation is that size data on which such analysis is based is very scarce on all other gears than purse seine.

China yellowfin tuna longline fishery

103. The WPTT **NOTED** paper IOTC–2015–WPTT17–22 which provided examined the size distribution of Indian Ocean yellowfin tuna caught in by Chinese longline vessels, including the following abstract provided by the author:

"*Yellowfin tuna (Thunnus albacares) is one of the important tuna species targeted by tuna purse seines and longlines in the Indian Ocean. Size distribution of yellowfin tuna was analyzed based on four trips collected by China's national tuna fisheries observers in the India Ocean between July 2010 and February 2014(no observer in 2011). In 2010-2014, the fork length distributed from 54 to180 cm and there were two predominant groups of yellowfin tuna, with the first FL class at 85-105 cm and the second at 125-160cm. The length distribution from 2010 to 2014 was mostly at 75-170 cm in the first and fourth quarters, and* *also mainly distributed in the area of 40°-70°E, 13°S-3°N, which suggested that the area is the spawning ground.*"

7.3 Review of new information on the stats of yellowfin tuna

7.3.1 Nominal and standardised CPUE indices

Report of the 2nd CPUE workshop on longline fisheries

104. The WPTT **NOTED** paper IOTC–2015–WPTT17–23 is the Report of the 2nd CPUE Workshop on Longline Fisheries, including the following abstract provided by the author:

"*A Workshop assessing CPUE trends and techniques used by the IOTC was held in Taipei from April 30th to May 2nd, 2015. The meeting covered some key aspects as to why there were differences in some of the longline fleets and addressed the following objectives that were identified in the 1st CPUE Workshop (IOTC–2013–CPUEWS01): 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: 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; and 5) Use operational level data in analyses of data for each fleet, and also in a joint meeting across the CPC's.*" – see paper for full abstract.

105. The WPTT **ACKNOWLEGED** the excellent progress of the workshop toward attaining reliable abundance indices for the stock assessment and Management Strategy Evaluation processes.

106. The WPTT **NOTED** that operational data should be collected and analysed wherever possible, and the scope of the studies should be expanded to include other fleets (e.g. Seychelles industrial longline and Indian survey data), and applied to other species of relevance to IOTC working parties (e.g. albacore and billfishes).

107. The WPTT **SUGGESTED** several directions for future studies, including: i) exploring negative effects of high effort concentration (i.e. through localised depletion or gear interactions); ii) efforts to understand the mechanism whereby clustering affects catchability; and iii) interactions between fixed 5x5 degree spatial effects and dynamic environmental effects.

108. The WPTT **NOTED** that combining observations across fleets in a single analysis should provide a time series with better spatial and temporal coverage, provided that data quality and consistency among fleets can be ascertained (Fig 2).

109. The WPTT **CONSIDERED** that the cluster analyses represents a powerful tool for classifying set types, however, it was recognised that the species composition is not necessarily a reliable indicator of targeting intent.

110. The WPTT **RECOGNISED** that the use of individual vessel effects appears to identify catchability changes in the Japan longline CPUE series that is not otherwise evident.

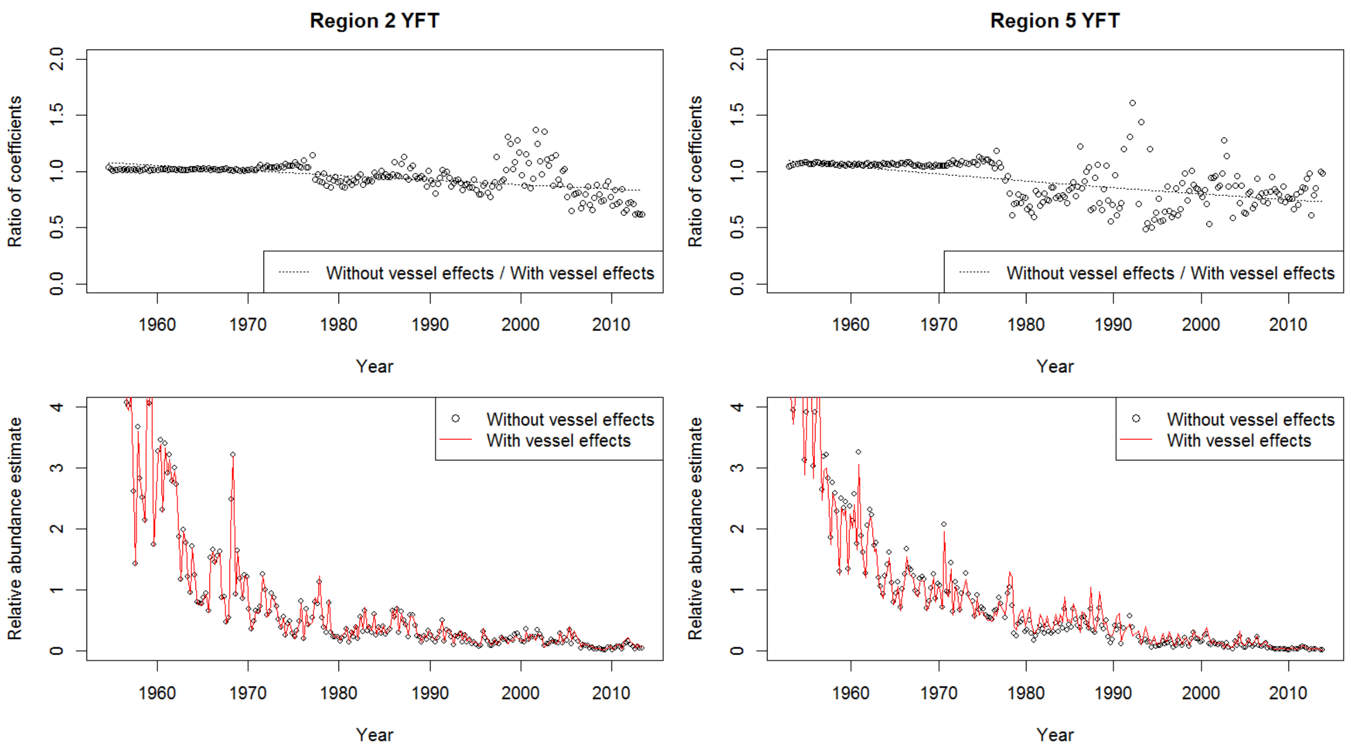


Fig. 2. Yellowfin tuna: Standardised longline CPUE series from the combined analysis of Japan, Taiwan,China and Rep. of Korea longline fleets, 1952–2013 (left panel = region 2, right panel = region 5). Note: Area definitions based on 2014 areas.

111. **NOTING** that the Taiwan,China longline CPUE in southern regions is affected by the rapid recent growth of the oilfish fishery, and that this is a new fishery with substantially lower catchability for tunas, it is important for CPUE indices to adjust for this change in catchability. Thus, the WPTT **RECOMMENDED** that future tuna CPUE standardisations should use appropriate methods to identify effort targeted at oilfish and related species, and either remove it from the dataset, or include a categorical variable for targeting method in the standardisation. The oilfish data variable should be provided to data analysts producing the CPUE index.

112. The WPTT **NOTED** that differences between the Japan and Taiwan.China longline CPUE indices were examined and attributed to either low sampling coverage of logbook data (between 1982–2000) or misreporting across oceans (Atlantic and Indian oceans) for bigeye tuna catches between 2002–04 for Taiwan,China. The WPTT **RECOMMENDED** the 1) development of minimum criteria (e.g. 10% using a simple random stratified sample) for logbook coverage to use data in standardisation processes; and 2) identifying vessels through exploratory analysis that were misreporting, and excluding them from the dataset in the standardisation analysis.

113. The WPTT **RECOMMENDED** that:
   - more credence should be given to CPUE indices based on operational data, since analyses of these data can take more factors into account, and analysts are better able to check the data for inconsistencies and errors.
   - Taiwan,China fleets provide all available logbook data to data analysts, representing the best and most complete information possible. This stems from the fact that the dataset currently used by scientists from Taiwan,China is incomplete and not updated with logbooks that arrive after finalisation.
   - that vessel identity information for the Japanese fleets for the period prior to 1979 should be obtained either from the original logbooks or from some other source, to the greatest extent possible to allow estimation of catchability change during this period and to permit cluster analysis using vessel level data. During this period there was significant technological change (e.g. deep freezers) and targeting changes (e.g. yellowfin tuna to bigeye tuna).
   - examining operation level data across all longline fleets (Rep. of Korea, Japan and Taiwan,China) will give us a better idea of what is going on with the fishery and stock especially if some datasets have low sample sizes or effort in some years, and others have higher sample sizes and effort, so we have a representative sample covering the broadest areas in the Indian Ocean. This will also avoid having no information in certain strata if a fleet were not operating there, and avoid combining two indices in that case.

114. **NOTING** paragraph 113, the WPTT **RECOMMENDED** that continued work on joint analysis of operational catch and effort data from multiple fleets be undertaken, to further develop methods and to provide indices of abundance for IOTC stock assessments.

India longline standardised CPUE

115. The WPTT **NOTED** paper IOTC–2015–WPTT17–24 which provided a standardisation of distant water tuna longline hooking rate for yellowfin tuna from Fishery Survey of India fleet (1981–2012), including the following abstract provided by the author:

> "*Generalized linear model (GLM) is commonly used to evaluate impacts of environmental as well as fisheries operational variables on fisheries catch per unit fishing effort (CPUE) and to arrive at standardized CPUE which could be used as a relative index in fisheries stock abundance. GLM analysis is an effective way of standardization of CPUE data with catch rates in which there is a high proportion of zeros in the catch data. This paper describes a method for the analysis of yellow fin survey data, incorporating zero and non-zero values into a single model. The database contains information on the long line sets carried out by survey vessels of FSI from 1981 to 2012. The catch in number of fish per 100 hooks was the response variable. The Standardized hooking rates for yellow fin tuna were derived by means of GLM approach. Ten variables, Year, Quarter, Latitude, Longitude, duration (soaking time), catch rate of sailfish, skipjack and marlin, gear and Vessel Type were used to build GLM model.*" – see paper for full abstract.

116. The WPTT **WELCOMED** the Indian survey results as a valuable relative abundance index which might not be biased by the changes in targeting and efficiency to the same degree as commercial fisheries and such that future experiments might be conducted to explicitly estimate catchability effects (Fig. 3).

117. The WPTT **NOTED** that there was very low yellowfin tuna catch in recent years, which is consistent with the limited commercial CPUE observations. The authors indicated that catches of other non-tuna species was unusually high during this period. There have been technological changes introduced to the survey which have probably affected catchability (e.g. the use of Salinity Temperature Depth meters and changing gear configuration).

118. The WPTT **ENCOURAGED** continuation of the survey, and **REQUESTED** further analyses for future use in the IOTC stock assessment process. Suggestions included provision of a detailed description of the survey methodology and alternative statistical models for admitting the large number of zero observations. These analyses should be pursued in conjunction with the CPUE standardisation analyses including partitioning of the survey areas by model assessment regions.

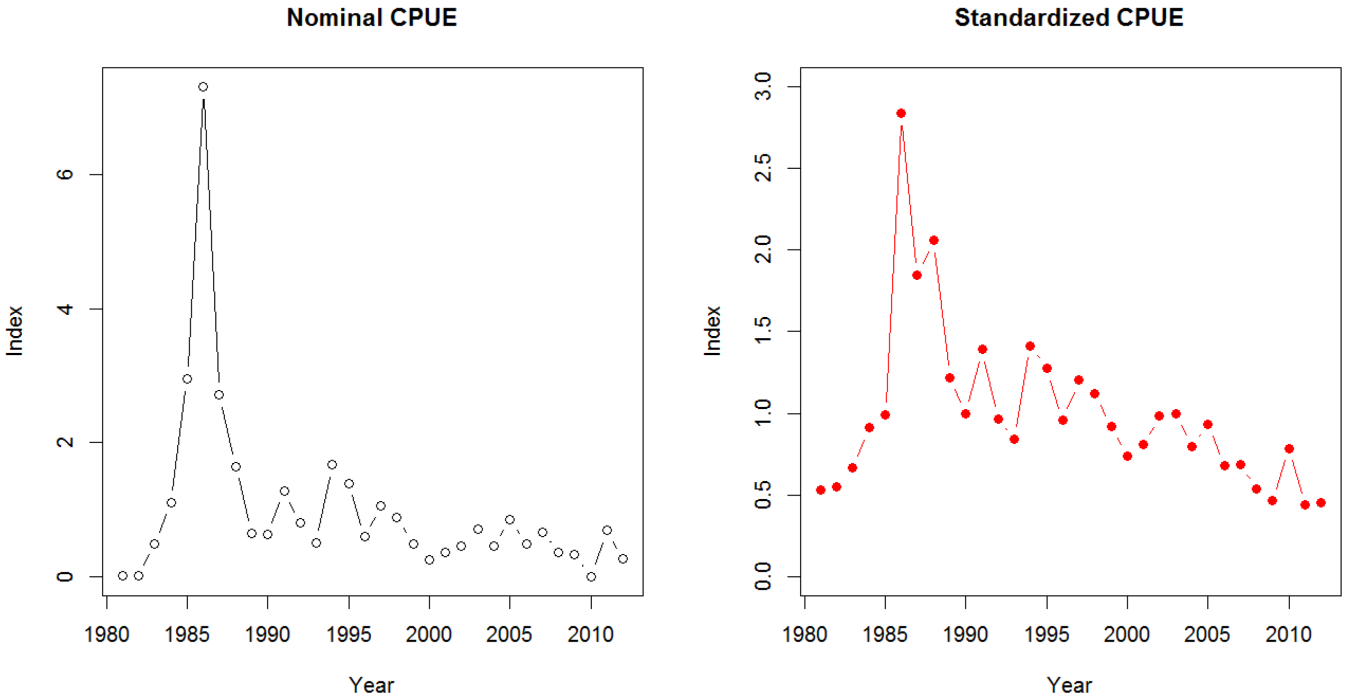


Fig. 3. Yellowfin tuna: Longline survey CPUE series for India 1981–2012 (from the Indian EEZ).

Taiwan,China longline standardised CPUE

119. The WPTT **NOTED** paper IOTC–2015–WPTT17–25 which provided updated CPUE standardisations for bigeye tuna and yellowfin tuna caught by Taiwan,China longline fishery in the Indian Ocean using generalized linear model, including the following abstract provided by the author:

 "*Updated 2012 and 2013 Taiwanese longline fishery data was used in this analysis. Cluster analysis was used to classify longline sets in relation to species composition of the catches to understand whether cluster analysis could identify distinct fishing strategies. Bigeye and Yellowfin tuna CPUE standardization were presented. All analyses were performed by the approaches used by the collaborative workshop of longline data and CPUE standardization for bigeye and yellowfin tuna held in March and April 2015 in Taipei.*"

120. The WPTT **NOTED** the updated CPUE analysis (Fig. 4) and the authors were encouraged to continue the analysis as part of the multi-nation collaborative effort to improve CPUE standardisations**.**

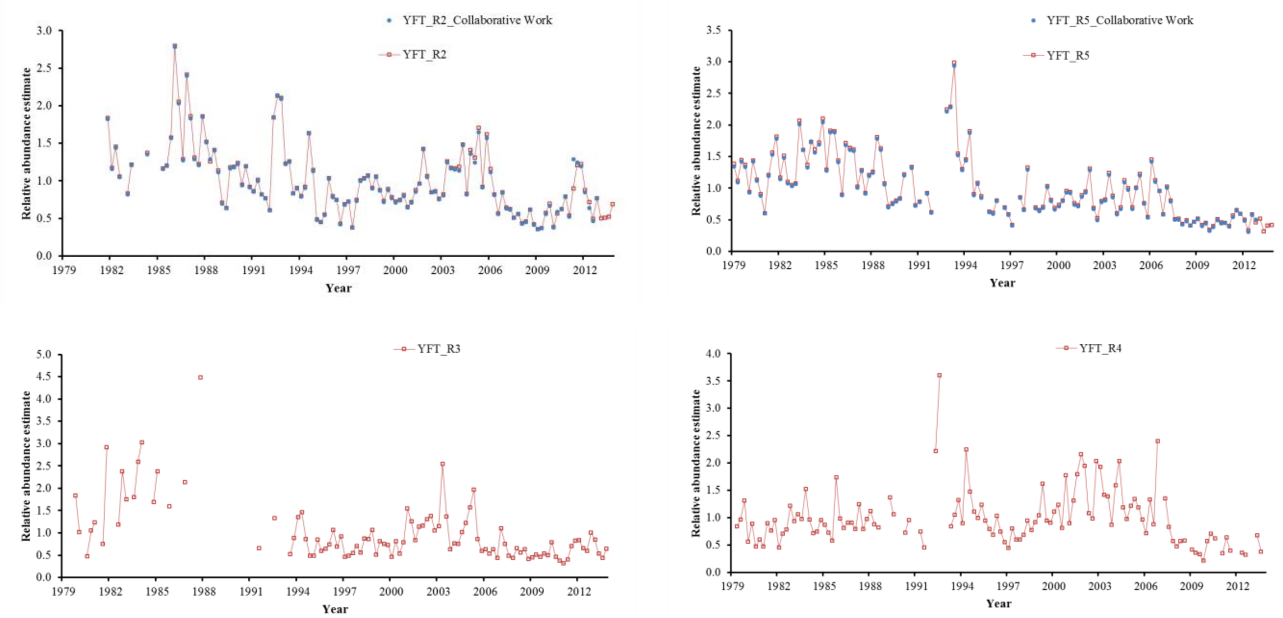


Fig. 4. Yellowfin tuna: Standardised longline CPUE series (by region/area) for Taiwan,China from 1979–2013. Note: Area definitions based on 2014 areas.

Japan longline – Catch-per-unit-of-effort (CPUE)

121. The WPTT **NOTED** paper IOTC–2015–WPTT17–26 which provided an updated standardised Japanese longline CPUE for yellowfin tuna in the Indian Ocean and consideration of standardisation methods, including the following abstract provided by the author:

 "*Japanese longline CPUE for yellowfin tuna in the main fishing ground and whole Indian Ocean, as well as area-specific CPUE in each areas was standardized up to 2014 by GLM. In order to avoid the bias of data, the scenarios without Area 2, with including area 3' that combined area 2 and 3, and standardization from whole catch data were also considered. Basically, these standardized CPUEs showed similar trends. CPUE continuously decreased from early 1960s to 1974, and was kept in the same level until 1990. Thereafter, it declined to historical low level in recent years. The stable trend in recent years at all models indicate decreased effort caused by piracy activity on area 2 have little effect on overall CPUE trends. Trends of area-specific CPUEs were similar among areas (2-5, and 3'). Applying 5 degrees latitude/longitude effect showed large effect on the CPUE trend for Area 3 and 4. Trends of CPUEs from whole data showed steeper declining in area 4. The standardized CPUE in area 3' showed intermediate trend between area 2 and 3.*"

122. The WPTT **WELCOMED** the updated catch rate standardisation analysis (Fig. 5) and **AGREED** that future analyses should continue in conjunction with the multi-nation collaboration, and the CPUE series provided for stock assessments should follow the recommendations of the CPUE workshop, including the use of operational data.

123. The WPTT **NOTED** that the analysis estimated an increase in yellowfin tuna catchability associated with the Number of Hooks Between Floats (HBF), which is the opposite of expectations (i.e. higher HBF is traditionally assumed to reflect deeper sets and BET targeting). This suggests that the relationship is not simple, and there are probably important interactions between HBF, time-area effects, and/or main-line effects that require further consideration.

124. The WPTT **NOTED** that the sharp decline in CPUE occurred in area 5 around 1990, which may have been a result of a change in targeting, but the detail remains unclear.

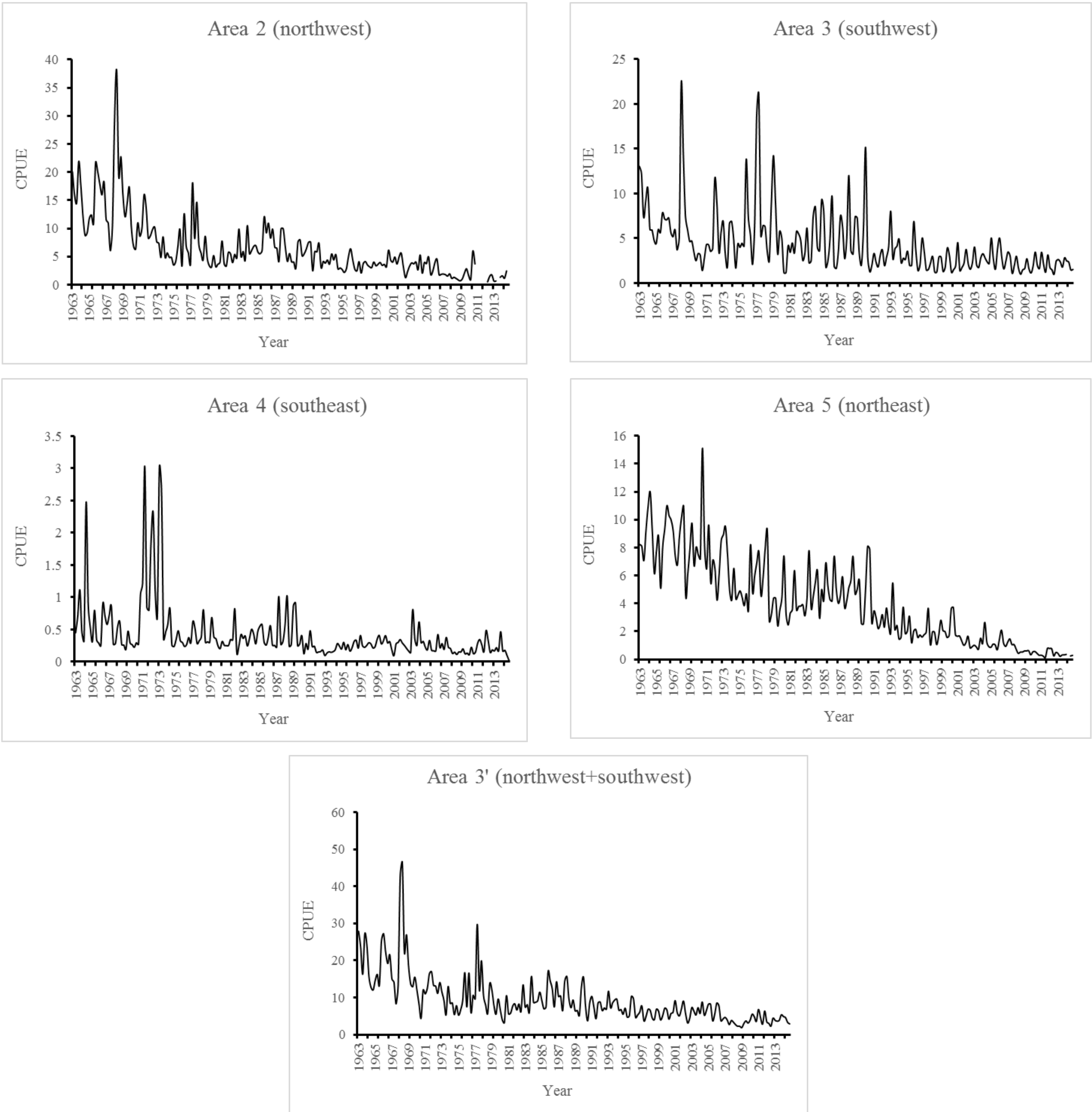


Fig. 5. Yellowfin tuna: Standardised Japan longline CPUE by area (Area 3' is a combination of areas 2 and 3) from 1963–2014. Note: Area definitions based on 2014 areas.

CPUE Summary discussion

125. The WPTT **NOTED** the following points in relation to the longline CPUE discussions:

- The latest yellowfin tuna CPUE series were relatively consistent with each other and with the Indian survey (as evident in Fig. 6, despite the inconsistency in spatial definitions for the series shown).
- The Japan longline CPUE series were given the primary emphasis in the stock assessments. The SS3 assessment also included sensitivity trials using the combined fleet data that included individual vessel effects, the Indian longline CPUE and the European Union purse seine CPUE.
- The effects of piracy increased the uncertainty of Japanese CPUE indices in the western equatorial Indian Ocean region since 2008, and consequently indices are not available for some quarters. The area of operation of the Japan longline fleet is greatly reduced and the indices are therefore derived from a smaller proportion of the region. Standardisation methods can potentially account for changes in spatial distribution, although bias may be introduced. Nonetheless the CPUE indices based on combined fleet data showed similar trends to the Japan longline indices during and after the period of piracy.

- There was a substantial reduction of longline fishing effort by distant water fishing nations in the northern Arabian sea and consequently a lack of CPUE series from that region.

126. The WPTT **AGREED** that the multi-nation CPUE standardisation collaboration continue their efforts to improve the understanding of commercial CPUE as relative abundance indices, and expand future work to include other fleets, including the Indian survey.

127. The WPTT **NOTED** that of the yellowfin tuna CPUE series available for assessment purposes, the Japan longline series would be used in the final stock assessment models investigated in 2015, for the reasons discussed above (Fig. 6).
    - India data (1981–2012) from document IOTC–2015–WPTT17–24
    - Taiwan,China data (1980–2014) from document IOTC–2015–WPTT17–25
    - Japan data (1963–2014) from document IOTC–2015–WPTT17–26
    - European Union data (purse seine on free-schools, including an annual 3% increase in fishing power; 1984–2014) and provided during the WPTT (no document provided)

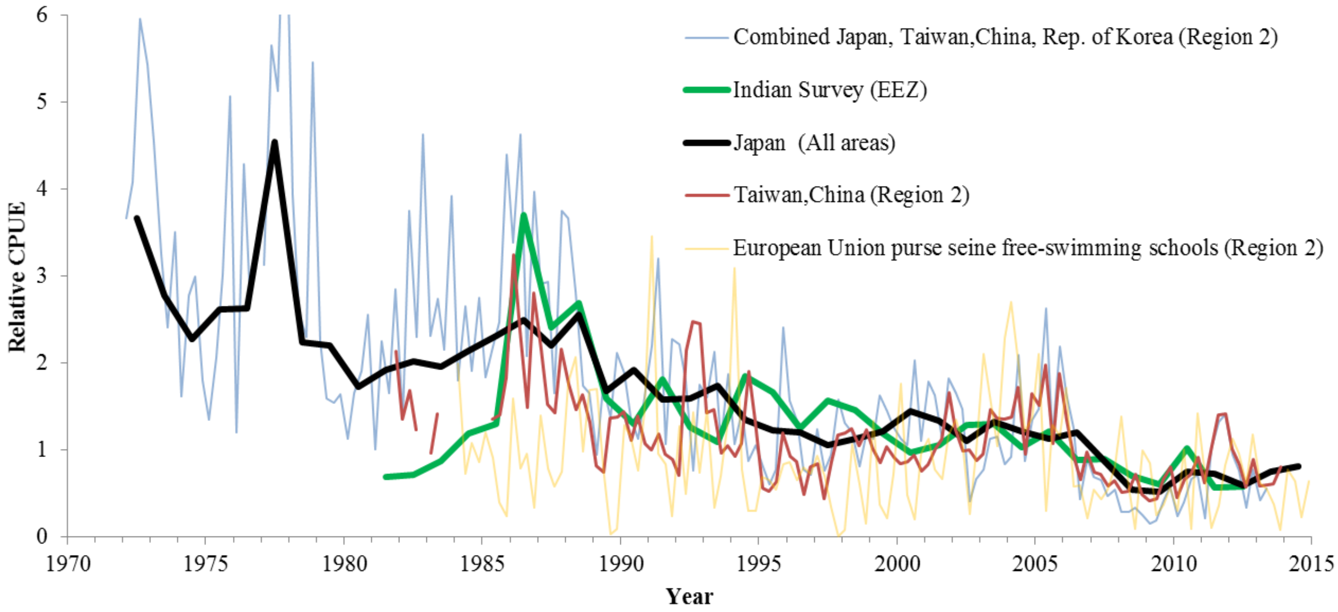


Fig. 6. Yellowfin tuna: Comparison of relative abundance indices derived from standardised commercial longline catch rates from Japan, Taiwan,China, and combined fleets series (Japan, Taiwan,China and Rep. of Korea), compared with the Indian survey (note that regions are not identical, all series are re-scaled relative to the 2001–10 mean, and observations before 1972 are omitted).

128. The WPTT **NOTED** that a CPUE series for the European Union purse seine fleet targeting free swimming schools was provided (1984–2014) as an exploratory yellowfin tuna abundance index. This series included an arbitrary assumption of catchability increasing at 3% per year, but did not show the overall long term abundance decline evident in the longline series. The WPTT **ENCOURAGED** the authors to carry out further analyses to explicitly quantify the catchability increases over time.

7.3.2 Stock assessments

129. The WPTT **NOTED** that three (3) modelling methods (BBPM, SCAA and SS3) were applied to the assessment of yellowfin tuna in 2015. The different assessments were presented to the WPTT in documents IOTC–2015–WPTT17–27, 28 Rev_2 and 30. Each model is summarised in the sections below.

Yellowfin tuna: Summary of stock assessment models in 2015

130. The WPTT **NOTED** Table 6, which provide an overview of the key features of each of the stock assessments presented in 2015 for the Indian Ocean-wide assessments (3 model types). Similarly, Table 7 provide a summary of the assessment results.

Table 6. Yellowfin tuna: Indian Ocean-wide assessments. Summary of final stock assessment model features as applied to the Indian Ocean yellowfin tuna resource in 2015.

Model feature	**BPPM (Doc#27)**	**SCAA (Doc#28 Rev_2)**	**SS3 (Doc# 30)**
Software availability	WinBUGS (Lunn et al 2000)	http://ocean-info.ddo.jp/kobeaspm/aspm/ASPM.zip	NMFS toolbox
Population spatial structure / areas	1	1	4
Number CPUE Series	2	One (JPN) area (23+5)	4
Uses Catch-at-length/age	No	CAA	CAL
Age-structured	No	0-5 and 6+	Yes
Sex-structured	No	No	Yes (for sensitivity only)
Number of Fleets	Combined into 1	7	21
Stochastic Recruitment	No	Yes	Yes

Lunn D J, Thomas A, Best N, et al. 2000. WinBUGS- a Bayesian modelling framework: Concepts, structure, and extensibility. Statistics and Computing, 10:325–337.

Table 7. Yellowfin tuna: Summary of key management quantities from the assessments undertaken in 2015 (See specific working papers for descriptions of the management quantity calculations).

Management quantity	**BBPM (Doc#27)**	**SCAA (Doc#28 Rev_2)**	**SS3 (Doc# 30)**
Most recent catch estimate (t) (2014)	430, 331	430,327	427,440
Mean catch over last 5 years (t) (2010–2014)	373,824	373,824	368,853
h (steepness)	n.a.	0.86	0.8
MSY (1,000 t) (80% CI)	344 (330–356)	415 (367–463)	421 (404–439)
Data period (catch)	1950–2014	1950–2014	1950–2014
CPUE series/period	Japan: 1972–2014 Taiwan China:1980–2012	Japan: 1963–2014	Japan: 1972–2014
F_{MSY} (80% CI)	0.37 (0.29–0.46)	0.54 (n.a.)	0.165 (0.162–0.168)
SB_{MSY} or $*B_{MSY}$ (1,000 t) (80% CI)	942.2* (779.4–1148.1)	788 (n.a.)	1,217 (1,165–1,268)
F_{2014}/F_{MSY} (80% CI)	1.87 (1.45–2.37)	1.07 (0.82–1.32)	1.34 (1.02–1.67)
B_{2014}/B_{MSY} (80% CI)	0.74 (0.62–0.90)	n.a.	n.a.
SB_{2014}/SB_{MSY} (80% CI)	n.a.	0.84 (0.50–1.18)	0.66 (0.58–0.74)
B_{2014}/B_{1950} (80% CI)	0.30 (0.25–0.37)	n.a.	n.a.
SB_{2014}/SB_{1950} (80% CI)	n.a.	0.30 (n.a.)	0.23 (0.21–0.26)
$SB_{2014}/SB_{current,\ F=0}$ (80% CI)	n.a.	n.a.	0.30 (n.a.)

n.a. = not available

Bayesian Biomass Production Model (BBPM) assessment of yellowfin tuna

131. The WPTT **NOTED** paper IOTC–2015–WPTT17–27 which provided a stock assessment of yellowfin tuna in the Indian Ocean by using Bayesian biomass production model (BBPM), including the following abstract provided by the authors:

“*A Fox-form Bayesian biomass dynamics model was developed to assess the stock status of yellowfin tuna (Thunnus albacares) in the Indian Ocean (1950-2014). The results showed that the median of Maximum sustainable yield (MSY) was 344,200 t, and the medians of B2014/BMSY and F2014/FMSY were 0.74 and 1.87, respectively. Thus, the stock was subject to overfishing and overfished at the end of 2014. The risk assessments suggest that the current catch level in 2014 (430, 331 t) is higher than MSY and this level can result in high risk for the stock to be overfished and subject to overfishing. Future catch should be reduced to 67% of the current level, which will lead to a 60% of probability for the biomass exceeding BMSY by 2024. The results are more pessimistic than those assessed with integrated age-structured models in 2012* *and this year. Because there are high uncertainties in the present assessment, we suggest that the results not be used for developing management advices, but for comparison with other model results.*"

132. The WPTT **NOTED** the key assessment results for the BBPM model as shown below (Tables 8, 9; Fig. 7).

Table 8. Yellowfin tuna: Key management quantities from the BBPM stock assessment, for the Indian Ocean.

