Report of the Sixteen Session of the IOTC Working Party on Tropical Tunas

Bali, Indonesia, 15–19 November 2014

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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 16th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Tropical Tunas (WPTT) was held in Bali, Indonesia, from 15 to 19 November 2014. The meeting was opened by Dr. Achmad Poernomo, Chief of the Agency for Marine and Fisheries Research and Development, Indonesia who welcomed participants to Bali, Indonesia. The Chair, Dr Hilario Murua (EU,Spain) and Vice-Chair, Dr Shiham Adam also welcomed participants. A total of 52 participants attended the Session (46 in 2013), including one invited expert, Dr Simon Hoyle, a consultant from New Zealand, who's participation was funded entirely by ISSF. The following are a subset of the complete recommendations from the WPTT15 to the Scientific Committee, which are provided at Appendix X.

Skipjack tuna indicators

WPTT16.01 (para. 139): The WPTT **ENCOURAGED** the production of such fishery indicators and **RECOMMENDED** that other indicators, such as the number of FADs deployed and active should also be examined in addition to existing environmental indices for the Indian Ocean.

Revision of the WPTT Program of Work (2015–2019)

WPTT16.03 (para. 236): The WPTT **RECOMMENDED** that the SC consider and endorse the WPTT Program of Work (2015–2019), as provided at Appendix IX.

Review of the draft, and adoption of the Report of the 16th Session of the WPTT

WPTT16.05 (para. 249): The WPTT **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPTT16, 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 2014 (Fig. 15):

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

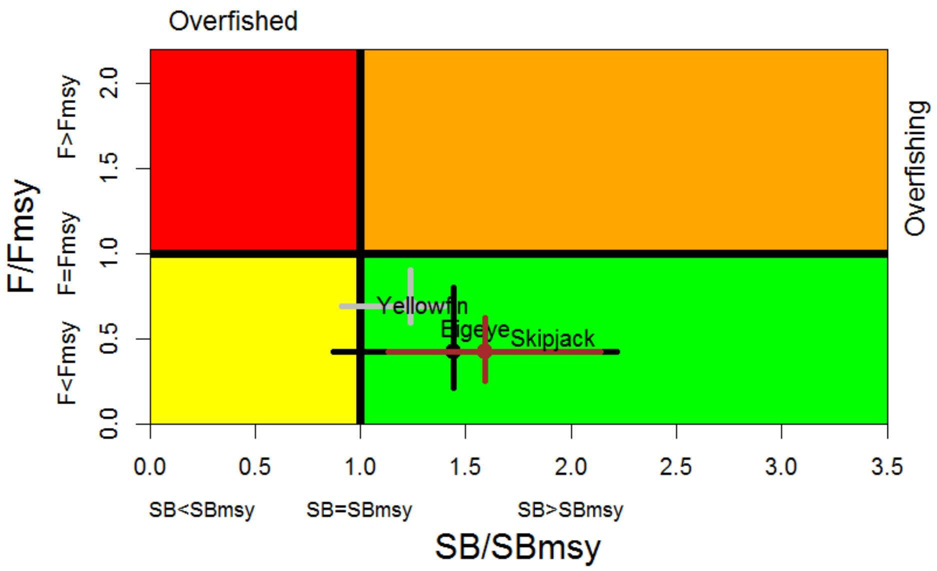


Fig. 15. Combined Kobe plot for bigeye tuna (black: 2013), skipjack tuna (brown: 2014) and yellowfin tuna (grey: 2012) showing the estimates of current stock size (SB) and current fishing mortality (F) in relation to optimal spawning stock size and optimal fishing mortality. Cross bars illustrate the 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	Advice to the Commission
Bigeye tuna *Thunnus obesus*	Catch in 2013: Average catch 2009–2013: 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):	109,343 t 105,924 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, thus, stock status is determined on the basis of the 2013 assessment and other indicators presented in 2014. All the runs (except 2 extremes) carried out in 2013 indicate the stock is above a biomass level that would produce MSY in the long term (i.e. SB_{2012}/SB_{MSY} > 1) and in all runs that current fishing mortality is below the MSY-based reference level (i.e. F_{2012}/F_{MSY} < 1). 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% of the unfished levels. Catches in 2013 (≈109,000 t) remain lower than the estimated MSY values from the 2013 stock assessments. The average catch over the previous five years (2009–13; ≈106,000 t) also remains below the estimated MSY. In 2012 catch levels of bigeye tuna increased markedly (≈26% over values in 2011), but have declined in 2013 by 9% from 2012 levels. Thus, on the weight-of-evidence available in 2014, the bigeye tuna stock is determined to be **not overfished** and is **not subject to overfishing**. <Click here for full stock status summary>
Skipjack tuna *Katsuwonus pelamis*	Catch in 2013: Average catch 2009–2013: 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):	424,580 t 401,132 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)								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 current the proxy for fishing mortality is below the MSY-based reference level (i.e. $C_{current}/C_{MSY}$ < 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% of the unfished levels. Catches in 2014 (≈424,000 t) remain lower than the estimated MSY values from the 2014 stock assessments). The average catch over the previous five years (2009–13; ≈401,000 t) also remains below the estimated MSY. 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**. <Click here for full stock status summary>
Yellowfin tuna *Thunnus albacares*	Catch 2013: Average catch 2009–2013: MSY (1000 t) (80% CI):	402,084 t 339,359 t 344 (290–453)								No new stock assessment was carried out for yellowfin tuna in 2014, thus, stock status is determined on the basis of the 2012 assessment and other indicators presented in 2014. Spawning stock biomass in 2010 was

	F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{curr}/F_{MSY} (80% CI): SB_{curr}/SB_{MSY} (80% CI): SB_{curr}/SB_0 (80% CI):	n.a (n.a.–n.a.) 881 (784–986) 0.69 (0.59–0.90) 1.24 (0.91–1.40) 0.38 (0.28–0.38)								estimated to be 38% (31–38%) of the unfished levels. Total catch has continued to increase with 400,292 t and 402,084 t landed in 2012 and 2013, respectively, well in excess of previous MSY estimates (≈17% above the MSY level of 344,000 t), in comparison to 327,453 t landed in 2011 and 299,713 t landed in 2010. The previous assessment showed that the stock was unlikely to support substantially higher yields based on the estimated levels of recruitment from the last 15 years although higher yield would be expected if recruitment corresponds to the long term average. Therefore it is difficult to know whether the stock is moving towards a state of being subject to overfishing. Thus, on the weight-of-evidence available in 2014, the yellowfin tuna stock is determined to be **not overfished** and **not subject to overfishing**. <Click here for full stock status summary>

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

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

1. Opening of the Meeting

1. The 16th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Tropical Tunas (WPTT) was held in Bali, Indonesia, from 15 to 19 November 2014. The meeting was opened by Dr Achmad Poernomo, Head of the Agency for Marine and Fisheries Research and Development, Ministry of Marine Affairs and Fisheries, Indonesia who welcomed participants to Bali, Indonesia. The Chair, Dr Hilario Murua (EU,Spain) and Vice-Chair, Dr Shiham Adam (Maldives) also welcomed participants. A total of 53 participants attended the Session (46 in 2013), including one invited expert, Dr Simon Hoyle, a consultant from New Zealand, funding by ISSF. 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 WPTT16 are listed in Appendix III.

3. The IOTC process: Outcomes, updates and progress

3.1 Outcomes of the 16th Session of the Scientific Committee

3. The WPTT **NOTED** paper IOTC–2014–WPTT16–03 which outlined the main outcomes of the 16th Session of the Scientific Committee (SC16), specifically related to the work of the WPTT, and **AGREED** to consider how best to progress these issues at the present meeting.

4. **NOTING** that the SC adopted a set of standardised IOTC Working Party and Scientific Committee reporting terminology, contained in Appendix IV of the SC16 Report (para. 23 of the SC16 Report), the WPTT **AGREED** that the terminology (which is provided in the opening pages of this WPTT16 Report) will provide greater clarity and remove some of the ambiguity in the way advice is provided to the next level in the Commission's structure.

5. The WPTT **RECALLED** that the SC adopted revised '*Guidelines for the presentation of stock assessment models'* in 2012, which include the minimum requirements for presenting CPUE standardisations. All participants who undertake CPUE standardisations and/or stock assessments should familiarise themselves with these guidelines (provided in paper IOTC–2014–WPTT16–INF01).

6. The WPTT **NOTED** that in 2013, the SC made a number of requests in relation to the WPTT16 report (noting that updates on Recommendations of the SC16 are dealt with under Agenda item 3.4 below.

3.2 Outcomes of the 18th Session of the Commission

7. The WPTT **NOTED** paper IOTC–2014–WPTT16–04 which outlined the main outcomes of the 18th 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.

8. The WPTT **NOTED** the 7 Conservation and Management Measures (CMMs) adopted at the 18th Session of the Commission (consisting of 6 Resolutions and 1 Recommendation):

IOTC Resolutions

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

IOTC Recommendations

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

9. The WPTT **ACKNOWLEDGED** the importance of standardising the way in which the subsidiary bodies of the Commission provide advice. Recommendation 14/07, newly adopted at the 18th Session of the Commission, details a range of options for further standardising the way in which advice may be presented in the IOTC Executive Summaries. While the current species Executive Summaries already comply with most of the suggestions contained in Recommendation 14/07, there is always room for improvement. However, the SC's '*Guidelines for the presentation of stock assessment models'* adopted in 2012 (provided in paper IOTC–2014–WPTT16–INF01), will now need to be updated to include the new elements from Recommendation 14/07.

10. **NOTING** that the Commission also made a number of general comments and requests on the recommendations made by the Scientific Committee in 2013, which have relevance for the WPTT (details as follows: paragraph numbers refer to the report of the Commission (IOTC–2014–S18–R): the WPTT **AGREED** that any advice to the Commission would be provided in the Management Advice section of each stock status summary for the tropical tuna species detailed in the relevant species sections of this report.

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

    Skipjack tuna

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

    Outlook on time-area closures

    ***NOTING** that the objective of Resolution 12/13 was to decrease the overall pressure on the main targeted stocks in the Indian Ocean, in particular yellowfin tuna and bigeye tuna, and also to evaluate the impact of the current time/area closure and any alternative scenarios on tropical tuna populations, the Commission **REQUESTED** that the SC (via the WPTT in 2014) undertake an analysis of the combined impacts of the two closed areas in the Indian Ocean (contained in Resolution 12/13 and the UK(OT) MPA), with the objective of determining the utility of closed areas in managing highly migratory species. (para. 23 of the S18 report)*

    Impacts of catching bigeye tuna and yellowfin tuna juveniles and spawners

    *The Commission **NOTED** however, that the fishery statistics available for many fleets, in particular for coastal fisheries, are not accurate enough for a comprehensive analysis as has been repeatedly noted in previous WPTT and SC reports. The Commission **REQUESTED** that the countries engaged in those fisheries take immediate actions to improve fishery statistics reporting to the IOTC Secretariat. (para. 27 of the S18 report)*

    Environmental conditions/functioning

    ***NOTING** the importance of the environmental conditions and their inter-annual variability on CPUE indices of IOTC species, and more generally, on recruitment and biomass, the SC **REQUESTED** that the working parties take into account more environment and ecosystem-related issues when undertaking stock assessment analyses. This could be achieved by encouraging a greater participation of oceanographers and ecosystem modellers in the work of the working parties. Additional funds may be needed to attract modellers to IOTC working parties.* (para. 140 of the SC16 Report)

Meeting participation fund

11. **NOTING** that the MPF was used to fund the participation of only 6 national scientists to the WPTT16 meeting in 2014 (from 8 applications) compared to 10 recipients in 2013 (from 10 applications), all of which were required to submit and present a working paper at the WPTT meeting, the WPTT **RECALLED** that:

    - The IOTC Meeting Participation Fund (MPF), adopted by the Commission in 2010 (Resolution 10/05 *On the establishment of a Meeting Participation Fund for developing IOTC Members and non-Contracting Cooperating Parties*), and now incorporated into the IOTC Rules of Procedure (2014), was established for the purposes of supporting scientists and representatives from IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs) who are developing States to attend and contribute to the work of the Commission, the Scientific Committee and its Working Parties.

- The Commission has made the following directives to the IOTC Secretariat:
  i. The Commission had directed the IOTC Secretariat (via Resolution 10/05 and now via the IOTC Rules of Procedure (2014)) to ensure that: (para. 88 of the S18 Report)
     a) the MPF be utilised, as a first priority, to support the participation of scientists from developing CPCs in scientific meetings of the IOTC, including Working Parties, rather than non-science meetings.
     b) the MPF will be allocated in such a way that no more than 25% of the expenditures of the Fund in one year is used to fund attendance to non-scientific meetings.
     c) thus, 75% of the annual MPF shall be allocated to facilitating the attendance of developing CPC scientists to the Scientific Committee and its Working Parties.
  ii. The Commission had directed the IOTC Secretariat that any cost savings made on the annual IOTC budget, shall also be used to further supplement the $60,000 currently budgeted for the MPF.

- In accordance with para. 89 of the S18 Report, the IOTC Secretariat is actively seeking extra budgetary funding sources to supplement the MPF budget from individual Contracting Parties as well as other interested groups. However, the WPTT was informed by the IOTC Secretariat that other sources should actively be sought by interested candidates, including the UNFSA meeting fund, as well as through their own domestic budgetary processes.

3.3 Review of Conservation and Management Measures relating to tropical tunas

12. The WPTT **NOTED** paper IOTC–2014–WPTT16–05 which aimed to encourage participants at the WPTT16 to review some of the existing Conservation and Management Measures (CMM) relevant to relevant to tropical tunas, noting the CMMs contained in document IOTC–2014–WPTT16–04; 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.
13. 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 WPTT15

14. The WPTT **NOTED** paper IOTC–2014–WPTT16–06 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.
15. The WPTT **NOTED** 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 Secretariat, another subsidiary body of the Commission or the Commission itself);
    - a desired time frame for delivery of the action (i.e. by the next working party meeting, or other date).
16. The WPTT **REQUESTED** that the IOTC Secretariat continue to prepare a paper on the progress of the recommendations arising from the previous WPTT, incorporating the final recommendations adopted by the Scientific Committee and endorsed by the Commission, as well as any updates and requests.

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

Thailand tuna longline fishery

17. The WPTT **NOTED** paper IOTC–2014–WPTT16–09 which provided an overview of Thailand’s tuna longline fleet from 2009 to 2013, including the following abstract provided by the author:
    “This report was based on the data extracted from fishing logsheets by two Thai tuna longliners namely, “Mook Andaman 018” and “Mook Andaman 028”, which declared to Department of Fisheries, Thailand. Data from their logsheets displayed important information of their fishing operation and effort. During 2009-2013, fishing grounds were mainly in the Western coast of the Indian Ocean, fishing operations

were recorded 2,073 fishing days. The highest total catch was in 2010 with 607.69 tonnes followed by 2012, 2011, 2013 and 2009 respectively (470.41, 373.44, 307.74 and 295.22 tonnes). The highest CPUE was found in 2010 with 13.62 fish/1,000 hooks followed by 2012 and 2013, respectively (10.83 and 10.16 fish/1,000 hooks). During 2009-2013, the bigeye tuna (Thunnus obesus) and yellowfin tuna (T. albacares) caught by number (and weight) were 24,126 fish (1,120.61 tonnes) and 10,531 fish (374.47 tonnes), respectively. The average percentage composition by number of the bigeye tuna and yellowfin tuna were 45.17% and 19.72% and by weight 54.54% and 18.23%, respectively. – see paper for full abstract."

18. The WPTT **WELCOMED** the contribution from Thailand scientists and **SUGGESTED** that they continue presenting fishery information at future meetings.

Japan tropical tuna fisheries

19. The WPTT **NOTED** paper IOTC–2014–WPTT16–10 which provided a review of Japanese fisheries and tropical tuna catch in the Indian Ocean, including the following abstract provided by the author:

    "*Fishing efforts, tropical tuna catch, CPUE and fish size was summarized for Japanese longline and purse seine fisheries operating in the Indian Ocean including recent trends. Japanese longline vessels have been targeting bigeye and yellowfin tunas along with albacore and southern bluefin tuna. The fishing effort for longline fishery fluctuated and sharply decreased in recent years, which is mainly by the decrease in the northwestern part (around Somalia) due to the effect of piracy activities. Both bigeye and yellowfin tuna catch peaked in 1968, sharply decreased in the 1970s especially as for yellowfin tuna, fluctuated after that, and sharply decreased around late 2000s. In the early period, the effort was deployed mainly in the tropical area, and then expanded to the south. High CPUE for bigeye and yellowfin tuna was observed mainly in the eastern and western Indian Ocean, respectively. Size data of bigeye and yellowfin tuna have been collected from on-board measurements by commercial and training longline vessels including those by scientific observers.* – see paper for full abstract."

20. The WPTT **NOTED** a large decline in Japanese longline effort due to piracy and other economic reasons detailed in previous WPTT reports. Those vessels that have stopped their operations in the Indian Ocean have moved to other Oceans or have been scrapped.

21. The WPTT **NOTED** that the reduction of effort could affect the estimation of the CPUE time series as some of the areas traditionally fished by the Japanese longlines are no longer active in those areas, which could in turn have an impact on the stock assessment of yellowfin tuna and bigeye tuna.

22. **NOTING** the current low size sampling of Japanese longline caught fish, the WPTT **REQUESTED** the use of observers on Japanese vessels to increase the number of size measurements made onboard. After a substantial reduction, currently size sampling is done almost only by the observer program which covers 5% of operations-mainly on vessels targeting southern bluefin tuna in southern Indian Ocean.