Management Quantity	Indian Ocean
Most recent catch estimate (t) (2014)	430, 331
Mean catch over last 5 years (t) (2010–2014)	373,824
h (steepness)	n.a.
MSY (1,000 t) (80% CI)	344 (330–356)
Data period (catch)	1950–2014
CPUE series/period	Japan: 1972–2014 Taiwan China:1980–2012
F_{MSY} (80% CI)	0.37 (0.29–0.46)
SB_{MSY} or $*B_{MSY}$ (1,000 t) (80% CI)	942.2* (779.4–1148.1)
F_{2014}/F_{MSY} (80% CI)	1.87 (1.45–2.37)
B_{2014}/B_{MSY} (80% CI)	0.74 (0.62–0.90)
SB_{2014}/SB_{MSY} (80% CI)	n.a.
B_{2014}/B_{1950} (80% CI)	0.30 (0.25–0.37)
SB_{2014}/SB_{1950} (80% CI)	n.a.
$SB_{2014}/SB_{current,\ F=0}$ (80% CI)	n.a.

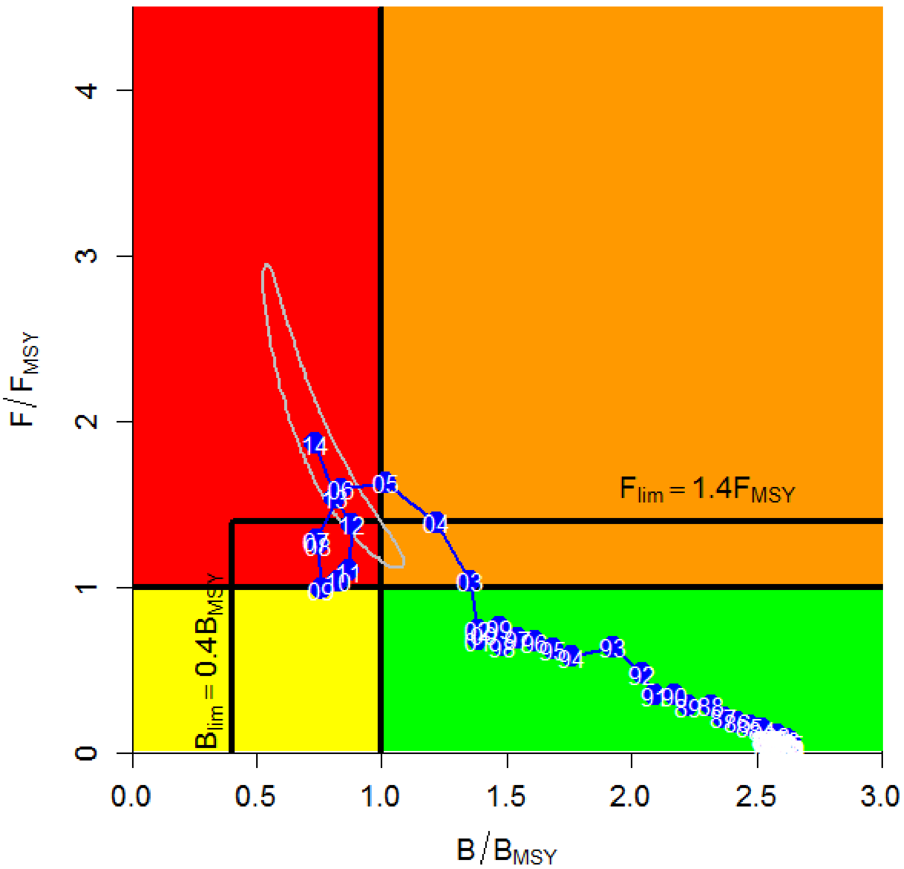


Fig. 7. Yellowfin tuna: BBPM Aggregated Indian Ocean assessment Kobe plot. Blue dots indicate the trajectory of the point estimates for the B/B_{MSY} ratio and F proxy ratio for each year 1950–2014. The grey line represents the 95% confidence interval associated with the 2014 stock status. The black lines are the IOTC interim reference points.

Table 9. Yellowfin tuna: BBPM 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 2014 (430,372 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 2014) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60% (258,223t)	**70%** (301,260t)	**80%** (344,298t)	**90%** (387,335t)	**100%** (430,372t)	**110%** (473,409t)	**120%** (516,446t)	**130%** (559484t)	**140%** (602,521t)
$B_{2017} < B_{MSY}$	77	92	98	99	99	100	100	100	100
$F_{2017} > F_{MSY}$	40	82	97	100	100	100	100	100	100
$B_{2024} < B_{MSY}$	10	57	95	100	100	100	100	100	100
$F_{2024} > F_{MSY}$	6	49	95	100	100	100	100	100	100
Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2014) and probability (%) of violating MSY-based limit reference points ($B_{lim} = 0.4\ B_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)**								
	60% (258,223t)	**70%** (301,260t)	**80%** (344,298t)	**90%** (387,335t)	**100%** (430,372t)	**110%** (473,409t)	**120%** (516,446t)	**130%** (559484t)	**140%** (602,521t)
$B_{2017} < B_{Lim}$	2	12	37	66	86	95	98	99	100
$F_{2017} > F_{Lim}$	9	43	80	96	99	99	100	100	100
$B_{2024} < B_{Lim}$	3	27	77	98	100	100	100	100	100
$F_{2024} > F_{Lim}$	3	34	86	99	100	100	100	100	100

133. The WPTT **NOTED** the following with respect to the BBPM modelling approach presented at the meeting:
- Biomass dynamic models provide a useful comparison to more complex age structured models, in this case illustrating the simple relationship between B/B_{MSY} and F/F_{MSY} trajectories that can be expected in the absence of recruitment variation, and which may appear counter-intuitive in the age-structured models.
- There were differences in the biomass trends estimated from the different CPUE time series, with less internal conflict in the models that used the Japan longline CPUE time series.

Statistical-Catch-At-Age (SCAA) assessment of yellowfin tuna

134. The WPTT **NOTED** paper IOTC–2015–WPTT17–28 Rev_2 which provided a stock assessment of yellowfin tuna in the Indian Ocean by using a Statistical-Catch-At-Age (SCAA) model from 1950–2014, including the following abstract provided by the authors:

> "*We attempted the stock assessments for the yellowfin tuna (YFT) in the Indian Ocean using SCAA (Statistical-Catch-At-Age) model and available data for 65 years (1950–2014). As a result, it is suggested that the current status of the stock (2014) is in the green zone close to the MSY levels of SB and F in the Kobe plot, i.e., F(2014)/Fmsy=0.85 and SB(2014)/SBmsy*."

135. The WPTT **NOTED** the key assessment results for the SCAA model as shown below (Tables 10, 11; Fig. 8).

Table 10. Yellowfin tuna: Key management quantities from the SCAA stock assessment, for the Indian Ocean. Values below represent the average and 80% confidence interval of a suite of 10 plausible model runs.

Management Quantity	**Indian Ocean**
Most recent catch estimate (t) (2014)	430,327
Mean catch over last 5 years (t) (2010–2014)	373,824
h (steepness)	0.86
MSY (1,000 t) (80% CI)	415 (367–463)
Data period (catch)	1950–2014
CPUE series/period	1963–2014
F_{MSY} (80% CI)	0.54 (n.a.)
SB_{MSY} or $*B_{MSY}$ (1,000 t) (80% CI)	788 (n.a.)
F_{2014}/F_{MSY} (80% CI)	1.07 (0.82–1.32)
B_{2014}/B_{MSY} (80% CI)	n.a.
SB_{2014}/SB_{MSY} (80% CI)	0.84 (0.50–1.18)

B_{2014}/B_{1950} (80% CI)	n.a.
SB_{2014}/SB_{1950} (80% CI)	0.30 (n.a.)
$SB_{2014}/SB_{current,\ F=0}$ (80% CI)	n.a.

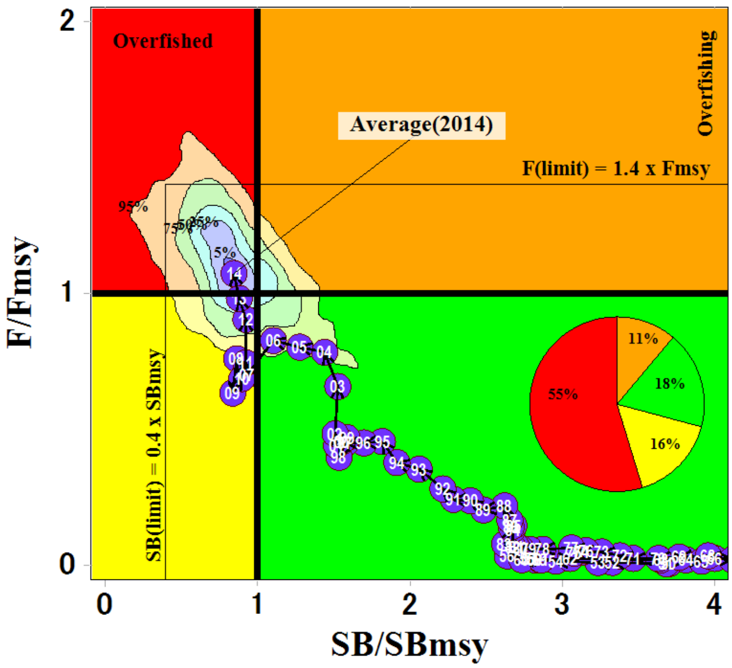


Fig. 8. Yellowfin tuna: SCAA Aggregated Indian Ocean assessment Kobe plot. Blue circles indicate the trajectory of the average point estimates for the SB/SB_{MSY} ratio and F proxy ratio for each year 1950–2014 for the base model. The contour lines represent confidence intervals associated with the 2014 stock status derived from the average of the 10 most plausible model runs.

Table 11. Yellowfin tuna: SCAA 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 2014 (430,372 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 2012-14) and probability (%) of violating MSY-based target reference points ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)								
	60% (247,657t)	**70%** (28,8933t)	**80%** (330,209t)	**90%** (371,485t)	**100%** (412,760t)	**110%** (454,037t)	**120%** (495,313t)	**130%** (536,589t)	**140%** (577,865t)
$SB_{2017} < SB_{MSY}$	0	n.a.	12	n.a.	46	n.a.	74	n.a.	92
$F_{2017} > F_{MSY}$	0	0	0	n.a.	14	n.a.	69	n.a.	95
$SB_{2024} < SB_{MSY}$	0	0	0	n.a.	51	n.a.	88	n.a.	100
$F_{2024} > F_{MSY}$	0	0	0	n.a.	29	n.a.	85	n.a.	100
Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2012-14) and probability (%) of violating MSY-based limit reference points ($SB_{lim} = 0.4\ SB_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)**								
	60% (247,657 t)	**70%** (28,8933t)	**80%** (330,209 t)	**90%** (371,485 t)	**100%** (412,760t)	**110%** (454,037 t)	**120%** (495,313 t)	**130%** (536,589 t)	**140%** (577,865 t)
$SB_{2017} < SB_{Lim}$	0	0	0	0	0	0	0	n.a.	11
$F_{2017} > F_{Lim}$	0	0	0	0	0	n.a.	19	n.a.	76
$SB_{2024} < SB_{Lim}$	0	0	0	0	0	n.a.	58	n.a.	71
$F_{2024} > F_{Lim}$	0	0	0	n.a.	16	n.a.	76	n.a.	90

136. The WPTT **NOTED** the following with respect to the SCAA modelling approach presented at the meeting:
- MSY-related reference points are fixed at a constant aggregate fishery selectivity, but it may be more appropriate to adjust it through time to account for changes in selectivity, which tends to moderate changes in F/F_{MSY}.
- Recruitment variability may be higher than the level assumed in this assessment.

- The majority of the runs resulted in implausible outcomes with very large values of MSY and/or biomass (i.e. explained CPUE trends on the basis of recruitment trends with insignificant fishing mortality).
- Selecting plausible runs on the basis of arbitrary MSY bounds represents a circular process to the estimation of stock status.

Stock Synthesis III (SS3) assessment of yellowfin tuna

137. The WPTT **NOTED** paper IOTC–2015–WPTT17–30 which provided an a stock assessment of yellowfin tuna in the Indian Ocean using Stock Synthesis III, including the following abstract provided by the author:

“*The model integrates fishery catch data, longline CPUE indices, fishery length composition data and tag release/recovery data from the RTTP. The base case was similar to the 2012 assessment conducted using MFCL with the exception of the amalgamation of the Arabian Sea and western equatorial regions in the current model. Within the four regions, 21 fisheries were defined based on fishing gear, fishing area and time period (4 additional fisheries were defined to investigate temporal variability in selectivity). The region specific longline standardised CPUE indices for 1972-2014 represented the primary abundance indices for the stock in each region. The tag release/recovery data informs the model regarding the absolute magnitude of stock abundance during the main recovery period in the late 2000s. The model period is 1950-2014 resolved at a quarterly time step. Quarterly recruitment is derived from a BH SRR (steepness 0.8) and is considered to be at the equilibrium level prior to 1972. Recruitment is apportioned between the two equatorial regions. Variation in the overall level of recruitment and regional specific recruitments were estimated for 1972-2014. Movement parameters were estimated for adjacent regions for juvenile and adult yellowfin. Base care natural mortality was assumed to be at a level equivalent to the 2012 IO assessment. The level of natural mortality is considerably lower than adopted for WCPO and EPO stock assessments; however, the level of natural mortality is more consistent with the long term tag recoveries from the RTTP. The biomass trajectories are consistent with the declining trend in the longline CPUE indices, especially from 1990 onwards. There was a sharp decline in stock biomass during the mid-2000s following a period of particularly high catches in 2004-05. The model estimates that recruitment was low during 2004-06 based on the lower subsequent longline CPUE indices and lower catches from the purse-seine log fishery during 2007-09 and longline size composition trends. Stock biomass recovered slightly recovered slightly during 2009–2011 (when catches declined in part due to piracy) and then steadily declined to a low level in 2014. Current (2014) total spawning biomass is estimated to be at a historically low level*.”

138. The WPTT **NOTED** that a large number of sensitivities were conducted to investigate key structural assumptions. A number of these model sensitivities to characterise the main sources of uncertainty were conducted relative to the base model, including:
    - SRR steepness at 0.7 and 0.9.
    - A lower overall level of natural mortality.
    - An extended tag mixing period of 10 quarters, substantially down weighting the overall influence of the tag data set in the model.
    - A model option amalgamating the two western regions and adopting a longline standardised CPUE index specific to the amalgamated region.
    - The exclusion of the western equatorial (R1) longline CPUE indices from 2008 and 2009. The indices were very low for those years and there is concern that the indices were biased by the threat of piracy in the region during that period.

139. The WPTT **NOTED** the key assessment results for the Stock Synthesis III model (SS3) as shown below (Tables 12, 13; Fig. 9).

Table 12. Yellowfin tuna: Key management quantities from the SS3 assessment, for the Indian Ocean. Values represent the Maximum Posterior Density from the base case and the confidence interval empirically derived from the covariance matrix.

Management Quantity	Indian Ocean
Most recent catch estimate (t) (2014)	427,440
Mean catch over last 5 years (t) (2010–2014)	368,853
h (steepness)	0.8
MSY (1,000 t) (80% CI)	421 (404–439)
Data period (catch)	1950–2014
CPUE series/period	1972–2014
F_{MSY} (80% CI)	0.165 (0.162–0.168)
SB_{MSY} or *B_{MSY} (1,000 t) (80% CI)	1,217 (1,165–1,268)

F_{2014}/F_{MSY} (80% CI)	1.34 (1.02–1.67)
B_{2014}/B_{MSY} (80% CI)	n.a.
SB_{2014}/SB_{MSY} (80% CI)	0.66 (0.58–0.74)
B_{2014}/B_{1950} (80% CI)	n.a.
SB_{2014}/SB_{1950} (80% CI)	0.23 (0.21–0.26)
$SB_{2014}/SB_{current,\ F=0}$ (80% CI)	0.30 (n.a.)

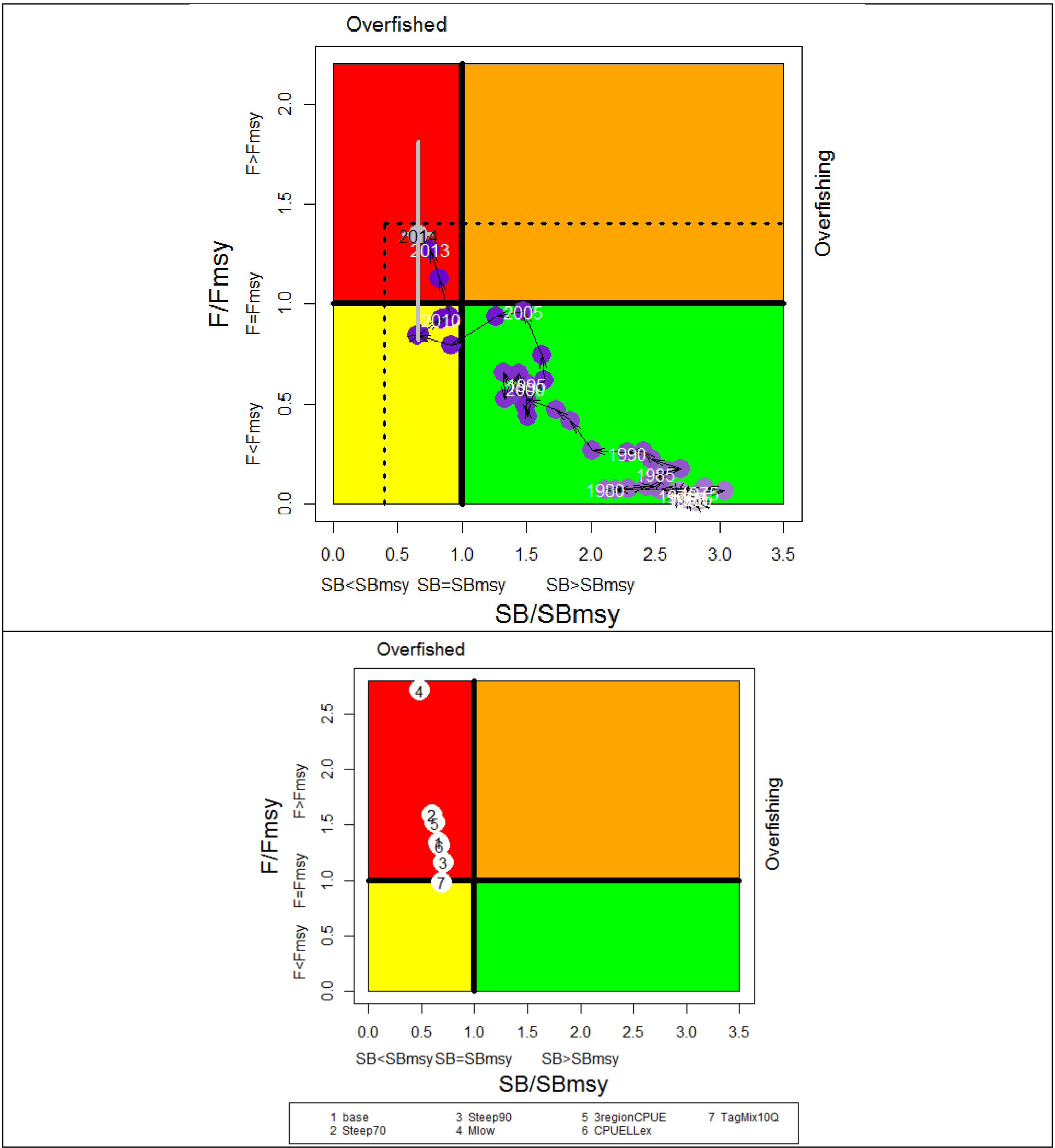


Fig. 9. Yellowfin tuna: **Top**) SS3 Indian Ocean assessment Kobe plot. Blue circles indicate the trajectory of the mode of the posterior distribution estimates for the SB/SB_0 ratio and F proxy ratio for each year 1950–2014 for the base model. The grey lines represent the (inverse Hessian-delta) 95% confidence interval associated with the 2014 stock status. Dotted black lines are the interim limit reference points adopted by the Commission via Resolution 15/10. **Bottom**) A comparison of current (2014) stock status from the base model and the range of model sensitivities. The model options are specified in the legend.

Table 13. Yellowfin tuna: SS3 base case 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 2014 (427,440 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 2014) and probability (%) of violating MSY-based target reference points ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60% (256,464t)	**70%** (299,208)	**80%** (341,952t)	**90%** (384,696t)	**100%** (427,440t)	**110%** (470,184t)	**120%** (512,928t)	**130%** (555,672t)	**140%** (598,416)
$SB_{2017} < SB_{MSY}$	69	95	91	99	99	100	100	100	100
$F_{2017} > F_{MSY}$	2	54	60	79	100	100	100	100	100
$SB_{2024} < SB_{MSY}$	4	36	50	100	100	100	100	100	100
$F_{2024} > F_{MSY}$	0	22	49	100	100	100	100	100	100
Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2014) and probability (%) of violating MSY-based limit reference points ($SB_{lim} = 0.4\ SB_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)**								
	60% (256,464t)	**70%** (299,208)	**80%** (341,952t)	**90%** (384,696t)	**100%** (427,440t)	**110%** (470,184t)	**120%** (512,928t)	**130%** (555,672t)	**140%** (598,416)
$SB_{2017} < SB_{Lim}$	2	15	12	44	33	n.a.	n.a.	n.a.	n.a.
$F_{2017} > F_{Lim}$	0	13	19	70	100	100	100	100	100
$SB_{2024} < SB_{Lim}$	<1	8	15	51	100	100	100	100	100
$F_{2024} > F_{Lim}$	0	2	21	100	100	100	100	100	100

140. The WPTT **NOTED** the following with respect to the SS3 modelling approach presented at the meeting:

- Biomass is high in region 2 given the size of the region in comparison to region 1. This is a consistent deficiency in the current assessment that has been present in previous assessments, and provides some justification for pooling these areas in future assessments. Its recognised that relative biomass by area is usually difficult to quantify and estimates usually depend on strong assumptions about shared selectivity, catchability and relative weighting of historically fished areas to extrapolate density to abundance. The model sensitivity that amalgamated the two regions yielded estimates of overall stock status that were very similar to the base model option, primarily due to the similar trends in the relative abundance indices from the two regions. On that basis, it was concluded that the results of the assessment were not sensitive to the regional structure in the western area of the assessment model.
- Around half of the recent yellowfin tuna catches is taken by artisanal fisheries, about which we have very little information on the total catches, their fishing areas and the sizes caught. This problem has an unquantified impact on the current yellowfin tuna assessment.
- The decline to low spawning biomass relative to MSY was not preceded by a period of high catch relative to MSY, and appears to have been largely caused by low recruitment. The declining spawning biomass estimates in the models are largely driven by declining CPUE in the longline fisheries, especially the low indices in region 1 (R1) during 2008 and 2009.
- The WPTT considered mechanisms which might have artificially caused the apparent recruitment decline in 2004-06, and explored alternative data sources for recruitment insight. These included:
    - Purse seine free school catch rates were low in 2006-07, for which a highly plausible cause would be a low catchability due to an anomalously deep thermocline in relation with a positive dipole event. The possibility these low catch rates would also be a consequence of low recruitment (as predicted by the model) cannot be discarded but cannot stand as the major cause of those low catch rates on free schools.
    - Purse seine log associated catches and catch rates were low in 2006–07. This is not inconsistent with the model estimates of lower recruitment in the preceding period, however, there may be other explanations for these lower catches.
    - That, by contrast to the low recruitment estimated by the model in 2004–06, the proportion of small size yellowfin tuna (less than 10kg) in the purse seine catch on FADs was stable from 2000 to 2008. Purse seine species composition changes were not informative about yellowfin tuna recruitment, primarily because changes in skipjack tuna abundance need to be accounted for.
    - Removing longline CPUE observations from the model corresponding to the estimated recruitment decline did not substantively change the recruitment pattern.
- The low CPUE in recent years occurs at the same time as an increase in longline mean sizes, which is consistent with reduced recruitment, but which was not observed in purse seine free-school mean sizes and

which may reflect changing selectivity from the longline fleets or insufficient size sampling from longline catches.

- Compared with the 2012 assessment the stock is now estimated to be considerably more depleted. In the 2012 assessment the south-western region was estimated to be less depleted than the equatorial region – while depletion in both areas is similar in the new assessment.
- Retrospective analyses terminating in 2011 were somewhat more pessimistic than the MFCL results from 2012. This is likely to be influenced by the way that MFCL introduces temporally varying recruitment in each region (the SS3 specification is thought to be more realistic in only introducing recruits to equatorial regions).
- A sensitivity analysis replacing the Japan longline CPUE in areas 1 and 4 with the Indian survey time series resulted in a slightly more optimistic outcome than the base case, though it was noted that the indices for 2013–14 were assumed to be equivalent to the 2012 survey index.
- A sensitivity analysis adding purse seine free school CPUE resulted in some conflict with the longline CPUE indices and slightly more optimistic outcomes than the base case. This was expected because the purse seine CPUE series did not decline to the same extent as the longline CPUE indices in region 1 (R1).
- It would be worth investigating whether the environmental movement co-variates could be replaced with consistent seasonal migration parameters (or whether the current series fit the data any better than a randomised time series).
- Natural mortality (M) is one of the most important parameter in all stock assessments, but it remains highly uncertain for yellowfin tuna. Our base assumption on M are much lower than the values used in the eastern Pacific Ocean by the IATTC. Based on the tag recoveries of the RTTP program after a long period at liberty, we are confident that out lower estimates of M are more appropriate for the Indian Ocean than the IATTC assumptions. However we are not confident that the functional form of M-at-age can be reliably estimated.
- Dome-shaped selectivity may be plausible for the longline fishery, and should be further explored in future assessments, recognising the interaction between selectivity and M.

Parameters for future analyses: Yellowfin tuna CPUE standardisation and stock assessments

141. The WPTT **RECALLED** that in order to obtain comparable assessments, the CPUE standardisations should be conducted with similar parameters and resolutions. However the improved methods recommended by the CPUE workshop should also be applied so that standardisation procedures can make progress. Table 14 provides a set of parameters, discussed during WPTT meetings that shall give guidelines, if available, for the standardisation of CPUE in the unimproved state.

Table 14. Yellowfin tuna: Parameters for the standardisation of CPUE series in 2016.

CPUE standardisation parameters	CPUE standardisations for consistency
Area	By region
CE Resolution	Aggregated data
GLM Factors	Year, Quarter, 5 degree squares, HBF, vessel, environmental + interactions
Model	lognormal + constant
Updated standardisation methods	
Area	By region
CE Resolution	Operational data
Data preparation	Cluster analysis or related approaches to select data or add cluster parameters
GLM Factors	Year, Quarter, 5 degree squares, SST (as appropriate) and gear effects, vessel effect
Model	Delta lognormal, negative binomial, zero inflated

142. The WPTT **REQUESTED** that EU and Seychelles scientists work on a standardized purse seine CPUE for large yellowfin tuna caught in free-swimming schools.

143. The WPTT **RECALLED** that the model parameters contained in Table 15 could be considered appropriate for future yellowfin tuna stock assessments preliminary base case analysis, with appropriate sensitivity runs.

Table 15. Yellowfin tuna: Model parameters agree to by the WPTT for use in future base case stock assessment runs.

Biological parameters	Value for assessments
Spatial structure	4 regions
Sex ratio	Sex aggregated
Age (longevity)	28 quarterly age classes with the last representing a plus group.
Natural mortality	Age-specific. Relative variation amongst ages based on WCPO yellowfin assessment and overall scale of natural mortality estimated in 2012 Indian Ocean yellowfin tuna assessment (see Figure 16 in SS3 assessment). Constant over time and among regions.
Growth formula	Estimates in Fonteneau 2008 (Replace with Eveson et al. 2015 and/or Dortel et al. 2015, but not for 2016 update). SD of length-at-age based on a constant coefficient of variation of average length-at-age.
Weight-length allometry	*a* = 1.7665e-05, *b* = 3.03542
Maturity	age-class 0-4: 0; 5: 0.1; 6: 0.15; 7: 0.2; 8: 0.5; 9: 0.5; 10: 0.7; 11: 0.9; 12-28: 1.0 (based on Zudaire et al. 2013)
Fecundity	Assume constant, since results are based on spawning biomass rather than egg production. (Potential to change this post-2016.)
Stock-recruitment	Beverton-Holt steepness of 0.8 with sensitivities at 0.7 and 0.9.
Other parameters	
Fisheries	25 fisheries defined by region and gear type, with temporal splits to reflect selectivity change in the region 1b PS fisheries.
Abundance indices	Regional standardised longline CPUE indices estimated jointly across flags
Selectivity	Age specific, constant over time. Principal longline fisheries share logistic selectivity parameters. Common selectivity for all PSLS fisheries. Common selectivity for all PSLS fisheries. LF4 fishery logistic selectivity. All other fisheries: double normal selectivity. OT 1a & 4 and TR 1b & 4 share selectivity parameters.

7.3.3 Selection of Stock Status indicators for yellowfin tuna

144. The WPTT **AGREED** that the base case model run from the SS3 stock assessment would be used for development of management advice for the Scientific Committee’s consideration. The other models (BBPM and SCAA) should be discussed as supporting evidence.

7.4 Development of management advice for yellowfin tuna & update of yellowfin tuna Executive Summary for the consideration of the Scientific Committee

145. The WPTT **ADOPTED** the management advice developed for yellowfin tuna as provided in the draft resource stock status summary and **REQUESTED** that the IOTC Secretariat update the draft stock status summary for the yellowfin tuna with the latest 2014 catch data (if necessary), and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration:
    - Yellowfin tuna (*Thunnus albacares*) – Appendix VIII.

7.5 Yellowfin tuna Management Strategy Evaluation process update

146. The WPTT **NOTED** paper IOTC–2015–WPTT17–36 which provided an update on the bigeye tuna and yellowfin tuna management strategy evaluation development framework, including the following abstract provided by the authors:
    “*Recent progress on the development of a Management Strategy Evaluation (MSE, or Management Procedure Evaluation) technical framework for Indian Ocean yellowfin (YFT) and bigeye (BET) tunas is described. This includes i) an outline of the key software features implemented to date, ii) an exploration of YFT Operating Model (OM) options (conditioned using Stock Synthesis software in association with the draft 2015 assessment), and iii) an outline of the software development plan through to mid-2016. We emphasize that this technical project is only one part of a much larger MSE process that requires the engagement and exchange of ideas among many parties, including technical experts that will need to contribute to the review and development of operating models and management procedures, and various stakeholders (including fisheries managers and IOTC Commissioners) that will need to articulate their expectations about management objectives and options. This specific component of the project is scheduled for completion mid-*

2016, so this presentation represents the primary opportunity to solicit feedback from the general participants of the IOTC WP Methods, WP Tropical Tunas, and Scientific Committee. We welcome feedback about the defined feature set for the projection model, and the approach to Operating Model conditioning."

147. The WPTT **NOTED** that the current project is scheduled to conclude in June 2016 with the release of the software, documentation, demonstration Operating Model cases, and evaluation of candidate Management Procedures for both bigeye tuna and yellowfin tuna. The WPTT **ENDORSED** the program of work.

148. While the timeline in the program of work is consistent with the requirements of Resolution 15/10, WPTT **NOTED** that additional work may well be required to fully meet the requests of the Commission and thus **REQUESTED** the Secretariat in coordination with the Chairs of WPTT, WPM and Scientific Committee evaluate the need for expanding the contract currently in place.

8. Development of options for alternative management measures for tropical tunas in the IOTC area of competence

149. **NOTING** that capacity controls based on fishing vessel numbers are likely to be insufficient in limiting the harvest of tropical tunas, since these measures seldom take into account 'effort creep' and vessel efficiency, none-the-less the WPTT **AGREED** that the current fleet capacity across all gear types is in excess of that needed to harvest yellowfin tuna at levels that would maintain the stock biomass necessary to support MSY catches.