I.R. Iran fisheries

23. The WPTT **NOTED** paper IOTC–2013–WPTT16–11 which provided an overview of the tropical tuna fisheries of I.R. Iran, including the following abstract provided by the author:

    "*Tuna catches covers 6 percent of the world total catch, but in Iran more than 40 percent of the country catch belongs to tuna and tuna-like species. So tuna catch in Iran has attach-importance. Because 6500 out of 11500 fishing vessel with 60000 fishers are engaged in fishing activities and as the capture fishery in Iran is handled mainly small scale, so there are variety of socio-economic and management issues. Islamic republic of Iran has a longest coastline in Persian Gulf and Oman sea and Caspian sea with 5800 km long (including islands) and 193 port and landing places encompassing 140 thousand fishermen and 11500 fishing crafts with annual marine capture of around 514 thousand tonnes in 2013. Figure 1 shows the country catch trend in recent decade.*"

24. The WPTT **NOTED** the indication from the author that in the past two years I.R. Iran carried out the following actions in line with recommendations and approvals of the WPTT, SC and Commission which led to the enhancement of compliance to provision and regulations from 11% in 2010 to 65% in 2013.

25. The WPTT **NOTED** that I.R. Iran fishers after piracy have switched targeting from tropical to neritic tuna species, primarily using gillnets. At present, there are four I.R. Iran purse seine vessels active in the Indian Ocean.

26. **NOTING** that size frequency data reported to the IOTC Secretariat by I.R. Iran is collected by port sampling and does not include IOTC grid reference, the WPTT **ENCOURAGED** I.R. Iran to implement the necessary steps to improve the collection of size data to ensure data is reporting according to the minimum standards (e.g., by fishery and grid area) required by IOTC Resolution 10/02.

27. The WPTT **REQUESTED** I.R. Iran to present the results of size-frequency data collected by port sampling at the next WPTT, to investigate in particular the presence of medium sized yellowfin tuna (e.g. around 80 cm) which are generally less abundant in catches reported by fisheries in more southerly waters.

EU,France purse seine fishery

28. The WPTT **NOTED** paper IOTC–2014–WPTT16–12 which provided an overview of the fishing activities of the French and associated flags purse seiners targeting tropical tunas in the Indian Ocean (1981-2013), including the following abstract provided by the author:

> "*In 2013, the French purse seine fishing fleet of the Indian Ocean was composed of 13 vessels of individual capacity >800 t, which all represented a total carrying capacity >13,000 t of tuna. The total cumulated nominal effort exerted during the year was 3,673 and 3,185 fishing and searching days, respectively. The French purse seiners cumulated a total of more than 2,800 fishing sets, with 1 third made on free-swimming schools (FSC) and 2 third realised on schools associated with fish aggregating devices (FADs). The total annual landings of the principal market tunas by the French purse seine fishing fleet has remained very stable during 2010-2013, with a total of 66,000 t landed in 2013. The landings were composed of more than 55%, 33%, and 10% yellowfin, skipjack, and bigeye, respectively. Catch on FADs increased by 36% between 2012 and 2013 to reach more than 46,000 t. The proportion of yellowin in FAD-catch has strongly increased in the recent years and reached 45% in 2012-2013.* – see paper for full abstract."

European Union purse seine fisheries

29. The WPTT **NOTED** paper IOTC–2014–WPTT16–13 which provided an overview of the statistics of the European Union and associated flags purse seine fishing fleet targeting tropical tunas in the Indian Ocean (1981-2013), including the following abstract provided by the author:

> "*In 2013, the European and associated flags (EAF) purse seine fishing fleet of the Indian Ocean was composed of 35 vessels of individual capacity >800 t, which all represented a total carrying capacity >45,000 t of tuna. The total cumulated nominal effort exerted during the year was about 10,000 and 8,000 fishing and searching days, respectively. The EAF purse seiners cumulated a total of more than 9,300 fishing sets, with 80% made on FAD-associated schools (FAD) and 20% realised on free-swimming schools (FSC). The total annual landings of the principal market tunas by the French purse seine fishing fleet increased by 20% between 2012 and 2013 and reached more than 270,000 t. The landings were composed of about 49%, 42%, and 9% yellowfin, skipjack, and bigeye, respectively. Total catches on FAD-associated schools increased from 150,000 t in 2012 to about 225,000 t in 2013 (+50%) while catches on FSC substantially decreased from 78,000 t to about 45,000 t (-43%).* – see paper for full abstract."

30. **NOTING** the decrease in catch rates of skipjack tuna from around FAD, concomitant with the increase in catch rates of yellowfin tuna around FADs, the WPTT **REQUESTED** that the authors investigated the reasons for the change and to report back to the WPTT in 2015.

31. **NOTING** that species composition around FADs may be dependent on time, as has been observed in the Pacific, the WPTT **REQUESTED** that this aspect is further investigated in order to understand the relative change in species composition observed in FAD sets.

32. **NOTING** that catches of skipjack tuna from free schools have almost disappeared in recent years, the WPTT **REQUESTED** that further research be undertaken to better understand the decline of catch rates of skipjack tuna on free swimming schools.

33. The WPTT **NOTED** that the number of sets on FADs has been relatively stable during the period of 2010 to 2013, but that the number of sets per searching day increased and are being maintained at high levels during this period. The increase in the use of artificial FADs in recent years could explain this trend.

Modelling spatial behaviour of tropical tuna purse seine fleet

34. The WPTT **NOTED** paper IOTC–2014–WPTT16–14 which provided the results of a study modelling the spatial behaviour of a tropical tuna purse seine fleet, including the following abstract provided by the author:

> "*Industrial tuna fisheries operate in the Indian, Atlantic and Pacific Oceans, but concerns over sustainability and environmental impacts of these fisheries have resulted in increased scrutiny of how they are managed. An important but often overlooked factor in the success or failure of tuna fisheries management is the behaviour of fishers and fishing fleets. Uncertainty in how a fishing fleet will respond to management or other influences can be reduced by anticipating fleet behaviour, although to date there has been little research directed at understanding and anticipating the human dimension of tuna fisheries. The aim of this study was to address gaps in knowledge of the behaviour of tuna fleets, using the Indian*

Ocean tropical tuna purse seine fishery as a case study. We use statistical modelling to examine the factors that influence the spatial behaviour of the purse seine fleet at broad spatiotemporal scales. This analysis reveals very high consistency between years in the use of seasonal fishing grounds by the fleet, as well as a forcing influence of biophysical ocean conditions on the distribution of fishing effort. – see paper for full abstract."

35. The WPTT **NOTED** that it would be positive to consider the effort devoted and catch rates of each of the strata to model the fleet behaviour, such as monthly aggregated data 1 by 1 º would only reflect the stationality of the fleet. Fine scale modelling of group level dynamics would be required to better anticipate model fleet behaviour in such a dynamic system. The size of the fleet could also be of relevance for this study. The environment can also play an important role when the catch rates are included in the model rather than just modelling the presence/absence of effort in monthly aggregated data 1x1º.

EU,Spain purse seine fleet

36. The WPTT **NOTED** paper IOTC–2014–WPTT16–15 which provided an overview of the statistics of the EU,Spain purse seine fleet operating in the Indian Ocean (1990-2013), including the following abstract provided by the author:

"*This document presents summary statistics of the purse seiner Spanish fleet fishing in the Indian Ocean from 1990 to 2013. Data include catch and effort statistics as well as some fishery index by species and fishing mode. Information about the sampling scheme and the coverage of sampling, together with maps and diagrams representing the fishing pattern of this fleet by time and area strata is also included.*"

New approaches for standardising purse seine CPUE

37. The WPTT **NOTED** paper IOTC–2014–WPTT16–16 which outlined some new approaches for standardising tropical purse seine CPUEs, including the following abstract provided by the author:

"*Indices of CPUE are presented for skipjack tuna (Katsuwonus pelamis) for the Indian Ocean over the period 1980-2013. The analysis was initiated under the framework of the E.U. research project CECOFAD, whose objectives are to enhance our understanding of fishing effort units and improve the accuracy of purse-seine CPUE estimates. Skipjack stock assessments mainly depend on abundance indices derived from purse-seine fleets, thus standardisation of purse seiner CPUEs for this species is a priority. We follow a CPUE definition framework where three different types of CPUE are calculated to describe trends in number of schools, school detectability and catchability and school size. CPUE standardization is typically achieved with the development of GLM models; these estimates are often biased because the range of the fishing area changes from one year to the next. We compare CPUE trends derived from conventional GLMs with trends based on GLMMs, where the spatial explanatory variables are treated as a random effect.* – see paper for full abstract."

38. The WPTT **NOTED** that the inter-annual variation of the distribution is also used in the IWC, but the model is simpler than that presented here. The aim of the work in the IWC is to evaluate the effect on the uncertainty of cpue and WPTT encourages coming progress in this work. These results show a CPUE series of free swimming school skipjack tuna, is relatively stable and that the decreasing trends showed in other works are not that clear here.

Spatial closure impacts on tropical tuna purse seine fleets

39. The WPTT **NOTED** paper IOTC–2014–WPTT16–17 which provided an examination of the impact of spatial closures on the behaviour of a tropical tuna purse seine fleets, including the following abstract provided by the author:

"*The use of spatial tools in fisheries management, which include marine reserves and temporary closures, has become increasingly popular in addressing problems of sustainability (Gell and Roberts, 2003; Hilborn et al., 2004; Sumaila et al., 2007). As with any other fisheries management tool, it is important to evaluate the performance of closed areas in achieving their objectives. Considerable work has focused on evaluating the conservation benefits to fish stocks and marine habitats within closed areas (Halpern and Warner, 2002; Halpern et al., 2009; Hart, 2006; Lester et al., 2009), as well as the contribution of closures to improving fishery yields (Gaines et al., 2010; Gell and Roberts, 2003; Sale et al., 2005). However, far less attention has been directed at evaluating the wider management implications of closed areas and, in particular, how a closure affects the dynamics of effort allocation in a fishery. To do this, a promising approach is to build up a counterfactual scenario of fleet behaviour by developing a predictive model of effort allocation that accounts for a broad range of influences on fishery dynamics.* – see paper for full abstract."

40. The WPTT **NOTED** that the behaviour of the EU,France and EU,Spain fleets during both closures were different, possibly explained by differences in fishing strategies. In the case of the IOTC closure, while

EU,Spain vessels redistributed the effort eastwards, EU,France vessels redirected their effort to the south. With the implementation of the UK(OT) closure, the EU,France vessels redirected their effort eastwards or southwestards while the EU,Spain fleet redistributed their effort westwards.

41. The WPTT **NOTED** that some observations east of Madagascar for the EU,France fleet during the UK(OT) closure may be associated to fishing days during trips towards harbours and not as a different behaviour during the closure.

42. The WPTT **NOTED** that effort units in the IOTC database are searching days associated to catch/sets and acknowledges that the use of the binary effort (presence/absence) units may not be the best one to model the effect of the closure on the fleet behaviour. This was identified as one of the weaknesses of the model.

Non-entangling FADS: impacts on incidental catches

43. The WPTT **NOTED** paper IOTC–2014–WPTT16–18 which provided an analysis of the impact of non-entangling FADs on incidental catches in the Indian Ocean tuna fishery, including the following abstract provided by the author:

    "*This document presents the results of the analysis of catch data from three purse-seiner vessels operating at the Indian Ocean using entangling (mesh surface and hanging open) and non-entangling FADs (mesh surface and hanging attached) to fish tuna. Skipjack (<u>Katsuwonus</u> <u>pelamis</u>) was the main species in the reported captures, but also yellowfin (<u>Thunnus</u> <u>albacares</u>) and the bigeye tuna (<u>T. obesus</u>) were target species. Twelve other species, considered as by-catch, were also caught during the fishing operations. Results showed that fishing on non-entangling FADs was more sustainable than that carried on entangling devices, particularly in relation to the number of sharks and turtles entangled. However, the efficiency of fishing operations done on non-entangling FADs was not different to that reported on traditional ones.*"

44. The WPTT **REQUESTED** clarification about the work in relation to how FAD entanglement was observed (i.e. if the FAD was taken out of the sea) as this may affect the results. Some of the non-entangling FADs can become entangling FADs after some months in the waters if nets are rolled up in to "sausages".

EU,Spain FAD management plan

45. The WPTT **NOTED** paper IOTC–2014–WPTT16–19 Rev_1 which detailed the EU,Spain fish aggregating device management plan, including the following abstract provided by the author:

    "*This document analyzes the Fish Aggregating Device National Management Plan undertaken by the Spanish General Secretariat of Maritime Fisheries (Ministry of the Environment, Marine and Rural Affairs), in collaboration with the Spanish Institute of Oceanography (Ministry of Economy and Competitiveness), and presents preliminary data obtained in 2013 on the number of FADs deployed by quarter, number of active FADs by quarter, FAD characteristics, types and materials used in its construction and activities on objects and geographical distribution of these activities.*"

46. The WPTT **ACKNOWLEDGED** the progress made by presenting FAD numbers, and **NOTED** the 448 FADs were followed daily and 915 FADs were deployed in 2013 by an average EU,Spain purse seine vessel (preliminary number, due to possible double-counting of FADs by vessels belonging to the same enterprise).

47. **NOTING** the validity of FAD data to standardise the FAD CPUE, the WPTT **SUGGESTED** that the authors work to gather historical information about number and use of FADs.

48. The WPTT **NOTED** the importance of collecting information on the retrieval of FADs in the FAD Management Plans.

49. The WPTT **NOTED** that the implementation of Non-Entangling FADs is already in progress in 2013 (as required in Resolution 13/08) which should allow a reduction in mortality due to entanglement and that it would be positive to set milestones for reaching the 100% of non-Entangling FADs in the FAD Management Plans developed (20% of non-entangling FADs were reported in 2013, although the percentage is likely to be under reported). In that respect, it is the intention of the EU,Spain fleet to use only non-entangling FADs by 2015.

50. The WPTT **AGREED** that the protocols for collecting the information about FAD activities needs to be standardised across different FAD Management Plans.

EU,France purse seine fleet FAD use

51. The WPTT **NOTED** paper IOTC–2014–WPTT16–20 which provided the historical perspective and current practice of use of artificial fish aggregating devices by the EU,France tropical tuna purse seine fleet, including the following abstract provided by the author:

"*Recent resolutions of the Indian Ocean Tuna Commission (IOTC) have been implemented to improve scientific knowledge on the effects of drifting fish aggregating devices (DFADs) through increased data collection and reporting. Here, we report information on DFADs collected from three distinct data sources to describe the use of DFADs and buoys by the French PS fleet of the Indian Ocean over the last decade. First, archives of buoy purchase orders during 2002-2014 were provided by fishing companies to give insight into the historical use of DFADs. Data show an homogeneity of the numbers of buoys available to each purse seiner and a steady increase of about 10 buoys per year per vessel, from 50-60 in the early 2000s to 200 in 2013. Second, information derived from satellite transmission data was made available for the period 2010-2013 based on quarterly reports that are produced by buoy supplier companies on a vessel basis.* – see paper for full abstract."

52. The WPTT **ACKNOWLEDGED** the progress made by presenting FAD numbers and characteristics being collected in the EU,France FAD Management Plan.

53. The WPTT **NOTED** that information on FADs has been collected systematically since October 2012 when the FAD logbook was implemented in the fleet. No information on the use of non-Entangling FADs is provided in the document as it is not collected in the FAD logbook.

54. The WPTT **NOTED** that it is necessary that all countries fishing on FADs (both anchored and drifting) present their FAD Management Plans as set out in Resolution 13/08.

Drifting FAD estimation

55. The WPTT **NOTED** paper IOTC–2014–WPTT16–21 which provided an estimation of the number of fish aggregating devices that are currently drifting in the Indian Ocean, including the following abstract provided by the author:

"*Since the mid 1990s, drifting Fish Aggregating Devices (dFADS), artificial objects specifically designed to aggregate fish, have become an important mean of catching tropical tunas in the Indian Ocean for the purse seine fleet. In recent years, the massive deployments of dFADs as well as the massive use of tracking GPS and echosounder buoys on dFADs and natural floating objects (logs) have raised serious concerns for tropical tuna stocks but also regarding the possible modifications in ecosystem functioning. However, relatively little remains known on the modalities of dFAD and tracking buoy use by purse seiners. These knowledge gaps render difficult the evaluation of the impacts of fishing practices with dFADs and logs. For the first time, the three French fishing companies operating or having operated in the Indian Ocean provided the GPS buoy tracks of a large proportion of the dFADs and logs monitored by the French fleet.* – see paper for full abstract."

56. The WPTT **NOTED** the increase in the number of FADs with echo-sounder buoys used by the EU purse seine fleet between 2007 and 2013. To understand the ecological effect of FADs, the spatio-temporal density of natural objects in relation to artificial FADs should be accounted for.

57. The WPTT **NOTED** that this approach can be used to assess the fishery impacts of FADs and to investigate the optimum number of FADs that can be deployed provided that the different confounding effects affecting the catch rates of FADs are determined.

Managing purse seine effort by limiting dFADs

58. The WPTT **NOTED** paper IOTC–2014–WPTT16–22 which provided options for managing tropical tuna purse seine fisheries through limiting the number of drifting fish aggregating devices in the Indian Ocean, including the following abstract provided by the author:

"*This paper deals with the use of drifting fish aggregating devices (DFADs) in the Indian Ocean and of the potential interest to manage purse seine fisheries through limiting their number. Potential risks associated with a massive use of DFADs are first discussed. Based on new information on the numbers of DFADs released by the French fleet in the 2003-2014 period, this paper estimates the levels and trends of the total numbers of DFADs deployed and active at-sea. It is estimated that the total number of DFADs numbers has been increasing by about 70% since the early 2000s and that they could reach 10,500-14,500 nowadays. A good knowledge of the total numbers of DFADs is urgently needed to better estimate the fishing effort and capacity of purse seine fisheries. Future limitations in the number of DFADs could be a direct and efficient way to reduce fishing effort exerted by purse seiners and their support vessels.* – see paper for full abstract."

59. The WPTT **NOTED** that a similar paper was discussed at the ICCAT last SCRS where it was agreed to create a working group to analyse the information collected in FAD Management Plans, started in recent years (IOTC Resolution 13/08), in order to assess their effects in the fishing mortality exerted by purse seine vessels.

60. The WPTT **AGREED** that a similar working group is created in the IOTC and that it should be included in the WPTT Program of Work. This working group will discuss different management options for the purse seine fleet, and also for other fleets, to reduce the effort as appropriate. In evaluations of the likely impacts on yield and stock status of the tropical tunas and future management options, the fleet development plans should be taken into account. As this question is global, this could be a discussion carried out among all RFMOs. An economic analysis of the optimum number of FADs should also be included in discussions.

61. The WPTT **NOTED** that the information on the increasing number of FADs and capacity increase would be important to include in the Management Strategy Evaluation framework currently in progress. The ecological impact of the increasing number of FAD used should also be investigated.

Ocean-climate interactions (Eastern Indian Ocean)

62. The WPTT **NOTED** paper IOTC–2014–WPTT16–23 which provided an overview of ocean-climate interactions in the eastern Indian Ocean for tuna fisheries and possible socio-economy impacts, including the following abstract provided by the author:

> "*The complexity of the climate - ocean interactions in Indonesia is caused by the Indonesia's geographical position at the crossroads of the Indian and the Pacific Ocean. Periodic phenomena such as ENSO, and non- periodic such as IOD affect Indonesian Monsoon system. A large volume of water masses from the Pacific Ocean that flows into the Indian Ocean passing through the territorial sea of Indonesia (Indonesian Through- flow) helps to provide a balance to the ocean climate in Indonesia as part their migration areas. For Tuna fisheries in Indonesia, Indian Ocean plays an important role for tuna's habitat. This article describes the physical condition of the ecosystem in the East Indian Ocean based on archive data of the climate - sea survey, and also describes sustainable tuna habitat survey data based on tuna catches data. The southern part of Indian Ocean is a high primary productivity area for tuna because there is a periodic Java upwelling system occurred between June and October annually, and the eddy current system encourages nutrients and chlorophyll from the coast towards the open sea.* – see paper for full abstract."

63. The WPTT **ACKNOWLEDGED** the work presented and encouraged the authors to continue working on aspects relating environmental parameters with fisheries.

Climate and oceanographic conditions in the Indian Ocean

64. The WPTT **NOTED** paper IOTC–2014–WPTT16–24 which provided an outline of climate and oceanographic conditions in the Indian Ocean, including the following abstract provided by the author:

> "*In this paper, we provide an update on the trends of climate and oceanographic conditions in the Indian Ocean, at both basin and regional scales. The ENSO cycle has been largely fluctuating between ENSO-neutral and Niña conditions during the past 4 year and is considered being in a neutral state in 2014. Forecast coupled models give a 58% chance that an El Nino will develop by the end of 2014, but there is consensus that, if it does so, it will be a weak event. The sea surface temperature (SST) of the whole Indian Ocean has increased by +0.68°C from the 1950s to the 2000s (50 years) and this warming is still ongoing. Investigating the patterns of inter-annual variability between the East and West regions of the Indian Ocean, we found a good coherence for SST whereas the sea surface chlorophyll (SSC) had more contrasted patterns. The magnitude of SSC anomalies is also greater in the West compared to the East.* – see paper for full abstract."

65. The WPTT **NOTED** that it is important to have such information in order to better understand the effects of environmental drivers in the productivity and catch rates of the tropical tunas as different species are affected differently by those drivers. It is also necessary to investigate long term changes in environmental parameters in order to identify productivity changes as have been suggested in other areas.

Electronic monitoring system options for purse seine fleets

66. The WPTT **NOTED** paper IOTC–2014–WPTT16–51 which provided a preliminary study on the suitability of an electronic monitoring system to record scientific and other information from the tropical tuna purse seine fishery, including the following abstract provided by the author:

> "*Electronic monitoring systems (EMS) are used in some fisheries to collect the same types of scientific information that human observers can collect, and in some cases for compliance with existing regulations. An EMS system was tested previously onboard a tropical tuna purse seiner in the Atlantic Ocean and it showed that the system could perform very well in many tasks. Since then, 17 purse seine vessels operating in the 4 RFMO´s, have been equipped with a different EMS that has been developed recently by SATLINK (SeaTube). In this paper, we present preliminary analyses comparing information collected by human observers from the IEO and recordings of the SeaTube system reviewed by DOS (Digital Observer Services) of 103 sets made along 4 trips in 2 different vessels in the Atlantic Ocean. We*

compare in particular estimates of catch per set (for target and non-target species), amounts of discards, fishing effort type and set location. – see paper for full abstract."

67. The WPTT **NOTED** that the use of the image analysis system which allows filtering of the image based on the activity (e.g. velocity of the vessels indicating a set) and, thus, reducing the time needed to analyse all the images of the trip. As such, the review of images can be done by selecting the recordings that belong to the fishing operations. It would require around two hours to review a set.

68. The WPTT **NOTED** that these tools are meant to complement onboard scientific observers work but not to replace observers, as some of the tasks of observers cannot be carried out with electronic monitoring. It might be difficult to establish species composition with these tools despite recent improvements; however, cameras put in the tracks could help to improve species composition estimations in the near future. The system is quite robust to measure total catch and, therefore, could be very useful to collect basic fishery information on vessels that does not report catches and to verify the best practices of the fleet.

69. The WPTT **NOTED** that the ICCAT is working towards the adoption of minimum standards for Electronic Monitoring Systems given that, according to recent analyses conducted, they can provide very useful information on fishing trips and be a complement to port sampling and human observer programs for tropical tuna purse seine fisheries. Since there are several vendors and multiple possible system configurations, these standards would aim to standardise the implementation of Electronic Monitoring systems and to ensure that the systems can result in collecting useful information for fisheries monitoring. ISSF's technical report 2014-08 "*Updated guidance on Electronic Monitoring Systems for tropical tuna purse seine fisheries*" could be used as a starting point for this objective. The Sub-Committee also noted the need to determine best practices for the integration of information from EMS, human observer, and port sampling programs.

Development of new MSY indicators

70. The WPTT **NOTED** paper IOTC–2014–WPTT16–52 which provided an overview of an EU project aiming to develop new MSY indicators (MyFISH), including the following abstract provided by the author:

    "*The Indian Ocean (IO) is an area of great commercial interest for European fishing industries. Among others, European fleets target bigeye, yellowfin and skipjack, three tuna species that conform the known as tropical tuna fisheries in the IO. These species inhabit international and national jurisdiction waters, which makes them prone for their collective management through Regional Fisheries Management Organizations (RFMO). The Indian Ocean Tuna Commission (IOTC) is an intergovernmental organization responsible for the management of tuna and tuna-like species in the IO. The Commission has among other functions, responsibilities on (1) data collection, (2) research coordination, (3) the adoption of conservation and management measures to ensure the conservation of fish stocks and to promote their optimal utilization, and (4) consider socioeconomic aspects of fisheries considering the interests of developing coastal States. Within IOTC, the Maximum Sustainable Yield (MSY) has been used as a recommended target reference point for the tropical tuna fisheries.* – see paper for full abstract."

71. The WPTT **NOTED** that the work is in line with the planned IOTC activities for Management Strategy Evaluation. As part of IOTC Resolution 14/03 *On enhancing the dialogue between fisheries scientists and managers*, a science-management dialogue process has commenced and will be meet before the next Session of the Commission. The process must include all stakeholders in the IOTC process.

Kobe I (Kobe plot) + Kobe II (risk assessment) software

72. The WPTT **NOTED** paper IOTC–2014–WPTT16–53 Rev_2 which provided an update on the software developed to produce Kobe I (Kobe plot) + Kobe II (risk assessment), including the following abstract provided by the author:

    "*This is the users' manual describing how to use the 3rd version of Kobe I (stock status trajectory plots) +Kobe II (risk assessment diagram) software. Kobe I and II were recommended by the 5 tuna-RFMO meeting in 2007 (Kobe, Japan) and 2009 (Barcelona, Spain) respectively. This software is free of charge available at http://ocean-info.ddo.jp/kobeaspm/kobeplot/KobePlot.zip (from Nov. 19, 2014). After users use this software and if users need improvements, please let us know. We will revise and will release more user's friendly software. As for Kobe II, the risk assessment matrix format was recommended, but the table formats have been difficult to understand its meanings often, especially for mangers and industries as it uses mathematical and technical notations. To improve this situation, we developed the visualized presentation (diagram) of the matrix for anyone to be able to understand its meanings easily. Please note that this software is suitable for those who have difficulties to make Kobe I plot and II quickly and effectively in a very short time, especially during the working meetings.* – see paper for full abstract."

73. The WPTT **NOTED** that the software will make it easier for those undertaking stock assessments to graphically represent the results in a standardised format, consistent with IOTC Recommendation 14/07.

74. The WPTT **THANKED** Japan for the development of a user friendly software for the development of Kobe plot and Kobe II Strategy Matrix for use in the IOTC stock assessment process which will facilitate the capacity building in the region.

AD Model builder software

75. The WPTT **NOTED** paper IOTC–2014–WPTT16–54 Rev_1 which detailed the AD model builder implemented age-structured production model (ASPM) software, including the following abstract provided by the author:

> "*This user's manual describes how to run the 3nd version of the AD Model Builder implemented Age-Structured Production Model (ASPM) software. In the 3nd version, we added the batch job option to conduct the grid search to find most optimum parameters effectively. In the previous versions, users can make only one ASPM run at once. In this way, searching optimum parameters normally is laborious and takes a very long time by trials and errors. Even an optimum parameter set were found, they might be local minima which will provide biased results. This batch option improves such situation. In the next version 4, we will develop the ASPM with size data option as CAA often include biases when size data are converted to age and such biases will become higher especially when number of size data are very limited. This software is free of charge. If some wants to obtain this software, please download from http://ocean-info.ddo.jp/kobeaspm/aspm/ASPM.zip (available from Nov. 18, 2014).* – see paper for full abstract."

76. The WPTT **THANKED** Japan for the development of the ASPM software for use in the IOTC stock assessment process which will facilitate the capacity building in the region.

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

5.1 Review of the statistical data available for bigeye tuna

77. The WPTT **NOTED** paper IOTC–2014–WPTT16–07 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 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*, for the period 1950–2013. 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.

78. 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.

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

80. 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, and **ACKNOWLEDGED** the work of Maldives to improve the estimate of juvenile bigeye tuna, presented in paper IOTC–2014–WPTT16–26.

81. The WPTT **NOTED** than during 2014, the IOTC-OFCF Project has conducted two data collection workshops with the Directorate General of Capture Fisheries of Indonesia (DGCF) aimed at improving the species identification of juvenile tunas by enumerators at selected Provinces in Indonesia. In addition, the IOTC-OFCF Project and BOBLME are currently funding a pilot sampling project in the Provinces of West Sumatera and North Sumatra to monitor the activities of coastal fisheries and assess catches of neritic tunas and juvenile tunas.

82. **NOTING** that catches of bigeye tuna reported by India to the IOTC Secretariat have decreased from around 3,000 t in 2011 to less than 1 t in 2013 – while catches of yellowfin tuna have increased by more than 17,000 t over the same period – the WPTT **REQUESTED** that the issue be investigated by the IOTC Secretariat in collaboration with India, and an update to be provided at the next WPTT.

Length Frequency inter-sessional meeting guidelines

83. The WPTT **NOTED** that despite the progress made by both Japan and Taiwan,China in resolving issues with the reliability of the size data for longline caught bigeye tuna (and yellowfin tuna) (e.g., low sampling rate, and discrepancies in catch, effort, and notably size data), a number of key matters remain to be resolved. Thus, the WPTT **RECALLED** the recommendation from the SC in 2013: SC Recommendation: SC16.41, para. 88 of the

SC16 Report), and **ENCOURAGED** all CPCs with longline fleets to 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

Indonesia: bigeye tuna distribution from observer data

84. The WPTT **NOTED** paper IOTC–2014–WPTT16–25 which provided spatial and temporal distribution of bigeye tuna in eastern Indian Ocean on RITF scientific observer data from 2005 to 2013, including the following abstract provided by the author:

> "*Bigeye tuna (Thunnus obesus) is one of the important catch for the fishing industry in Indonesia. The aim of this study is to determine the spatial and temporal distribution of bigeye tuna in the Eastern Indian Ocean. Scientific observers on tuna longline vessels conducted data collection, mainly based in Port of Benoa Bali, from August 2005 to November 2013. Total of 5,340 bigeye tuna were caught and as many as 5,253 of them measured in length. Distribution of bigeye tuna caught by Indonesia tuna longline spreads from 0°-33° S and 76°-128° E. The highest percentage of bigeye tuna > 110 cm (Lm) occurred in the west of West Sumatera and in the South of East Java. There was significant difference in the hook rate by months with the highest hook rate occurred in August with 0.54/100 hooks. This research recommends that fishermen should conduct fishing operations in areas that have a high percentage of bigeye tuna length > 110 cm (Lm), to provide opportunities for the species to spawn at least once throughout their life.* – see paper for full abstract."

85. The WPTT **NOTED** that catches are very important in terms of quantity caught, yet the area described in these data is fairly limited.

86. The WPTT **ENCOURAGED** that available copies of the observer data be submitted to the IOTC Secretariat, at the earliest convenience.

Maldives: bigeye tuna and yellowfin tuna size ratio and distribution

87. The WPTT **NOTED** paper IOTC–2014–WPTT16–26 which provided some details on yellowfin tuna and bigeye tuna ratio and size distribution in the Maldivian tuna fishery, including the following abstract provided by the author:

> "*The main target of livebait tuna pole-and-line fishery of the Maldives is surface-schooling skipjack (Katsuwonus pelamis). A small proportion of juvenile yellowfin tuna (Thunnus albacares) is also caught with skipjack. Presence of juvenile bigeye tuna (T. obesus) in the yellowfin component was first noticed in 1986. Review of data up to 1990 showed that proportion of bigeye in the Thunnus component was higher in the south than in the north. A small-scale tuna tagging experiment during mid-1990s allowed reasonable amount of sampling to provide estimates of bigeye in pole-and-line yellowfin component to be 15% in the south (1° 55'N – 0° 25'S) and 1.3% in the north (7°00'N- 4°50'N). Here we attempt to revise this information on bigeye composition and their size distribution from tag release data of the IOTC Regional Tuna Tagging Project. Estimates indicate bigeye composition in Thunnus catch was 4% in the north (north of 2°N), where as in the south it was 22%.* – see paper for full abstract."

88. The WPTT **ACKNOWLEDGED** the work and progress done by Maldives to improve the estimates of juvenile bigeye tuna.

89. The WPTT **REQUESTED** that the Maldives and the IOTC Secretariat work together to evaluate the new estimates of bigeye tuna catches and ensure consistency, as far as possible, between data published by the IOTC Secretariat and Maldives.

Bigeye tuna and yellowfin tuna CPUE spatial considerations

90. The WPTT **NOTED** paper IOTC–2014–WPTT16–27 Rev_1 which detailed spatial considerations in bigeye tuna and yellowfin tuna CPUE from Japanese and Taiwan,China longline fisheries in the Indian Ocean, including the following abstract provided by the author:

> "*Aggregated catch and effort data from the Japanese and Taiwan,China longline fisheries were analyzed in order to investigate spatial patterns in CPUE trend and effort concentration. Analyses were carried out by region and also at finer spatial scales, as well as by fleet and species. The CPUE standardizations used generalized linear models that included temporal effects and 5 degree grid squares, and assumed lognormal error distributions. Gulland's index of effort concentration was extended to include standardized CPUE, which reduced noise and bias in the index, and facilitated comparison with long-term spatial abundance patterns. Results indicated that the differences in CPUE trend between fleets were maintained when fishing locations were taken into account. They also indicated spatial differences*

in CPUE trend within fleets and regions, which are likely to be at least partly due to apparent differences in targeting, but may also be affected by differences in abundance trends, and differences in reporting. – see paper for full abstract."

91. The WPTT **ACKNOWLEDGED** the progress made to investigate the discrepancies identified in previous WPTT between Japan and Taiwan,China longline CPUE and **REQUESTED** the authors to continue working to solve the pending issues before the next round of bigeye tuna and yellowfin tuna assessments.

92. The WPTT **NOTED** that while the CPUE trend for both fleets were similar for yellowfin tuna, they were very different for bigeye tuna. Spatial variation is very important to address in CPUE and that for doing so changes in targeting, vessel effect and other covariates should also be taking into account.

5.3 Data for input into stock assessments

Bigeye tuna and yellowfin tuna: Comparison of longline CPUE series for Japan and Taiwan,China

93. The WPTT **NOTED** paper IOTC–2014–WPTT16–28 Rev_1 which provided the results of a provisional study on comparing CPUE trends of bigeye tuna and yellowfin tuna between the Japan and Taiwan,China longline fisheries based on whole and shared strata in the Indian Ocean, including the following abstract provided by the author:

"*Fishing effort and bigeye and yellowfin catch data of Japanese and Taiwan-China longline fisheries in the Indian Ocean was analyzed to develop the core area where the effort of both fleets has historically covered to be used for CPUE standardization. The region from 10N to 15S showed relatively high coverage of effort and catch of both species of both fleets, this tropical area was defined as core area for both species. If different trend of CPUE of both fleet is mainly derived from the difference of fishing ground, both CPUE trend should be closer by applying core area. Tropical area from 10N to 15S was selected as core area. Bigeye and yellowfin CPUEs are standardized applying simple model for whole strata and for strata shared by both fleet in the core area (15N-15S was used in this case), and their trends are provisionally compared between both fleets. –* see paper for full abstract."