150. The WPTT **NOTED** existing fleet development plans, if realised, will substantially increase overall fishing capacity and effort which would result in even higher fishing pressure on the tropical tuna stocks.

151. The WPTT **AGREED** that the Chairperson, in collaboration with the IOTC Secretariat, develop draft Terms of Reference for a consultant to undertake an analysis of fishery-specific impacts, including implications of the uncertainty in catch composition by species as well as size frequency available for the different fleets, on the stocks of tropical tunas in line with those provided by the WCPFC Scientific Committee, to inform the Commission of the potential impact of overall fleet capacity growth on tropical tuna stocks. A starting point for the TORs would be to:
    - Provide an evaluation of fleet-specific fishery impacts on the stock of bigeye tuna, skipjack tuna and yellowfin tuna; taking into account the various sources of uncertainty (e.g. uncertainty in catch and lack of size data).
    - Project potential impact of realising fleet development plans on the status of tropical tunas based upon most recent stock assessments.
    - Cost estimate: US$30,000, 60 days over 6 months. Travel, if necessary, additional.

9. WPTT Program of work

9.1 Revision of the WPTT Program of Work (2016–2020)

152. The WPTT **NOTED** paper IOTC–2015–WPTT17–08 which provided the WPTT17 with an opportunity to consider and revise the WPTT Program of Work (2016–2020), by taking into account the specific requests of the Commission, Scientific Committee, and the resources available to the IOTC Secretariat and CPCs.

153. The WPTT **RECALLED** that the SC, at its 17th Session, made the following request to its working parties:

> "*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*." (SC17. Para 178)

154. The WPTT **REQUESTED** that the Chairperson and Vice-Chairperson of the WPTT, in consultation with the IOTC Secretariat, develop Terms of Reference (TOR) to for each of the high priority projects that are yet to be funded, for circulation to potential funding sources.

155. **NOTING** that the current IOTC *Guidelines for the presentation of CPUE standardisations and stock assessment models* (IOTC–2015–WPTT17–INF01) may need revising, as it was felt that the current Stock Status summary table, which is the principal communication tool regarding stock status used on the IOTC website, understates uncertainty in stock status evaluations, the WPTT **RECOMMENDED** that the following be reviewed:
    - the annual status coding scheme;
    - the historic coding scheme;

- consideration of the status coding scheme for years when no quantitative stock assessment is available.

Data exchange timings

156. **NOTING** that the current time frames for data exchange do not allow enough time to conduct thorough stock assessment analyses, which has a detrimental effect on the quality of advice provided, the WPTT **ENCOURAGED** that exchanges of data (CPUE indices and coefficient of variation) should be made as early as possible, but **no later than** 60 days prior to a working party meeting, so that stock assessment analysis can be provided to the IOTC Secretariat no later than 30 days before a working party meeting.

Consultants

157. **NOTING** the excellent work done by IOTC consultants in the past and for the WPTT17, the WPTT **RECALLED** that the Commission has pre-approved a consultant to undertake a bigeye tuna stock assessment in 2016, by the inclusion of funds in the 2016 budget. The budget (2016–18) is provided at Table 16 for implementation by the IOTC Secretariat.

Table 16. Budget for an IOTC consultant to conduct SS3 stock assessments on tropical tuna in 2016, 2017 and 2018

Description	Unit price	Units required	Total
Bigeye tuna Stock Assessment (fees) 2016	US$550	40	22,000
Bigeye tuna Stock Assessment (travel) 2016	US$5,000	1	5,000
Skipjack tuna Stock Assessment (fees) 2017	US$550	40	22,000
Skipjack tuna Stock Assessment (travel) 2017	US$5,000	1	5,000
Yellowfin tuna Stock Assessment (fees) 2018	US$550	40	22,000
Yellowfin tuna Stock Assessment (travel) 2018	US$5,000	1	5,000
Total estimate (US$)			**81,000**

158. The WPTT **AGREED** that a number of priority issues (in order of importance) should be examined to support further development of the stock assessments for tropical tunas. The Chairperson and IOTC Secretariat shall develop Terms of Reference and seek funding. Specifically:
    - Tropical tunas
        - The refinement of current estimates of natural mortality informed by tag release/recovery data.
        - Incorporation of uncertainty associated with fishery catches and fishery selectivity especially for non-industrial fisheries. This element would also incorporate the refinement of the fishery structure of the model to account for heterogeneity in the size composition of catches (e.g. the handline fishery).
        - Improvement in the approach used to conduct stock projections and the associated estimates of uncertainty for K2MSM, including the incorporation of variability in recruitment (resampling approaches).
    - Yellowfin tuna
        - The development of a two sex model to account for sex specific differences in the biological parameters (especially growth and natural mortality).
        - A review of the assumptions associated with the mixing of tagged fish following release.
        - Determination of the structural uncertainty of the assessment model, incorporating the interactions among key model parameters (e.g. a grid approach).

Summary

159. The WPTT **RECOMMENDED** that the SC consider and endorse the WPTT Program of Work (2016–2020), as provided at Appendix IX.

9.2 Development of priorities for an Invited Expert at the next WPTT meeting

160. The WPTT **NOTED** with thanks, the outstanding contributions of the invited expert for the meeting, Dr Simon Hoyle, New Zealand, both prior to and during the WPTT meeting which contributed greatly to the group's understanding of tropical tuna data, CPUE standardisation and assessment methods. His travel was funded via the IOTC Invited Expert process to contribute as a peer reviewer for the meeting, as well as ISSF support to present the Report of the 2nd IOTC CPUE workshop on longline fisheries.

161. The WPTT **AGREED** to the following core areas of expertise and priority areas for contribution that need to be enhanced for the next meeting of the WPTT in 2016, by an Invited Expert:
    - **Expertise**: Stock assessment; including from regions other than the Indian Ocean; size data analysis; and CPUE standardisation.

- **Priority areas for contribution**: Providing expert advice on stock assessments; refining the information base, historical data series and indicators for tropical tuna species for stock assessment purposes (species focus: bigeye tuna and yellowfin tuna).

10. Other Business

10.1 Date and place of the 18th and 19th Sessions of the WPTT

162. The WPTT **THANKED** France for hosting the 17th Session of the WPTT and commended IRD on the warm welcome, the excellent facilities and assistance provided to the IOTC Secretariat in the organisation and running of the Session.

163. **NOTING** the discussion on who would host the 18th and 19th Sessions of the WPTT in 2016 and 2017 respectively, the WPTT **REQUESTED** that the IOTC Secretariat liaise with CPCs to determine if they would be able to host the 18th and 19th sessions of the WPTT respectively (Table 17).

Table 17. Draft meeting schedule for the WPTT (2016 and 2017)

Meeting	2016		2017	
	Date	Location	Date	Location
Working Party on **Tropical Tunas**	Third week in October (5 d)	TBD	Third week in October (5 d)	TBD

10.2 Review of the draft, and adoption of the Report of the 17th Session of the WPTT

164. The WPTT **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPTT17, provided at Appendix X, as well as the management advice provided in the draft resource stock status summary for each of the three tropical tuna species under the IOTC mandate, and the combined Kobe plot for the three species assigned a stock status in 2015 (Fig. 10):
    - Bigeye tuna (*Thunnus obesus*) – Appendix VI
    - Skipjack tuna (*Katsuwonus pelamis*) – Appendix VII
    - Yellowfin tuna (*Thunnus albacares*) – Appendix VIII

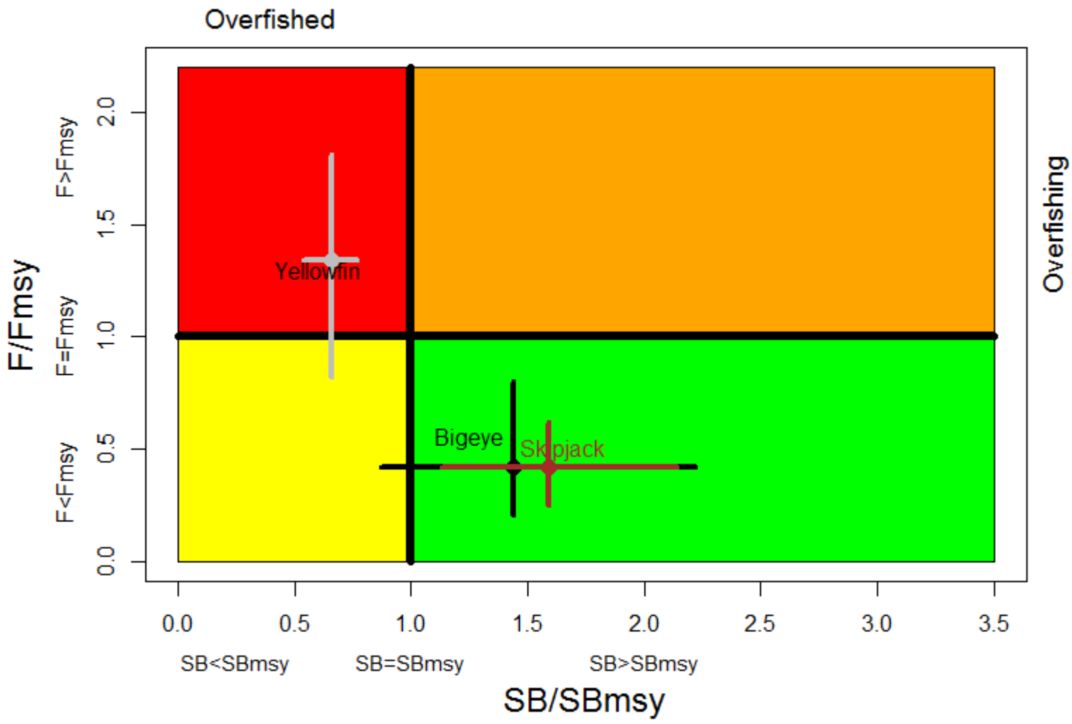


Fig. 10. Combined Kobe plot for bigeye tuna (black: 2013), skipjack tuna (brown: 2014) and yellowfin tuna (grey: 2015) showing the estimates of current stock size (SB) and current fishing mortality (F) in relation to optimal spawning stock size and optimal fishing mortality. Cross bars illustrate the 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.

165. The report of the 17th Session of the Working Party on Tropical Tunas (IOTC–2015–WPTT17–R) was **ADOPTED** on the 27 October 2015.

APPENDIX I
LIST OF PARTICIPANTS

Chairperson
Dr M. Shiham **Adam**
Marine Research Centre, Maldives
Email: msadam@mrc.gov.mv

Vice-Chairperson
Dr Gorka **Merino**
AZTI Tecnalia, Spain,
European Union
Email: gmerino@azti.es

Invited Expert:
Dr Simon **Hoyle**
Consultant, New Zealand
Email: simon.hoyle@gmail.com

Stock Assessment Consultant
Mr Adam **Langley**
Consultant, New Zealand
Email: adam_langley@xtra.co.nz

Other Participants:
Mr Mokhtar **Akhondi**
Iran Fisheries Organization (IFO)
Iran (Islamic Republic of)
Email: akhondi2200@yahoo.com

Mr John **Burton**
IPNLF
Email: john.burton@ipnlf.org

Dr Emmanuel **Chassot**
IRD, Seychelles
Email: Emmanuel.chassot@ird.fr

Dr Pascal **Bach**
IRD
France
Email: pascal.bach@ird.fr

Mr Nokome **Bentley**
Trophia Ltd.
Email: nbentley@trophia.com

Dr Manuela **Capello**
IRD, France
Email: Manuela.capello@ird.fr

Mr Chirdsak **Chookong**
Deep Sea Fishery Technology
Research and Development Institute,
Marine Fisheries Research and
Development Bureau, Dept. of
Fisheries, Thailand
Email: chirdchoo@gmail.com

Dr Wetjens **Dimmlich**
WWF, Seychelles
Email: wdimmlich@wwf.panda.org

Dr Jean-Noel **Druon**
European Commission, Joint
Research Center, Italy
Email: jean-noel.druon@jrc.ec.europa.eu

Dr Alain **Fonteneau**
IRD, France
Email: Alain.fonteneau@ird.fr

Mr Laurent **Floch**
IRD
France
Email: laurent.floch@ird.fr

Dr Daniel **Gaertner**
IRD
France
Email: daniel.gaertner@ird.fr

Ms Chunxia **Gao**
Shanghai Ocean University
Email: cxgao@shou.edu.cn

Mr James **Geehan**
IOTC Secretariat
Email: james.geehan@iotc.org

Dr Wenjiang **Guan**
Shanghai Ocean University
China
Email: wjguan@shou.edu.cn

Dr Adrian **Gutteridge**
Marine Stewardship Council
Email: adrian.gutteridge@msc.org

Mr Deepak **Gulati**
Fishery Survey of India
India
Email: deegulatiin@yahoo.com

Mr Miguel **Herrera**
OPAGAC
Spain
Email: Miguel.Herrera@opagac.org

Mr Ahmed Riyaz **Jauharee**
Ministry of Fisheries and Agriculture
Maldives
Email: arjauharee@mrc.gov.mv

Dr Dale **Kolody**
CSIRO
Australia
Email: dale.kolody@csiro.au

Dr Toshihide **Kitakado**
Tokyo University of Marine Science
and Technology, Japan
Email: kitakado@kaiyodai.ac.jp

Dr Francis **Marsac**
IRD, France
Email: francis.marsac@ird.fr

Mr Tobias **Mildenberger**
Leibniz Center for Marine Tropical
Ecology, Bremen, Germany
Email: tobias.mildenberger@zmt-bremen.de

Dr Hilario **Murua**
AZTI Tecnalia, Spain,
European Union
Email: hmurua@azti.es

Dr Tom **Nishida**
National Research Institute of Far
Seas Fisheries of Japan, Japan
Email: tnishida@affrc.go.jp

Ms Sampan **Panjarat**
Andaman Sea Fisheries Research and
Development Center, Department of
Fisheries
Thailand
Email: spanjarat@yahoo.com

Dr Chintha **Perera**
National Aquatic Resources Research and Development Agency
Sri Lanka
Email: chinthaperera2@yahoo.com

Dr Evgeny **Romanov**
CAPRUN – Hydro–Reunion, Reunion Island, France
Email: evgeny.romanov@ird.fr

Dr Philippe **Sabarros**
IRD
France
Email: philippe.sabarros@ird.fr

Dr Gerald **Scott**
International Seafood Sustainability Foundation, United States of America
Email: gpscott_fish@hotmail.com

Mr Anwar **Sheik Mamode**
Albion Fisheries Research Centre
Mauritius
Email: asheik-mamode@govmu.org

Dr Takayuki **Matsumoto**
National Research Institute of Far Seas Fisheries, Japan
Email: matumot@affrc.go.jp

Ms Alexandra **Maufroy**
IRD, France
Email: alexandra.maufroy@ird.fr

Dr Maria **Soto**
IEO, Spain
Email : maria.soto@md.ieo.es

Mr Paul **Taconet**
IRD
France
Email: paul.taconet@ird.fr

Dr Xuefang **Wang**
Shanghai Ocean University
Email: xfwang@shou.edu.cn

Dr David **Wilson**
IOTC Deputy Secretary / Science Manager, Seychelles
Email: david.wilson@iotc.org

Dr Ashley **Williams**
Department of Agriculture
Australia
Email:
ashley.williams@agriculture.gov.au

Mr Arief **Wujdi**
Research Institute for Tuna Fisheries, Indonesia
Email: arief_wujdi@yahoo.com

Dr Yu-min **Yeh**
Nanhua University, Taiwan,China
Email: ymyeh@mail.nhu.edu.tw

APPENDIX II
AGENDA FOR THE 17TH WORKING PARTY ON TROPICAL TUNAS

Date: 23–28 October 2015
Location: Montpellier, France
Venue: Montpellier Aquarium
Time: 09:00 – 17:00 daily
Chair: Dr Shiham Adam (Maldives) **Vice-Chair**: Dr Gorka Merino (EU,Spain)

1. **OPENING OF THE MEETING** (Chair)
2. **ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION** (Chair)
3. **THE IOTC PROCESS: OUTCOMES, UPDATES AND PROGRESS**
   - 3.1 Outcomes of the 17th Session of the Scientific Committee (IOTC Secretariat)
   - 3.2 Outcomes of the 19th Session of the Commission (IOTC Secretariat)
   - 3.3 Review of Conservation and Management Measures relevant to tropical tunas (IOTC Secretariat)
   - 3.4 Progress on the recommendations of WPTT16 (IOTC Secretariat)
4. **NEW INFORMATION ON FISHERIES AND ASSOCIATED ENVIRONMENTAL DATA RELATING TO TROPICAL TUNAS**
   - 4.1 Review of the statistical data available for tropical tunas (IOTC Secretariat)
   - 4.2 Review new information on fisheries and associated environmental data (general CPC papers)
5. **BIGEYE TUNA – REVIEW OF NEW INFORMATION ON STOCK STATUS**
   - 5.1 Review of the statistical data available for bigeye tuna (IOTC Secretariat)
   - 5.2 Review new information on bigeye tuna biology, ecology, stock structure, their fisheries and associated environmental data (CPC papers)
   - 5.3 Review of new information on the status of bigeye tuna (all)
     - Nominal and standardised CPUE indices
     - Stock assessments
     - Selection of Stock Status indicators for bigeye tuna
   - 5.4 Development of management advice for bigeye tuna, and update of bigeye tuna Executive Summary for the consideration of the Scientific Committee (all)
   - 5.5 Bigeye tuna Management Strategy Evaluation process update (all)
6. **SKIPJACK TUNA – REVIEW OF NEW INFORMATION ON STOCK STATUS**
   - 6.1 Review of the statistical data available for skipjack tuna (IOTC Secretariat)
   - 6.2 Review new information on skipjack tuna biology, ecology, stock structure, their fisheries and associated environmental data (CPC papers)
   - 6.3 Review of new information on the status of skipjack tuna (all)
     - Nominal and standardised CPUE indices
     - Stock assessments
     - Selection of Stock Status indicators for skipjack tuna
   - 6.4 Development of management advice for skipjack tuna, and update of skipjack tuna Executive Summary for the consideration of the Scientific Committee (all)
   - 6.5 Skipjack tuna Management Strategy Evaluation process update (all)
7. **YELLOWFIN TUNA – REVIEW OF NEW INFORMATION ON STOCK STATUS**
   - 7.1 Review of the statistical data available for yellowfin tuna (IOTC Secretariat)
   - 7.2 Review new information on yellowfin tuna biology, ecology, stock structure, their fisheries and associated environmental data (CPC papers)
   - 7.3 Review of new information on the status of yellowfin tuna (all)
     - Nominal and standardised CPUE indices
     - Stock assessments
     - Selection of Stock Status indicators for yellowfin tuna
   - 7.4 Development of management advice for yellowfin tuna, and update of yellowfin tuna Executive Summary for the consideration of the Scientific Committee (all)
   - 7.5 Yellowfin tuna Management Strategy Evaluation process update (all)

8. DEVELOPMENT OF OPTIONS FOR ALTERNATIVE MANAGEMENT MEASURES FOR TROPICAL TUNAS IN THE IOTC AREA OF COMPETENCE

9. WPTT PROGRAM OF WORK

9.1 Revision of the WPTT Program of Work (2016–2020)

9.2 Development of priorities for an Invited Expert at the next WPTT meeting

10. OTHER BUSINESS

10.1 Date and place of the 18th and 19th Sessions of the WPTT (Chair and IOTC Secretariat)

10.2 Review of the draft, and adoption of the Report of the 17th Session of the WPTT (Chair)

APPENDIX III
LIST OF DOCUMENTS

Document	Title	Availability
IOTC–2015–WPTT17–01a	Agenda of the 17th Working Party on Tropical Tunas	✓(26 December 2014) ✓(23 October 2015)
IOTC–2015–WPTT17–01b	Draft: Annotated agenda of the 17th Working Party on Tropical Tunas	✓(14 October 2015) ✓(25 October 2015)
IOTC–2015–WPTT17–02	Draft: List of documents for the 17th Working Party on Tropical Tunas	✓(30 September 2015) ✓(25 October 2015)
IOTC–2015–WPTT17–03	Outcomes of the 17th Session of the Scientific Committee (IOTC Secretariat)	✓(1 October 2015)
IOTC–2015–WPTT17–04	Outcomes of the 19th Session of the Commission (IOTC Secretariat)	✓(1 October 2015)
IOTC–2015–WPTT17–05	Review of Conservation and Management Measures relevant to tropical tunas (IOTC Secretariat)	✓(7 October 2015)
IOTC–2015–WPTT17–06	Progress made on the recommendations of WPTT16 (IOTC Secretariat)	✓(7 October 2015)
IOTC–2015–WPTT17–07 Rev_1	Review of the statistical data and fishery trends for tropical tunas (IOTC Secretariat)	✓(8 October 2015) ✓(20 October 2015)
IOTC–2015–WPTT17–08	Revision of the WPTT Program of Work (2016–2020) (IOTC Secretariat)	✓(7 October 2015)
Environmental conditions		
IOTC–2015–WPTT17–09	Outline of climate and oceanographic conditions in the Indian Ocean: an update to August 2015 (Marsac F)	✓(12 October 2015)
Fisheries information		
IOTC–2015–WPTT17–10	A review of the catch of tropical tunas from longline and purse seine vessels licensed in Mauritius (Mamode AS, Sooklall T & Curpen-Mahadoo M)	✓(7 October 2015)
IOTC–2015–WPTT17–11	Review of the size-frequency data collected from industrial Seychelles longliners during 2007-2014 (Assan C, Lucas J, Lucas V, Issac P & Chassot E)	Withdrawn
IOTC–2015–WPTT17–12 Rev_1	Statistics of the European Union and associated flags purse seine fishing fleet targeting tropical tunas in the Indian Ocean during 1981-2014 (Chassot E, Assan C, Soto M, Damiano A, Delgado de Molina A, Joachim LD, Cauquil P, Lesperance F, Curpen M, Lucas J & Floch L)	✓(7 October 2015) ✓(27 October 2015)
IOTC–2015–WPTT17–13	Statistics of the purse seine Spanish fleet in the Indian Ocean (1990-2014) (Soto M & Fernandez F)	✓(16 October 2015)
IOTC–2015–WPTT17–14 Rev_1	Evaluating the efficiency of tropical tuna purse seiners in the Indian Ocean: first steps towards a measure of fishing effort (Maufroy A, Gaertner D, Kaplan DM, Bez N, Soto M, Assan C, Lucas J & Chassot E)	✓(13 October 2015) ✓(21 October 2015)
IOTC–2015–WPTT17–15	Review of catch and effort for tropical tunas by Korean tuna fisheries (LL, PS) in the Indian Ocean (Lee SI, Kim DN, Ku EJ, Lee MK, Park HW, Kwon Y & Cha HK)	Withdrawn
Yellowfin tuna		
IOTC–2015–WPTT17–16	Analysis of sex ratio by length class of yellowfin (*Thunnus albacares*) and bigeye tuna (*Thunnus obesus*) caught by Indonesian longliners in the eastern Indian Ocean (Wujdi A, Jatmiko I, Novianto D, Bahtiar A, Nugraha B, Hartaty H & Sadiyah L)	✓(9 October 2015)
IOTC–2015–WPTT17–17	Review of yellowfin tuna fisheries in the Maldives (Adam MS, Jauharee R & Miller K)	✓(8 October 2015)
IOTC–2015–WPTT17–18	Preliminary evaluation of differences in habitat quality between FADs-associated and unassociated schools of yellowfin tuna *Thunnus albacares* (Wang X)	✓(7 October 2015)
IOTC–2015–WPTT17–19	Opportunistic dietary nature of yellowfin tuna (*Thunnus albacares):* Occurrence of polythene and plastic debris in the stomach (Perera HACC, Maldeniya R, Weerasekara SA & Senadheera SPSD)	✓(8 October 2015)
IOTC–2015–WPTT17–20	Temporal and spatial trends of yellowfin schools' clusters in the West Indian Ocean (Marsac F & Soto M)	Withdrawn

Document	Title	Availability
IOTC–2015–WPTT17–21	Temporal and spatial patterns in the catch ratio of adult yellowfin for the West Indian purse seine fishery (1984-2014) (Marsac F & Floch L)	✓(7 October 2015)
IOTC–2015–WPTT17–22	Size distribution of Indian Ocean yellowfin tuna *Thunnus albacares* in China longline fishery (Gao C, Dai X & Wu F)	✓(7 October 2015)
IOTC–2015–WPTT17–23	Report of the 2nd CPUE Workshop on Longline Fisheries, 30 April – 2 May 2015 (Hoyle SD, Okamoto H, Yeh Y-M, Kim ZG, Lee SI & Sharma R)	✓(2 October 2015)
IOTC–2015–WPTT17–24	Standardization of distant water tuna longline hooking rate for yellowfin tuna (*Thunnus albacares*) from Fishery Survey of India fleet (1981–2012) (Gulati DK & Premchand)	✓(6 October 2015)
IOTC–2015–WPTT17–25	Updated CPUE standardizations for bigeye and yellowfin tuna caught by Taiwanese longline fishery in the Indian Ocean using generalized linear model (Yeh Y-M & Chang S-T)	✓(8 October 2015)
IOTC–2015–WPTT17–26 Rev_1	Update of standardized Japanese longline CPUE for yellowfin tuna in the Indian Ocean and consideration of standardization methods (Ochi D, Matsumoto T, Nishida T & Kitakado T)	✓(8 October 2015) ✓(22 October 2015)
IOTC–2015–WPTT17–27	Preliminary stock assessment of yellowfin tuna (*Thunnus albacares*) in the Indian Ocean by using Bayesian biomass production model (Guan W, Zhu J, Xu L, Wang X & Gao C)	✓(7 October 2015)
IOTC–2015–WPTT17–28 Rev_2	Stock assessment of yellowfin tuna (*Thunnus albacares*) in the Indian Ocean by SCAA (Statistical-Catch-At-Age) (1950-2014) (Nishida T & Kitakado T)	✓(8 October 2015) ✓(23 October 2015) ✓(28 October 2015)
IOTC–2015–WPTT17–29	Stock assessment of yellowfin tuna (*Thunnus albacares*) in the Indian Ocean by SCAS (Statistical-Catch-At-Size) (Kitakado T & Nishida T)	Withdrawn
IOTC–2015–WPTT17–30	Stock assessment of yellowfin tuna in the Indian Ocean using Stock Synthesis (Langley A)	✓(16 September 2015)
Fish Aggregating Devices		
IOTC–2015–WPTT17–31	Preferred habitat of tropical tuna species in the Eastern Atlantic and Western Indian Oceans: a comparative analysis between FAD-associated and free-swimming schools (Druon JN, Chassot E, Floch L & Maufroy A)	✓(9 October 2015)
IOTC–2015–WPTT17–32 Rev_1	Technological and fisher’s evolution on fishing tactics and strategies on FADs vs. non-associated fisheries (Lopez J, Fraile I, Murua J, Santiago J, Merino G & Murua H)	✓(21 October 2015) ✓(25 October 2015)
IOTC–2015–WPTT17–33	Verification of the limitation of the number of FADs and best practices to reduce their impact on bycatch fauna (Goñi N, Santiago J, Murua H, Fraile I, Ruiz J, Krug I, Sotillo de Olano B, González de Zarate A, Moreno G & Murua J)	✓(22 October 2015)
Bigeye tuna		
IOTC–2015–WPTT17–34	Japanese longline CPUE for bigeye tuna in the Indian Ocean standardized by GLM (Matsumoto T, Ochi D & Satoh K)	✓(8 October 2015)
MSE updates		
IOTC–2015–WPTT17–35	An operating model for the Indian Ocean skipjack tuna fishery (Bentley N & Adam MS)	✓(8 October 2015)
IOTC–2015–WPTT17–36	IOTC bigeye and yellowfin tuna management strategy evaluation (MSE) software development progress update (Kolody D, Jumppanen P, Langley A & Carruthers T)	✓(8 October 2015)
Other papers		
IOTC–2015–WPTT17–37	Tuna catch parameters analysis in the Malagasy EEZ (Razafimandimby Y, Rijasoa F & Joachim DL)	Withdrawn
IOTC–2015–WPTT17–38	Tuna longline fishery in the east Indian Ocean (Panjarat S, Hoimuk S, Jaiyen T, Rodpradit S & Singtongyam W)	✓(21 September 2015)
IOTC–2015–WPTT17–39	Tropical tuna catch in Iran (Akhondi M)	✓(7 October 2015)
IOTC–2015–WPTT17–40	Tuna size sampling from purse seine landing at Mombasa port (Ndegwa S)	Withdrawn
IOTC–2015–WPTT17–41 Rev_1	Seychelles auxiliary vessels in support of purse seine fishing in the Indian Ocean during 2005–2014: summary of a decade of monitoring (Assan C, Lucas J, Augustin E, Delgado de Molina A, Maufroy A & Chassot E)	✓(13 October 2015) ✓(21 October 2015)

Document	Title	Availability
IOTC–2015–WPTT17–42	Vertical behavior and habitat utilization of yellowfin and bigeye tuna in the South West Indian Ocean inferred from PSAT tagging data (Sabarros PS, Romanov EV & Bach P)	✓(8 October 2015)
Information papers		
IOTC–2015–WPTT17–INF01	IOTC SC – Guidelines for the Presentation of Stock Assessment Models (IOTC Scientific Committee)	✓(29 January 2015)
IOTC–2015–WPTT17–INF02	2015 ISSF Stock Assessment Workshop "*Characterising uncertainty in stock assessment and management advice*" (Anon)	✓(25 June 2015)
IOTC–2015–WPTT17–INF03	Female tuna reproductive cycle - Protocol for histology analysis and reproductive studies (Zudaire I, Chassot E, Diaha C, Cedras M, Murua H & Bodin N)	✓(24 September 2015)
IOTC–2015–WPTT17–INF04	Resolution 14/02 *For the conservation and management of tropical tunas stocks in the IOTC area of competence*	✓(10 September 2015)
IOTC–2015–WPTT17–INF05	Resolution 05/01 *On conservation and management measures for bigeye tuna*	✓(10 September 2015)
IOTC–2015–WPTT17–INF06	Resolution 03/01 *On the limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*	✓(10 September 2015)
IOTC–2015–WPTT17–INF07	Descriptive analyses of the Korean Indian Ocean longline fishery, focusing on tropical areas (Hoyle SD, Lee SI & Kim ZG)	✓(7 October 2015)
IOTC–2015–WPTT17–INF08	Descriptive analyses of the Japanese Indian Ocean longline fishery, focusing on tropical areas (Hoyle SD & Okamoto H)	✓(7 October 2015)
IOTC–2015–WPTT17–INF09	Descriptive analyses of the Taiwanese Indian Ocean longline fishery, focusing on tropical areas (Hoyle SD, Yeh Y-M, Chang S-T & Wu R-F)	✓(7 October 2015)
Data sets		
IOTC–2015–WPTT17–DATA01 Rev_1	Tropical tuna datasets available (IOTC Secretariat)	✓(17 September 2015) ✓(22 September 2015)
IOTC–2015–WPTT17–DATA02	Yellowfin tuna (YFT) data for Stock Assessment	✓(17 September 2015)
IOTC–2015–WPTT17–DATA03	Japanese longline standardised CPUE data for yellowfin tuna from 1963 to 2014	✓(24 September 2015)
IOTC–2015–WPTT17–DATA04	Nominal Catches per Fleet, Year, Gear, IOTC Area and species	✓(10 September 2015)
IOTC–2015–WPTT17–DATA05	Catch and Effort - Longline	✓(10 September 2015)
IOTC–2015–WPTT17–DATA06	Catch and Effort - Vessels using pole-and-line or purse seine	✓(17 September 2015)
IOTC–2015–WPTT17–DATA07	Catch and Effort - Coastal	✓(10 September 2015)
IOTC–2015–WPTT17–DATA08	Catch and Effort - All vessels	✓(10 September 2015)
IOTC–2015–WPTT17–DATA09	Catch and Effort - Reference	✓(10 September 2015)
IOTC–2015–WPTT17–DATA10	Size Frequency - Tropical tuna species	✓(10 September 2015)
IOTC–2015–WPTT17–DATA11	Size frequency - Reference	✓(10 September 2015)
IOTC–2015–WPTT17–DATA12	DATA - Tropical tunas equations	✓(14 September 2015)
IOTC–2015–WPTT17–DATA13	Catch-at-Size (CAS) and Catch-at-Age (CAA) files for yellowfin tuna raised to total catches	✓(17 September 2015)
IOTC–2015–WPTT17–DATA14	Japanese longline CPUE for bigeye tuna in the Indian Ocean standardized by GLM from 1960 to 2014	✓(22 September 2015)
IOTC–2015–WPTT17–DATA15	Japanese longline standardized CPUE data for yellowfin tuna from 1963 to 2014 regions aggregated	✓(2 October 2015)
IOTC–2015–WPTT17–DATA16	India standardised CPUE for yellowfin tuna from 1981 to 2012	✓(7 October 2015)
IOTC–2015–WPTT17–DATA17	Taiwan,China longline standardised CPUE for yellowfin tuna from 1979 to 2013	✓(24 October 2015)
IOTC–2015–WPTT17–DATA18	European (and associated) purse seine fleets standardised CPUE for yellowfin tuna from 1984 to 2014	✓(24 October 2015)
Stock Assessment Input and Output files		
IOTC–2015–WPTT17–SAF01	Yellowfin tuna Bayesian Biomass Production Model (BBPM) (see Paper 27)	✓(7 October 2015)
IOTC–2015–WPTT17–SAF02	Yellowfin tuna Statistical-Catch-At-Age (SCAA) (see Paper 28)	✓(12 October 2015)
IOTC–2015–WPTT17–SAF03	Yellowfin tuna Statistical-Catch-At-Size (SCAS) (see Paper 29)	Withdrawn
IOTC–2015–WPTT17–SAF04	Yellowfin tuna Stock Synthesis (SS3) (see Paper 30)	✓(13 October 2015)

APPENDIX IVA
STATISTICS FOR TROPICAL TUNAS

Extracts from IOTC–2015–WPTT17–07 Rev_1

Fisheries and catch trends for tropical tuna species

- Main species: Skipjack tuna accounts for 44% of total catches of tropical tunas, followed closely by yellowfin tuna (≈44%), while catches of bigeye tuna account for the remaining 12% of catches (**Fig. 1d**).