94. The WPTT **NOTED** that fundamental questions remain about why the time series differ between the two fleets. The author suggested that reasons for the remaining differences may include fishing position and gear configuration.

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

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

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

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

Japan longline CPUE comparison for bigeye tuna and yellowfin tuna

99. The WPTT **NOTED** paper IOTC–2014–WPTT16–31 which detailed CPUE of bigeye tuna and yellowfin tuna caught by Japanese longliners in the Indian Ocean standardised by GLM considering several aspects of area, catchability and data resolution, including the following abstract provided by the author:

"*Using Japanese and Taiwan-China longline catch and effort data aggregated by 5x5 degree and month, bigeye and yellowfin CPUE in the tropical Indian Ocean from 10N-15S (core area) were standardized from 1967 to 2012. Bigeye CPUE of both fleets showed quite similar trends until 1976, after which Taiwan-China CPUE did not show a clear trend but continued at a similar level. Japanese CPUE increased suddenly in the mid-1970s, remained at a high level until 1991, and then decreased steadily to about half the level of the mid-1980s by 2002. In the case of yellowfin, the CPUE trends of both fleets showed generally similar trends, with a large decline before 1979, relatively stability until 2005, and sudden decreases to less than half the 2003-2005 level by 2008. For both species and both fleets, large differences were not observed between standardized CPUE derived from all strata and that from strata shared by both fleets. –* see paper for full abstract."

100. The WPTT **NOTED** that the changes in fishing efficiency estimated using vessel identification, represents changes associated with the changing composition of the fleet, but do not account for changes of individual vessels.

101. The WPTT **NOTED** the different targeting practices of the Taiwan,China and Japan fleets, and in particular that the Japan fleet has tended to use more hooks between floats than the Taiwan,China fleet.

102. The WPTT **ENCOURAGED** the exploration of other approaches to identify effort by targeting strategy instead of the current approach based on gear configuration which has been used so far.

Taiwan,China longline CPUE comparision for bigeye tuna and yellowfin tuna

103. The WPTT **NOTED** paper IOTC–2014–WPTT16–55 which detailed an analysis of Taiwna,China longline fisheries based on operational catch and effort data for bigeye tuna and yellowfin tuna in the Indian Ocean from 1979 to 2012, including the following abstract provided by the author:

> "*We compared nominal and standardized bigeye and yellowfin CPUE using Taiwanese longline catch and effort data, both operational and aggregated by 5x5 degree square and month, in the tropical Indian Ocean between 10N-15S (core area) from 1979 to 2012. Nominal and standardized bigeye CPUE for both data types showed quite similar trends. The standardized bigeye CPUE trend from operational data kept at nearly the same level from 1970 to 2012. In the case of yellowfin, CPUE trends of both data types showed similar trends but with small differences in amplitude; overall they were relatively stable until 2005, then decreased to less than half in 2009 from the 2003-2005 level. Historical change in the fishing efficiency of the Taiwanese longline fishery was estimated for bigeye and yellowfin by including Vessel ID in the standardization using operational data. The estimated fishing efficiency for bigeye across all core areas increased from 0.9 to 1.1 during 1979 ~ 2012.* – see paper for full abstract."

104. The WPTT **WELCOMED** this contribution from Taiwan,China, which addressed several concerns raised at WPTT15. It was indicated from the author that cluster analysis may have advantages over NHBF as a targeting proxy, since the depth of the set depends on the whole gear configuration. Further exploration of this issue would be useful for discussion at the next WPTT meeting.

105. The WPTT **NOTED** that the bigeye tuna CPUE series is relatively stable for the entire series (Fig. 1) in comparison to the Japan and Rep. of Korea series, which could be because the main species targeted was bigeye tuna throughout the study period. Other possible reasons for this difference may be the spatial stratification of the effort between the two fleets.

106. The WPTT **NOTED** that a joint analysis of the Rep. of Korea, Japan, and Taiwan,China operational level data is needed to attempt to resolve the differences in patterns between the Taiwan,China, Japan and Rep. of Korea and other longline catch rates and that the methods described in this study may be generally applicable to the operational data for other longline data.

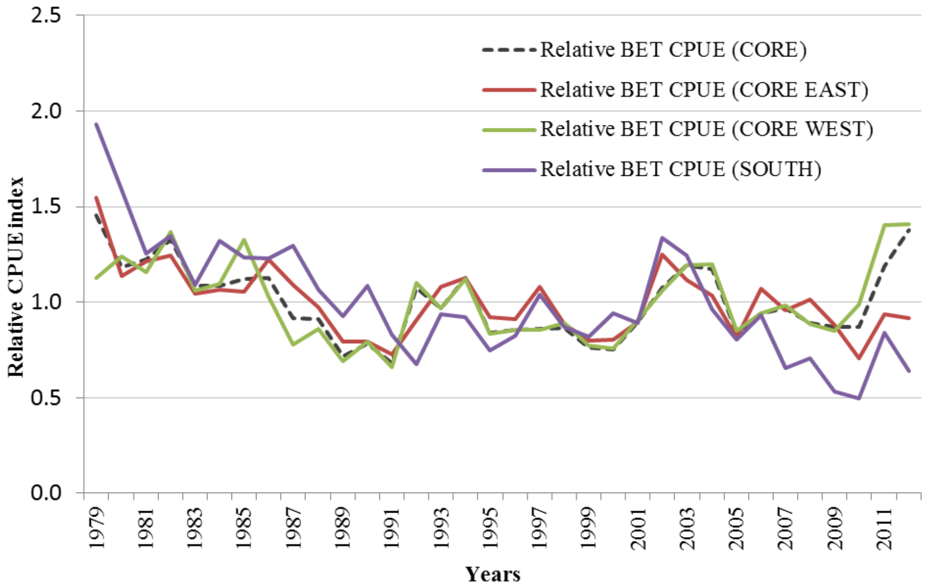


Fig. 1. Bigeye tuna: Comparison of the standardised longline CPUE series (by area) for Taiwan,China. Series have been rescaled relative to their respective means from 1979–2012.

Japan longline CPUE for bigeye tuna

107. The WPTT **NOTED** paper IOTC–2014–WPTT16–29 Rev_1 which provided the Japanese longline CPUE for bigeye tuna in the Indian Ocean standardised by GLM from 1960 to 2013, including the following abstract provided by the author:

> "*Standardization of Japanese longline CPUE for bigeye tuna was conducted for 1960-2013 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 2013 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 slightly decrease in the latest year are seen as for each area.* – see paper for full abstract."

108. The WPTT **WELCOMED** the updated catch rate standardisation for the Japan fleet in the Indian Ocean for bigeye tuna (Fig. 2).

109. The WPTT **NOTED** that the change in gear appears to have had the effect of increasing the catch ratio of yellowfin tuna in the Japan longline catch when compared to bigeye tuna and that shrinkage of the Japanese fishing ground might be better accounted for by finer scale area definitions.

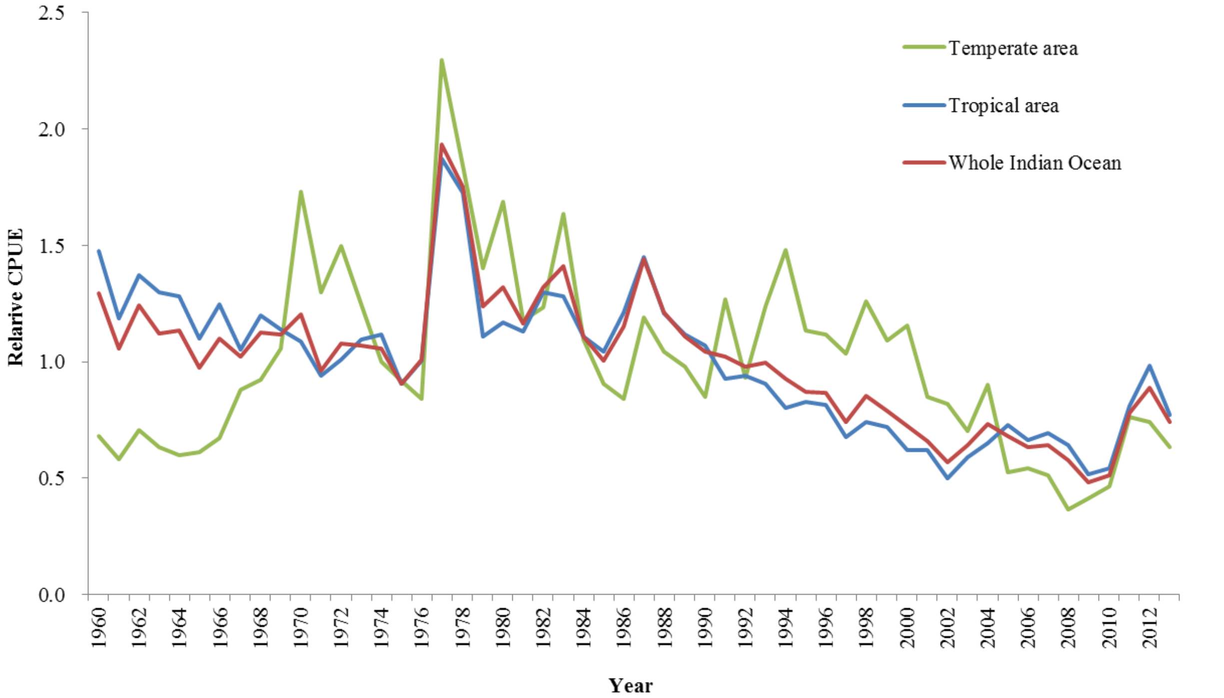


Fig. 2. Bigeye tuna: Comparison of the standardised longline CPUE series for Japan. Series have been rescaled relative to their respective means from 1960–2013.

Rep. of Korea longline CPUE for bigeye tuna

110. The WPTT **NOTED** paper IOTC–2014–WPTT16–30 which provided a CPUE standardisation of bigeye tuna caught by Rep. of Korea tuna longline fishery in the Indian Ocean from 1977 to 2013, including the following abstract provided by the author:

> "*CPUE standardization for bigeye tuna of Korean longline fishery in the Indian Ocean was conducted by Generalized Linear Model (GLM) using operational data from 1977 to 2013. The data used for GLM were catch (in number), effort (number of hooks) and number of hooks between floats (HBF) by year, month and area. Bigeye tuna CPUE by Korean longline fishery was standardized for the whole, tropical and south areas. Although the trends of CPUE showed differences by area, since 1980s they had shown the declining trend until the early of 2000s, and showed a steady trend with somewhat of increasing thereafter. However, the standardized CPUE for south area had a large fluctuation, especially after the early of 2000s.*"

111. The WPTT **WELCOMED** the updated catch rate standardisation for the Rep. of Korea fleet in the Indian Ocean for bigeye tuna.

112. The WPTT **NOTED** that CPUE is variable in recent years due to the low effort, and also due to a switch to targeting southern bluefin tuna.

113. The WPTT **NOTED** the validity and usefulness of the Rep. of Korea CPUE (Fig. 3) and **ENCOURAGED** further investigation and possible use of CPUE data from the Rep. of Korea in the future bigeye tuna assessment.

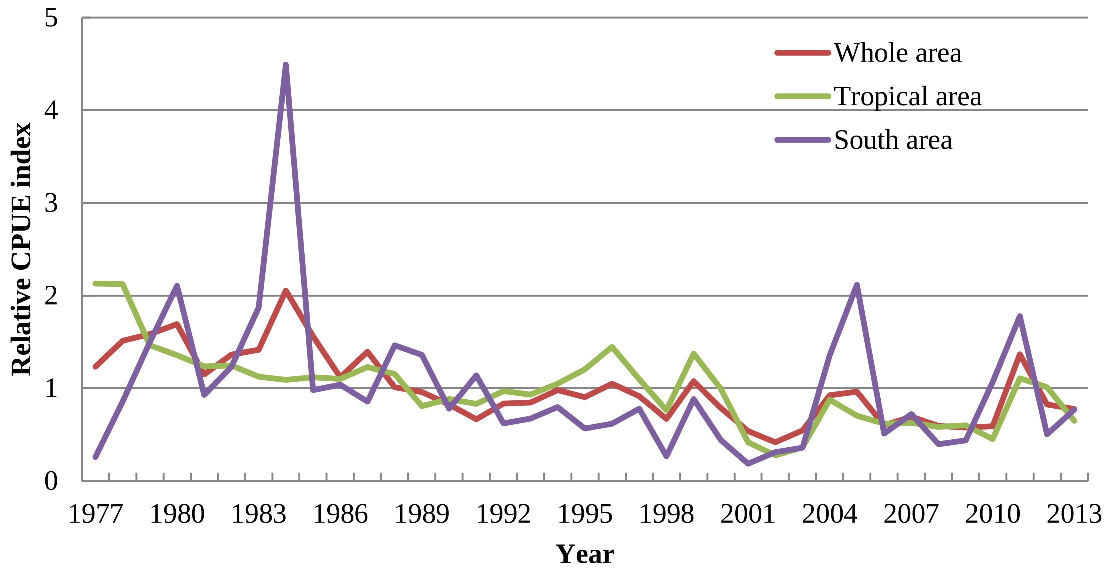


Fig. 3. Bigeye tuna: Comparison of the standardised longline CPUE series for the Rep. of Korea. Series have been rescaled relative to their respective means from 1977–2013.

5.4 Stock assessments

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

114. **NOTING** that no new stock assessments were carried out on bigeye tuna in 2014, 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

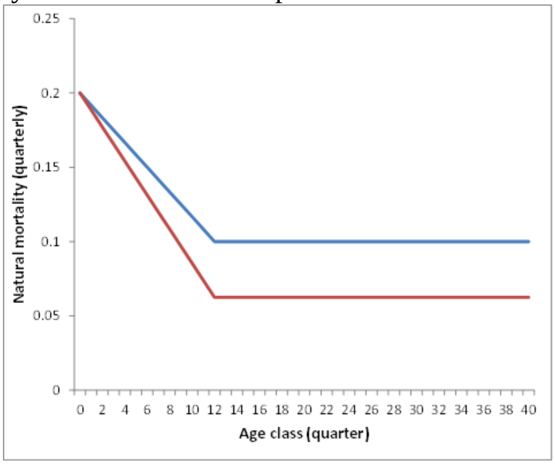
115. The WPTT **AGREED** that in order to obtain comparable CPUE standardisations, the analyses shall be conducted with similar parameters and resolutions when the stock is next assessed. Table 2 provides a set of parameters that shall give guidelines, if available, for the standardisation of CPUE to be used as indices of abundance for the stock assessments.

Table 2. Tentative set of parameters for the standardisation of CPUE series in the future.

CPUE standardisation parameters	Value for future CPUE standardisation
Area	1 region
CE Resolution	Operational data
GLM Factors	Year, area, SST (as appropriate) and gear effects (no vessel effect)
Model	Lognormal

116. The WPTT **NOTED** 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.
	
Growth formula	VB log K 2-stanza growth (Eveson et al. 2012 IOTC–2012–WPTT14–23)
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)
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	12 (Longline (5); Baitboat; 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)
Selectivity	Age based, fishery specific

5.5 *Selection of Stock Status indicators*

117. The WPTT **AGREED** that as no new stock assessment was carried out for bigeye tuna in 2014, 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 meeting.

5.6 *Development of technical advice on the status of bigeye tuna*

118. 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 2013 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

6. SKIPJACK TUNA – REVIEW OF NEW INFORMATION ON STOCK STATUS

6.1 *Review of the statistical data available for skipjack tuna*

119. The WPTT **NOTED** paper IOTC–2014–WPTT16–07 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 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*, for the period 1950–2013. 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.

120. The WPTT **EXPRESSED** concern about substantial drops in total catch, catch rates, and average catch reported by the purse seine, pole-and-line, and gillnet fisheries in the western Indian Ocean in recent years (since 2006), as well as a large decline in the contribution of skipjack tuna from free-schools to total catches of skipjack tuna

reported by purse seine vessels flagged to the European Union. Although part of the decrease in catch could be explained by the presence of piracy activities, the nature of the decline warrants further investigation (e.g., a decline in catches from Maldivian pole and line vessels, as well as purse seine free-schools) and it was stressed that there was a need to closely monitor the fisheries involved in the future.

121. The WPTT **NOTED** that in 2013, catches of skipjack tuna increased to over 420,000 t (compared to 340,000 t in 2012), mostly due to increases by purse seine and pole and line catches, as well as handline/trolling (India).

122. The WPTT **NOTED** that it is estimated that approximately 50% of the catches of skipjack tuna are taken by artisanal and/or semi-industrial fisheries (mainly gillnet) and that those catches are not reported accurately to IOTC Secretariat. Those countries with gillnet fleets catching skipjack tuna should work to develop a sampling scheme to collect such fishery data and submit to IOTC Secretariat.

123. **NOTING** the decline in skipjack catches report by the Maldives pole and line fleet since the mid-2000s, the WPTT **REQUESTED** that 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

Sri Lanka skipjack tuna landings

124. The WPTT **NOTED** paper IOTC–2014–WPTT16–32 which detailed an analysis of skipjack tuna landings made by Sri Lankan fishing vessels operated during 2005 to 2012 with special reference to the nature of the fishing operations, including the following abstract provided by the author:

> "*Skipjack tuna (Katsuwonus pelamis) landed by Sri Lankan fishing vessels were monitored during the period January 2005 – December 2012 at the major large pelagic fish landing sites and fishery harbours in Sri Lanka. The unloaded skipjack tuna catch of the vessels was recorded. In addition, other parameters in relation with fishing operations were recorded: boat type, used gear type, number of days taken for the completion of the fishing trip etc. During this period, about 8% of skipjack tuna catch had been landed in dry form and the vessels which brought skipjack in dry form were about 1.8% of the total skipjack tuna landed vessels. A number of gear-vessel combinations are being operated in Sri Lanka tuna fishery. Sri Lankan fishing vessels which operate targeting large pelagic fish has been categorized into six categories based on the length of the vessel and other technical features and a clear differentiation among them with respect to the nature of fishing operations and skipjack tuna landings was observed.* – see paper for full abstract."

125. The WPTT **NOTED** that Sri Lanka received support in 2012 from the IOTC-OFCF Project and 2013 from the BOBLME and IOTC to strengthen its data collection and processing systems and expects to improve data collection, processing and reporting for its fisheries, and **REQUESTED** that an update on the extent to which the recent improvements in data collection revise the catch estimates for Sri Lanka, be presented at the next WPTT meeting.

126. **NOTING** that Sri Lanka official statistics on catches of skipjack tuna presented in this paper and those available in the IOTC database are different, the WPTT **REQUESTED** that the authors work with the IOTC Secretariat to resolve the differences.

Indonesian caught skipjack tuna size structure

127. The WPTT **NOTED** paper IOTC–2014–WPTT16–33 which provided the results of an analysis of size structure of skipjack tuna caught by Indonesian fisheries, including the following abstract provided by the author:

> "*Small scale tuna fisheries in Indonesia are dominated by hand lines, trolling lines and purse seine. The aim of this research was to provide the size structure of skipjack in FMA 573 waters as dominant commodity large pelagic species. The data analyzed were collected by enumerator on 7 (seven) fish landing site in FMA 573. Data collection was conducted during a period of January 2013 to December 2013. The result shown in this research, the maximum length of skipjack was 104 cm FL and the minimum length was 20 cm FL found in Kupang, East Nusa Tenggara. Common to 41 cm FL length found in Labuhan Lombok, West Nusa Tenggara with total amount 1,220 specimens. In the present study, length at first capture (Lc) of skipjack caught in FMA 573 was 42.9 cm FL. In conclusion assumed that skipjack caught in FMA 573 was matured.* – see paper for full abstract."

128. **NOTING** that Indonesia has not reported size frequency data to the IOTC Secretariat for a number of years, the WPTT **REQUESTED** that the size data presented in the paper be submitted to the IOTC Secretariat (according to the reporting standards by fishery and area specified by IOTC Resolution 10/02) at the earliest opportunity.

129. **NOTING** the large variation in size frequencies by landing site and questioned the likely impact of species misidentification particularly in Kupang, East Nusa Tenggara, on size frequencies or gear differences between locations, the WPTT **REQUESTED** that the analysis be updated to include the size frequency distributions by gear and vessel type, for presentation at the next WPTT meeting.

Skipjack tuna reproductive biology: Eastern Indian Ocean

130. The WPTT **NOTED** paper IOTC–2014–WPTT16–35 which provided the results of a study examining the reproductive biology of skipjack tuna in eastern Indian Ocean, including the following abstract provided by the author:

> "*Skipjack tuna (Katsuwonus pelamis) is the one of the important catch for fishermen in the Indian Ocean. The objectives of this research are to investigate gonad maturity and length at first maturity for female skipjack tuna in Indian Ocean. Skipjack tuna were sampled from several places in South Coast of Java i.e.: Palabuhanratu, Cilacap, Pacitan, Sendang Biru, Kedonganan, Tanjung Luar, Labuhan Lombok and Oeba from April 2012 to November 2013. Fork length of the sampled 136 fish ranged from 35 to 68 cm. Gonadal maturity stages were investigated using histological analysis and Gonadosomatic index (GSI) calculation. The results showed that maturity stage of skipjack tuna dominated by stage IV with 43%, followed by stage III (21%), stage I (17%),stage II (16%) and stage V (2%). Length at first maturity occurred at 42.9 cm.*"

131. **NOTING** that the number of samples was relatively low, the WPTT **ENCOURAGED** the authors to undertake further sampling, and for the results to be presented at the next WPTT meeting, when available.

132. **NOTING** that the Spearman-Karber method applied in the paper, used the cumulative percentage frequency curve of mature fish in the sample, specifically that the size at first maturity used corresponded to the size at 50% maturity, the WPTT **AGREED** that an analysis of the size at 50% maturity, would be a useful input into future stock assessments on skipjack tuna using the Indonesian data.

Skipjack tuna movements and stock structure

133. The WPTT **NOTED** paper IOTC–2014–WPTT16–36 which discussed the movements and stock structure of skipjack in the Indian Ocean, including the following abstract provided by the author:

> "*This paper discusses the skipjack movements observed in the Indian Ocean based on an analysis of fishery data of the 13.128 selected recoveries of tagged skipjack. Its goal is to evaluate the potential geographical heterogeneity of the skipjack population fished in the Indian Ocean. Significant latitudinal & longitudinal movements have been frequently observed; the geographical range of skipjack movements appears to be wide in scale, showing an average distance over 1000 miles between tagging & recovery positions. These distances are showing an increasing trend with time at liberty, and reaching average distances of 1400 miles after 2 years. Recovery data are also showing that skipjack movements are often very fast, for instance reaching average distances over 800 miles after only 1 month at liberty in the Tanzania tagging. Distances covered are the lowest for skipjack tagged in the Maldives and in Seychelles islands and much larger in the Tanzania and Seychelles tagging.* – see paper for full abstract."

134. The WPTT **NOTED** that estimates of distances travelled are biased because they are minimum straight line distances. The estimated movements are a function of fishing intensity and of distances between tagging location and fishing location.

135. The WPTT **ENCOURAGED** further, more sophisticated analyses of tagging data be done to refine estimates of movement, allowing the estimation of mixing rates between areas. Based on the analysis it was suggested that the four areas North West, South West, Central and Eastern may be suitable areas for future stock assessment.

136. The WPTT **NOTED** that tagging experiments in the eastern Indian Ocean would likely provide a clearer picture of the movement dynamics of skipjack tuna throughout the ocean, as the previous tagging project was limited in the eastern Indian Ocean. The uncertainty in the date and position of recapture was high for skipjack tuna in the previous study. In other fisheries, tag seeding data has indicated large errors in tag recovery data. A large proportion of the catch was landed in the Seychelles and a lot of work had be done on to validate recovery date and position. There was a thorough vessel well sampling plan for sampling the catch for tagged fish.

137. The WPTT **NOTED** the indication by the author that the implementation of tagging programmes every 10 years, as done in the Western Central Pacific Ocean, would be essential to update the information on the demography and levels of fishery interaction of the three main tropical tuna stocks and improve overall stock assessments. Due to the short lifespan of skipjack tuna (approximately 5-6 years), this species might require more frequent

tagging programs (or using genetic-based methods) but that such a time-period might be a good trade-off with regards to the time required for implementing the program (administration, etc.) and the interest of tagging the three tropical tuna species together.

6.3 Data for input into stock assessments

Skipjack tuna indicators

138. The WPTT **NOTED** paper IOTC–2014–WPTT16–40 Rev_2 which provided some indicators of stock status for skipjack tuna in the Indian Ocean, including the following abstract provided by the author:

> "*Fully quantitative stock assessments for skipjack tuna are difficult to conduct and as such alternative methods of investigating current stock status are required. Fishery stock status indicators have been constructed from total catch, average weight and catch rates from the purse seine fisheries of France and Spain as well as Maldivian baitboat (when possible) have been investigated to infer stock status. In order to investigate current status in relation to historic levels, upper and lower limit reference levels have been advocated including both 5th and 95th percentiles as well as a standard deviation multiplier that incorporates 90% of the data series. These rough indicators can be difficult to interpret and are sometimes potentially contradictory. The indicators in this study provide some evidence that the SKJ population may be experiencing increasing pressure, although further analysis is required. These indicators provide a potential tool for applying empirical harvest control rules for fisheries management*."

139. The WPTT **ENCOURAGED** the production of such fishery indicators and **RECOMMENDED** that other indicators, such as the number of FADs deployed and active should also be examined in addition to existing environmental indices for the Indian Ocean.

140. The WPTT **NOTED** the difference between the nominal and standardised Maldives CPUE presented in 2012. This difference may be due to errors in the most recent data which may not have been corrected yet in the IOTC database. Any corrections that have been made should be reflected in the IOTC database.

141. The WPTT **NOTED** the information shown throughout the document that reviewed skipjack tuna fisheries indicators do not indicate that overexploitation is occurring. However, the purse seine fleets targeting free swimming school show a consistent declining trend.

EU,France purse seine CPUE

142. The WPTT **NOTED** paper IOTC–2014–WPTT16–41 which examined skipjack tuna CPUE trends (Fig. 4) using alternative indices from the EU,France purse seine logbooks, including the following abstract provided by the author:

> "*We used the French purse seine data to examine the trend of skipjack CPUEs for the period 1984-2013. Only sets made on drifting objects (logs and fish aggregating devices –FADs) are used in this analysis. Sensitivity tests were performed to evaluate the effect of the size of the core area in the north equatorial area (0-13N/45'70E) as well as effort minimal thresholds, on CPUE estimates (filtered nominal indices based on the catch per set). No significant effect was noted suggesting that the north equatorial area, as a whole, is a pertinent skipjack core area. A standardization procedure was applied to datasets based on CPUEs aggregated by 1°longitude/0.33° latitude and by month, to which corresponding environmental data such as the depth of the mixed layer, the sea surface anomaly, the speed of the current and the chlorophyll concentration were added. Generalized additive models (GAMs) were used to explore the shape of relationships with fishery-derived and environmental covariates, and undertake transformation in the dataset used by generalized linear models (GLMs).* – see paper for full abstract."

143. The WPTT **NOTED** that the size of purse seine nets has not changed substantially during the history of the fishery and although the depth of sets had slightly increased, there have been relatively minor changes in the purse seine gear.

144. The WPTT **NOTED** that there have been substantial changes in technology, such as the use of wide-angle sonar, GPS, satellites, that have affected the catch per set. On top of this increased deployment of FADs may also lead to a fragmentation of the skipjack tuna population across FADs, inhibiting free-school formation and so ideally, the number of FADs would be incorporated into the analysis.

145. **NOTING** that latitude and longitude had been incorporated as simple linear effects, the WPTT **ENCOURAGED** using lat/long grid cells as an alternative.

146. The WPTT **NOTED** that environmental variables may affect both catchability and abundance and that incorporating those variables that affect abundance should be avoided. Mixed layer depth, the variable included in this analysis, is more likely to affect catchability rather than abundance.

147. The WPTT **NOTED** that the standardisation models had not incorporated vessel technology and operational information and therefore, underlying decline in abundance may be steeper than reflected in CPUE which has not been accommodated in the standardisation procedure.

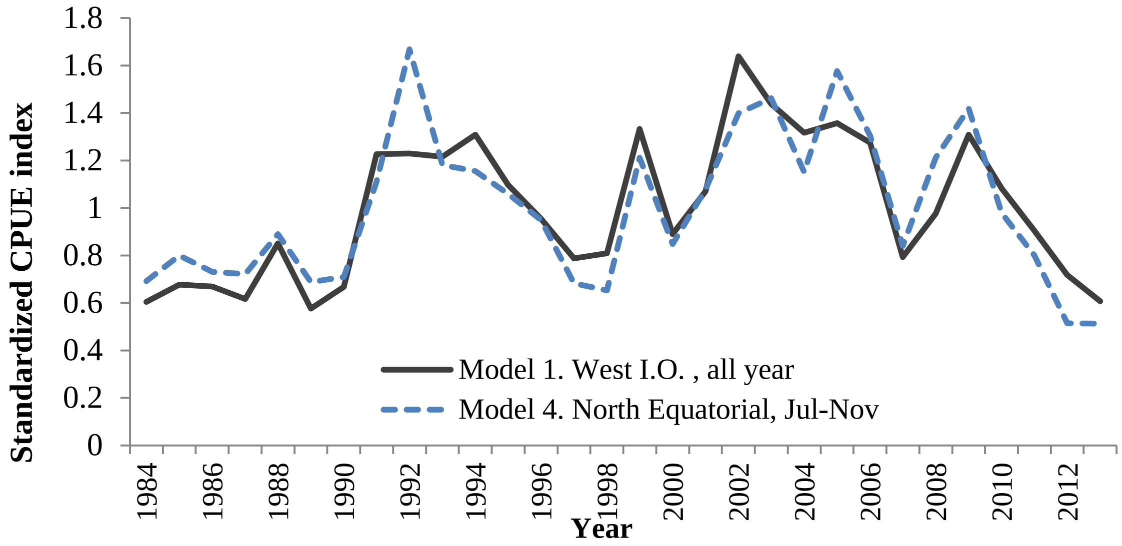


Fig. 4. EU,France purse seine standardised CPUE series for skipjack tuna from 1984–13.

Purse seine species composition

148. The WPTT **NOTED** additional information presented on standardisation of species composition from purse seine catches which included a novel approach to addressing some of the difficulties with using purse seine CPUE.

149. The WPTT **URGED** that that methodology be further evaluated and presented at future WPTT meetings.

150. The WPTT **NOTED** that the approach showed a reduction in the proportion of skipjack tuna in recent years. However, this proportion will be affected with changes in the abundance of other species, in particular yellowfin tuna. To obtain an index of skipjack tuna abundance it is necessary to incorporate independent estimates of yellowfin tuna abundance of the appropriate size.

151. The WPTT **NOTED** that species misidentification will affect the species composition obtained at unloading sites. However, the analysis has been done with both fisheries observers at landing sites and logbook data and the estimates of skipjack tuna proportions were very close.

Maldives pole and line CPUE standardisation

152. The WPTT **NOTED** paper IOTC–2014–WPTT16–42 which provided a standardised CPUE series for the Maldives skipjack pole and line fishery from 2004 to 2012, including the reconstruction of historic CPUE until 1985, including the following abstract provided by the author:

> "*A qualitative description and GLM-based standardization of the Maldivian skipjack (Katsuwonus pelamis, SKJ) pole and line fishery catch rate data are presented for the period 2004-2012. The raw data consists of around 135,645 records of catch (numbers) and effort (fishing days) by month, atoll and vessel; vessel characteristics were added to the CPUE dataset based on information from the registry of vessels. A subset of 55,930 records was extracted from the dataset, identified as records of fishing activity targeting skipjack. In the process, the paper discusses a number of serious issues with the quality of the CPUE dataset, notably records with zero skipjack catch with a directed pole and line (PL) fishery and which were eventually discounted from the final analysis. FAD data was also incorporated into the analysis using the number of active anchored FADS (aFADs) associated with the nearest atoll that the landing data is collected from.* – see paper for full abstract."

153. The WPTT **NOTED** that the CPUE indices for the Maldives are likely to provide a representative index of abundance only for the Maldives area (Fig. 5).

154. The WPTT **NOTED** that zero catch records were a substantial proportion of the data which are believed to be days fishing that were incorrectly identified as skipjack pole and line fishing when they were in fact spent handlining for yellowfin tuna.

155. The WPTT **NOTED** that atoll effects were initially investigated but it was found that vessels may not always be fishing in their own atoll and thus the three broad areas were identified and used in the standardisation.

156. The WPTT **WELCOMED** the improvements to the recording of Maldives pole and line fishing operations, which includes more detailed information recorded in logbooks, and allow analyses at a finer resolution (individual trips), which addresses a number of the recommendations made by WPTT15.

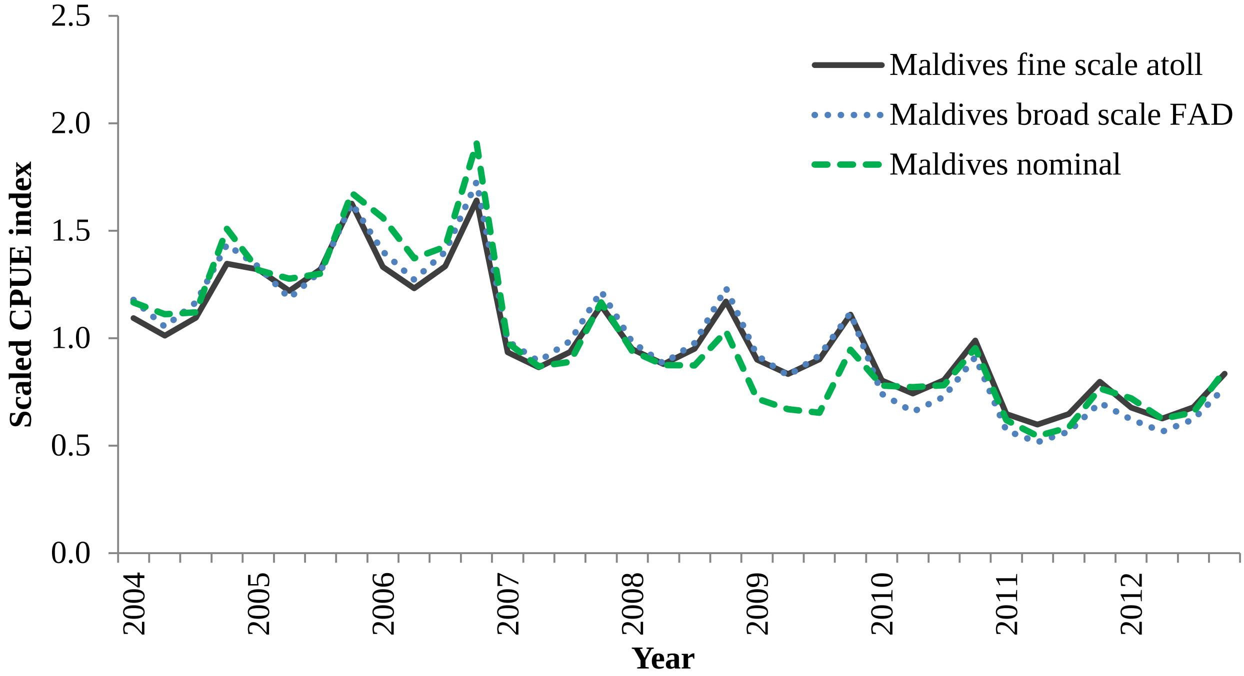


Fig. 5. Maldives pole-and-line nominal and standardised CPUE series for skipjack tuna from 2004–13.