- Main fishing gear (2011-14): purse seiners account for 36% of total catches of tropical tuna, with important catches also reported by handlines and trolling (19%), gillnets (18%), longlines (12%), and pole-and-line (11%), in both coastal waters and the high seas.

  Tropical tunas are the target of many fisheries although they are also a bycatch of fisheries targeting other tunas, small pelagic species, or other non-tuna species (e.g. sharks).

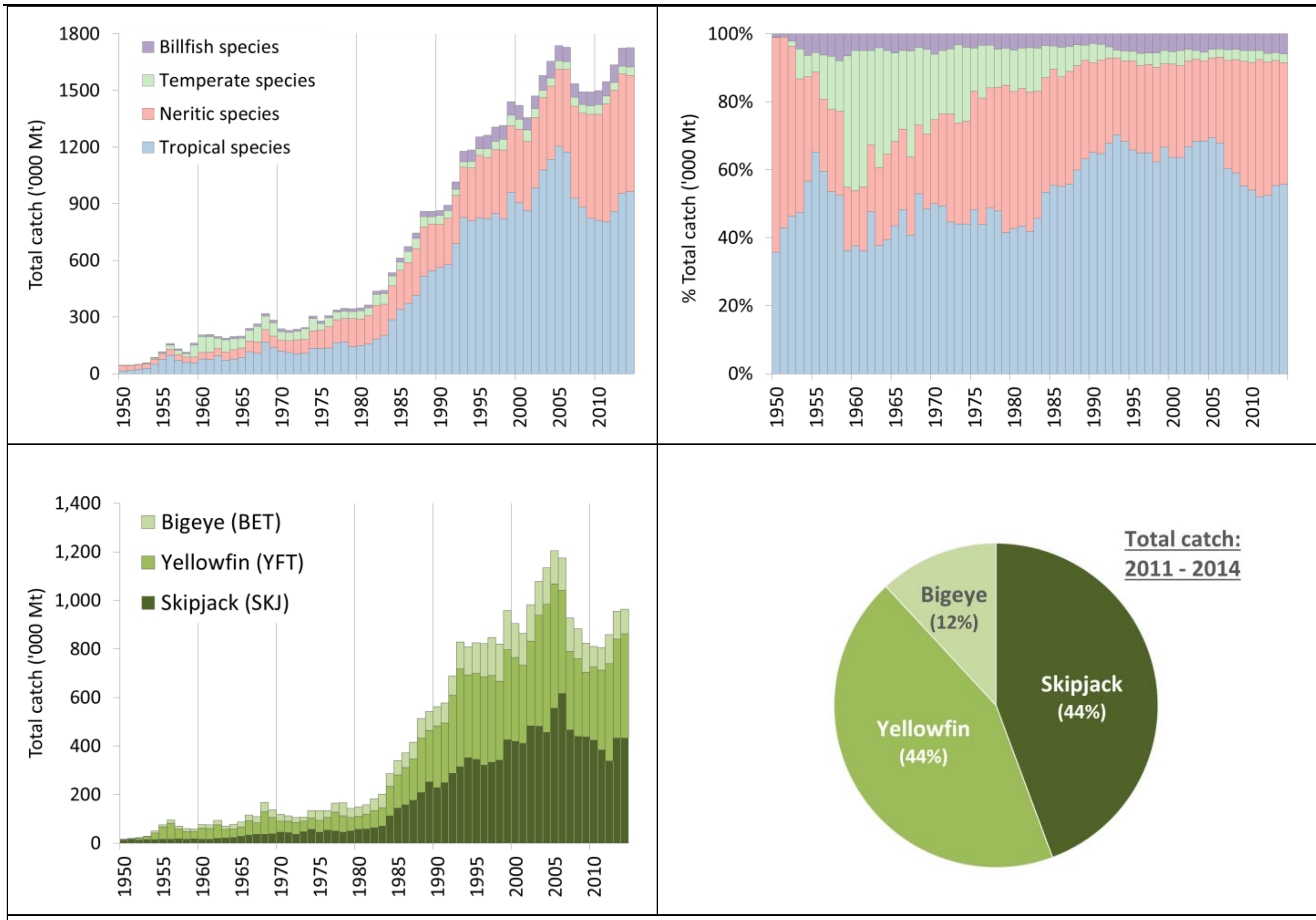
- Main fleets (i.e. highest catches in recent years): Tropical tunas are caught by both coastal countries and distant water fishing nations (**Fig. 2**).

  In recent years the coastal fisheries of five countries (Indonesia, Maldives, Sri Lanka, I.R., Iran, and India) have reported around 55% of the total catches of tropical tuna species in the Indian Ocean, while the industrial purse seiners and longliners flagged as EU-Spain, Seychelles and EU-France reported a further 30% of total catches of these species.

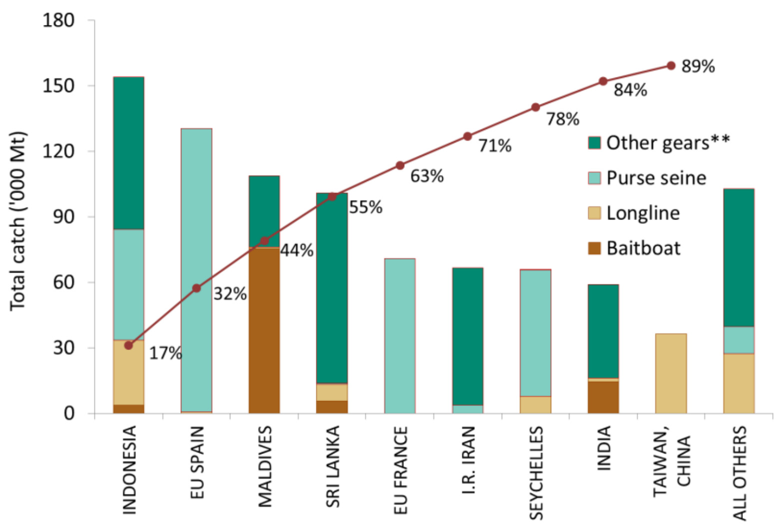
- Retained catch trends: The importance of tropical tunas to the total catches of IOTC species in the Indian Ocean has changed over the years (**Figs. 1a-b.**), in particular following the arrival of industrial purse seine fleets to the Indian Ocean in the early-1980s targeting tropical tunas. With the onset of piracy in the late-2000s, the activities of fleets operating in the north-west Indian Ocean have been displaced or reduced – particularly the Asian distant-water longline fleet – leading to a relative decline in the proportion of catches from tropical tunas (i.e., around 52% of total catches of all IOTC species, compared to 59% over the period 1950-2014).

  Since 2012 catches of tropical tunas appear to show some signs of recovery – in particular catches from distant water longline fleets – as a result of the reduction of the threat of piracy and return of fleets and to the north-west Indian Ocean. Total catches of tropical tunas have increased from around 800,000 t during the years of piracy in the late 2000s, to over 960,000 t in 2014.

- Economic markets: The majority of catches of tropical tuna species are sold to international markets, including the sashimi market in Japan (large specimens of yellowfin tuna and bigeye tuna in fresh or deep-frozen condition), and processing plants in the Indian Ocean region or abroad (small specimens of skipjack tuna and, to a lesser extent, yellowfin tuna and bigeye tuna). A component of the catches of tropical tunas, in particular skipjack tuna caught by some coastal countries in the region, is sold in local markets or retain by the fishermen for direct consumption.



Figs. 1a-d. Top: Contribution of the three tropical tuna species under the IOTC mandate to the total catches of IOTC species in the Indian Ocean, over the period 1950-2014 (a. Top left: total catch; b. Top right percentage, same colour key as Fig. 1a); **Bottom:** Contribution of each tropical tuna species to the total combined catches of tropical tunas (c. Bottom left: nominal catch of each species, 1950-2014; d. Bottom right: share of tropical tuna catch by species, 2011-14)



*** Other gears includes handline, gillnet, gillnet-longline, trawling.*

Fig. 2. All tropical tunas: average catches in the Indian Ocean over the period 2011–14, by country. Countries are ordered from left to right, according to the importance of catches of tropical tunas reported. The red line indicates the (cumulative) proportion of catches of tropical tunas for the countries concerned, over the total combined catches of species reported from all countries and fisheries.

APPENDIX IVB
MAIN STATISTICS OF BIGEYE TUNA

(Extracts from IOTC–2015–WPTT17–07 Rev_1)

Fisheries and main catch trends

- Main fishing gear (2011–14): industrial fisheries account for the majority of catches of bigeye tuna, i.e. deep-freezing and fresh longline (≈50%) and purse seine (≈30%) (**Table 1; Fig. 1**).

  In recent years catches by gillnet fisheries have also been increasing, 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 important for bigeye tuna targeted by other fisheries.

- Main fleets (and primary gear associated with catches): percentage of total catches (2011–14):
  Indonesia (fresh longline, coastal longline, coastal purse seine): 27%; Taiwan,China (longline): 22%; Seychelles (longline and purse seine): 10%; EU-Spain (purse seine): 10% (**Fig. 3**).

- Main fishing areas: Primary: Western Indian Ocean, in waters off Somalia (West A1), although in recent years fishing effort has moved eastwards due to piracy. Secondary: Eastern Indian Ocean (East A2) (**Table 2; Fig.2**).

  In contrast to yellowfin tuna and skipjack tuna – where the majority catches are taken in the western Indian Ocean – bigeye tuna is also exploited in the eastern Indian Ocean, particularly since the late 1990's due to increased activity of small longliners fishing tuna to be marketed fresh (e.g., Indonesia). However, in recent years catches of bigeye tuna in the eastern Indian Ocean have shown a decreasing trend, as some vessels have moved south to target albacore.

- Retained catch trends:

  Total catches of bigeye tuna in the Indian Ocean increased steadily from the 1970's, from around 20,000 t in the 1970s, to over 150,000 t by the late 1990s with the development of the industrial longline fisheries and arrival of European purse seiners during the 1980s. Since 2007 catches of bigeye tuna by longliners have been relatively low - less than half the catch levels recorded - before the onset of piracy in the Indian Ocean (e.g., ≈50,000 t).

  Longline fisheries:

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

  Since the late 1980's Taiwan,China has been the major longline fleet targeting bigeye tuna in the Indian Ocean, accounting for as much as 40-50% of the total longline catch in the Indian Ocean (**Fig. 2**).

  Between 2007 and 2011 catches have fallen sharply, largely due to the decline in the number of Taiwanese longline vessels active in the north-west Indian Ocean in response to the threat of piracy. Since 2012 catches appear to show some signs of recovery as a consequence of improvements in security in the area off Somalia and return of fleets (mostly Taiwan,China longline vessels) resuming activities in their main fishing grounds (West (A1)). However current catches still remain far below levels recorded in 2003 and 2004.

  Purse seine fisheries:

  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. 1**) of yellowfin tuna or skipjack tuna. Purse seiners under flags of EU countries and Seychelles account for the majority of purse seine catches of bigeye tuna in the Indian Ocean (**Fig. 3**) – mainly 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.

  While the activities of purse seiners have also been affected by piracy in the Indian Ocean, the decline in catches of tropical tunas have not been as marked as for longline fleets. The main reason is the presence of security personnel onboard purse seine vessels of the EU and Seychelles, which has made it possible for vessels under these flags to continue operating in the northwest Indian Ocean (**Fig. 4**).

- Discard levels: Low, although estimates of discards are unknown for most industrial fisheries, excluding industrial purse seiners flagged in EU countries for the period 2003–07.

Changes to the catch series**:** no major changes to the catch series since the WPTT meeting in 2014.

Table 1. 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 (2005–2014), in tonnes. Catches by decade represent the average annual catch, noting that some gears were not in operation since the beginning of the fishery. Data as of October 2015.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
BB	21	50	264	1,517	2,932	5,010	5,499	5,117	5,972	6,035	6,788	6,701	6,788	6,787	7,164	6,458
FS	-	-	0	2,339	4,823	6,197	8,484	6,407	5,672	9,646	5,302	3,792	6,223	7,180	4,654	3,841
LS	-	-	1	4,853	18,317	20,273	17,557	18,526	18,105	19,875	24,708	18,486	16,386	10,434	22,814	18,828
LL	6,488	21,861	30,413	43,077	62,230	71,158	75,813	72,752	73,867	51,376	51,390	31,784	34,944	65,404	46,562	38,270
FL	-	-	218	3,066	26,282	23,490	19,637	18,788	22,450	23,323	15,810	9,782	12,031	12,495	14,616	14,104
LI	43	295	658	2,386	4,443	6,103	6,385	6,177	7,211	7,166	8,318	8,997	9,333	9,310	10,473	11,707
OT	38	63	166	878	1,393	3,774	4,063	4,637	4,574	4,769	6,041	5,569	6,693	7,943	7,493	7,022
Total	**6,589**	**22,269**	**31,720**	**58,118**	**120,419**	**136,003**	**137,438**	**132,403**	**137,851**	**122,189**	**118,356**	**85,111**	**92,397**	**119,554**	**113,777**	**100,231**

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 2. 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 (2005–2014), in tonnes. Catches by decade represent the average annual catch. Data as of October 2015.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
A1	2,484	12,015	17,591	34,756	58,601	76,974	84,897	81,685	80,167	67,277	57,817	37,427	38,157	71,865	66,807	58,854
A2	3,900	7,240	10,301	18,834	46,962	48,818	43,119	44,829	53,667	50,269	57,002	42,710	48,644	41,253	39,254	34,580
A3	205	3,014	3,828	4,527	14,856	10,211	9,424	5,888	4,017	4,645	3,537	4,973	5,596	6,438	7,715	6,796
Total	**6,589**	**22,268**	**31,720**	**58,118**	**120,419**	**136,003**	**137,440**	**132,403**	**137,851**	**122,190**	**118,356**	**85,110**	**92,397**	**119,555**	**113,776**	**100,230**

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.

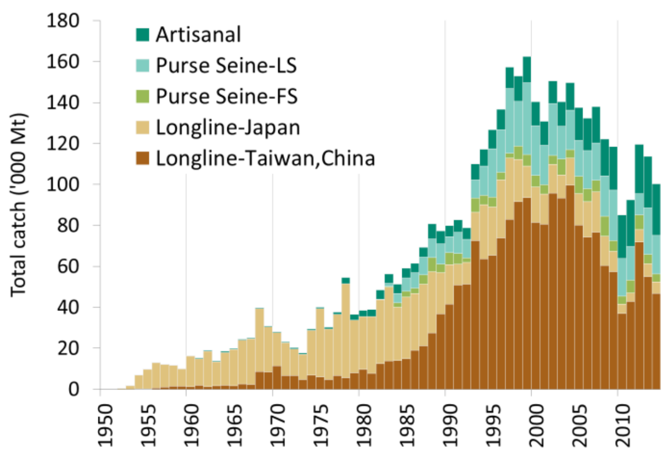
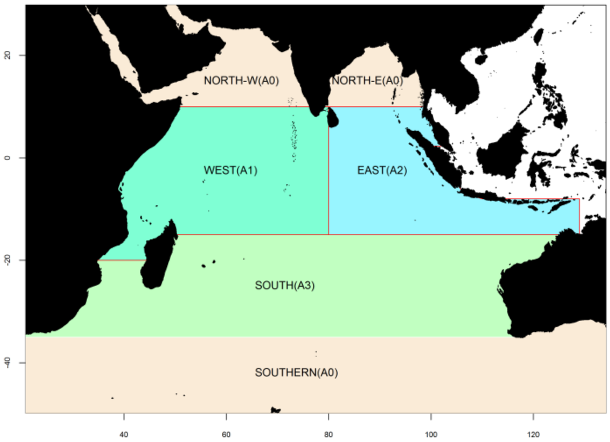


Fig. 1. Annual catches of bigeye tuna by gear (1950–2014). Data as of October 2015.

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**).



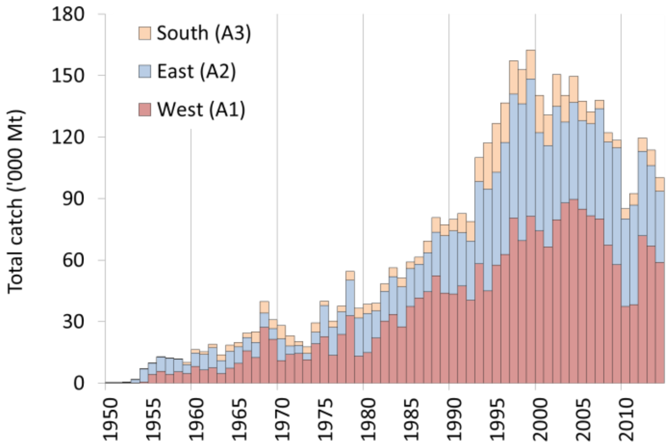


Fig. 2(a-b). Bigeye tuna: Catches of bigeye tuna by area by year estimated for the WPTT (1950–2014). Catches outside the areas presented in the map were assigned to the closest neighbouring area for the assessment. Data as of October. 2015.

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.

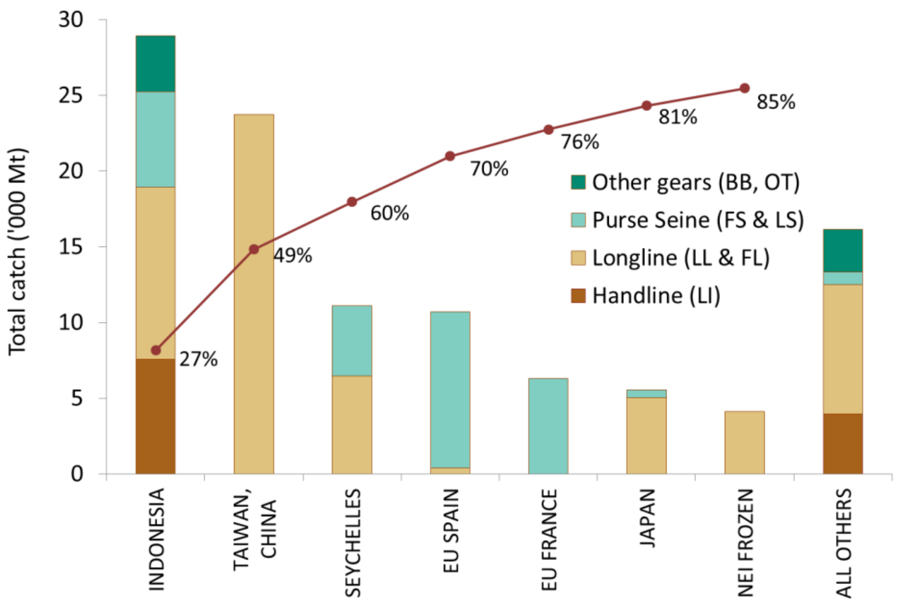


Fig. 3. Bigeye tuna: average catches in the Indian Ocean over the period 2011–14, by country. Countries are ordered from left to right, according to the importance of catches of bigeye reported. The red line indicates the (cumulative) proportion of catches of bigeye for the countries concerned, over the total combined catches of this species reported from all countries and fisheries. Data as of Oct. 2015.

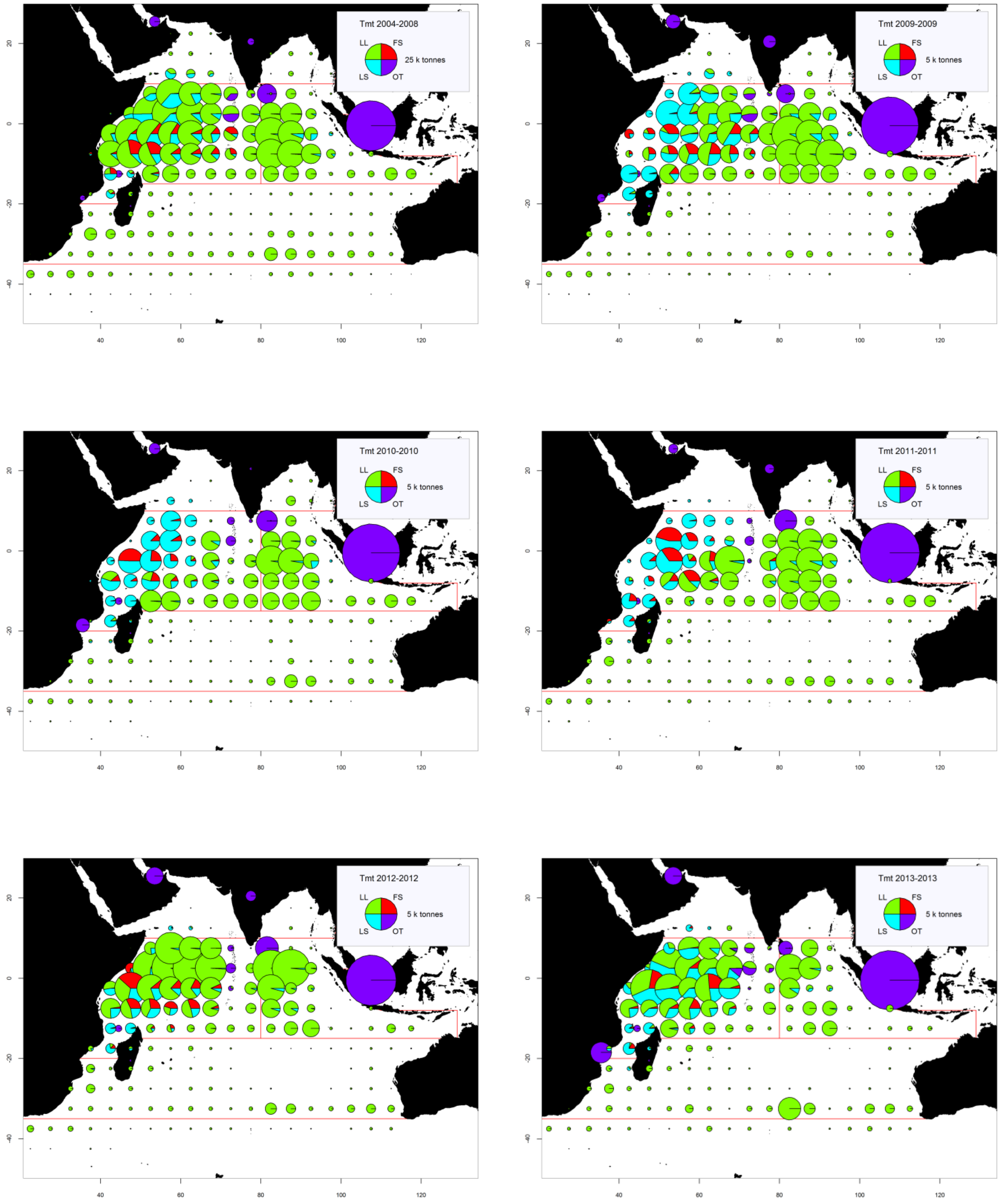


Fig. 4(a-f). Time-area catches (total combined in tonnes) of bigeye tuna estimated for the period 2004–2008 by type of gear and for 2009–13, by year and type of gear. Longline (**LL**), Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), and other fleets (**OT**), including pole-and-line, drifting gillnets, and various coastal fisheries. 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, gillnet and longline fishery of Sri Lanka, and coastal fisheries of Indonesia.

Bigeye tuna: data availability and related data quality issues

Retained catches

- Data are considered to be well known for the major industrial fleets, with the proportion of catches estimated, or adjusted, by the IOTC Secretariat relatively low (**Fig. 5a**). Catches are less certain for the following fisheries/fleets:
  - Non-reporting industrial purse seiners and longliners (NEI) and other industrial fisheries (e.g. longliners of India).
  - Some artisanal fisheries, including: pole-and-line fishery in Maldives, drifting gillnet fisheries of I.R. Iran (before 2012) and Pakistan (drifting gillnets), Sri Lanka (gillnet-longline fishery) and the artisanal fisheries in Indonesia, Comoros (before 2011) and Madagascar.

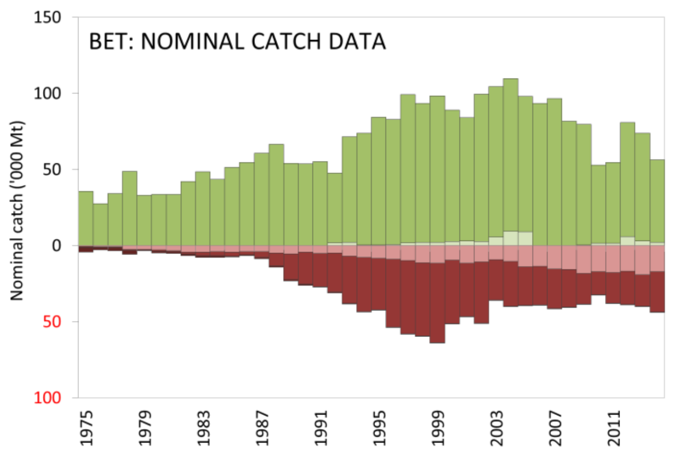
Catch-per-unit-effort (CPUE) trends

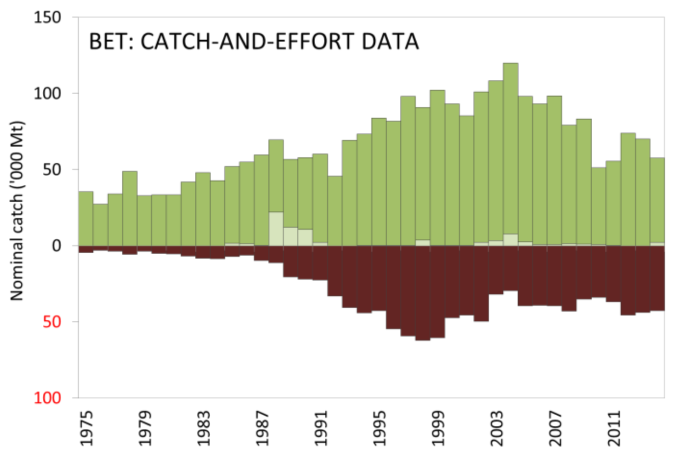
- Availability: Catch-and-effort series are available for the major industrial fisheries (e.g., Japan, Rep. of Korea, Taiwan,China).

  For most other fisheries, catch-and-effort are either not available (**Fig. 5b**), or are considered to be of poor quality – especially since the early-1990s and for the following fisheries/fleets:
  - 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, while 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 I.R. Iran and longliners from India, Indonesia, Malaysia, Oman, and Philippines;
  - incomplete or missing 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)

- Average fish weight: can be assessed for several industrial fisheries although they are incomplete (**Fig. 5c**) 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) .
- Catch-at-Size (Age) table: data are available, but the estimates are more uncertain for some years and some fisheries due to:
  1. 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)
  2. the paucity of catch by area data available for some industrial fleets (NEI, India, Indonesia, I.R. Iran, Sri Lanka.





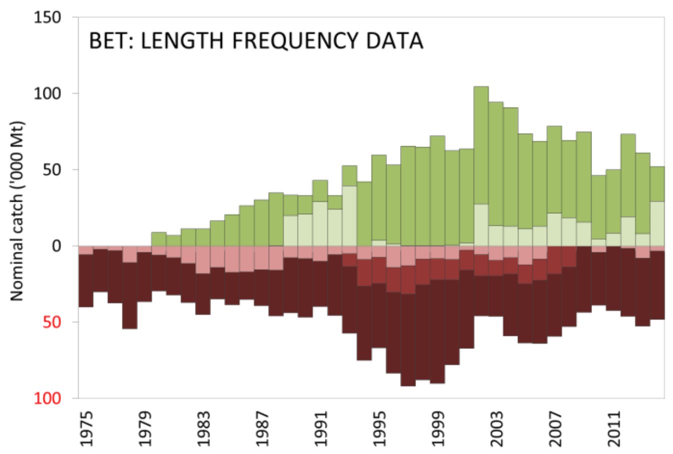


Fig. 5a-c. Bigeye tuna: data reporting coverage (1975–2014).

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 October 2015.

IOTC Data reporting score:

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

*E.g., 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
Fully available according to the minimum reporting standards	0	0
Partially available according to the minimum reporting standards*	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

* E.g., Catch-and-effort not fully disaggreaged by species, gear, area, or month.

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

* E.g., Size data not fully available by species, gear, gear, month, or recommended size interval.

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)

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. 6**). The remaining were tagged during small-scale projects, and by other institutions with the support of the IOTC Secretariat, in the Maldives, Indian, and in the south west and the eastern Indian Ocean.
- To date, 5,824 specimens (16.2% of releases for this species) have been recovered and reported to the IOTC Secretariat[1]. These tags were mainly reported from the purse seine fleets operating in the Indian Ocean (90.7%), while 5.4% were recovered from longline vessels.