Skipjack tuna: Sequential population analysis

157. The WPTT **NOTED** paper IOTC–2014–WPTT16–50 which provided a tentative sequential population analysis of Indian Ocean skipjack catch at size, including the following abstract provided by the author:

> "*This paper is attempting to do a simplified sequential population analysis of skipjack CAA based on 2 average CAS estimated during the 2004-2013 period (original and corrected ones), and assuming various levels of natural mortality at age. It was first noticed that when the estimated CAA is showing a very low apparent total mortality between the various ages estimated by slicing (using the Eveson & al 2014 growth curve), the life expectancy of tagged skipjack recovered is very short, showing an apparent total yearly mortality estimated at about 2.0. As a result of this basic inconsistency between CAA and natural mortality, all ASP have been providing totally unrealistic results, estimating very low fishing mortality exerted at all ages. An ad hoc analysis of the recovery data has been done, and it is showing that skipjack growth rates appear to be highly variable between individuals.* – see paper for full abstract."

158. The WPTT **NOTED** that there is a high variability in growth which is likely to explain the unrealistic low total mortality in the catch-at-age estimated by slicing, when skipjack tuna recoveries are showing a high total mortality at levels close to 2.0.

European Union and Associated purse seine CPUE

159. The WPTT **NOTED** paper IOTC–2014–WPTT16–INF05 which examined skipjack tuna CPUE trends using alternative indices from the European Union and Associated purse seine logbooks (Fig. 6).

160. The WPTT **URGED** this methodology be further evaluated and presented in future WPTT meetings.

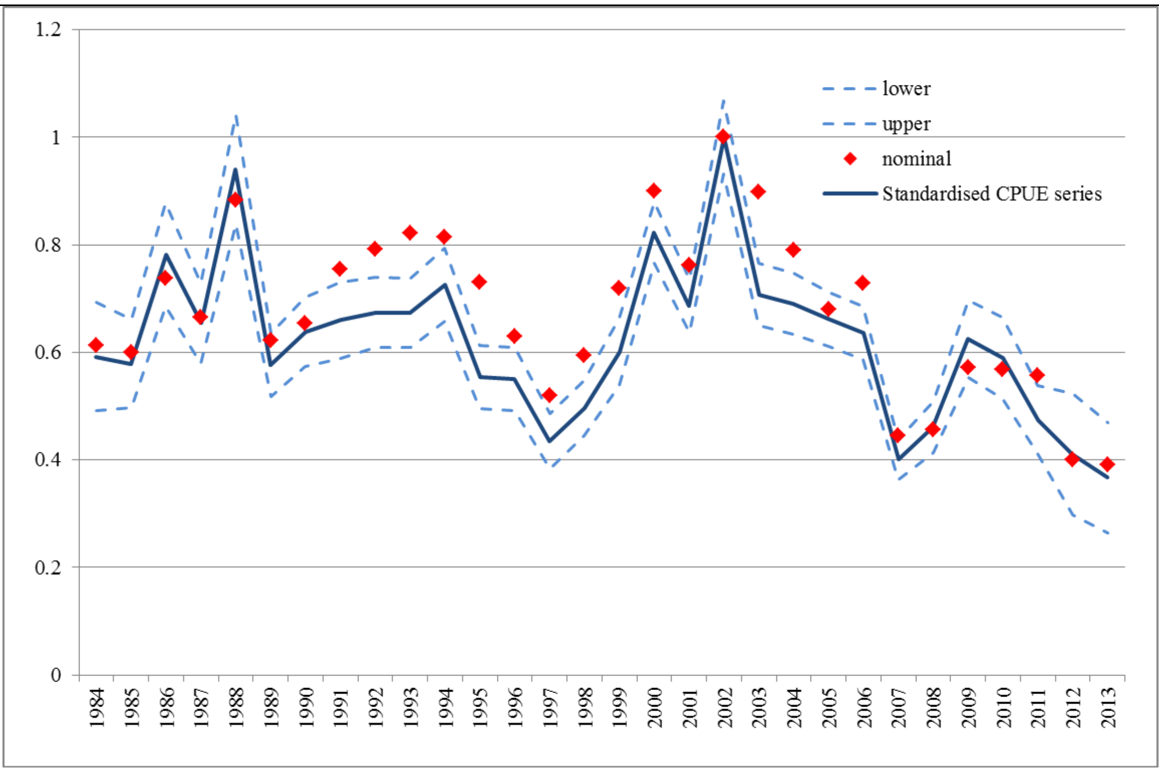


Fig. 6. European Union and Associated purse seine nominal and standardised CPUE series for skipjack tuna from 1984–13.

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

161. 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 WPTT 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, HBF, vessel characteristics, environmental + interactions, number of FADs and species composition
Model	negative binomial, zero-inflated or delta-lognormal models

162. The WPTT **NOTED** that the issues identified in WPTT15 regarding the Maldivian pole and line CPUE had been addressed in the updated CPUE analysis, however, outstanding issues in the standardisation process needs further refinement of this index.

~~163. The WPTT **RECALLED** that …..~~‘*text removed due to duplication of para. 164 in original version*’~~.~~

164. The WPTT **NOTED** 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. in press)*
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 (In Press) 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.

6.4 Stock assessments

165. The WPTT **NOTED** that a two modelling methods (Catch based method and SS3) were applied to the assessment of skipjack tuna in 2014. The different assessments were presented to the WPTT in documents IOTC–2014–WPTT16–37 and 43 Rev_2. Each model is summarised in the sections below. A catch based method was used as a preliminary investigation of the productivity of the stock.

Skipjack tuna: Summary of stock assessment models in 2014

166. The WPTT **NOTED** Table 6, which provide an overview of the key features of each of the stock assessments presented in 2014 for the Indian Ocean-wide assessments (2 model types). Similarly, Table 7 provide a summary of the assessment results.

Table 6. Skipjack tuna: Indian Ocean-wide assessments. Summary of final stock assessment model features as applied to the Indian Ocean skipjack tuna resource in 2014.

Model feature	**Catch based method (Doc#37)**	**SS3 (Doc# 26 Rev_3)**
Software availability	Martel and Frose (2013)*	NMFS toolbox
Population spatial structure / areas	No	1
Number CPUE Series	0	2
Uses Catch-at-length/age	No	Yes
Age-structured	No	Yes
Sex-structured	No	Yes
Number of Fleets	1	4
Stochastic Recruitment	No	Yes

*****Martell S & Froese R (2013) A simple method for estimating MSY from catch and resilience. Fish and Fisheries, Volume 14, Issue 4, pages 504–514, December 2013Fish

Table 7. Skipjack tuna: Summary of key management quantities from the assessments undertaken in 2014.

Management quantity	**Catch based method (Doc#37)**	**SS3 (Doc# 43 Rev_2)**
Most recent catch estimate (t) (2013)	424,580	424,580
Mean catch over last 5 years (t) (2009–2013)	401,100	401,100
h (steepness)	–	0.7, 0.8 0.9 used in the grid
MSY (1,000 t) (80% CI)	441 (360–489)	684 (550–849)
Data period (catch)	1950–2013	1950–2013
CPUE series/period	–	PL (2004–2012), PSLS (1982–2013)
F_{MSY} (80% CI)	0.25 (0.14–0.51)	0.65 (0.51–0.79)
SB_{MSY} or $*B_{MSY}$ (1,000 t) (80% CI)	1,827 (922–2,813)	875 (708.5–1,075)
$F_{current/}F_{MSY}$ (80% CI)	n.a.	0.42 (0.25–0.62)
B_{2013}/B_{MSY} (80% CI)	n.a.	n.a.
SB_{2013}/SB_{MSY} (80% CI)	n.a.	1.59 (1.13–2.14)
B_{2013}/B_{1950} (80% CI)	n.a.	n.a.
SB_{2013}/SB_{1950} (80% CI)	n.a.	0.58 (0.53–0.62)
$SB_{2013}/SB_{current,\ F=0}$ (80% CI)	n.a.	n.a.

LL = longline; n.a. = not available

Catch based method for estimating productivity

167. The WPTT **NOTED** paper IOTC–2014–WPTT16–37 which provided an estimation of Indian Ocean skipjack fisheries' productivity using a catch based method, including the following abstract provided by the authors:

> "*Fisheries are managed using biological information of fish stocks, historical catch data and complex numerical models. However, the availability of reliable and complete information of both biological characteristics and fisheries yield is often incomplete, inaccurate or non-available. Therefore, there is a need for simple methods that allow estimating fish stocks productivity using limited data. In this study we use a simple method to investigate the productivity and historical harvest rates applied to Indian Ocean skipjack, a species exploited by several nations and a diversity of gears and managed by the Indian Ocean Tuna Commission (IOTC). Our results suggest that current and recent catch is within the estimated limits of the capacities of these stocks to replace the amount of biomass harvested except for the year 2008, where these limits were exceeded. We discuss that these results need to be supported by deeper studies and new data due to the limitations of catch based methods.*"

168. The WPTT **NOTED** the key assessment results for the catch base method model as shown below (Table 8).

Table 8. Skipjack tuna: Key management quantities from the catch based method assessment, for the Indian Ocean.

Management Quantity	**Indian Ocean**
2013 catch estimate (t)	424,580
Mean catch from 2009–2013 (t)	401,100
MSY (1000 t) (80% CI)	441.23 (360–489)
Data period used in assessment	1950–2013
F_{MSY} (80% CI)	0.25 (0.14–0.51)
SB_{MSY} (1000 t) (80% CI)	1,827 (922–2,813)
F_{2013}/F_{MSY} (80% CI)	–
B_{2013}/B_{MSY} (80% CI)	–
SB_{2013}/SB_{MSY} (80% CI)	–
B_{2013}/B_{1950} (80% CI)	–
SB_{2013}/SB_{1950} (80% CI)	–
$B_{2013}/B_{1950,\ F=0}$ (80% CI)	–
$SB_{2013}/SB_{1950,\ F=0}$ (80% CI)	–

169. The WPTT **NOTED** that based only on catch data, the maximum productivity of this stock was surpassed in 2006 but recent catches fall below or just at the estimated catch-based MSY (441,200 t).

170. The WPTT **NOTED** the following with respect to the modelling approach presented at the meeting:
- as an alternative to the Shaefer model the Pella-Tomlinson model which allows for MSY at lower stock status, may be more appropriate taking into account skipjack tuna life history and would not necessarily require the estimation of another parameter (i.e. fix the 3rd parameter).
- there had been a change in the size selectivity with the shift to FAD fishing which a catch-only method could not account for.
- catch-only methods may provide reasonably accurate estimates of MSY but may perform less well in estimating stock status (e.g. relative to B_0).

Stock Synthesis III assessment of skipjack tuna

171. The WPTT **NOTED** paper IOTC–2014–WPTT16–43 Rev_2 which provided an a stock assessment of skipjack tuna using stock synthesis III, including the following abstract provided by the author:

“*A stock assessment of the Indian Ocean skipjack tuna (Katsuwonus pelamis, SKJ) population from 1950 to 2013 has been conducted and is presented. The analysis follows the first two assessments developed by Kolody et. al., 2011 and Sharma et. al. 2012. In this assessment spatial structure was not considered due to limited time constraints. In future years the focus should be on a 2/3 area assessment with some finer fisheries resolutions as was done in 2012. The primary fleets that were used for CPUE indicators were the Maldivian Pole and Line fleet (IOTC–2014–WPTT16–42), and the European Fad based PS CPUE that was presented in 2013 (IOTC–2013–WPTT15–23).* – see paper for full abstract.”

172. The WPTT **NOTED** the key assessment results for the Stock Synthesis III model (SS3) as shown below (Tables 9, 10; Fig. 7).

Table 9. Skipjack tuna: Key management quantities from the SS3 assessment, for the Indian Ocean.

Management Quantity	**Indian Ocean**
2013 catch estimate	424,580
Mean catch from 2009–2013	401,100
MSY (1000 t) (80% CI)	684 (550–849)
Data period used in assessment	1950–2013
F_{MSY} (80% CI)*	0.65 (0.51–0.79)
SB_{MSY} (1000 t) (80% CI)	875 (708.5–1,075)
F_{2013}/F_{MSY} (80% CI)*	0.42 (0.25–0.62)
C_{2013}/C_{MSY} (80% CI)*	0.62 (0.49–0.75)
B_{2013}/B_{MSY} (80% CI)	n.a.
SB_{2013}/SB_{MSY} (80% CI)	1.59 (1.13–2.14)
B_{2013}/B_{1950} (80% CI)	n.a.
SB_{2013}/SB_{1950} (80% CI)	0.58 (0.53–0.62)
$B_{2013}/B_{1950, F=0}$ (80% CI)	n.a.
$SB_{2013}/SB_{1950, F=0}$ (80% CI)	n.a.

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

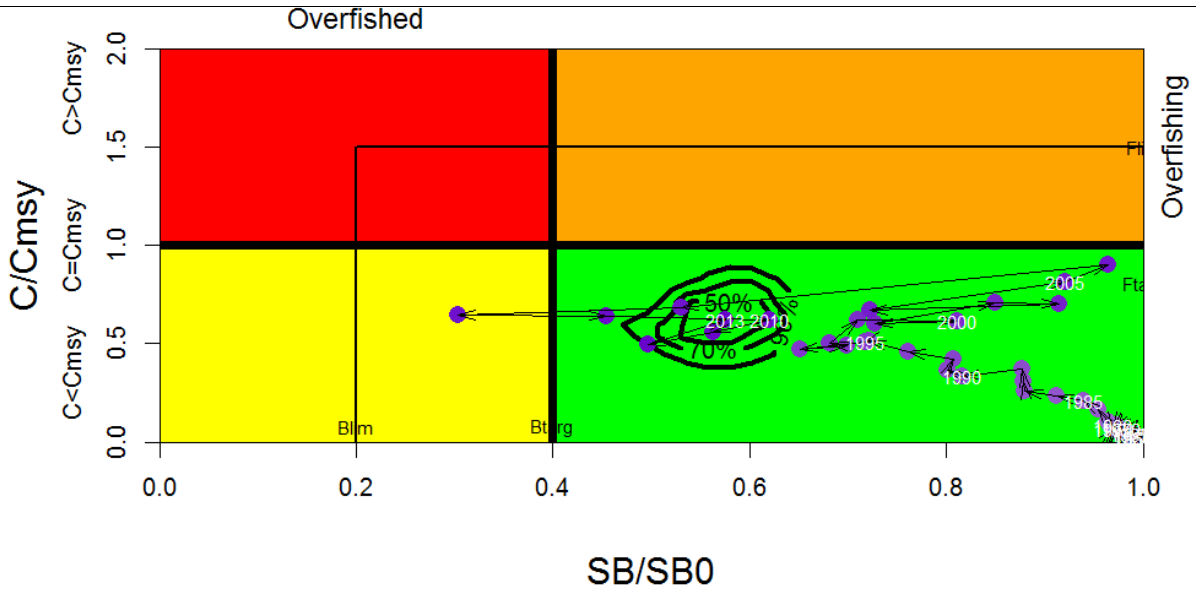


Fig. 7. Skipjack tuna: SS3 Aggregated Indian Ocean assessment Kobe plot (contours are the 50, 70 and 90 percentiles of the 2013 estimate). Blue circles indicate the trajectory of the point estimates for the SB/SB0 ratio and F proxy ratio for each year 1950–2013 estimated as C/C_{MSY}. Interim target (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 10. 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% (254,748t)	**70%** (297,206t)	**80%** (339,664t)	**90%** (382,122t)	**100%** (424,580t)	**110%** (467,038t)	**120%** (509,496t)	**130%** (551,954t)	**140%** (594,412t)
$SB_{2016} < SB_{MSY}$	0		1		1		1		9
$F_{2016} > F_{MSY}$	0		1		1		5		12
$SB_{2023} < SB_{MSY}$	0		1		1		6		25
$F_{2023} > F_{MSY}$	0		1		1		5		20
Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2013) and probability (%) of violating MSY-based limit reference points ($SB_{lim} = 0.4\ B_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)**								
	60% (254,748t)	**70%** (297,206t)	**80%** (339,664t)	**90%** (382,122t)	**100%** (424,580t)	**110%** (467,038t)	**120%** (509,496t)	**130%** (551,954t)	**140%** (594,412t)
$SB_{2016} < SB_{Lim}$	0		0		0		0		0
$F_{2016} > F_{Lim}$	1		1		1		1		1
$SB_{2023} < SB_{Lim}$	0		0		0		0		0
$F_{2023} > F_{Lim}$	0		1		1		1		6

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels (Green: 0–25; Yellow: >25–50; Orange: >50–75; Red: >75–100) associated with the interim target and limit reference points set by the Commission.

173. The WPTT **NOTED** the following with respect to the SS3 modelling approach presented at the meeting:
    - The runs where high weighting of the tags showed bad fit to tagging data resulting in too many pessimistic results. Thus, an alternative grid that used the M (0.7, 0.8 and 0.9), and h(0.7,0.8 and 0.9), lower weighting of tags along with length composition and CPUE series was proposed and presented.
    - The model had issues with estimating MSY related to reference points. C/C_{MSY} was used as in previous assessments (although it should be noted there are concerns with the estimation of this value as well), for the Kobe trajectories.