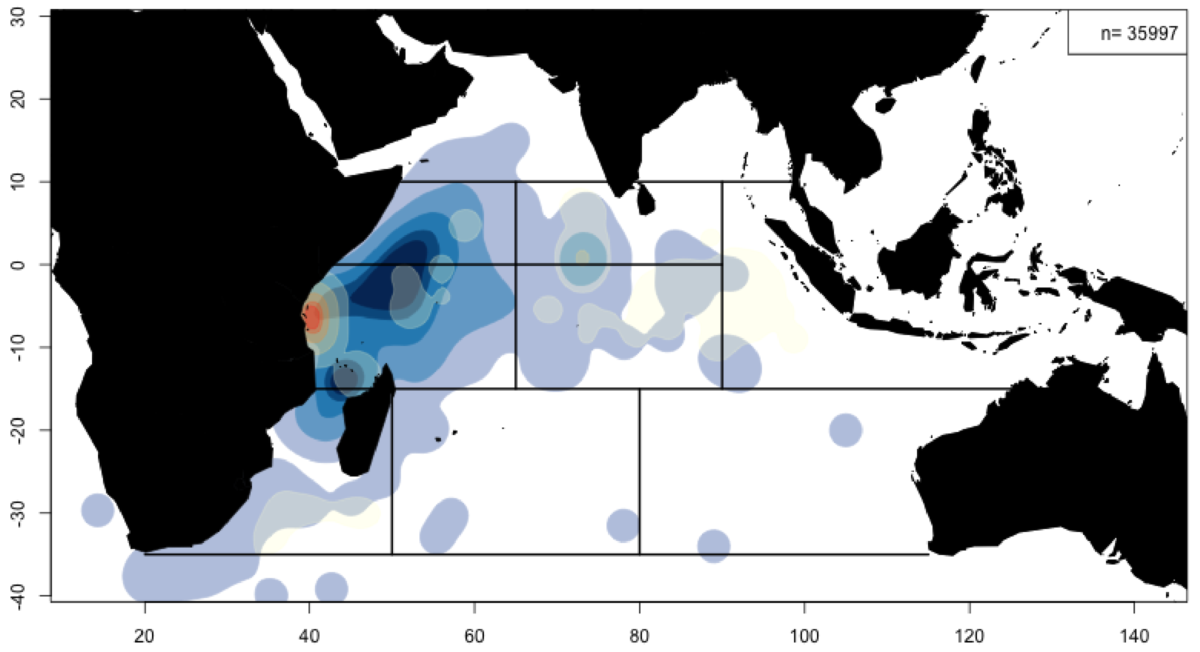
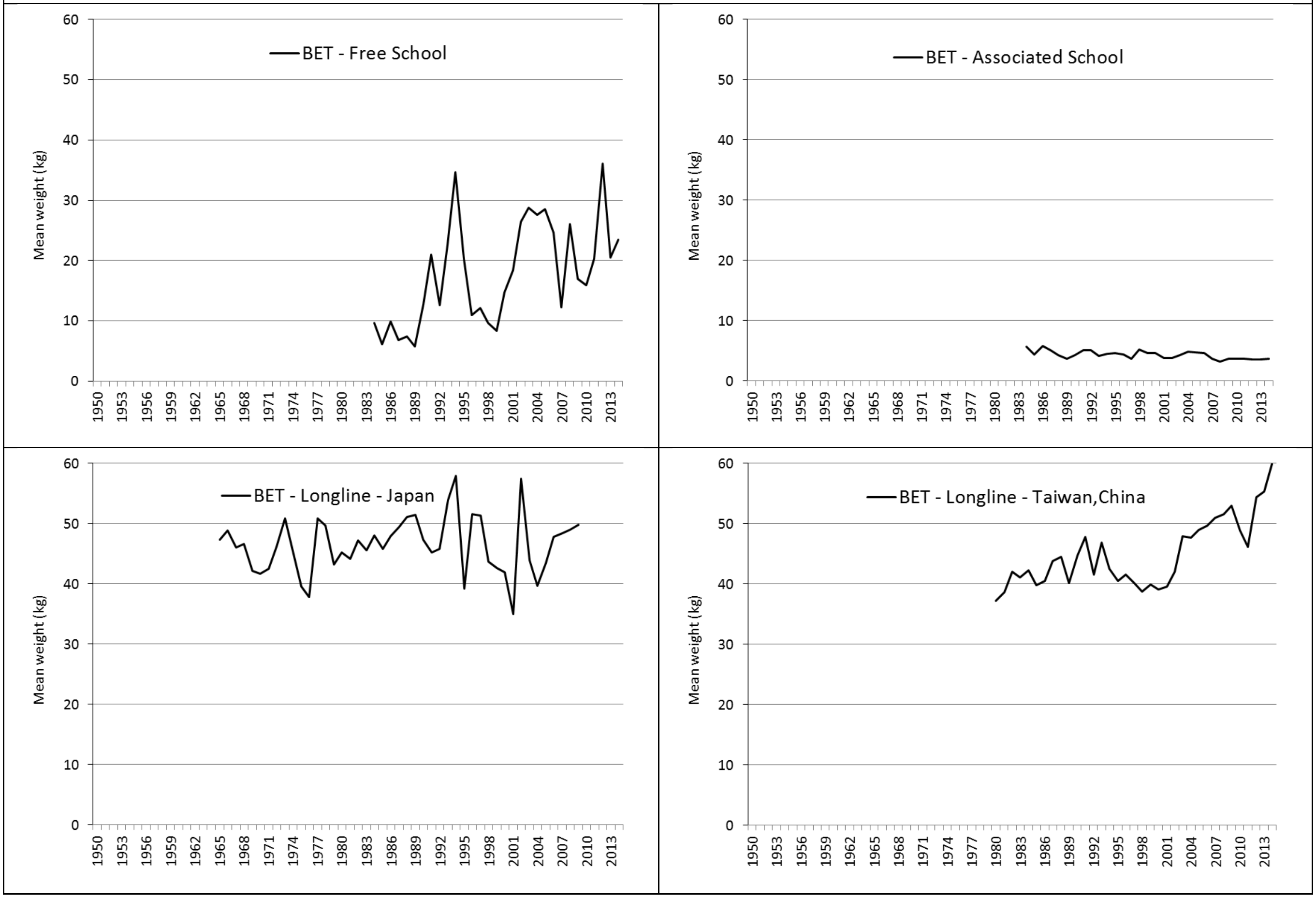


Fig. 6. Bigeye tuna: densities of releases (in red) and recoveries (in blue). The black line represents the stock assessment areas. Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s. Data as of September 2012.

[1] Recoveries by species based on species ID recorded during tagging, prior to release.

Bigeye tuna (BET)

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



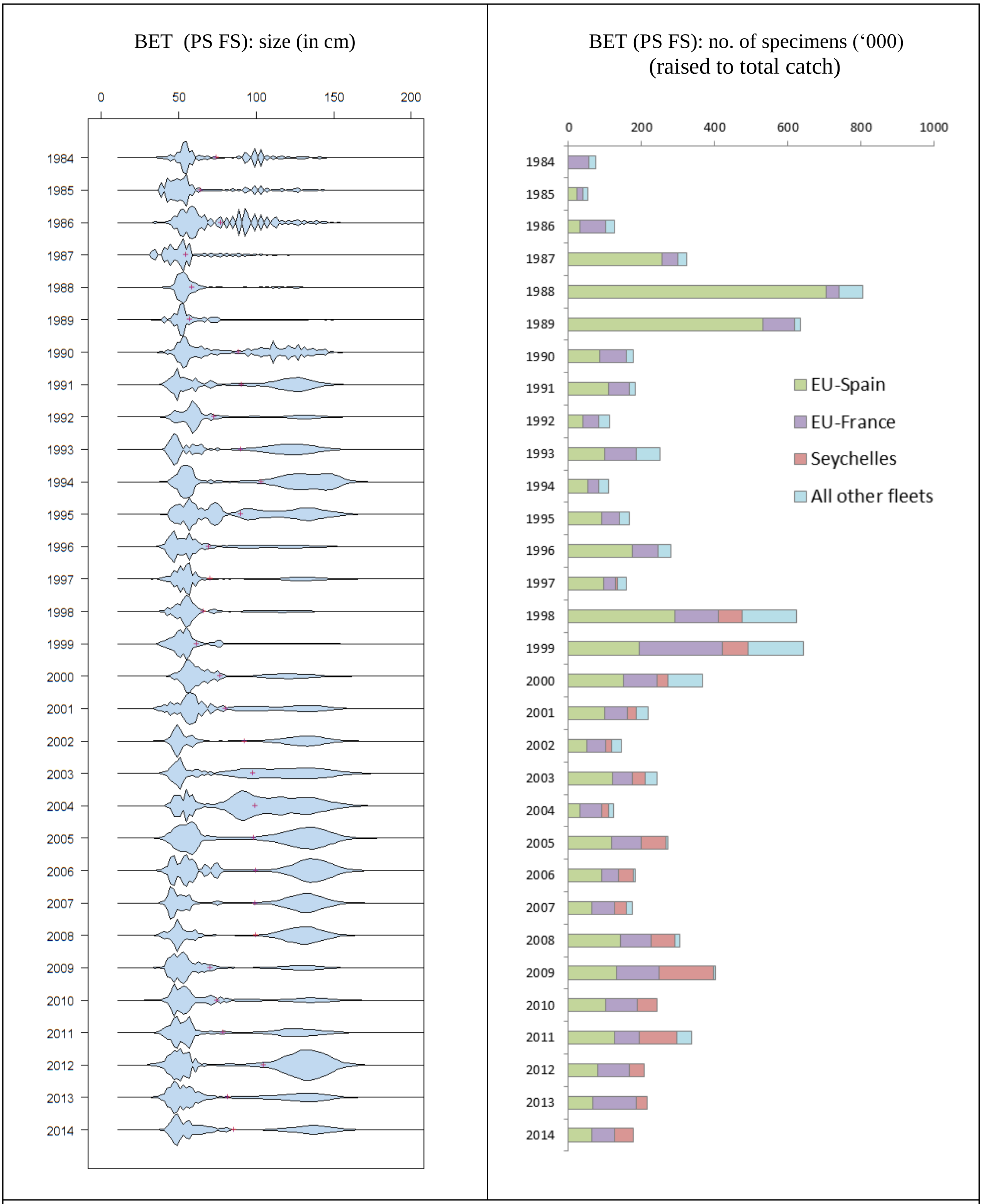


Fig. 8 Bigeye tuna (PS Free school): **Left:** length frequency distributions for PS Free School fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of bigeye tuna specimens sampled for lengths (raised to total catch),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

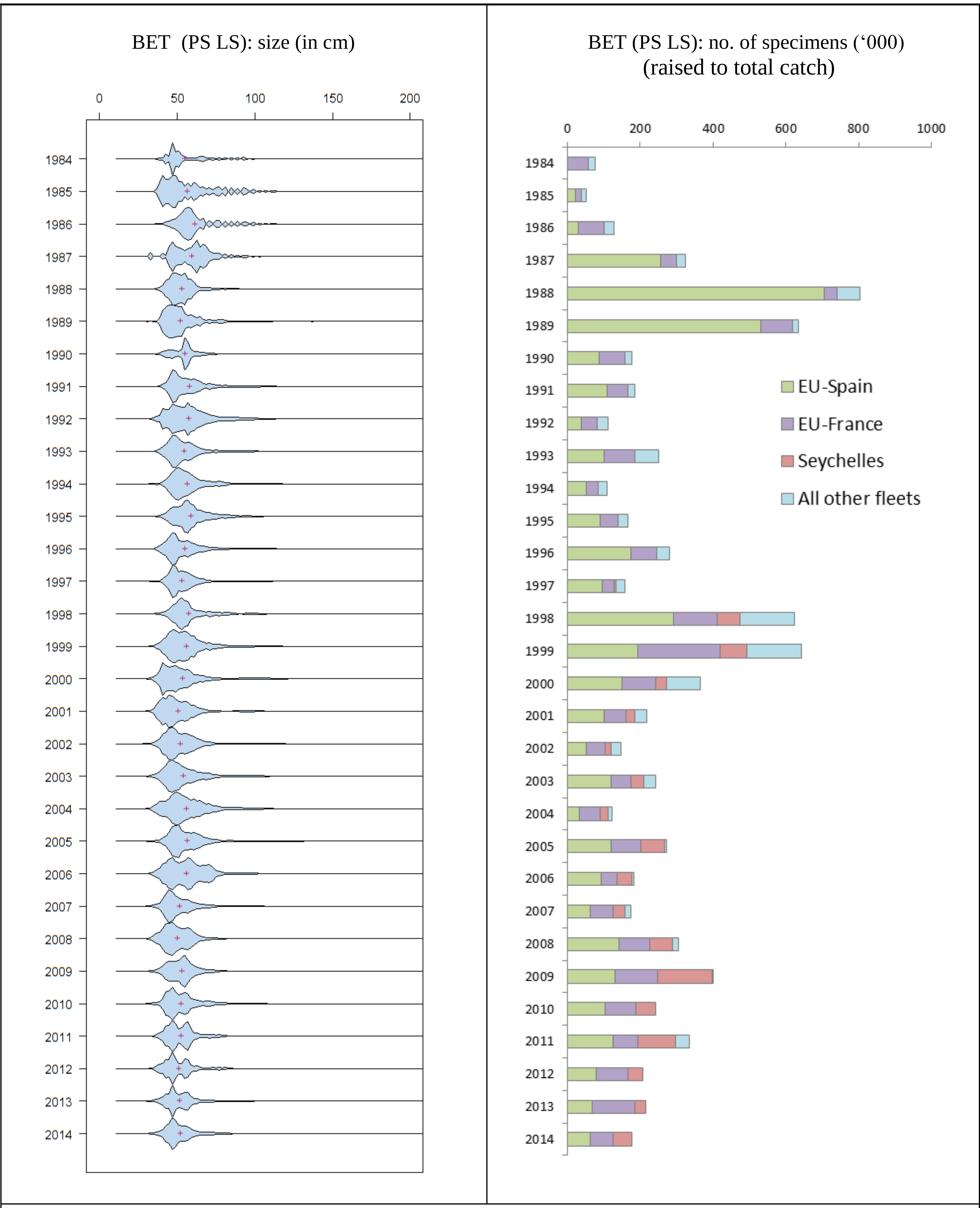


Fig. 9 Bigeye tuna (PS Associated school): **Left:** length frequency distributions for PS Associated school fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of bigeye tuna specimens sampled for lengths (raised to total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

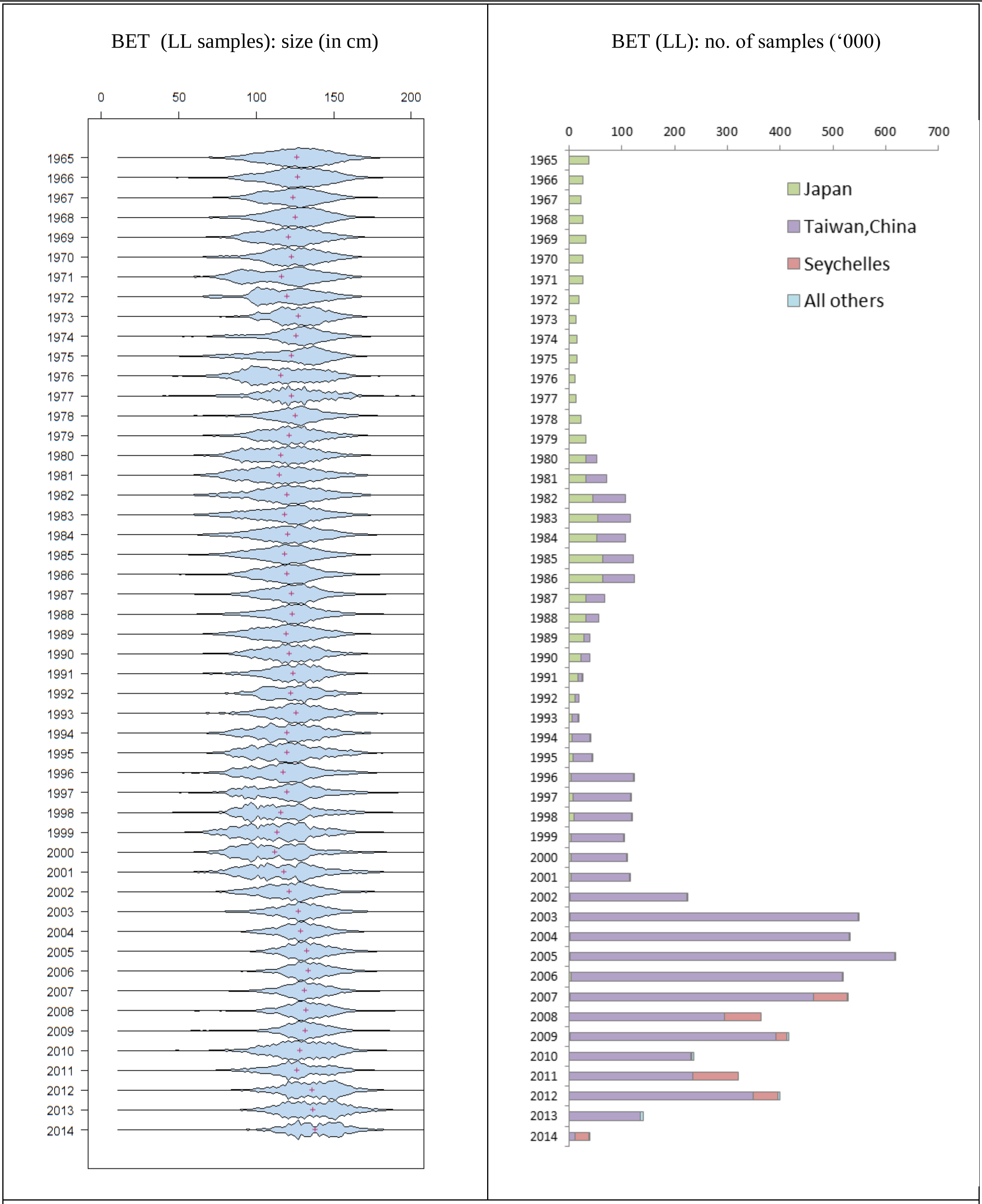


Fig. 10 Bigeye tuna (longline): **Left:** length frequency distributions for longline fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of bigeye tuna specimens sampled for lengths, by fleet (longline only).

APPENDIX IVC
MAIN STATISTICS OF SKIPJACK TUNA

(Extracts from IOTC–2015–WPTT17–07 Rev_1)

Skipjack tuna (*Katsuwonus pelamis*)

Fisheries and main catch trends

- Main fishing gear (2011–14): skipjack tuna are mostly caught by industrial purse seiners (≈30%), gillnet (≈25%) and pole-and-line (≈20%) (**Table 1; Fig. 1**).

- Main fleets (and primary gear associated with catches): percentage of total catches (2011–14):
  Almost 70% of catches are accounted for by four fleets (**Fig. 3**):
  - Indonesia (coastal purse seine, troll line, gillnet): 22%; Sri Lanka (gillnet-longline): 16%; Maldives (pole-and-line): 16%; EU-Spain (purse seine): 15%.

- Main fishing areas:

  Primary: Western Indian Ocean (West R2), in waters off Somalia (**Table 2; Fig.2**)
  - In recent years catches of skipjack in this area have dropped considerably as fishing effort has been displaced or reduced due to piracy – particularly catches from industrial purse seiners and fleets using driftnets flagged under I.R. Iran and Pakistan.

  Secondary: Maldives (Area R2b)
- Since the mid-2000s decreases in skipjack catches have also been reported by the Maldivian pole-and-line fishery – although the reasons remain unclear.

- Retained catch trends:
  Purse seine fisheries:
  The increase in catches of skipjack tuna in the last 30 years have largely been driven by the arrival of purse seiners in the early 1980s, and the development of the fishery in association with Fish Aggregating Devices (FADs) since the 1980s. In recent years, well over 90% of the skipjack tuna caught by purse seine vessels are taken from around FADs.

  Annual catches peaked at over 600,000 t in 2006. The constant increase in catches and catch rates of purse seiners until 2006 are believed to be associated with increases in fishing power and also increases in the number of FADs (and technology associated with them) used in the fishery.

  Since 2006 catches have declined to around 340,000 t in 2012 – the lowest catches recorded since 1998 – although in 2013 and 2014 catches increased to over 420,000 t.

  Pole-and-line fisheries:

  The Maldivian pole-and-line fishery effectively increased its fishing effort with the mechanisation of its fleet since 1974, including an increase in boat size and power, as well as the use of anchored FADs since 1981. Skipjack tuna represents around 80% of the total catch of Maldives, where catches of skipjack tuna increased regularly between 1980 and 2006 – from around 20,000 t to over 130,000 t.

  Catches of skipjack tuna reported by Maldives pole-and-line have since declined in recent years to as low as 55,000t - less than half the catches taken in 2006 - although the reasons for the decline remain unclear. One explanation may be improvements in the data collection with the introduction of logbooks and more accurate, albeit lower, estimates of skipjack landed; while the introduction of handlines and a shift in targeting from skipjack tuna to yellowfin tuna may also be a contributing factor.

  Gillnet fisheries:
  Several fisheries using gillnets have reported large catches of skipjack tuna in the Indian Ocean, including the gillnet/longline fishery of Sri Lanka, driftnet fisheries of I.R. 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 I.R. 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.

- Discard levels: Low, although estimates of discards are unknown for most industrial fisheries, excluding industrial purse seiners flagged in EU countries for the period 2003–07.

***Changes to the catch series*:** no major changes to the catch series since the WPTT meeting in 2014.

Table 1. 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 (2005–2014), in tonnes. Catches by decade represent the average annual catch, noting that some gears were not used since the beginning of the fishery. Data as of October 2015.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
BB	10,007	15,148	24,684	41,705	76,903	109,571	139,627	147,902	107,383	99,104	75,761	83,506	69,404	68,817	92,949	87,323
FS	0	0	32	15,232	29,372	25,898	45,110	36,083	25,950	16,211	10,366	8,965	9,138	3,034	5,760	6,317
LS	0	0	134	34,476	125,447	163,576	166,074	210,369	119,199	128,519	148,202	143,905	122,918	80,939	119,854	131,439
OT	5,008	11,719	22,022	38,374	87,948	177,207	204,866	221,806	213,089	194,591	203,470	187,616	181,744	185,922	214,208	207,388
Total	**15,015**	**26,867**	**46,872**	**129,788**	**319,670**	**476,251**	**555,678**	**616,160**	**465,621**	**438,424**	**437,800**	**423,993**	**383,204**	**338,713**	**432,770**	**432,467**

Gears: Pole-and-Line (**BB**); Purse seine free-school (**FS**); Purse seine associated school (**LS**); Other gears nei (**OT**) (e.g., troll line, handline, beach seine, Danish seine, liftnet).

Table 2. 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 (2005–2014), in tonnes. Catches by decade represent the average annual catch. Data as of October 2015.

	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
R1	4,524	9,951	19,284	34,584	80,744	118,318	114,265	109,014	137,692	139,937	151,486	154,434	153,882	149,769	167,635	149,019
R2	1,492	4,117	7,914	59,420	170,502	255,757	309,352	368,688	231,068	211,415	220,124	195,837	171,650	135,552	190,713	214,950
R2b	9,000	12,800	19,674	35,784	68,424	102,176	132,060	138,458	96,861	87,072	66,189	73,721	57,672	53,392	74,422	68,498
Total	**15,015**	**26,867**	**46,872**	**129,788**	**319,670**	**476,251**	**555,678**	**616,160**	**465,621**	**438,424**	**437,800**	**423,993**	**383,204**	**338,713**	**432,770**	**432,467**

Areas: East Indian Ocean (**R1**); West Indian Ocean, (**R2**); Maldives baitboat (R2b).

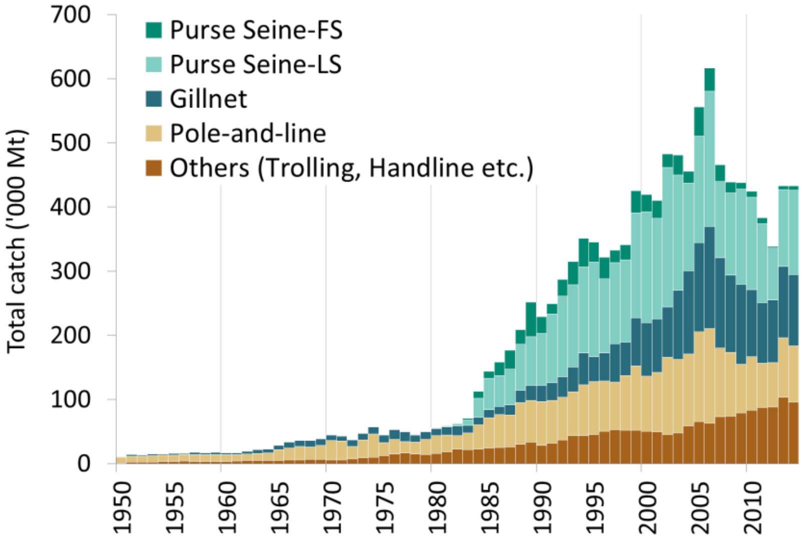


Fig. 1. Annual catches of skipjack tuna by gear (1950–2014). Data as of October 2015.

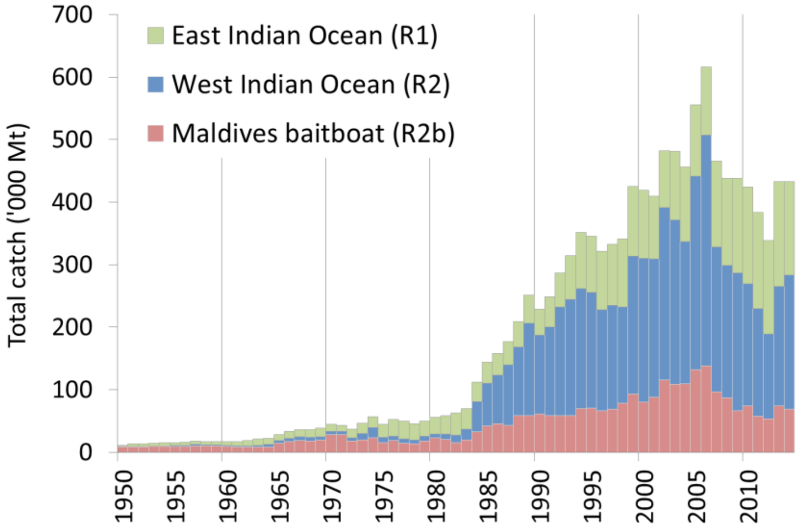


Fig. 2. Skipjack tuna: Catches of skipjack tuna by area by year estimated for the WPTT (1950–2014).

Areas: East Indian Ocean (**R1**); West Indian Ocean (**R2**); Maldives baitboat (**R2b**). Data as of October 2015.

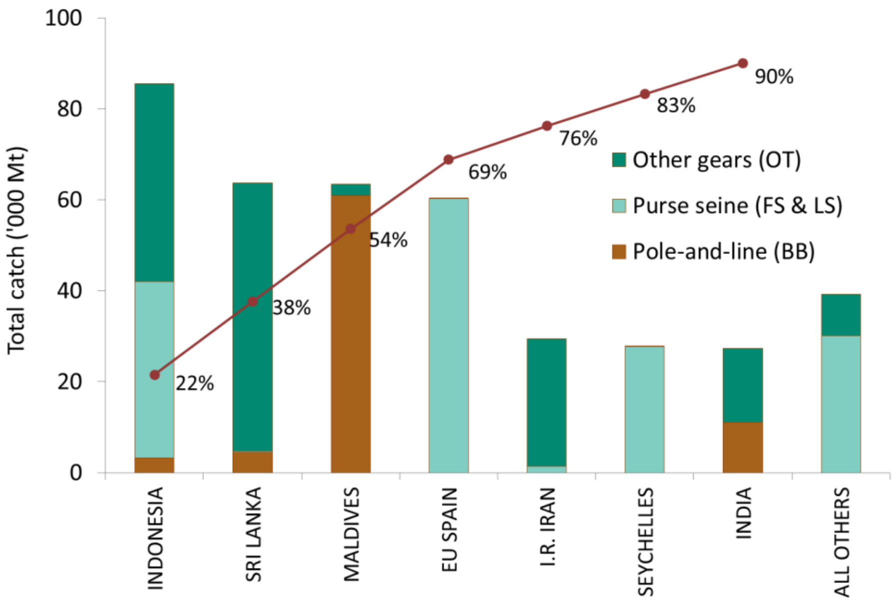


Fig. 3. Skipjack tuna: average catches in the Indian Ocean over the period 2011–14, by country. Countries are ordered from left to right, according to the importance of catches of skipjack reported. The red line indicates the (cumulative) proportion of catches of skipjack for the countries concerned, over the total combined catches of this species reported from all countries and fisheries. Data as of October 2015.

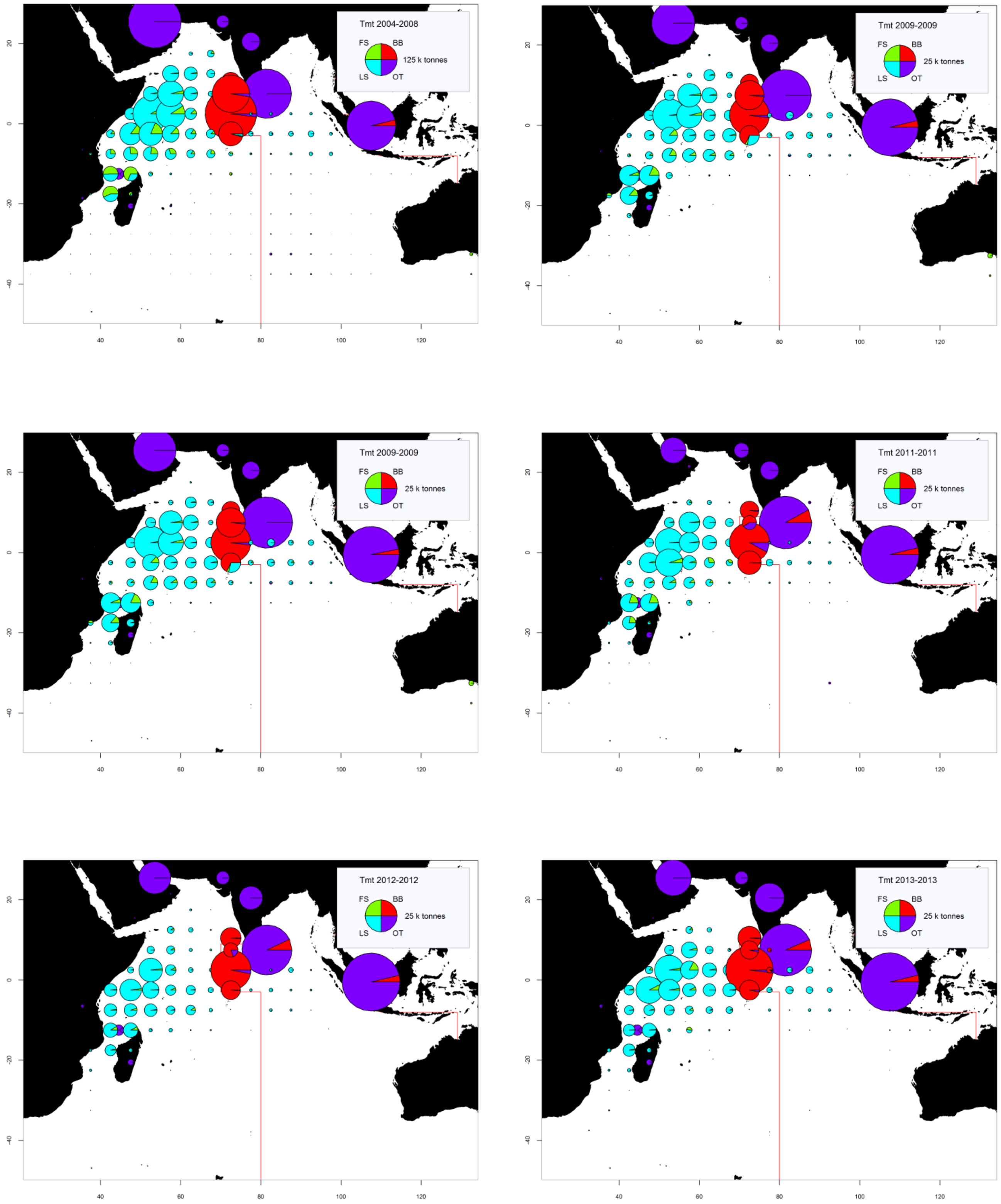


Fig. 4(a-f). Skipjack tuna: Time-area catches (total combined in tonnes) of skipjack tuna estimated for the period 2004–08 by type of gear and for 2009–13, by year and type of gear. Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (BB), and other fleets (**OT**), including longline, drifting gillnets, and various coastal fisheries. 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 Comoros, Indonesia and India.

Skipjack tuna: data availability and related data quality issues

Retained catches

- Retained catches are considered to be generally well known for the major industrial fleets, with the proportion of catches estimated, or adjusted, by the IOTC Secretariat relatively low (**Fig. 5a**). Catches are less certain for many artisanal fisheries for a number of reasons, including:

    - catches not fully reported by species;
    - uncertainty in the catches from some significant fleets including the Sri Lankan coastal fisheries, and coastal fisheries of Comoros and Madagascar.

Catch-per-unit-effort (CPUE) trends

- Catch-and-effort series are available for the various industrial and artisanal fisheries (e.g., Maldives pole-and-line fishery, EU-France purse seine).

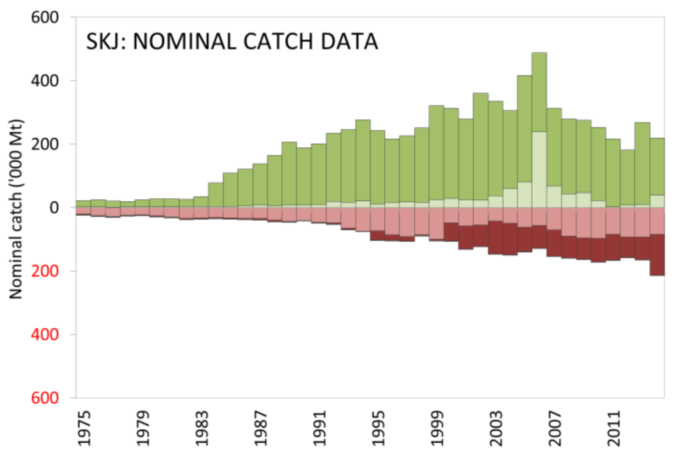
  However for a number of other important fisheries catch-and-effort are either not available (**Fig. 5b**), or are considered to be of poor quality, notably:

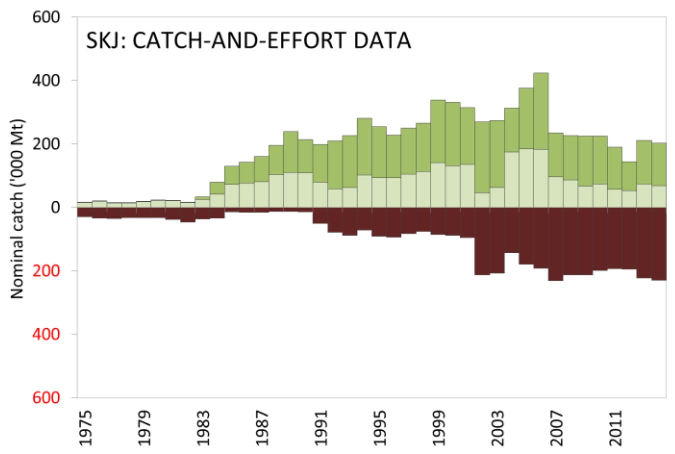
    - insufficient data available for the gillnet fisheries of I.R. Iran and Pakistan;
    - poor quality effort data for the gillnet-longline fishery of Sri Lanka. In previous years catch-and-effort has not been reported fully by area, or disaggregated by gear (i.e., gillnet-longline) according to the IOTC reporting standards – however in 2014 detailed information by EEZ area (for coastal fisheries) and grid area (for offshore fisheries) and gear was submitted to the IOTC Secretariat for the first time;
    - no catch-and-effort data are available for 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)

- Average fish weight: trends in average weights cannot be assessed before the mid-1980s and are also incomplete for most artisanal fisheries, namely hand lines, troll lines and many gillnet fisheries (e.g., Indonesia) (**Fig. 5c**).
- Catch-at-Size (Age) table: are available but the estimates are uncertain for some years and fisheries due to:

    - a general lack of size data before the mid-1980s, for all fleets/fisheries;
    - lack of size data available for some artisanal fisheries, notably most hand lines and troll line fisheries (e.g., Madagascar, Comoros) and many gillnet fisheries (e.g., Indonesia, Sri Lanka) – although in 2014 Sri Lanka reported size information for gillnets for the first time since the early-1990s.





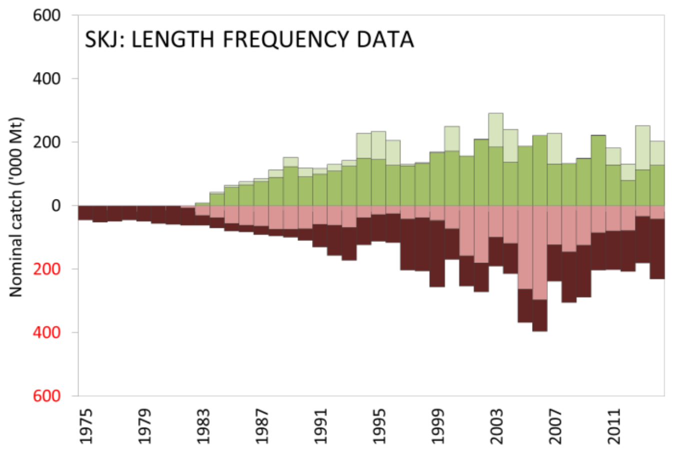


Fig. 5a-c. Skipjack tuna: data reporting coverage (1975–2014).

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 October 2015.

IOTC Data reporting score:

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

*E.g., 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
Fully available according to the minimum reporting standards	0	0
Partially available according to the minimum reporting standards*	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

* E.g., Catch-and-effort not fully disaggreaged by species, gear, area, or month.

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

* E.g., Size data not fully available by species, gear, gear, month, or recommended size interval.

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)

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. 6**). 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, or which 1,960 were recovered mainly in the Maldives.

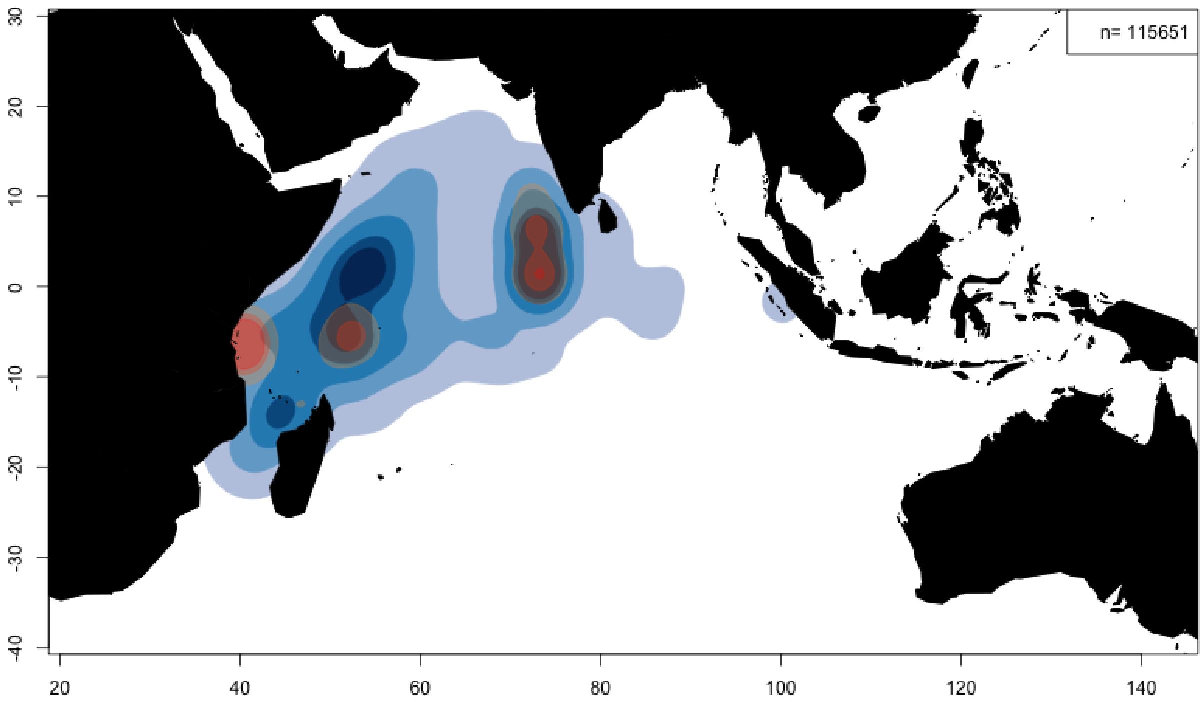
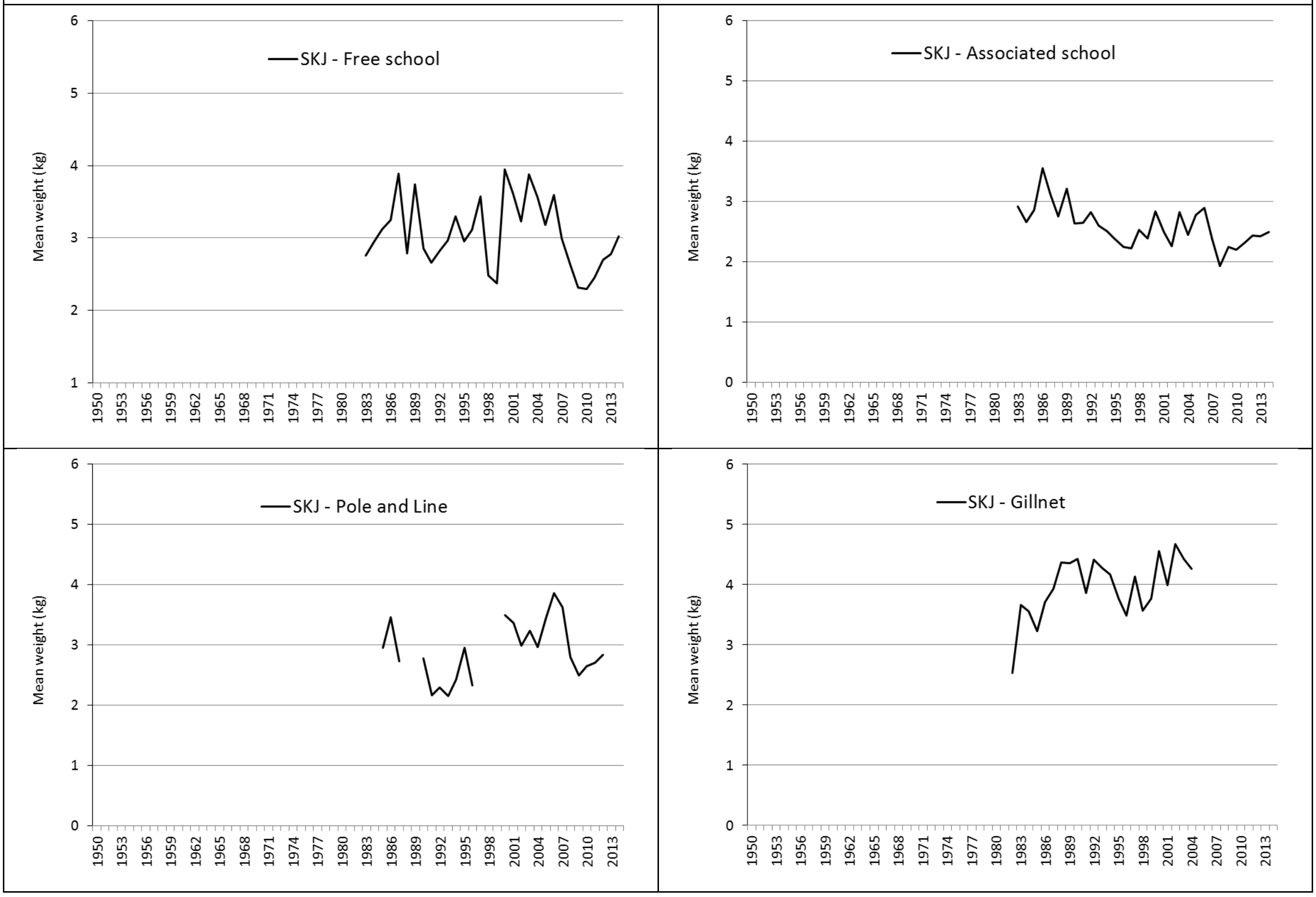


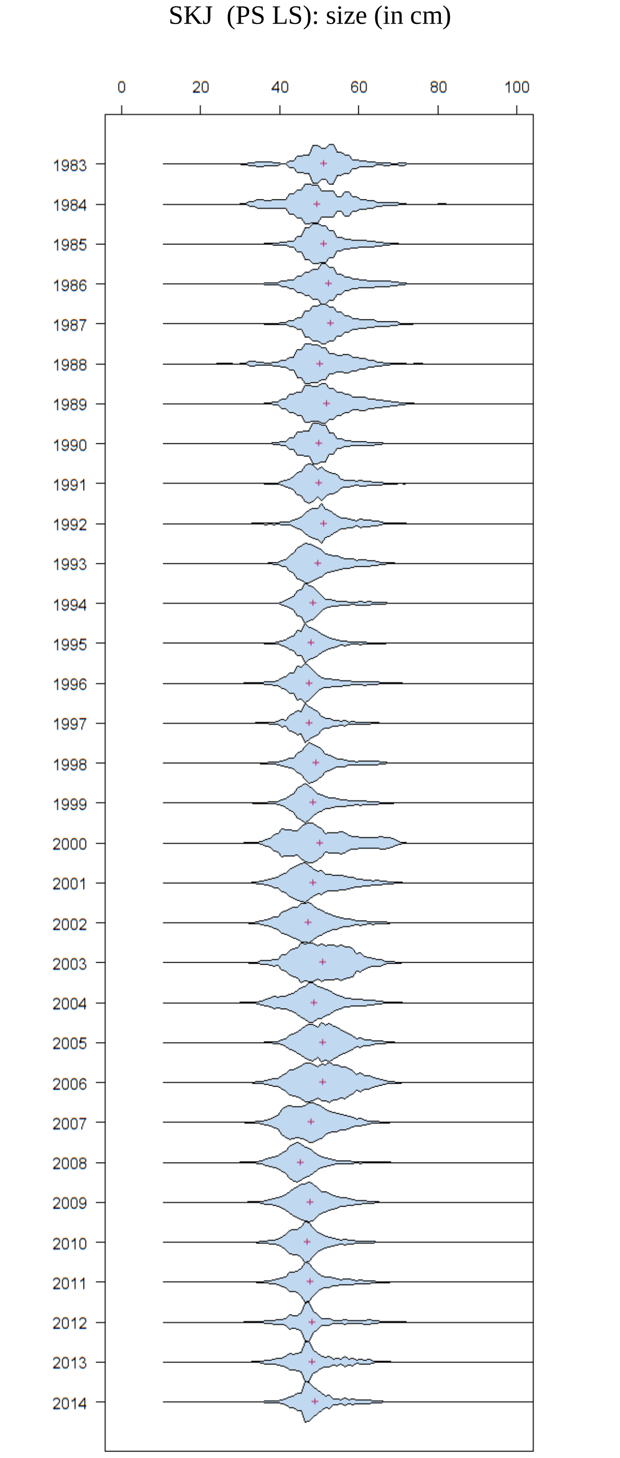
Fig. 6. Skipjack tuna: Densities of releases (in red) and recoveries (in blue). Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s. Data as of September 2012.

Skipjack tuna (SKJ)

Fig. 7 Average weight of skipjack tuna (SKJ) taken by:

- 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)





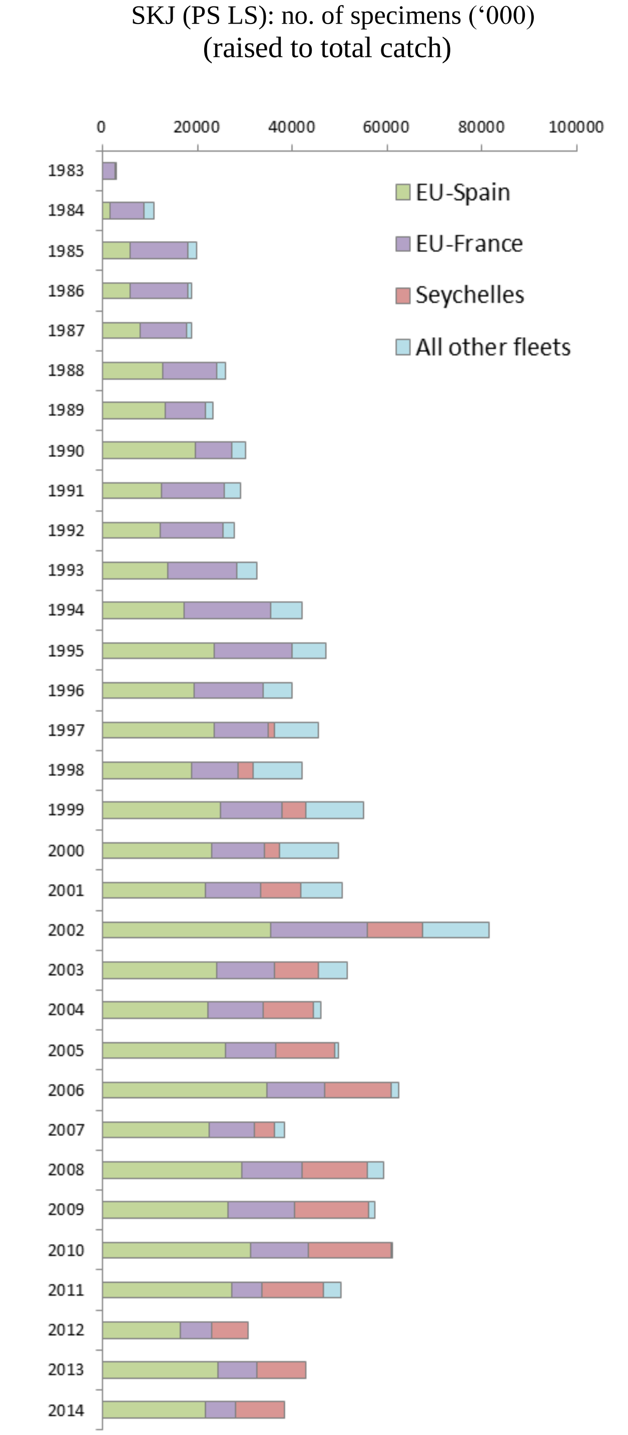


Fig. 8 Skipjack tuna (PS Associated school): **Left:** length frequency distributions for PS Associated school fisheries (total amount of fish measured by 1 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of skipjack tuna specimens sampled for lengths (raised to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

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).

APPENDIX IVD
MAIN STATISTICS OF YELLOWFIN TUNA

(Extracts from IOTC–2015–WPTT17–07 Rev_1)

Fisheries and main catch trends

- Main fishing gear (2011–14): In recent years catches have been evenly split between industrial and artisanal fisheries. Purse seiners (free and associated schools) and longline fisheries still account for around 50% of total catches, while catches from artisanal gears – namely handline, gillnet, and pole-and-line – have steadily increased since the 1980s (**Table 1**; **Fig. 1**).

  Contrary to other oceans, the artisanal fishery component of yellowfin catches in the Indian Ocean are substantial, accounting for catches of over 200,000 t per annum since 2012. Moreover, the proportion of yellowfin catches from artisanal fisheries has increased from around 30% in 2000 to nearly 50% in recent years.

- Main fleets (and primary gear associated with catches): percentage of total catches (2011–14):
  EU-Spain (purse seine): 15%; Maldives (handline, pole-andline): 11%; EU-France (purse seine): 10%; Indonesia (fresh longline, handline): 10%; I.R. Iran (gillnet): 9% (**Fig. 3**).

- Main fishing areas: Primary: Western Indian Ocean, around Seychelles and waters off Somalia (Area R2), and Mozambique Channel (Area R3) (**Fig.2**).

- Retained catch trends:
  Catches of yellowfin tuna remained stable between the mid-1950s and the early-1980s, ranging between 30,000 t and 70,000 t, with longliners and gillnetters the main fisheries. Catches increased rapidly in the early-1980s with the arrival of the purse seiners and increased activity of longliners and other fleets, reaching over 400,000 t by 1993.

  Exceptionally high catches were recorded between 2003 and 2006 – with the highest catches ever recorded in 2004 at 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.

  Between 2007 and 2011 catches dropped considerably (around ≈40% compared to 2004) as longline fishing effort in the western Indian Ocean have been displaced eastwards or reduced due to the threat of piracy. Catches by purse seiners also declined over the same period – albeit not to the same extent as longliners – due to the presence of security personnel onboard purse seine vessels of the EU and Seychelles which has enabled fishing operations to continue.

  Since 2012 catches have once again been increasing, with catches over 400,000 t recorded.

  Purse seine fishery:

  Although some Japanese purse seiners have fished in the Indian Ocean since 1977, the purse seine fishery developed rapidly with the arrival of European vessels between 1982 and 1984. Since then, there has been an increasing number of yellowfin tuna caught, 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.

  The purse seine fishery is characterized by the use of two different fishing modes. 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.

  Longline fishery:

  The longline fishery started in the early 1950's and expanded rapidly over throughout the Indian Ocean. The longline fishery targets several tuna species in different parts of the Indian Ocean, with yellowfin tuna and bigeye tuna being the main target species in tropical waters. The longline fishery can be subdivided into a deep-freezing longline component (i.e., large scale deep-freezing longliners operating on the high seas from Japan, Korea and Taiwan,China) and a fresh-tuna longline component (i.e., small to medium scale fresh tuna longliners from Indonesia and Taiwan,China).

- Discard levels: Low, although estimates of discards are unknown for most industrial fisheries, excluding industrial purse seiners flagged in EU countries for the period 2003–07.

  Changes to the catch series**:** no major changes to the catch series since the WPTT meeting in 2014.

Table 1. 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 (2005–2014), in tonnes. Catches by decade represent the average annual catch, noting that some gears were not used since the beginning of the fishery. Data as of October 2015.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
FS	-	-	18	31,552	64,938	89,204	123,997	85,039	53,527	74,986	36,047	32,136	36,453	64,594	34,457	53,916
LS	-	-	17	17,597	56,278	61,890	69,879	74,601	43,777	41,539	51,351	73,382	76,658	66,165	101,907	95,081
LL	21,990	41,351	29,588	33,968	66,318	56,758	117,341	70,397	51,224	25,937	19,917	18,661	20,550	19,499	16,124	15,675
LF	141	1,214	2,281	7,721	58,525	55,539	57,523	57,139	55,619	58,102	49,883	50,485	43,455	54,643	59,044	63,984
BB	2,110	2,318	5,809	8,295	12,803	16,072	16,822	18,021	16,327	18,279	16,827	14,106	14,009	15,512	24,047	23,598
GI	1,566	4,109	7,928	11,993	39,540	49,393	61,379	62,579	43,510	47,872	41,906	51,121	50,964	63,458	56,570	65,783
HD	558	552	2,956	7,630	19,471	34,768	40,938	34,678	34,636	31,371	28,945	35,003	60,492	79,687	73,923	77,787
TR	1,092	1,957	4,293	7,331	12,271	16,145	17,888	17,371	19,052	16,514	14,611	19,056	18,730	28,550	32,699	26,326
OT	80	193	454	1,871	3,378	5,402	5,829	5,800	6,703	6,556	7,361	7,705	7,872	8,214	8,861	8,176
Total	**27,538**	**51,694**	**53,344**	**127,959**	**333,524**	**385,171**	**511,596**	**425,624**	**324,377**	**321,156**	**266,848**	**301,655**	**329,184**	**400,322**	**407,633**	**430,327**

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

Table 2. Yellowfin tuna: Best scientific estimates of the catches of yellowfin tuna (*Thunnus albacares*) by area by decade (1950–2009) and year (2005–2014), in tonnes. Catches by decade represent the average annual catch. The areas are presented in Fig. 20(a). Data as of October 2015.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
R1	1,931	4,395	8,670	8,670	75,066	85,358	130,875	101,328	78,580	72,086	60,230	71,819	103,546	131,944	122,971	135,948
R2	12,259	24,035	22,127	22,127	142,282	180,618	248,558	201,688	123,016	134,759	99,646	115,041	121,442	145,391	155,526	179,964
R3	724	7,449	4,282	4,282	21,818	23,626	24,353	23,836	23,568	19,925	18,542	18,195	18,911	17,059	20,830	10,127
R4	918	1,799	1,356	1,356	3,414	2,508	3,697	1,904	1,027	587	895	1,406	530	601	859	529
R5	11,706	14,016	16,909	16,909	90,944	93,060	104,113	96,868	98,186	93,799	87,536	95,194	84,754	105,327	107,448	103,759
Total	**27,538**	**51,694**	**53,344**	**53,344**	**333,524**	**385,171**	**511,596**	**425,624**	**324,377**	**321,156**	**266,848**	**301,655**	**329,184**	**400,322**	**407,633**	**430,327**

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**).

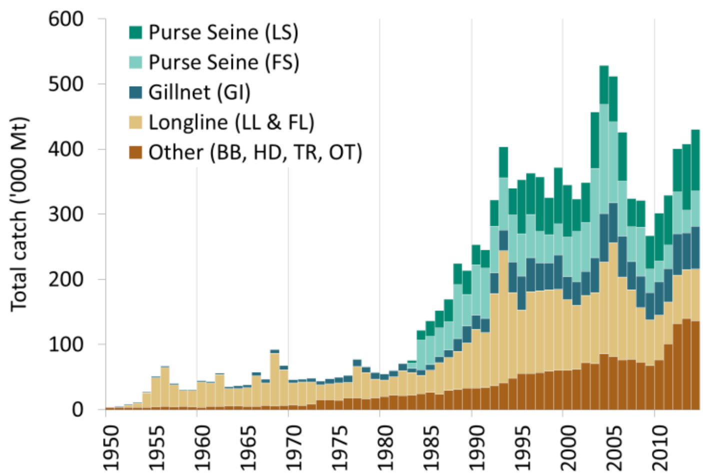


Fig. 1. Annual catches of yellowfin tuna by gear (1950–2014). Data as of October 2015.

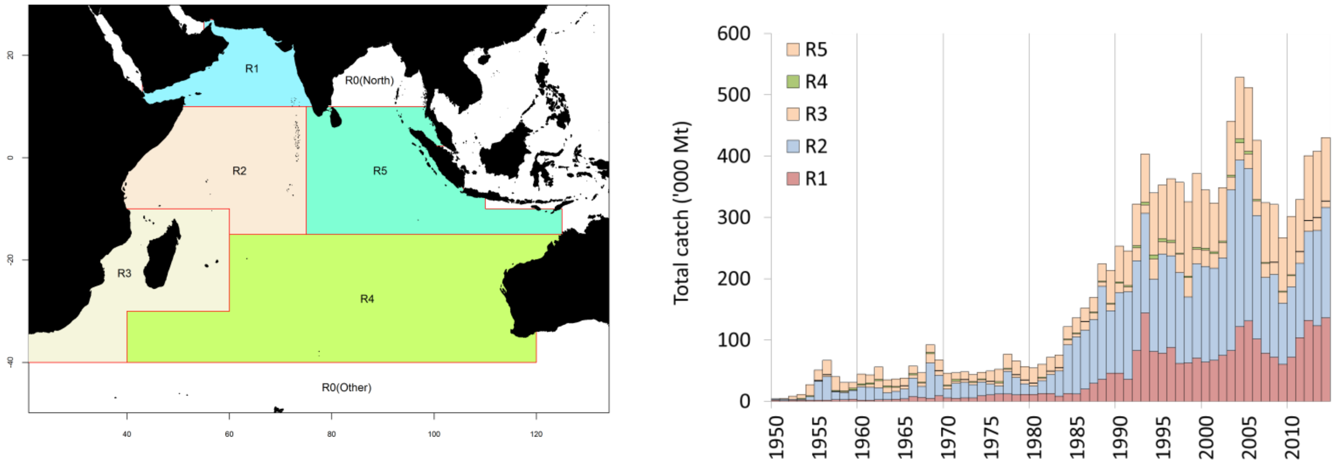


Fig. 2(a-b). Yellowfin tuna: Catches of yellowfin tuna by area by year estimated for the WPTT (1950–2014). Catches in areas R0 were assigned to the closest neighbouring area for the assessment. Data as of October 2015.

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**).

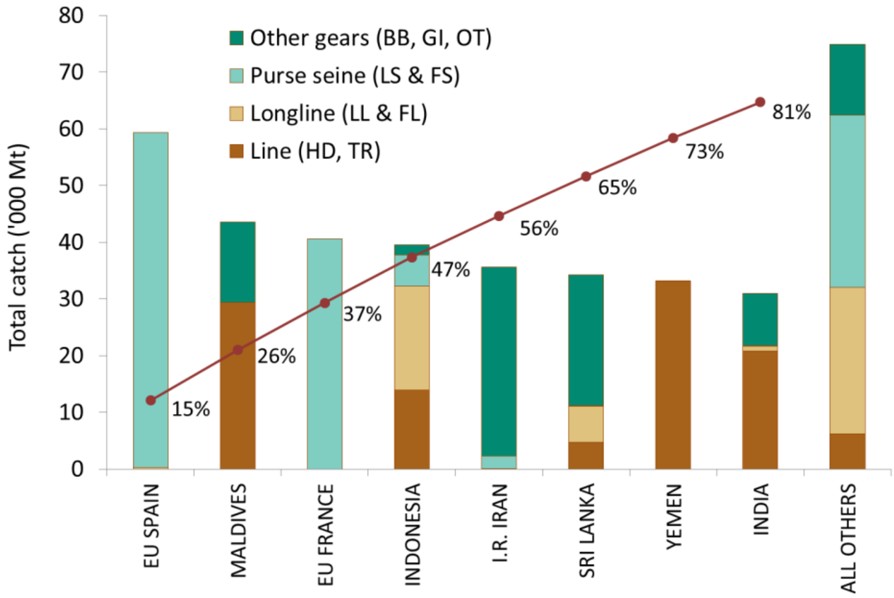


Fig. 3. Yellowfin tuna: average catches in the Indian Ocean over the period 2011–14, by country. Countries are ordered from left to right, according to the importance of catches of yellowfin reported. The red line indicates the (cumulative) proportion of catches of yellowfin for the countries concerned, over the total combined catches of this species reported from all countries and fisheries. Data as of October 2015.

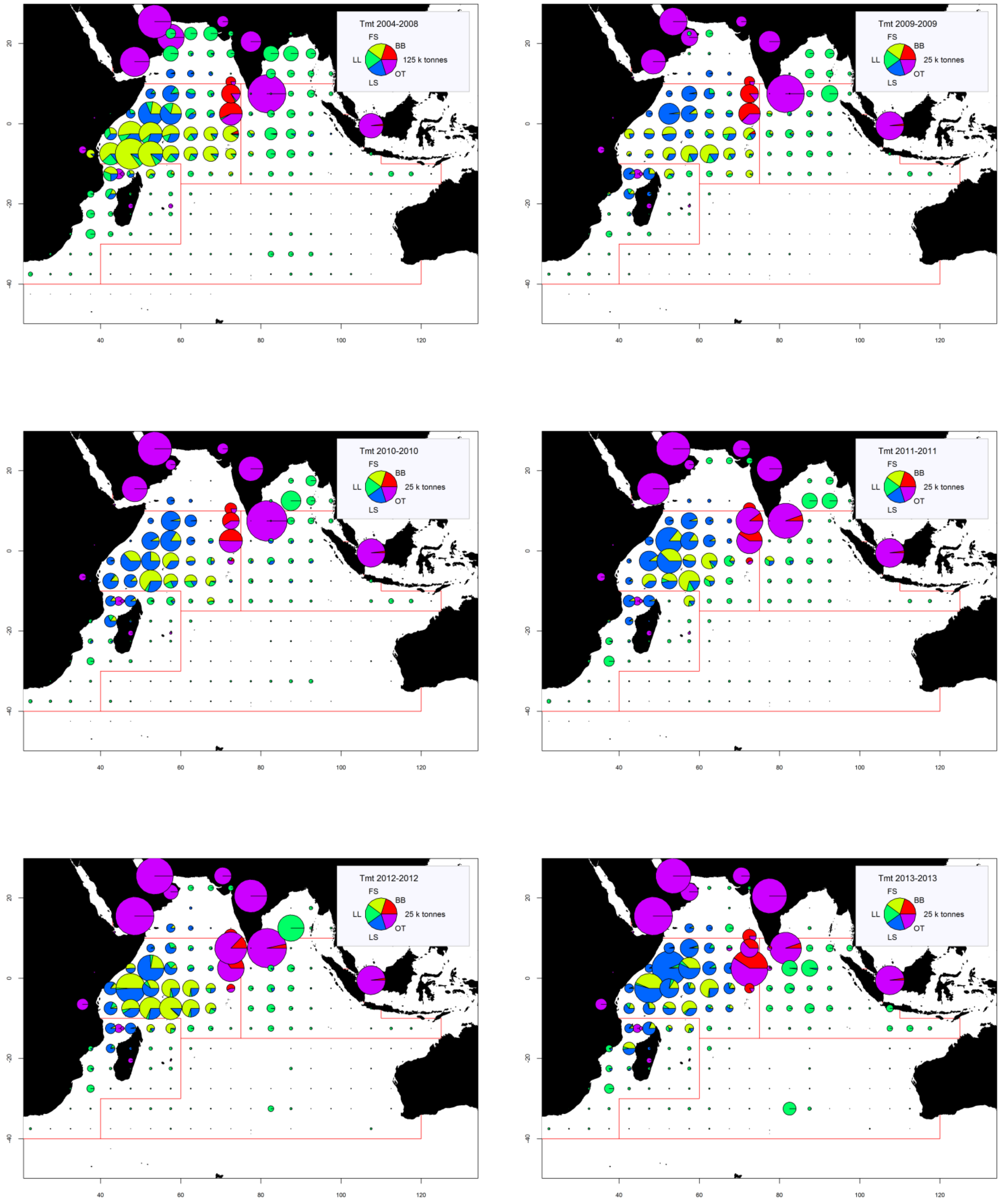


Fig. 4(a-f). Time-area catches (total combined in tonnes) of yellowfin tuna estimated for the period 2004–2008 by type of gear and for 2009–2013, by year and type of gear. Longline (**LL**), Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (**BB**), and other fleets (**OT**), including drifting gillnets, and various coastal fisheries. 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: data availability and related data quality issues

Retained catches

- Data are considered to be generally well known for the major industrial fisheries, with the proportion of catches estimated, or adjusted, by the IOTC Secretariat relatively low (**Fig. 5a**). Catches are less certain for the following fisheries/fleets:
  - many coastal fisheries, notably those from Indonesia, Sri Lanka, Yemen, and Madagascar;
  - gillnet fishery of Pakistan;
  - Non-reporting industrial purse seiners and longliners (NEI), and longliners of India.