174. The WPTT **NOTED** that some fishery indicators may indicate a lower MSY reference points than SS3, as follows:

- A decline of catches of large skipjack tuna in the last 10 years resulting in a decline of average weight observed for pole-and-line and purse seine fisheries;
- A decline of FAD catch per set by purse seine, during a period of major increase in FAD seeding;
- A decline in the purse seine CPUE of free swimming schools skipjack tuna in most areas;
- A lesser proportion of skipjack tuna relative to other species in the FAD sets;
- There were still issues on the spatial complexity and the use of tags that needed to be further understood. The present model based on a single area does not take into account the complex movement patterns that have been observed from the tagged skipjack tuna recoveries. A new model structure based on MFCL/SS3 could be investigated in future years;
- Mixing rates need to be evaluated under a new model structure with more areas to avoid discounting the first three quarters, as this leads to eliminating more than 70% of the recoveries;
- There were concrens raised about the pole-and-line and purse seine indices of abundance used in the assessment;
- Thus, a stock trajectory based on B_t/B_0 (with a reference at 40% as a proxy MSY as is used for other fisheries) along with a plot of the increasing fishing mortality, F as shown in Fig. 8, was agreed to be used.

175. The WPTT **REQUESTED** that further analysis be conducted or to develop better indices of abundance.

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

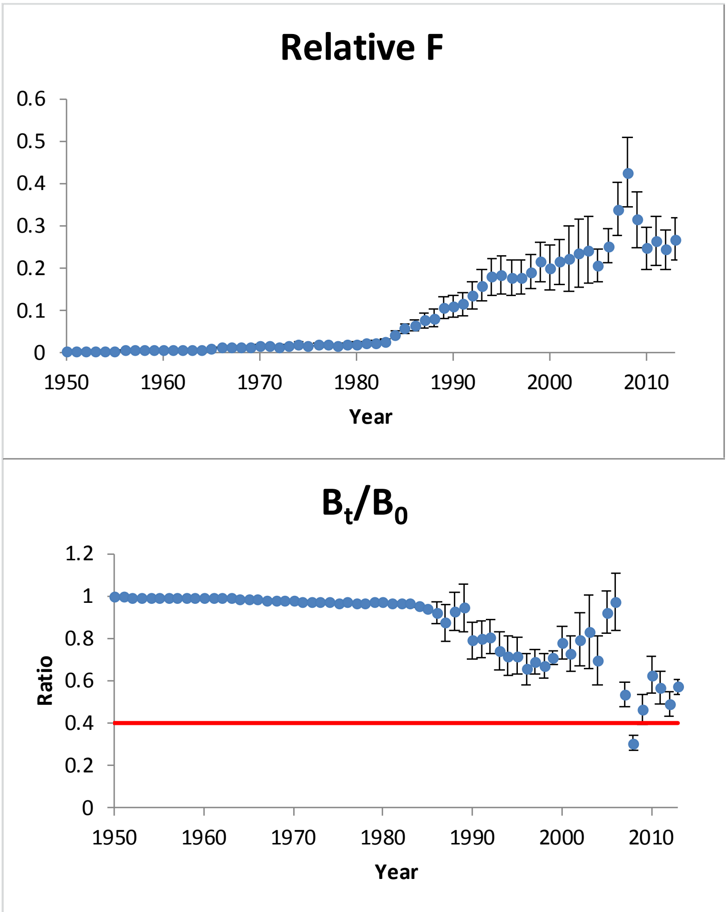


Fig. 8. Top: relative fishing mortality over time. Bottom: B_{MSY}/B_0. Note, these figures were suggested as alternative figures for evaluation as F_{MSY} is not estimated well, reference point $0.4B_0$ was suggested as a target and $0.2B_0$ as a limit for skipjack tuna by the WPTT.

6.5 Selection of Stock Status indicators

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

6.6 Development of technical advice on the status of skipjack tuna

177. 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 2013 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.

6.7 Progress on the development of Management Strategy Evaluation (MSE) and Harvest Control Rules (HCR) for skipjack tuna

Size based indicators of skipjack tuna: HCR development

178. The WPTT **NOTED** paper IOTC–2014–WPTT16–38 which provided size based indicators of performance of Indian Ocean skipjack tuna towards developing specifically built Harvest Control Rules, including the following abstract provided by the author:
    "*Fully quantitative stock assessments for skipjack tuna are difficult to conduct and therefore, alternative methods of investigating current stock status are required. As a first step towards designing applicable HCR for the Indian Ocean skipjack fisheries, we explore the size based information available in IOTC and the possible pathways to make them useful for the management of this species. We use this information to assess on the sustainability of this fishery and the different gears they are composed of, using Froeses's guidelines of sustainability. We also classify each fishery in relation to the size segment they exploit according the length based decision tree and HCR from Cope and Punt (2009). With the preliminary set of parameters used in this work, this fishery can be considered as "Fish maturity ogive" and within reference biomass levels, as currently, the proportion of mature individuals (Pmat) is above 0.9. However, the Pmat of this fishery has recently been below the benchmark of 0.9, which would in turn classify it as below reference levels of biomass that would recommend action to increase Pmat above 0.9. The gears that exploit a larger proportion of immature fish are trolling and baitboat.*"

179. The WPTT **NOTED** that changes in regulations with regard to discards of small fish may reduce the observed proportion of mature skipjack tuna independent of changes in the population.

180. The WPTT **NOTED** that the observed proportion of mature fish may also be affected by recruitment pulses which could cause the proportion to fall below the benchmark of 0.9 despite being beneficial for the fishery.

181. The WPTT **AGREED** that such an approach as summarised in the paper, is a reasonable approach for data limited stocks and could be useful in cases where adequate quantitative stock assessments cannot be satisfactorily achieved.

182. The WPTT **NOTED** that based on the decision tree defined in Cope and Punt (2009) this fishery fulfils sustainability guidelines detailed in Froese (2004) as (i) catch length composition reflects almost exclusive take of mature individuals, (ii) catch length composition consists primarily of fish of the size at which the highest yield from a cohort occurs and (iii) catch length composition demonstrates the conservation of large mature individuals.

Management strategy evaluation: skipjack tuna

183. The WPTT **NOTED** paper IOTC–2014–WPTT16–39 which detailed the first steps in the development of a management strategy evaluation for Indian ocean skipjack tuna, including the following abstract provided by the author:
    "*This report describes progress towards management strategy evaluation (MSE) for the Indian Ocean skipjack fishery. This work has been progressed by the Maldives pole-and-line fishery in partial fulfilment of the conditions of its Marine Stewardship Council (MSC) certification. Adam et al (2013) provided a background and rationale for the project at WPTT15 in San Sebastian, Spain. An initial methodology was presented at an informal meeting of the Working Party on Methods (WPM) which occurred during that meeting. Substantial progress has been made on coding and testing the operating model and management procedures. A MSE workshop of WPM in Ispara, Italy during March 2014 was updated on progress and feedback was obtained (IOTC 2014). An Advisory Committee (AC) has been established for the project. The AC includes a number of experienced MSE practitioners and tuna fisheries scientists including those involved in both the IOTC WPTT and WPM.* – see paper for full abstract."

184. The WPTT **NOTED** that the initiative undertaken by the Maldives in support of MSE for skipjack tuna fisheries fits well within the workplan for MSE that the Scientific Committee and Commission have endorsed. The work of MSE initiated by the Maldives is being carried out in close collaboration with the WPTT and WPM, with updates being provided to the WPTT at its annual meetings.

185. The WPTT **WELCOMED** the progress made on MSE for SKJ since the last meeting and **AGREED** that the work continue as outlined by the authors and further progress be presented to the WPM and Scientific Committee at the next meetings.

186. The WPTT **NOTED** that some of the candidate management procedure have control parameters which allow for the evaluation of alternative frequencies of assessments and tagging studies.

187. The WPTT **ENCOURAGED** the evaluation of management procedures under simulation scenarios that impact on future stock productivity (e.g. due to climate change).

188. The WPTT **NOTED** the importance of considering fleet dynamics in evaluations of future management and that the likely impacts on yield and stock status of the IOTC fleet development plans could be evaluated using this framework.

189. The WPTT **ENCOURAGED** that the skipjack tuna MSE framework being developed include a definition of a review cycle and exceptional circumstances under which a management procedure would be abandoned pending further scientific studies and evaluations.

190. The WPTT **NOTED** that in addition to evaluating trade-offs in achieving various management objectives identified by the Commission, the sensitivity of management procedure performance to each of the model's parameters could be examined. This could be used to help identify priorities for reducing scientific uncertainty in stock dynamics.

191. The WPTT **NOTED** that the Commission has established a Science and Management Dialogue process dedicated to enhance the decision making response of managers to existing Resolutions, and the recommendations made by the Scientific Committee to the IOTC, with the objective of a) Enhancing communication and to foster mutual understanding between fisheries managers, stakeholders and scientists; b) defining management objectives to support the MSE work; c) Promoting the efficient use of scientific resources and information.

192. The WPTT **AGREED** that the work undertaken and progress it has made for the skipjack tuna MSE should be an important element discussed at the next IOTC science-management dialogue meeting in 2015, and **REQUESTED** that the IOTC Secretariat ensure it is included in any proposed agenda.

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

7.1 Review of the statistical data available for yellowfin tuna

193. The WPTT **NOTED** paper IOTC–2014–WPTT16–07 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 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*, for the period 1950–2013. 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.

194. 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, longliner vessels flagged to Japan continue to be almost completely absent from the area since July 2009.

195. **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.

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

Indonesia yellowfin tuna fishery

196. The WPTT **NOTED** paper IOTC–2014–WPTT16–44 which detailed the distribution and biological aspects of yellowfin tuna caught by Indonesian tuna longline in the eastern Indian Ocean, including the following abstract provided by the author:

"*Yellowfin tuna or YFT (Thunnus albacares) is one of the important catch for the fishing industry in Indonesia. The aim of this study is to determine the spatial and temporal distribution of YFT in the Eastern Indian Ocean. Scientific observers on commercial tuna longline conducted data collection, mainly based in Benoa, Palabuhan Ratu and Bungus from August 2005 to November 2013. Total of 2,250 YFT were caught and as many as 2,227 of them measured in length. Distribution of YFT caught by Indonesia tuna longline scattered from 0-34°S and 76-133°E where hook rates around Mentawai Islands and along Eastern Java to West Nusa Tenggara tend to be high (> 0.12 fish/100 hooks). A wide size group represented the fishery with the fork length of YFT measuring from 30 cm to 179 cm with mean length was 101.65 cm and modes at 106-110 cm. Mostly YFT has larger size than Lm (100 cm) with percentage 81.04% and caught in most area of the Eastern Indian Ocean.* – see paper for full abstract."

197. The WPTT **WELCOMED** the contribution from Indonesian scientists and **SUGGESTED** that sampling continues on yellowfin tuna and results be presented at the next WPTT meeting.

Biological characteristics of yellowfin tuna: Research survey results

198. The WPTT **NOTED** paper IOTC–2014–WPTT16–45 Rev_2 which provided a comparison of biological characteristics of yellowfin tuna in the Western and Central Indian Ocean, including the following abstract provided by the author:

"*Based on the yellowfin tuna (Thunnus albacares) biological data collected from two surveys conducted on board two Chinese tuna longliners in the Western and Central Indian Ocean from Sep. 2008 to Jan. 2009 (the 1st survey) and from Oct. 2013 to Apr. 2014 (the 2nd survey) respectively, this paper analyzed the biological characteristics of yellowfin tuna by statistic methods. The goal of this study is to determine if there was an impact of piracy activity on the yellowfin tuna resource in the Western and Central Indian Ocean. Our results indicated: (1) There was significant difference (p = 0.0404<0.05) between the yellowfin tuna fork length distribution of the above two surveys. The average fork length was 136.7±1.43cm , with dominant fork length of 125～145cm from the samples collected in the 1st survey and was 140.2±1.37 cm, with dominant fork length of 115～165cm from the samples collected in the 2nd survey.* – see paper for full abstract."

199. The WPTT **WELCOMED** the contribution from Chinese scientists and **SUGGESTED** that factors in addition to the Piracy factor could be influencing the results and should be investigated in continued studies.

200. The WPTT **NOTED** significant differences in biological characteristics of yellowfin tuna between surveys in 2008-09 and 2012-13, and attributed these changes to the piracy-driven reduction in fishing effort in the northwest Indian Ocean beginning in the mid-2000s. However, the WPTT **ENCOURAGED** the authors to consider alternative possible hypotheses explaining these observed changes in biological characteristics before a conclusion on yellowfin tuna stock recovery can be established.

Indonesian biometrics and condition factors

201. The WPTT **NOTED** paper IOTC–2014–WPTT16–46 which provided weight-weight and length-weight relationships and condition factor of yellowfin tuna in eastern Indian Ocean, including the following abstract provided by the authors:

"*Yellowfin tuna (Thunnus albacares) is one of the important catch for the fishing industry in Indonesia. The objectives of this study are to determine the weight-weight relationship between gilled-gutted weight (GW) and whole weight (WW), to calculate length weight relationship between fork length (FL) and whole weight (WW) and to assess the relative condition factor (Kn) of yellowfin tuna in Eastern Indian Ocean. Yellowfin tuna data were collected from three landing site i.e. Malang, East Java; Benoa, Bali and Kupang, East Nusa Tenggara from January 2013 to February 2014. Linear regression analysis applied to test the significance between weight-weight relationships and log transformed length weight relationship. Relative condition factor (Kn) used to identify fish condition among length groups and months. There was a significant positive linear relationships between whole weight (WW) and gilled-gutted weight (GW) of T. albacares (p<0.001). There was a significant positive linier relationships between log transformed fork length and log transformed whole weight of T. albacares (p<0.001).* – see paper for full abstract."

202. The WPTT **WELCOMED** this contribution by Indonesian scientists and **NOTED** that these biometric relationships will be useful in estimating whole weight of the catch of yellowfin tuna landed in Indonesian ports.

7.3 Data for input into stock assessments

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

203. The WPTT **NOTED** paper IOTC–2014–WPTT16–47 Rev_1 which provided the Japanese longline CPUE for yellowfin tuna in the Indian Ocean up to 2013 standardised by generalized linear model, including the following abstract provided by the authors:

 "*Japanese longline CPUE (quarterly and annual) for yellowfin tuna in the main fishing ground and whole Indian Ocean, as well as CPUE in each of four areas for SS3 and Multifan-CL, was standardized up to 2013 by GLM (CPUE-LogNormal error structured model). Number of hooks between float (NHF) and material of main line and branch line were applied in the model to standardize the change of the catch rate which has been derived by fishing gear configuration. In order to avoid the bias of CPUE trend which may be caused by critical decrease of effort in the northwestern Indian Ocean, the scenarios without Area 2 (northwest) were also applied. Basically, these standardized CPUEs on the both scenarios showed similar trend. In the main fishing ground, CPUE continuously decreased from around 15 (a nominal scale) in early 1960s to around 5.0 in 1974, and was kept in the same level until 1990 with jump to 11.0 in 1977.* – see paper for full abstract."

204. The WPTT **WELCOMED** the updated catch rate standardisation for the Japanese fleet In the Indian Ocean (Fig. 9).

205. The WPTT **NOTED** that the change in gear appears to have had the effect of increasing the catch ratio of yellowfin tuna in the Japanese longline catch when compared to bigeye tuna and that shrinkage of the Japanese fishing ground might be better accounted for by finer scale area definitions.

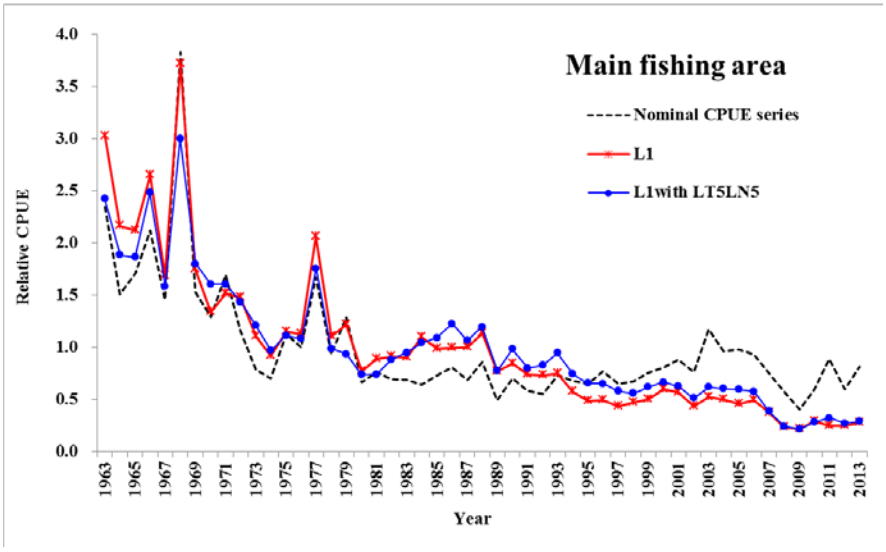


Fig. 9. Comparison of annual based area aggregated CPUE between the models with the effect of subarea and LT5LN5, standardized for whole fishing grounds expressed in relative scale overlaid with nominal CPUE. Series have been rescaled relative to their respective means from 1963–2013.

Japan – Area stratification for CPUE

206. The WPTT **NOTED** paper IOTC–2014–WPTT16–48 Rev_1 which provided an exploration of area stratification for CPUE standardization of yellowfin tuna by Japanese longline, including the following abstract provided by the author:

 "*New spatial sub-area for yellowfin tuna CPUE standardization process of Japanese longline fishery in the Indian Ocean was proposed using the simultaneous tree method and examined performance for the present and new sub-area definition. Relative abundance indices using the two area definitions were compared. The analyses in this study included three components: Analysis 1; using only size data, Analysis 2; using only CPUE data, and Analysis 3; using both size and CPUE data. The trees of the three analyses appear to show agreement in two points: 1) the first split around 15S, and 2) the second split on around equatorial. The seasonal effect in the analysis 1 was not clear in the analyses 2 and 3. It looks like CPUE trends have more influence on the simultaneous tree structure than the size distributions do. The statistics, U(s), for ranking the candidate stratifications in the analysis 3 (0.154) was larger than the value of 0.117 for the present sub-area definition.*" – see paper for full abstract."