Catch-per-unit-effort (CPUE) trends

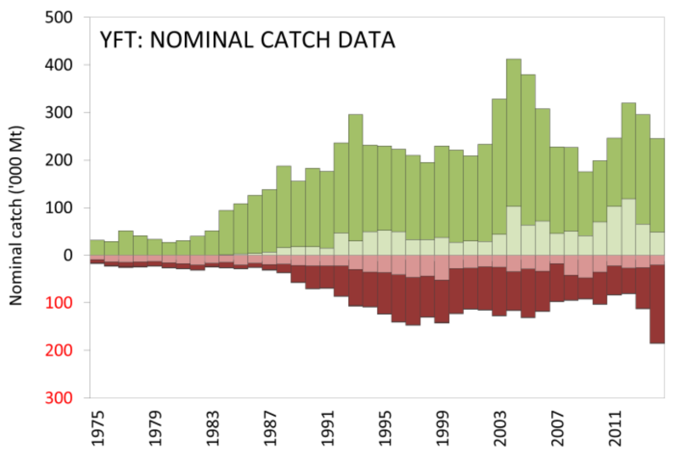
- Availability: Catch-and-effort series are available for the major industrial and artisanal fisheries (e.g., Japan longline, Taiwan,China) (**Fig. 5b**).

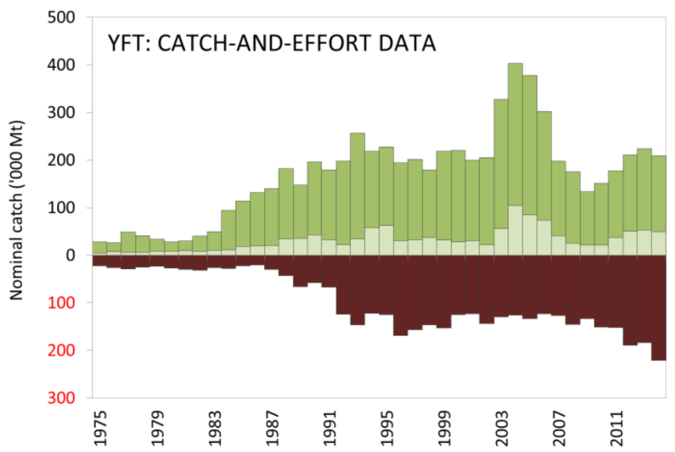
  However, for other important fisheries catch-and-effort are either not available, or are considered to be of poor quality for the following reasons:
  - no data are available for the fresh-tuna longline fishery of Indonesia, over the entire time series, and data for the fresh-tuna longline fishery of Taiwan,China are only available since 2006;
  - insufficient data for the gillnet fisheries of I.R., Iran and Pakistan;
  - 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.

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

- Average fish weight: trends in average weight 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 (**Fig. 5c**).
  - ➢ 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.
  - ➢ 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.

- Catch-at-Size (Age) table: data are available, although the estimates are more uncertain in some years and some fisheries due to:
  - size data not being available from important fisheries, notably Yemen, Pakistan, Sri Lanka and Indonesia (lines and gillnets) and Comoros and Madagascar (lines)
  - the paucity of size data available from industrial longliners from the late-1960s up to the mid-1980s, and in recent years (Japan and Taiwan,China)
  - the paucity of catch by area data available for some industrial fleets (NEI fleets, I.R. Iran, India, Indonesia, Malaysia).





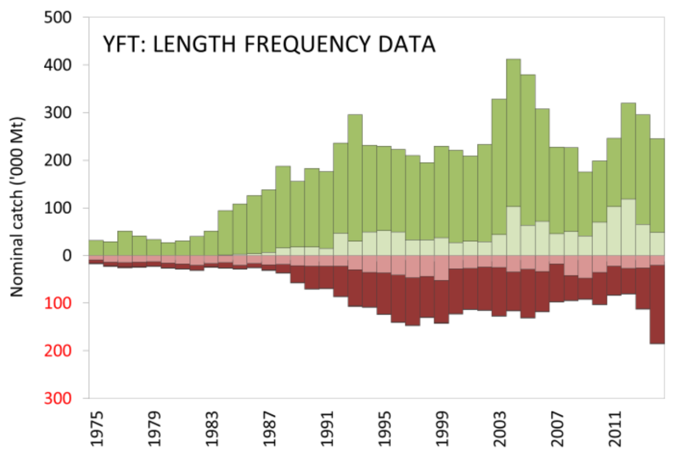


Fig.5a-c. Yellowfin tuna: data reporting coverage (1975–2014).

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 October 2015.

IOTC Data reporting score:

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

*E.g., 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
Fully available according to the minimum reporting standards	0	0
Partially available according to the minimum reporting standards*	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

* E.g., Catch-and-effort not fully disaggreaged by species, gear, area, or month.

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

* E.g., Size data not fully available by species, gear, gear, month, or recommended size interval.

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)

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. 6**). 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, 10,842 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, or which 151 were recovered, mainly from the Maldives.

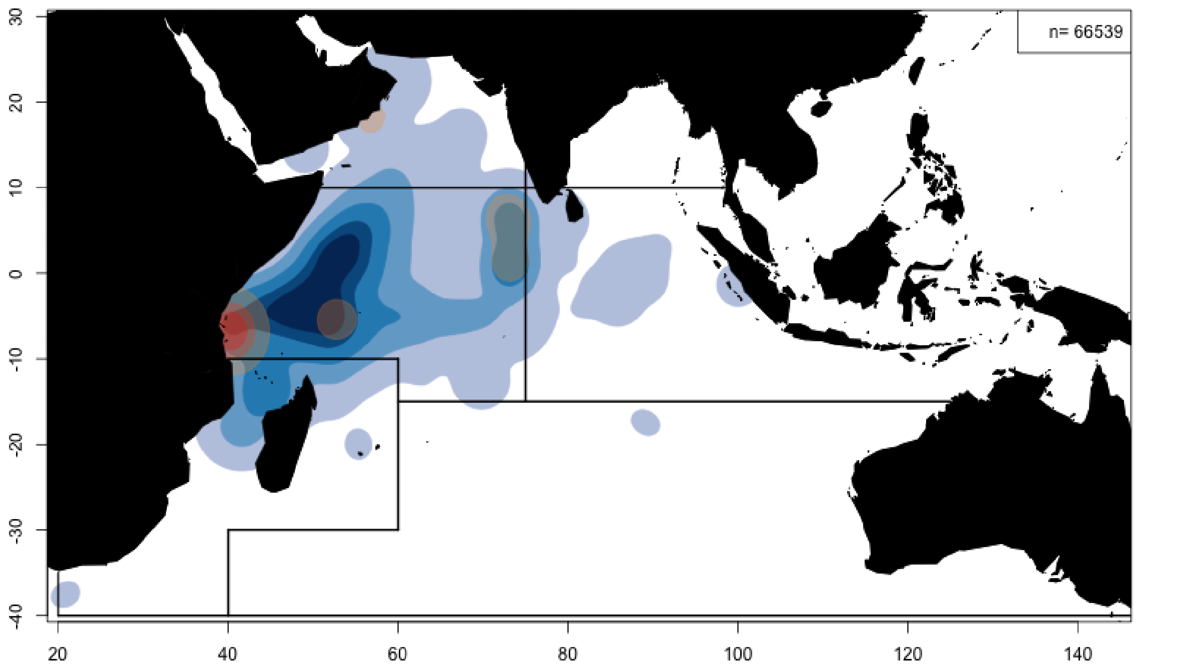
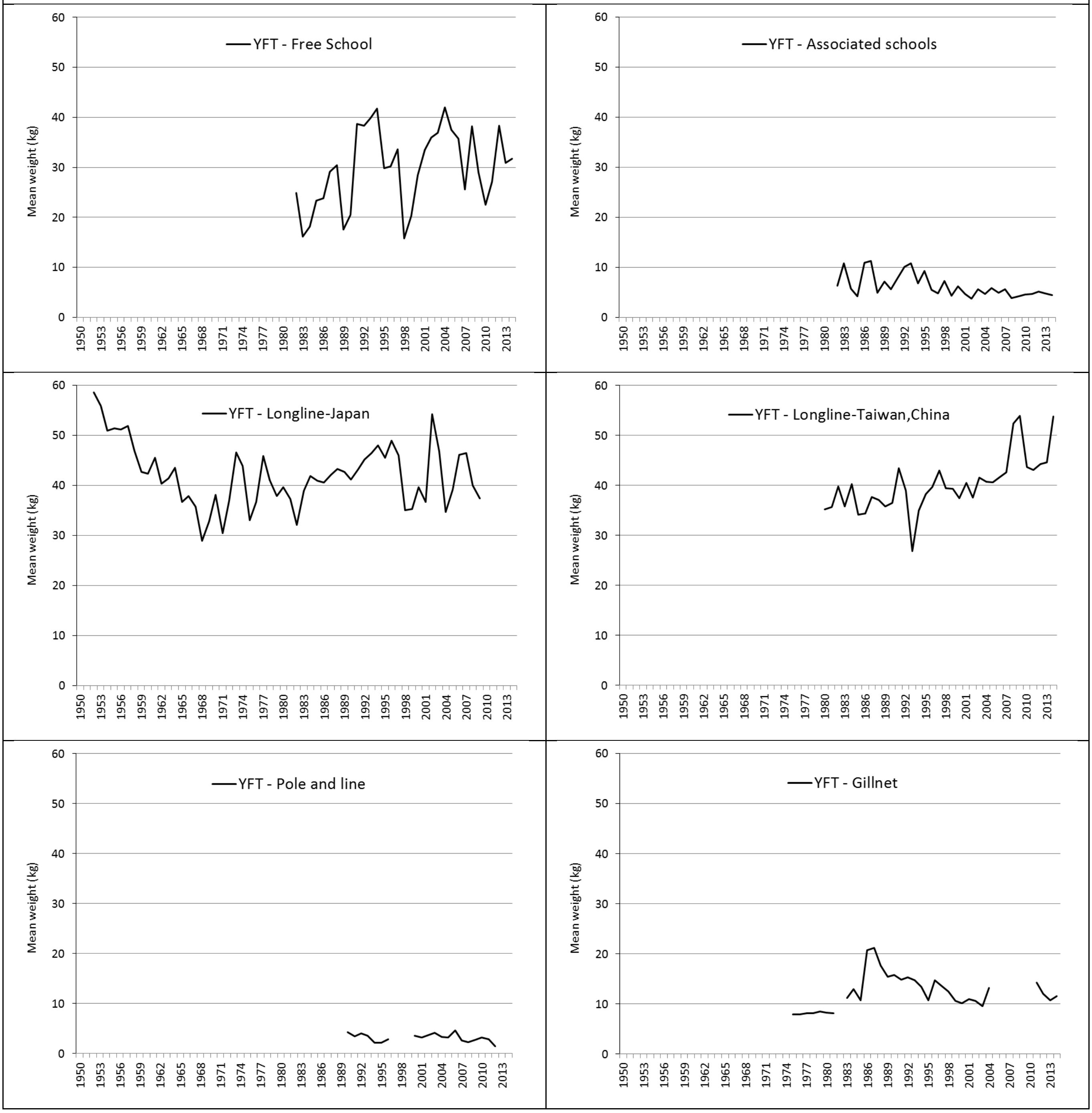


Fig. 6 Yellowfin tuna: Densities of releases (in red) and recoveries (in blue). The black line represents the stock assessment areas. Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s. Data as of September 2012.

Yellowfin tuna (YFT)

Fig. 7 Average weight of yellowfin tuna (YFT) taken by:

- 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)



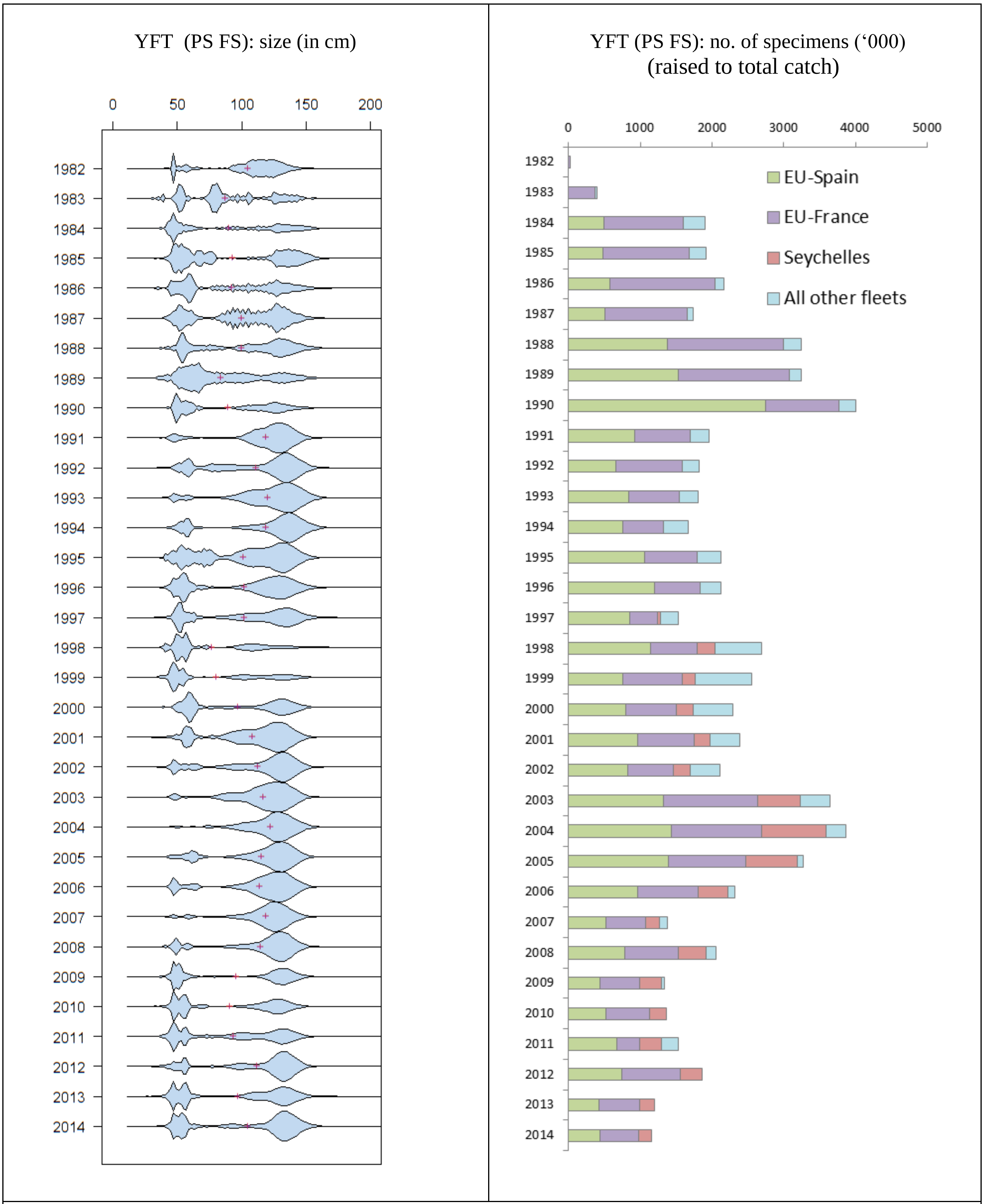


Fig. 8 Yellowfin tuna (PS Free school): **Left:** length frequency distributions for PS Free school fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of yellowfin tuna specimens sampled for lengths (raised to total catch),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

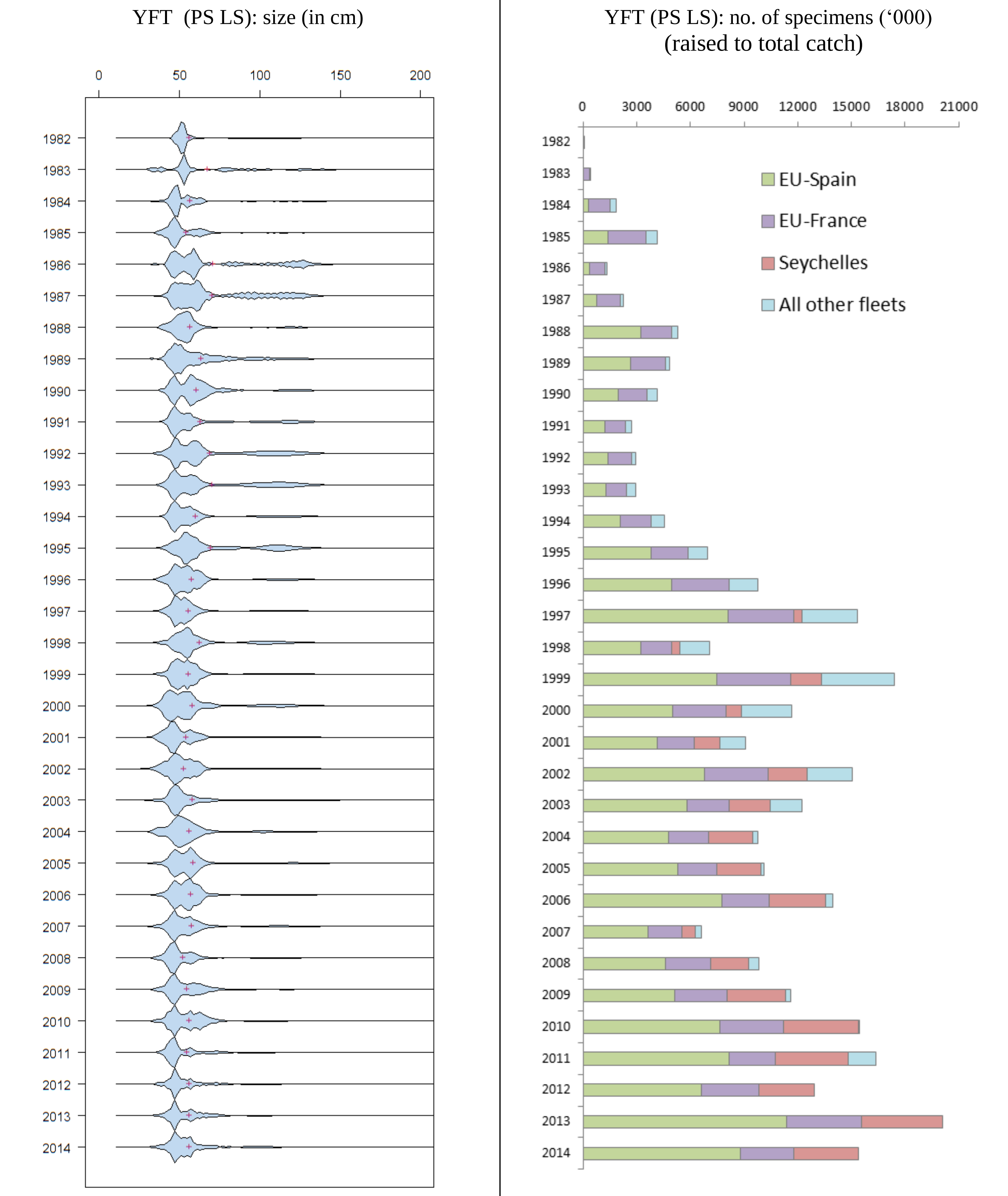


Fig. 9 Yellowfin tuna (PS Associated school): **Left:** length frequency distributions for PS Associated school fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of yellowfin tuna specimens sampled for lengths (raised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

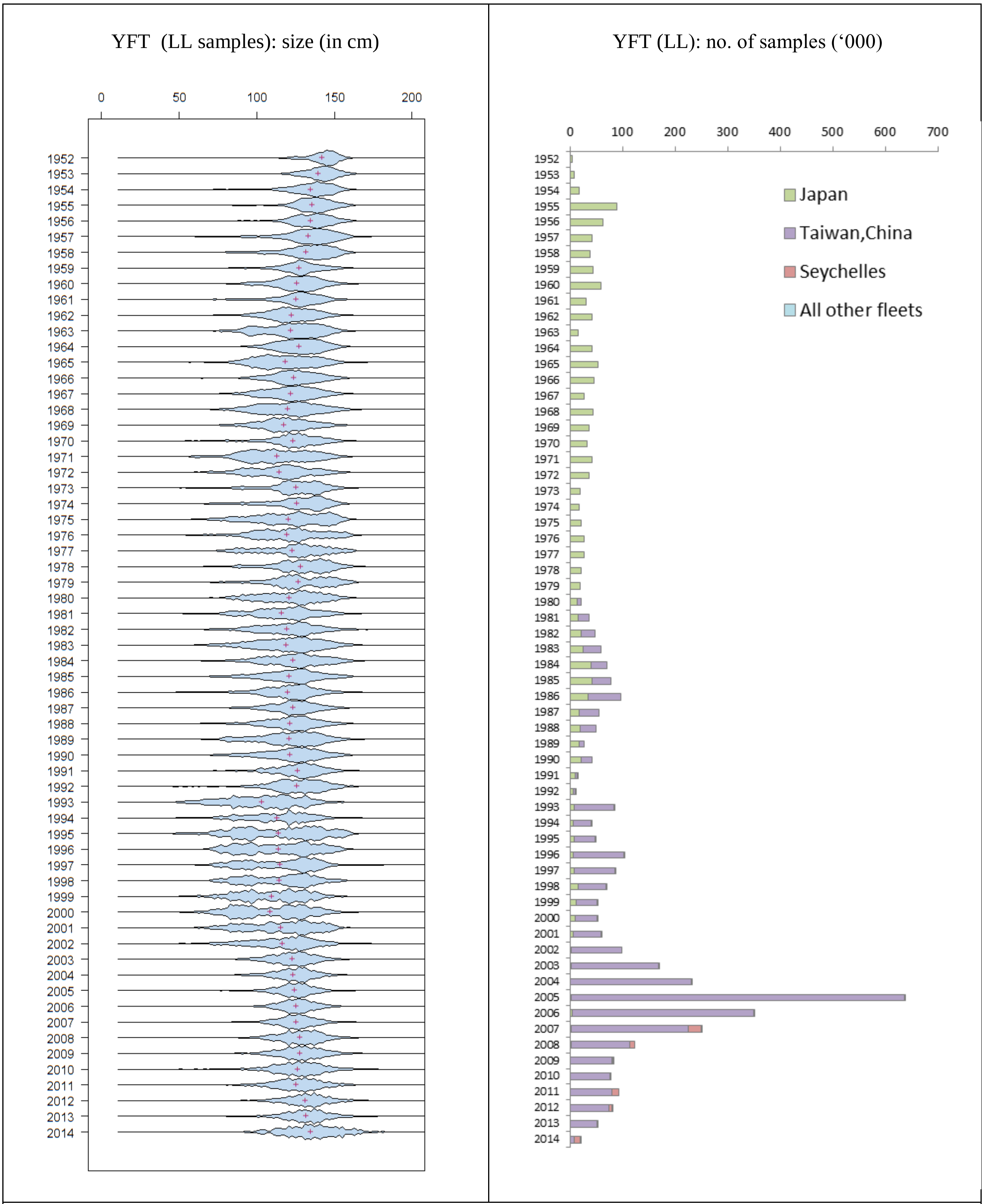


Fig. 10 Yellowfin tuna (longline): **Left:** length frequency distributions for longline fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of yellowfin tuna specimens sampled for lengths, by fleet (longline only).

APPENDIX V
MAIN ISSUES IDENTIFIED RELATING TO THE STATISTICS OF TROPICAL TUNAS

Extract from IOTC–2015–WPTT17–07 Rev_1

The following list provides a summary of the main issues that the IOTC Secretariat considers to negatively affect the quality of tropical tuna statistics available at the IOTC, by type of dataset and fishery.

1. *Nominal (retained) catches*

- Maldives (pole-and-line): the pole-and-line fishery is known to catch some juvenile bigeye tuna, however up to 2013, yellowfin tuna and bigeye tuna were aggregated and reported to the IOTC Secretariat as yellowfin tuna only. The IOTC Secretariat has previously used the proportion of bigeye tuna in samples collected in the Maldives in the past to disaggregate the catches of yellowfin tuna, per year, with average catches of bigeye tuna estimated at around 850 t per year.
  - *Update*: While Maldives has made progress in improving the estimate of juvenile bigeye tuna, e.g., proposals to use tagging information to disaggregate catches reported as yellowfin tuna, estimates still remain uncertain for the fishery and further work is needed to improve the accuracy of catches for the historical series.
- Sri Lanka (gillnet-longline fishery): Although Sri Lanka has reported catches of bigeye tuna for its gillnet/longline fishery, catches are considered to be too low, possibly due to the mislabelling of catches of bigeye tuna as yellowfin tuna.
- I.R. Iran (drifting gillnet): In 2013 I.R. Iran reported catches of bigeye tuna for its drifting gillnet fishery for the first time (for year 2012). The IOTC Secretariat has estimated caches of bigeye tuna for Iran for years before 2012, assuming various levels of activity of vessels using driftnets on the high seas, depending on the year, and catch ratios between bigeye tuna and yellowfin tuna recorded for industrial purse seiners on free-swimming tuna schools in the northwest Indian Ocean. Catches of bigeye tuna have been estimated for the period 2005–11 (at around 700 t per year), however estimates remain uncertain.
- Pakistan (drifting gillnet): To date, Pakistan has not reported catches of bigeye tuna for its gillnet fishery, although a component of the fleet is known to operate on the high seas, where catches of bigeye tuna are reported by other fleets operating the same area.
- Coastal fisheries of Indonesia, Madagascar, Sri Lanka[2] (other than gillnet/longline) and Yemen: The catches of tropical tunas for these fisheries have been estimated by the IOTC Secretariat in recent years – although the quality of the estimates is thought to be very poor due to the lack of information available about the fisheries operating in these countries.
- Indonesia (longline): have not reported catches for longliners under their flag that are not based in their ports.
- Comoros (coastal fisheries): In 2011–12 the IOTC and the OFCF provided support to the strengthening of data collection for the fisheries of Comoros, including a Census of fishing boats and the implementation of sampling to monitor the catches unloaded by the fisheries in selected locations over the coast. The IOTC Secretariat and the *Centre National de resources Halieutiques* of Comoros derived estimates of catch using the data collected and the new catches estimated are at around half the values reported in the past by Comoros (around 5,000 t per year instead of 9,000 t). The IOTC Secretariat revised estimates of catch for the period 1995–2010 using the new estimates.

2. *Discards – all fisheries*

- The total amount of tropical tunas discarded at sea remains unknown for most fisheries and time periods. Discards of tropical tunas are thought to be significant during some periods of industrial purse seine fisheries using fish aggregating devices (FADs) and may also be high due to depredation of catches of longline fisheries, by sharks or marine mammals, in tropical areas.

[2] In 2012-13 the Ministry of Fisheries and Aquatic Resources Development of Sri Lanka received support from IOTC, the OFCF and BOBLME to strengthen its data collection and processing system, which should lead to improvements in the estimate of catch for the coastal fisheries of Sri Lanka for 2012 and subsequent years.

3. Catch-and-effort

For a number of fisheries important for catches of tropical tuna, catch-and-effort remains either totally unavailable, incomplete (i.e., missing catches by species, gear, or fleet), or only partially reported according to the standards of IOTC Resolution 15/02, and of limited value in deriving indices of abundance:

- I.R. Iran (coastal and offshore fisheries): I.R. Iran ranks 6th largest in terms of total catches of tropical tunas (mostly drifting gillnets), however catch-and-effort have not been reported according to IOTC standards, in particular for vessels operating outside of its EEZ. No information is reported on effort, while catches are provided by province rather than 5° grid area.
- Sri Lanka (gillnet-longline): In previous years Sri Lanka has not reported catch-and-effort data as per the IOTC standards, including separate catch-and-effort data for gillnet-longline and catch-and-effort data for those vessels that operate outside its EEZ.
  - *Update*: In 2014 Sri Lanka provided more detailed catch-and-effort for the first time, which the IOTC Secretariat is currently reviewing.
- Indonesia (longline): To date, Indonesia has not reported catch-and-effort data for its longline fishery.
  - *Update*: An IOTC-OFCF mission is scheduled for November 2015 to assist Indonesia with reporting of catch-and-effort, size frequency data and Regional Observer data collected on-board longline vessels. Update to be provided for the next WPTT.
- Pakistan (drifting gillnet): no catch-and-effort reported for the gillnet fishery, in particular for vessels that operate outside the EEZ of Pakistan.
- India (longline): catches and catch-and-effort data have been reported for its commercial longline fishery for activities inside of the EEZ of India. However, India has not reported catches of tropical tunas or other species for longline vessels under its flag, operating offshore.

4. Size data (all fisheries)

- Japan and Taiwan,China (longline fisheries): In 2010, the IOTC Scientific Committee identified several issues concerning the size frequency statistics available for Japan and Taiwan,China, which remain unresolved. In 2013 the IOTC Secretariat presented a paper to WPTT15 documenting the current data quality issues and inconsistences between the length frequency data and catch-and-effort reported in particular by Taiwan,China since the mid-2000s[3].

  The WPTT recommended an inter-sessional meeting attached to the WPDCS and WPM on *data collection and processing systems for size data from the main longline fleets in the Indian Ocean*, be carried out in early 2014. Unfortunately arrangements for the inter-sessional meeting were never taken forward.
  - *Update*: Collaboration between the IOTC Secretariat, Japan, and Taiwan,China is on-going and progress will be reported to the WPDCS, WPTT and SC in due course.
- In addition, the number of specimens sampled for length on-board longliners flagged in Japan in recent years remains below the minimum recommended by the IOTC (i.e. 1 fish per metric ton of catch measured for length).
- I.R. Iran and Pakistan (gillnet): although both countries have reported size frequency data gillnet fisheries in recent years, data have not been reported by area and the number of samples are below the minimum sample size recommended by the IOTC.
- Sri Lanka (gillnet-longline): Although Sri Lanka has reported length frequency data for tropical tunas in recent years, sampling coverage is below recommended levels and lengths are not available by gear type or fishing area[4].
  - *Update*: In 2014 Sri Lanka provided more detailed catch-and-effort for the first time, which the IOTC Secretariat is currently reviewing.
- Indonesia (longline): size frequency data have been reported for its fresh-tuna longline fishery in previous years (e.g., 2002-2003), however samples cannot be fully broken fishing area (i.e., 5° degree grid) and they refer exclusively to longliners based in ports in those countries.

---

[3] See IOTC Secretariat, IOTC-2013-WPTT15-41 Rev_1, for more details.

[4] In 2012–13 the Ministry of Fisheries and Aquatic Resources Development of Sri Lanka received support from IOTC, the OFCF and BOBLME to strengthen its data collection and processing system, including collection of more length frequency data from the fisheries.

- *Update*: An IOTC-OFCF mission is scheduled for November 2015 to assist Indonesia with reporting of catch-and-effort, size frequency data and Regional Observer data collected on-board longline vessels. Update to be provided for the next WPTT.

- To date, these countries have not reported size frequency data for their fisheries:
  - India, Oman and the Philippines (longline);
  - India, Indonesia and Yemen (coastal fisheries).

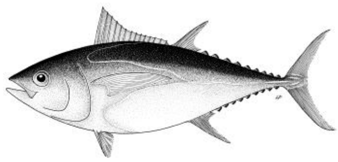
5. Biological data for all tropical tuna species

- Surface and longline fisheries, in particular Taiwan,China, Indonesia, Japan, and China:

  The IOTC database does not contain enough data to allow for the estimation of statistically robust length-weight or non-standard size to standard length keys for tropical tuna species due to the general lack of biological data available from the Indian Ocean.

APPENDIX VI
DRAFT RESOURCE STOCK STATUS SUMMARY – BIGEYE TUNA

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



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		2015 stock status[2] determination
Indian Ocean	Catch in 2014: Average catch 2010–2014:	100,231 t 102,214 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 or 2015, thus, stock status is determined on the basis of the 2013 assessment and other indicators presented in 2015. 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 (2010–14; ≈102,000 t) also remains below the estimated MSY. In 2012 catch levels (≈120,000 t) of bigeye tuna increased markedly (≈29% over values in 2011: ≈92,000 t), but have declined to ≈102,000 t in 2014. Thus, on the weight-of-evidence available in 2015, 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 Rep. 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).

Management advice. 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 following key points should also 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).
- **Interim reference points**: Noting that the Commission has agreed to Resolution 15/10 *on 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 interim target reference point of F_{MSY}, and therefore below the interim limit reference point of $1.4 \cdot F_{MSY}$ (Fig. 1).
    - **Biomass**: Current spawning biomass is considered to be above the interim target reference point of SB_{MSY}, and therefore above the interim limit reference point of $0.4 \cdot SB_{MSY}$ (Fig. 1).
- **Main fishing gear** (Average catch 2011–14): Longline ≈56.0% (frozen ≈43.5%, fresh ≈12.5%); Purse seine ≈21.2% (FAD associated school ≈16.1%; free swimming school ≈5.1%); Line other ≈9.6%; Other ≈6.8%.
- **Main fleets** (Average catch 2011–14): Indonesia ≈27%; Taiwan,China ≈22%; European Union ≈16% (EU,Spain: ≈10%; EU,France: ≈6%); Seychelles ≈11; Japan ≈5%; All other fleets ≈19%.

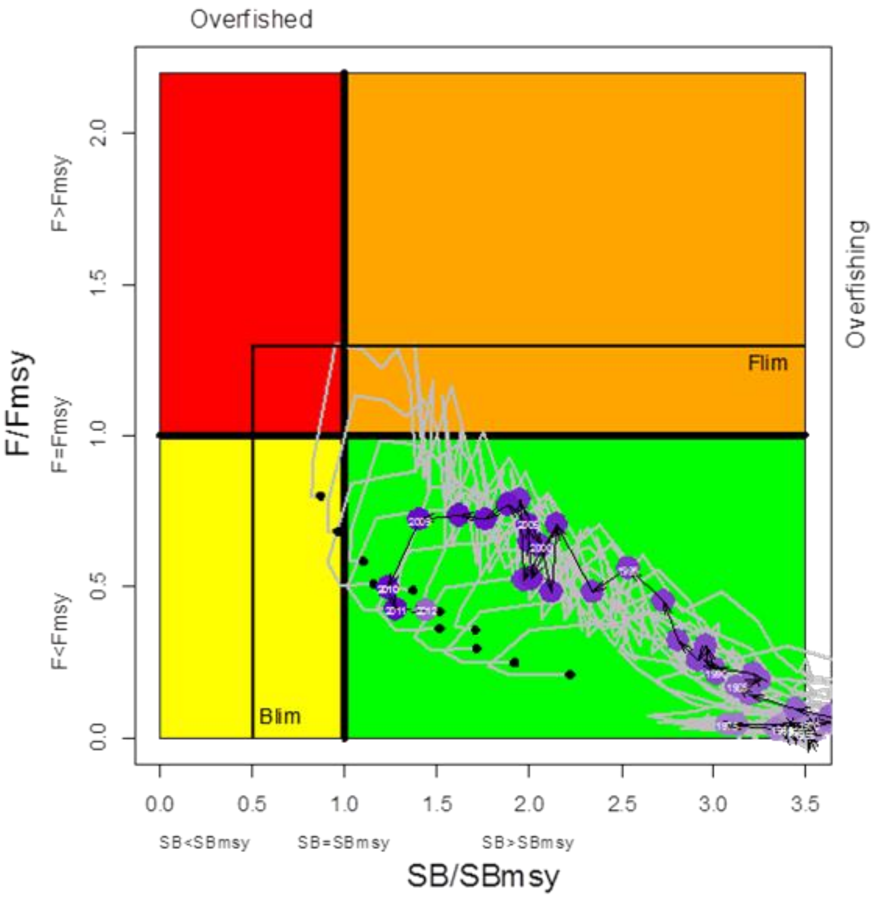


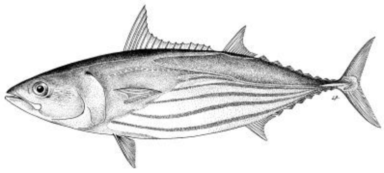
Fig. 1. Bigeye tuna: SS3 Aggregated Indian Ocean assessment Kobe plot. The Kobe plot presents the trajectories for the range of 12 plausible model options included in the formulation of the final management advice (grey lines with the black point representing the terminal year of 2012). The trajectory 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 VII
DRAFT RESOURCE STOCK STATUS 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		2015 stock status determination
Indian Ocean	Catch 2014: Average catch 2010–2014:	432,467 t 402,229 t	(green)
	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 ($F_{year}/F_{MSY} > 1$)	(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. No new stock assessment was carried out for skipjack tuna in 2015, thus, stock status is determined on the basis of the 2014 assessment and other indicators presented in 2015. 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 (≈432,500 t) remain lower than the estimated MSY values from the 2014 stock assessments (Table 1). The average catch over the previous five years (2010–14; ≈402,000 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 ≈425,000 t (< 1 % risk that $B_{2016} < B_{MSY}$ and 1 % risk that C_{2023}>MSY as proxy of $F > F_{MSY}$).

Management advice. 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 following key points should also 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 600,000 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 2010–2014 was ≈402,000 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 ≈432,500 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.

- 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.
- **Interim reference points:** Noting that the Commission in 2015 agreed to Resolution 15/10 *on 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 interim target reference point of F_{MSY}, and therefore below the interim limit reference point of $1.5*F_{MSY}$ (Fig. 1). Based on the current assessment there is a very low probability that the interim 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 interim target reference point of SB_{MSY}, and therefore above the interim 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 interim limit reference point of $0.4*SB_{MSY}$ in 3 or 10 years.
- **Main fishing gear** (Average catch 2011–14): Purse seine ≈30.2% (FAD associated school ≈28.7% and free swimming school ≈1.5%); Gillnet ≈26.1%; Pole-and-line ≈20.1%; Other ≈23.6%.
- **Main fleets** (Average catch 2011–14): Indonesia ≈22%; European Union ≈21% (EU,Spain: ≈15%; EU,France: ≈6%); Sri Lanka ≈16%; ≈Maldives 16%; ≈I.R. Iran 7%; Seychelles ≈7%; India ≈7%.

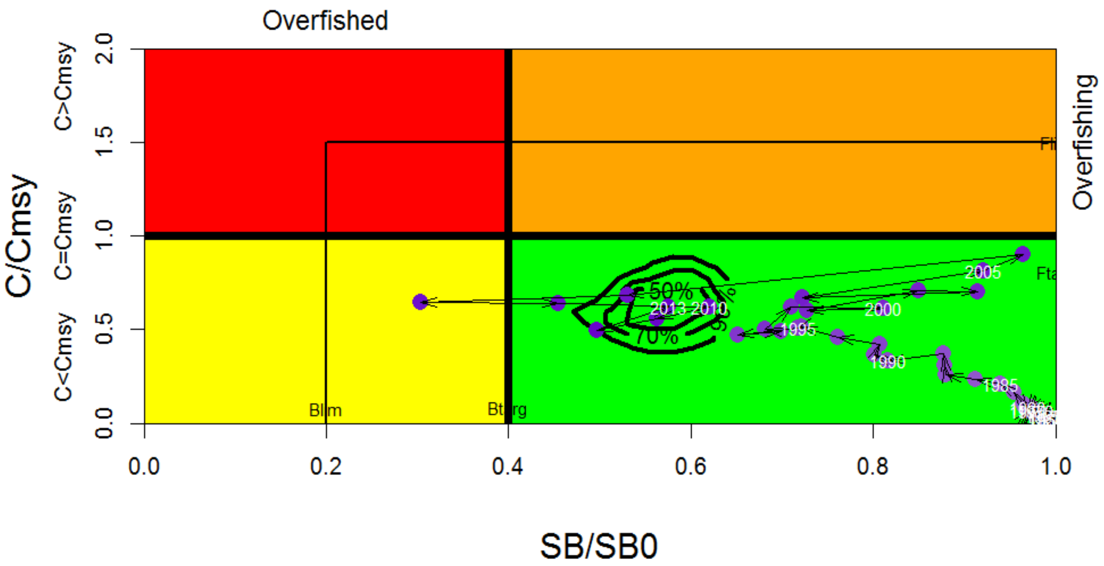


Fig. 1. Skipjack tuna: SS3 Aggregated Indian Ocean assessment Kobe plot (contours are the 50, 70 and 90 percentiles of the 2013 estimate). Blue circles indicate the trajectory of the point estimates for the SB/SB0 ratio and F proxy ratio for each year 1950–2013 estimated as C/C_{MSY}. Interim target (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.

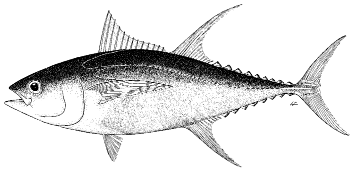
TABLE 2. Skipjack tuna: SS3 aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target (top) and limit (bottom) reference points for nine constant catch projections (average catch level from 2013 (424,580 t), ± 10%, ± 20%, ± 30% ± 40%) projected 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 SB_{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 VIII
DRAFT RESOURCE STOCK STATUS 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**		**2015 stock status determination**
Indian Ocean	Catch 2014: Average catch 2010–2014:	430,327 t 373,824 t	**94%***
	MSY (1000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2014}/F_{MSY} (80% CI): SB_{2014}/SB_{MSY} (80% CI): SB_{2014}/SB_0 (80% CI):	421 (404–439) 0.165 (0.162–0.168) 1,217 (1,165–1,268) 1.34 (1.02–1.67) 0.66 (0.58–0.74) 0.23 (0.21–0.36)	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
*Estimated probability that the stock is in the respective quadrant of the Kobe plot (shown below), derived from the confidence intervals associated with the current stock status.

Colour key	Stock overfished ($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)	**94%**	**0%**
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)	**6%**	**0%**
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. In 2015, three models were applied to the yellowfin tuna stock in the IOTC area of competence, a BBPM, SCAA and Stock Synthesis III model, all of which give qualitatively similar results. Stock status is based on the SS3 model formulation. Spawning stock biomass in 2014 was estimated to be 23% (21–36%) of the unfished levels (Table 1) and 66% (58–74%) of the level which can support MSY. The low level of stock biomass in 2014 is consistent with the long-term decline in the primary stock abundance indices (longline CPUE indices) and recent trends are attributable to increased catch levels. Total catch has continued to increase with 430,327 t taken in 2014, up from 407,633 t in 2013 and 400,322 t in 2012, in comparison to 329,184 t landed in 2011, 301,655 in 2010 and 266,848 t landed in 2009. The assessment is more pessimistic that the 2012 assessment due to the increase in catches and the changes in assessment assumptions regarding the recruitment processes. Fishing mortality estimates for 2014 was 34% (2–67%) higher than the corresponding fishing mortality rate that would produce MSY. Thus, on the weight-of-evidence available in 2015, the yellowfin tuna stock is determined to be **overfished** and **subject to overfishing** (Table 1 and Fig. 1).

Outlook. The substantial increase in longline, gillnet, handline and purse seine effort and associated catches in recent years has substantially increased the pressure on the Indian Ocean stock as a whole, with recent fishing mortality exceeding the MSY-related levels. The current assessment estimates that the stock biomass is below the level that will support the MSY and current levels of catch. There is a very high risk of continuing to exceed the biomass MSY-based reference point if catches increase further or are maintained at current levels (2014) until 2017 (>99% risk that $SB_{2017} < SB_{MSY}$), and similarly a very high risk that $F_{2017} > F_{MSY}$ (≈100% if maintained) (Table 2). The modeled probabilities of the stock achieving levels consistent with the Commission's current management objective (e.g. $SB > SB_{MSY}$) are 50% for a future constant catch at 80% of current catch levels by 2024. Higher probabilities of rebuilding require longer timeframes and/or larger reduction of current catches (Table 2). The K2MSM provides the Commission with a range of options for reducing catches and the probabilities of the yellowfin tuna stock recovering to the MSY target levels (Table 2).

Management advice. The stock status determination changed in 2015 as a direct result of the large and unsustainable catches of yellowfin tuna taken over the last three (3) years, and the relatively low recruitment levels estimated by the model in recent years. The Commission does not currently have any Conservation and Management Measures in place, other than the FAD limitation measure (Resolution 15/08, which is yet to be evaluated) to regulate the fisheries for yellowfin tuna. Given the short term projected decline in stock status if catches are maintained or increased from 2014 levels, catches should be reduced in conformity with the decision framework described in Resolution 15/10 (Table 2).

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY):** estimate for the whole Indian Ocean is 421,000 t with a range between 404,000–439,000 t for SS3 (Table 1). The average catches (357,000 t) since 2006 were below the MSY level.
- **Interim reference points**: Noting that the Commission in 2015 agreed to Resolution 15/10 *on target and limit reference points and a decision framework*, the following should be noted:
    - **Fishing mortality**: Current fishing mortality is considered to be well above the interim target reference point of F_{MSY}, and at or just under the interim limit reference point of $1.4*F_{MSY}$ (Fig. 1).
    - **Biomass**: Current spawning biomass is considered to be well below the interim target reference point of SB_{MSY}, however above the interim limit reference point of $0.4*SB_{MSY}$ (Fig. 1).
- **Main fishing gear** (Average catch 2011–14): Purse seine ≈33.8% (FAD associated school ≈21.7%; free swimming school ≈12.1%); Longline ≈18.7% (frozen ≈4.6%, fresh ≈14.1%); Handline ≈18.6%; Gillnet ≈15.1%; Trolling ≈6.8%; Pole-and-line ≈4.9%; ≈Other 2.1%).
- **Main fleets** (Average catch 2011–14): European Union ≈26% (EU,Spain ≈15%; EU,France ≈11%); Maldives ≈11%; Indonesia ≈10%; I.R. Iran ≈9%; Sri Lanka ≈9%; Yemen ≈8%; India ≈8%.

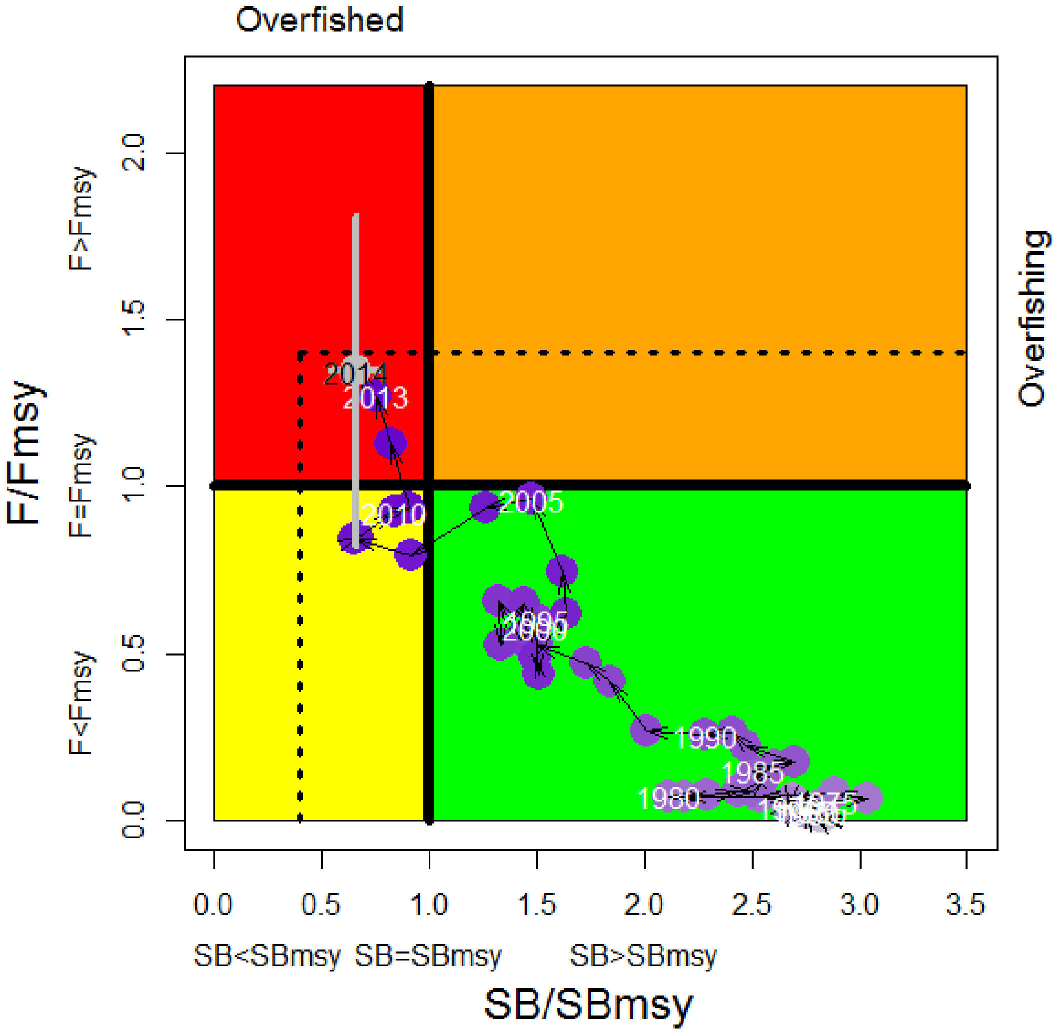


Fig. 1. Yellowfin tuna: SS3 Aggregated Indian Ocean assessment Kobe plot. Blue circles indicate the trajectory of the point estimates for the SB/SB_0 ratio and F proxy ratio for each year 1950–2014 for the base model. The grey lines represent the 95% confidence interval associated with the 2014 stock status. Dotted black lines are the interim limit reference points adopted by the Commission via Resolution 15/10.

Table 2. Yellowfin tuna: SS3 base case 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 2014 (427,440 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 2014) and probability (%) of violating MSY-based target reference points ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60% (256,464t)	**70%** (299,208)	**80%** (341,952t)	**90%** (384,696t)	**100%** (427,440t)	**110%** (470,184t)	**120%** (512,928t)	**130%** (555,672t)	**140%** (598,416)
$SB_{2017} < SB_{MSY}$	69	95	91	99	99	100	100	100	100
$F_{2017} > F_{MSY}$	2	54	60	79	100	100	100	100	100
$SB_{2024} < SB_{MSY}$	4	36	50	100	100	100	100	100	100
$F_{2024} > F_{MSY}$	0	22	49	100	100	100	100	100	100
Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2014) and probability (%) of violating MSY-based limit reference points ($SB_{lim} = 0.4\ SB_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)**								
	60% (256,464t)	**70%** (299,208)	**80%** (341,952t)	**90%** (384,696t)	**100%** (427,440t)	**110%** (470,184t)	**120%** (512,928t)	**130%** (555,672t)	**140%** (598,416)
$SB_{2017} < SB_{Lim}$	2	15	12	44	33	n.a.	n.a.	n.a.	n.a.
$F_{2017} > F_{Lim}$	0	13	19	70	100	100	100	100	100
$SB_{2024} < SB_{Lim}$	<1	8	15	51	100	100	100	100	100
$F_{2024} > F_{Lim}$	0	2	21	100	100	100	100	100	100

APPENDIX IX
WORKING PARTY ON TROPICAL TUNAS PROGRAM OF WORK (2016–2020)

The WPTT Program of Work (2016–2020) consists of the following, noting that a timeline for implementation would be refined by the Scientific Committee once it has agreed to the priority projects across all of its Working Parties:

- **Table 1**: Priority topics for obtaining the information necessary to develop stock status indicators for tropical tunas in the Indian Ocean;
- **Table 2**: Stock assessment schedule.

Table 1. Priority topics for obtaining the information necessary to develop stock status indicators for tropical tunas in the Indian Ocean.

Topic	Sub-topic and project	Priority ranking	Lead	Est. budget (potential source)	Timing				
					2016	2017	2018	2019	2020
1. Stock structure (connectivity and diversity)	1.1 Genetic research to determine the connectivity of tropical tuna species throughout their distribution (including in adjacent Pacific Ocean waters as appropriate) and the effective population size.	High	CSIRO/AZTI /IRD/RITF	1.3 m Euro: (European Union; 20% additional co-financing)					
	1.1.1 Next Generation Sequencing (NGS) to determine the degree of shared stocks for tropical tuna species in the Indian Ocean. Population genetic analyses to decipher inter- and intraspecific evolutionary relationships, levels of gene flow (genetic exchange rate), genetic divergence, and effective population sizes.								
	1.1.2 Nuclear markers (i.e. microsatellite) to determine the degree of shared stocks for tropical tuna species in the Indian Ocean with the Pacific Ocean, as appropriate.								
	1.2 Connectivity, movements and habitat use								
	1.2.1 Connectivity, movements, and habitat use, including identification of hotspots and investigate associated environmental conditions affecting the tropical tuna species distribution, making use of conventional and electronic tagging (P-SAT).	High		US$?? (TBD)					
2. Biological and ecological information	2.1 Age and growth								
	2.1.1 Design and develop a plan for a biological sampling program to support research on tropical tuna biology. The plan would consider the need for the sampling program to provide	High	CPCs directly	US$?? (TBD)					

Topic	Sub-topic and project	Priority ranking	Lead	Est. budget (potential source)	Timing				
					2016	2017	2018	2019	2020
(incl. parameters for stock assessment)	representative coverage of the distribution of the different tropical tuna species within the Indian Ocean and make use of samples and data collected through observer programs, port sampling and/or other research programs. The plan would also consider the types of biological samples that could be collected (e.g. otoliths, spines, gonads, stomachs, muscle and liver tissue, fin clips etc), the sample sizes required for estimating biological parameters, and the logistics involved in collecting, transporting and processing biological samples. The specific biological parameters that could be estimated include, but are not limited to, estimates of growth, age at maturity, fecundity, sex ratio, spawning season, spawning fraction and stock structure.								
	2.2 Age-at-Maturity								
	2.2.1 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	CPCs directly	US$?? (TBD)					
3. Ecological information	3.1 Spawning time and locations								
	3.1.1 Collect gonad samples from tropical tunas to confirm the spawning time and location of the spawning area that are presently hypothesised for each tropical tuna species.	High		US$?? (TBD)					
4. Historical data review	4.1 Changes in fleet dynamics need to be documented by fleet								
	4.1.1 Provide an evaluation of fleet-specific fishery impacts on the stock of bigeye tuna, skipjack tuna and yellowfin tuna. Project potential impact of realizing fleet development plans on the status of tropical tunas based upon most recent stock assessments.	High	Consultant	US$30K					
5. CPUE standardisation	5.1 Develop standardised CPUE series for each tropical tuna fleet/fishery for the Indian Ocean								

Topic		Sub-topic and project	Priority ranking	Lead	Est. budget (potential source)	Timing				
						2016	2017	2018	2019	2020
	5.1.1	There is an urgent need to establish procedures for annually developing longline CPUE indices using the combined data from multiple fleets, and to further develop and validate the methods used in these analyses.	High	Scientific Committee and consultants	US$40K (IOTC)					
	5.1.2	That standardised CPUE index for juvenile yellowfin tuna and bigeye tuna caught by the EU purse seiner fleets, be estimated and submitted to the WPTT before the next round of stock assessments of tropical tunas.		CPCs directly	US$?? (TBD)					
	5.1.3	Development of minimum criteria (e.g. 10% using a simple random stratified sample) for logbook coverage to use data in standardisation processes; and 2) identifying vessels through exploratory analysis that were misreporting, and excluding them from the dataset in the standardisation analysis.		CPCs directly	US$?? (TBD)					
	5.1.4	Vessel identity information for the Japanese fleets for the period prior to 1979 should be obtained either from the original logbooks or from some other source, to the greatest extent possible to allow estimation of catchability change during this period and to permit cluster analysis using vessel level data.		Japan	US$?? (TBD)					
	5.1.5	The standardisation of purse seine CPUE be made where possible using the operational data on the fishery.		CPCs directly	US$?? (TBD)					
		Bigeye tuna: High priority fleets	High	CPCs directly	US$?? (TBD)					
		Skipjack tuna: High priority fleets	High	CPCs directly	US$?? (TBD)					
		Yellowfin tuna: High priority fleets	High	CPCs directly	US$?? (TBD)					
	5.1.6	That methods be developed for standardising purse seine catch species composition using operational data, so as to provide alternative indices of relative abundance.	High	Consultant and CPCs directly	US$?? (TBD)					
	5.1.7	Investigate the potential to use the Indian longline survey as a fishery-independent index of abundance for tropical tunas.	High	Consultant	US$30K (TBD)					

Topic	Sub-topic and project	Priority ranking	Lead	Est. budget (potential source)	Timing				
					2016	2017	2018	2019	2020
			And CPCs directly						
6. Stock assessment / stock indicators	6.1 Develop and compare multiple assessment approaches to determine stock status for tropical tunas	High	CPCs directly	US$?? (TBD)					
7. Fishery independent monitoring	7.1 All of the tropical tuna stock assessments are highly dependent on relative abundance estimates derived from commercial fishery catch rates, and these could be substantially biased despite efforts to standardise for operational variability (e.g. spatio-temporal variability in operations, improved efficiency from new technology, changes in species targeting). Accordingly, the IOTC should continue to explore fisheries independent monitoring options which may be viable through new technologies. Possibilities include: • Aerial surveys, potentially using remotely operated or autonomous drones • Acoustic FAD monitoring • Genetics-based tagging techniques using recaptured individuals or identification of closely-related pairs • Longline-based surveys (expanding on the Indian model) or “sentinel surveys” in which a small number of commercial sets follow a standardised scientific protocol	Med	CPCs directly	US$?? (TBD)					
8 Target and Limit reference points	8.1 To advise the Commission, by end of 2016 at the latest on Target Reference Points (TRPs) and Limit Reference Points (LRPs).								
	8.1.1 Used when assessing tropical tuna stock status and when establishing the Kobe plot and Kobe matrices	High	CPCs directly	US$?? (TBD)					
9 Management measure options	9.1 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.								

Topic	Sub-topic and project	Priority ranking	Lead	Est. budget (potential source)	Timing				
					2016	2017	2018	2019	2020
	9.1.1 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.	High	CPCs directly	US$?? (TBD)					

Table 2. Assessment schedule for the IOTC Working Party on Tropical Tunas (WPTT)

Species	2016	2017	2018	2019	2020
Working Party on Tropical Tunas					
Bigeye tuna	**Full assessment**	Indicators	Indicators	**Full assessment**	Indicators
Skipjack tuna	Indicators	**Full assessment**	Indicators	Indicators	**Full assessment**
Yellowfin tuna	Indicators	Indicators	**Full assessment**	Indicators	Indicators

APPENDIX X
CONSOLIDATED RECOMMENDATIONS OF THE 17TH SESSION OF THE WORKING PARTY ON TROPICAL TUNAS

Note: Appendix references refer to the Report of the 17th Session of the Working Party on Tropical Tunas (IOTC–2015–WPTT17–R)

Skipjack tuna Management Strategy Evaluation process update

WPTT17.01 (para. 82): The WPTT **RECOMMENDED** that the Scientific Committee consider endorsing the skipjack tuna Operating Model for evaluating management procedures, as stipulated in Resolution 15/10.

Report of the 2nd CPUE workshop on longline fisheries

WPTT17.02 (para. 111): **NOTING** that the Taiwan,China longline CPUE in southern regions is affected by the rapid recent growth of the oilfish fishery, and that this is a new fishery with substantially lower catchability for tunas, it is important for CPUE indices to adjust for this change in catchability. Thus, the WPTT **RECOMMENDED** that future tuna CPUE standardisations should use appropriate methods to identify effort targeted at oilfish and related species, and either remove it from the dataset, or include a categorical variable for targeting method in the standardisation. The oilfish data variable should be provided to data analysts producing the CPUE index.

WPTT17.03 (para. 112): The WPTT **NOTED** that differences between the Japan and Taiwan.China longline CPUE indices were examined and attributed to either low sampling coverage of logbook data (between 1982–2000) or misreporting across oceans (Atlantic and Indian oceans) for bigeye tuna catches between 2002–04 for Taiwan,China. The WPTT **RECOMMENDED** the 1) development of minimum criteria (e.g. 10% using a simple random stratified sample) for logbook coverage to use data in standardisation processes; and 2) identifying vessels through exploratory analysis that were misreporting, and excluding them from the dataset in the standardisation analysis.

WPTT17.04 (para. 113): The WPTT **RECOMMENDED** that:

- more credence should be given to CPUE indices based on operational data, since analyses of these data can take more factors into account, and analysts are better able to check the data for inconsistencies and errors.
- Taiwan,China fleets provide all available logbook data to data analysts, representing the best and most complete information possible. This stems from the fact that the dataset currently used by scientists from Taiwan,China is incomplete and not updated with logbooks that arrive after finalisation.
- that vessel identity information for the Japanese fleets for the period prior to 1979 should be obtained either from the original logbooks or from some other source, to the greatest extent possible to allow estimation of catchability change during this period and to permit cluster analysis using vessel level data. During this period there was significant technological change (e.g. deep freezers) and targeting changes (e.g. yellowfin tuna to bigeye tuna).
- examining operation level data across all longline fleets (Rep. of Korea, Japan and Taiwan,China) will give us a better idea of what is going on with the fishery and stock especially if some datasets have low sample sizes or effort in some years, and others have higher sample sizes and effort, so we have a representative sample covering the broadest areas in the Indian Ocean. This will also avoid having no information in certain strata if a fleet were not operating there, and avoid combining two indices in that case.

WPTT17.05 (para. 114): **NOTING** paragraph 113, the WPTT **RECOMMENDED** that continued work on joint analysis of operational catch and effort data from multiple fleets be undertaken, to further develop methods and to provide indices of abundance for IOTC stock assessments.

Revision of the WPTT Program of Work (2016–2020)

WPTT17.06 (para. 155): **NOTING** that the current IOTC *Guidelines for the presentation of CPUE standardisations and stock assessment models* (IOTC–2015–WPTT17–INF01) may need revising, as it was felt that the current Stock Status summary table, which is the principal communication tool regarding stock status used on the IOTC website, understates uncertainty in stock status evaluations, the WPTT **RECOMMENDED** that the following be reviewed:

- the annual status coding scheme;
- the historic coding scheme;
- consideration of the status coding scheme for years when no quantitative stock assessment is available.

WPTT17.07 (para. 159): The WPTT **RECOMMENDED** that the SC consider and endorse the WPTT Program of Work (2016–2020), as provided at Appendix IX.

Review of the draft, and adoption of the Report of the 17th Session of the WPTT

WPTT17.08 (para. 164): The WPTT **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPTT17, provided at Appendix X, as well as the management advice provided in the draft resource stock status summary for each of the three tropical tuna species under the IOTC mandate, and the combined Kobe plot for the three species assigned a stock status in 2015 (Fig. 10):

- Bigeye tuna (*Thunnus obesus*) – Appendix VI
- Skipjack tuna (*Katsuwonus pelamis*) – Appendix VII
- Yellowfin tuna (*Thunnus albacares*) – Appendix VIII

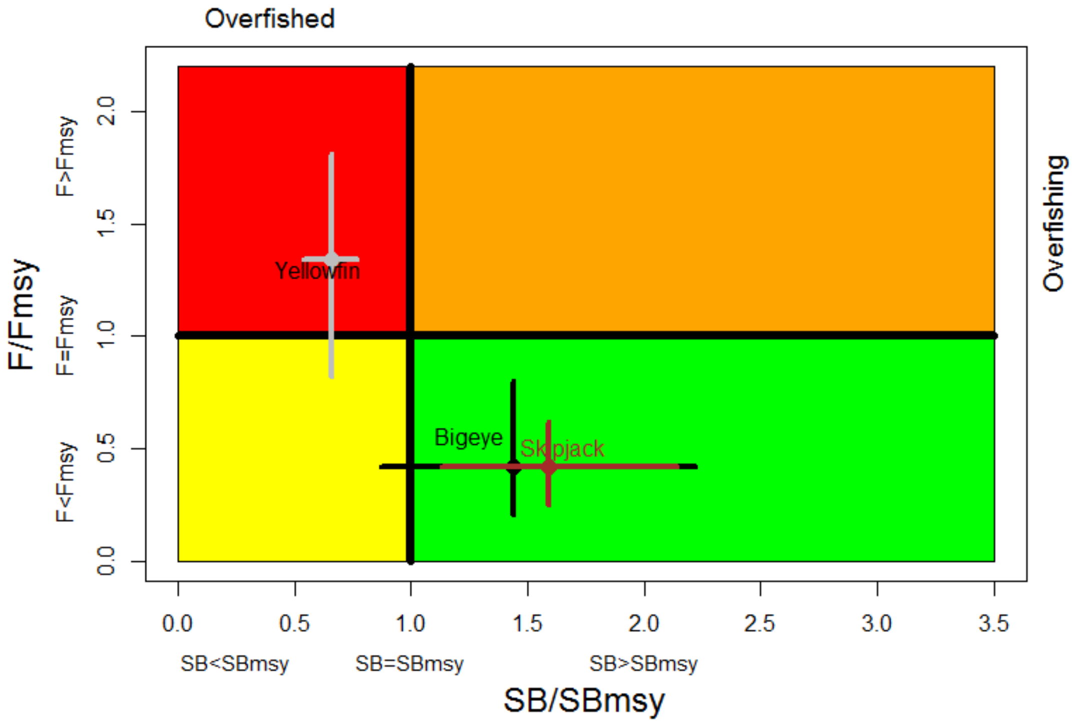


Fig. 10. Combined Kobe plot for bigeye tuna (black: 2013), skipjack tuna (brown: 2014) and yellowfin tuna (grey: 2015) showing the estimates of current stock size (SB) and current fishing mortality (F) in relation to optimal spawning stock size and optimal fishing mortality. Cross bars illustrate the 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.