207. The WPTT **WELCOMED** this contribution, which addressed concerns raised at WPTT15. An examination of whether the areas are representative and how they are weighted in the analysis needed to be examined because

the size of areas does not always correspond to sample size. This is particularly a concern when the samples in a given area keep declining. Examining alternative hypothesis should be made in future years. The primary ones to be examined are whether the fisheries and stocks are spatially and temporally dynamic processes and how these are accounted for within the standardisation procedures.

208. The WPTT **NOTED** that the approach used appeared appropriate to address the questions previously raised and could be generally applied to better align area strata to investigate a prospective stock structure.

209. The WPTT **SUGGESTED** that further evaluation of non-rectangular areas and potential oceanographic conditions could be of benefit.

210. The WPTT **NOTED** that a joint analysis of the Rep. of Korea, Japan and Taiwan,China operational level data is needed to attempt to resolve the differences in patterns between the Taiwan,China, Japan, and Rep. of Korea and other longline catch rates. The methods described in this study may be generally applicable to the operational data for other longline data.

Rep. of Korea – Catch-per-unit-of-effort (CPUE)

211. The WPTT **NOTED** paper IOTC–2014–WPTT16–49 which provided the CPUE standardisation of yellowfin tuna caught by Rep. of Korea tuna longline fishery in the Indian Ocean, including the following abstract provided by the authors:

“*CPUE standardization for yellowfin tuna of Korean longline fishery in the Indian Ocean was conducted by Generalized Linear Model (GLM) using operational data from 1977 to 2013. The data used for GLM were catch (in number), effort (number of hooks) and number of hooks between floats (HBF) by year, month and area. Yellowfin tuna CPUE by Korean longline fishery was standardized for the whole, west and east areas. The standardized CPUE trends were different between the west and east areas. The standardized CPUE for whole area was about 8 in 1977, and showed sharply decreased after that. During 1980s it showed a level of 3-4, but again decreased thereafter. Since the mid-1990s it has shown the steady trend with a level of about 1.0. The standardized CPUE for west area showed a similar trend with those of whole area, but showed the large increasing in 2003-2005 and 2013. However, the standardized CPUE for east area had decreased since 1977, and is showing the low level of below 1.0 in recent years.*”

212. The WPTT **NOTED** the validity and usefulness of the Rep. of Korea CPUE (Fig. 10) and **ENCOURAGED** further investigation and possible use of CPUE data from the Rep. of Korea in the future yellowfin tuna stock assessment.

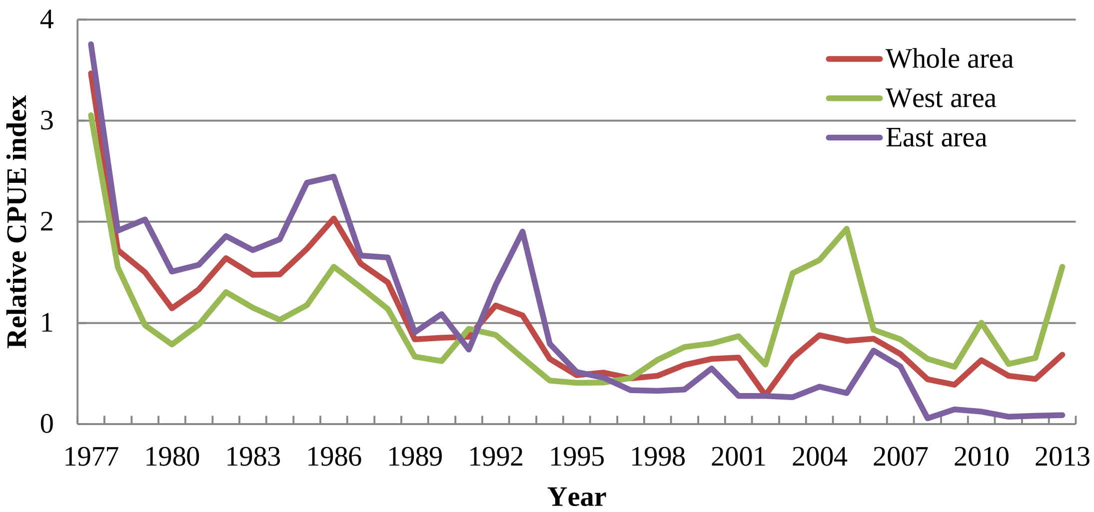


Fig. 10. Yellowfin tuna: Comparison of the standardised longline CPUE series for the Rep. of Korea. Series have been rescaled relative to their respective means from 1977–2013.

Taiwan,China longline CPUE comparision for bigeye tuna and yellowfin tuna

213. The WPTT **NOTED** paper IOTC–2014–WPTT16–55 which detailed an analysis of Taiwna,China longline fisheries based on operational catch and effort data for bigeye tuna and yellowfin tuna in the Indian Ocean from 1979 to 2013, including the following abstract provided by the author:

“ – see bigeye tuna section above for paper abstract.”

214. The WPTT **NOTED** that the yellowfin tuna CPUE series is relatively stable for the entire series (Fig. 11) in comparison to the Japan and Rep. of Korea series, which could be because the main species targeted was bigeye tuna, while yellowfin tuna was an incidental catch. Other possible reasons for this difference may be the spatial stratification of the effort between the two fleets.

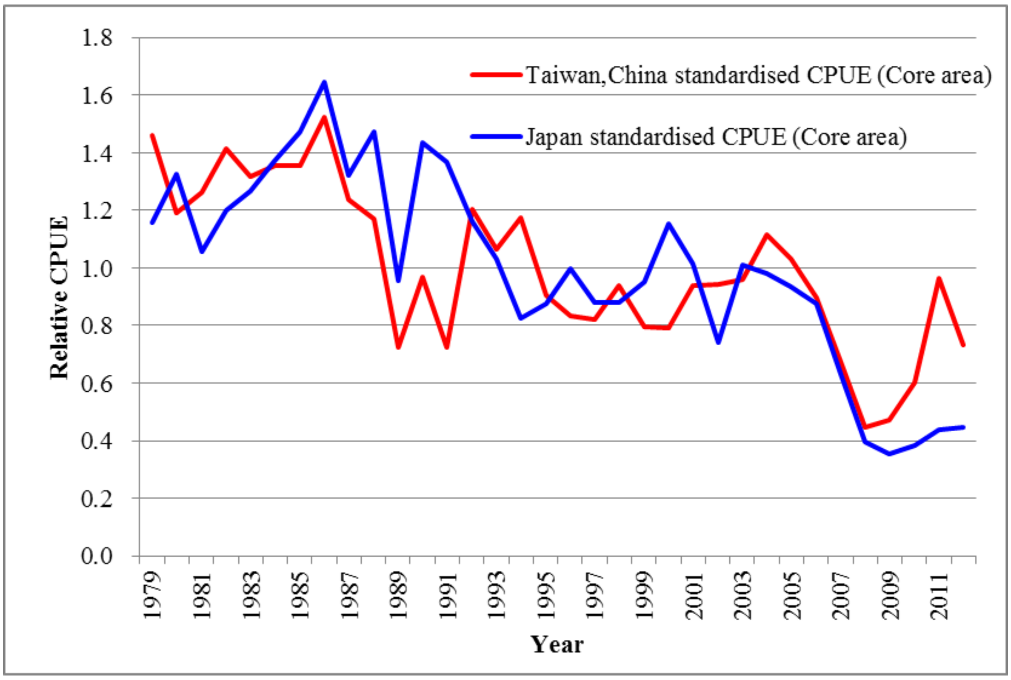


Fig. 11. Yellowfin tuna: Comparison of the standardised longline CPUE series (by area) for Taiwan,China. Series have been rescaled relative to their respective means from 1979–2013.

7.4 Stock assessments

215. The WPTT **NOTED** that no new stock assessments were carried out for yellowfin tuna in 2014. The next assessment is scheduled for 2015.

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

216. The WPTT **RECALLED** that in order to obtain comparable assessments, the CPUE standardisations should be conducted with similar parameters and resolutions. Table 11 provides a set of parameters, discussed during WPTT meetings that shall give guidelines, if available, for the standardisation of CPUE in 2015 to be used as indices of abundance for future stock assessments (currently scheduled for 2015).

Table 11. Yellowfin tuna: A set of parameters for the standardisation of CPUE series in 2015.

CPUE standardisation parameters	Value next CPUE standardisations
Area	*To be defined.* Explore core area(s)
CE Resolution	Operational data
GLM Factors	Year, Quarter, Area, HBF, vessel, environmental + interactions
Model	negative binomial, zero-inflated or delta-lognormal models

217. **NOTING** that the areas used in the various CPUE standardisations were very different from one analysis to another, the WPTT **AGREED** that there is a need to define core area(s) for the CPUE standardisation of yellowfin tuna and **REQUESTED** that scientists from CPCs with longline and purse seine fisheries for yellowfin tuna, work together to explore their data and define such core areas, well in advance of the next WPTT meeting in 2015.

7.5 Selection of Stock Status indicators

218. The WPTT **AGREED** that as no new stock assessment was carried out for bigeye tuna in 2014, management advice for yellowfin tuna should be based on the range of results from the last assessment models (MFCL, SS3 and ASPM) in 2012, as well as the updated CPUE series presented at the WPTT16 meeting.

7.6 Development of technical advice on the status of yellowfin tuna

219. 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 2013 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.

8. EFFECT OF PIRACY ON TROPICAL TUNA CATCHES

Kenya: Piracy impacts

220. The WPTT **NOTED** paper IOTC–2014–WPTT16–56 which described the impacts of piracy on the Kenyan fleet targeting tropical tunas, including the following abstract provided by the authors:

> "*Yellowfin tuna (Thunnus albacares), Skipjack tuna (Katsuwonus pelamis) and Bigeye tuna (Thunnus obesus) are target species by Kenyan flagged longliners, foreign fishing vessels licensed to fish in Kenyan EEZ, sports fishers and artisanal fishers. This reports looks at the fishery situation for the 8 critical years beginning 2005 before the onset of the piracy up to 2012 when the situation seems to have been put under control. The fishery was affected by piracy with the deliveries to the cannery dropping from 23,500 tons to 6,557 and later increasing with the reduction of the piracy. The number of foreign licensed longliners dropped from 59 in 2005 to none by the year 2009. Sports fishing was also affected with the tropical tuna catches plummeting from 13 tons to 1.4 tons annually as well as the artisanal landings which also dropped from 336 to 139 tons. The country previously had two flagged longline vessels which after experiencing the challenge left the country.* – see paper for full abstract."

221. The WPTT **NOTED** that there was a difference in the sizes of fish landed at tuna cannery in Mombasa during the peak of the piracy season. The possible reason behind this was a change of fishing grounds or fishing behaviour by the purse seiners. This may be a possible area for future research.

222. The WPTT **NOTED** that most of the tuna related activities in Kenya are returning back to normal. The challenge however remains the reduced sports fishing activities due to terrorism threats and travel advisories. Although the piracy problem seems to have subsided, the terrorism threat needs to be addressed to ensure return to normalcy in the region.

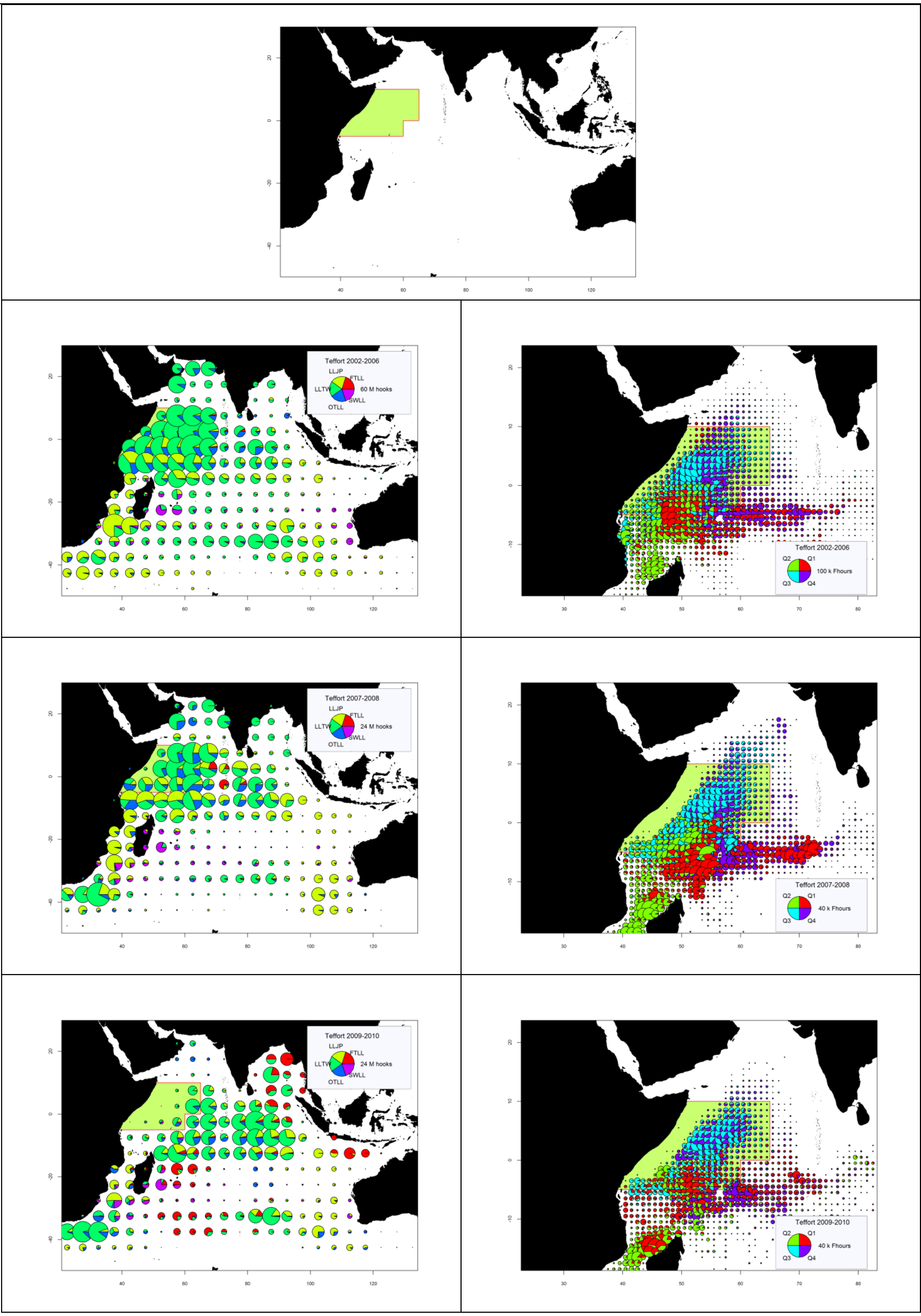
223. **NOTING** that the analyses on the impacts of piracy on tropical tuna fisheries in Kenyan waters, showed *inter alia* a sharp decline in fishing licences purchased by DWFN longline vessels observed during 2009 to 2012, the WPTT **RECALLED** that this result corroborated previous findings of the WPTT regarding the displacement of fishing effort by longline vessels away from the northwest Indian Ocean beginning in the mid-2000s.

Piracy impacts: Summary

224. The WPTT **NOTED** some longline vessels have returned to their traditional fishing areas in the northwest Indian Ocean, due to security on board. Although no specific analysis of the impacts of piracy on all fisheries in the Indian Ocean were presented at this meeting, many papers presented demonstrated clear impacts of piracy on fishing operations in the western Indian Ocean (Somali basin) and other areas as a result of relocated fishing effort (Fig. 12).

225. The WPTT **NOTED** that the relative number of active longline vessels in the IOTC area of competence declined substantially from 2008 until 2011 (Fig. 13a, b), as did the purse seine fleets, albeit to a lesser extent (Fig. 13c). The decline was likely due to the impact of piracy activities in the western Indian Ocean. The fishing effort by the purse seine fleets shifted east by at least 100 miles during 2008–11 compared to the historic distribution of effort (Fig. 12), although vessels remained in the area impacted by piracy due to the presence of onboard military personnel.

226. The WPTT **NOTED** that since 2011, there has been an increase in the number of active longline vessels in the Indian Ocean for Japan (68 in 2011, 72 in 2012 and also in 2013), China (15 in 2011, 36 in 2012 and also in 2013), Taiwan,China (132 in 2011, 138 in 2012 and 147 in 2013) and the Philippines (2 in 2011, 14 in 2012 and 9 in 2013) (Fig. 13a). Similarly, there has been an overall increase in the number of active purse seine vessels in the Indian Ocean for the European Union and assimilated fleets (34 in 2011, 37 in 2012 and 35 in 2013) and for all other purse seine fleets combined (23 in 2011, 31 in 2012 and 48 in 2013) (Fig. 13c).


Teffort 2002-2006
LLJP
FTLL
LLTW
60 M hooks
SWLL
OTLL
Teffort 2002-2006
Q2
Q1
100 k Fhours
Q3
Q4
Teffort 2007-2008
LLJP
FTLL
LLTW
24 M hooks
SWLL
OTLL
Teffort 2007-2008
Q2
Q1
40 k Fhours
Q3
Q4
Teffort 2009-2010
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40 k Fhours
Q3
Q4

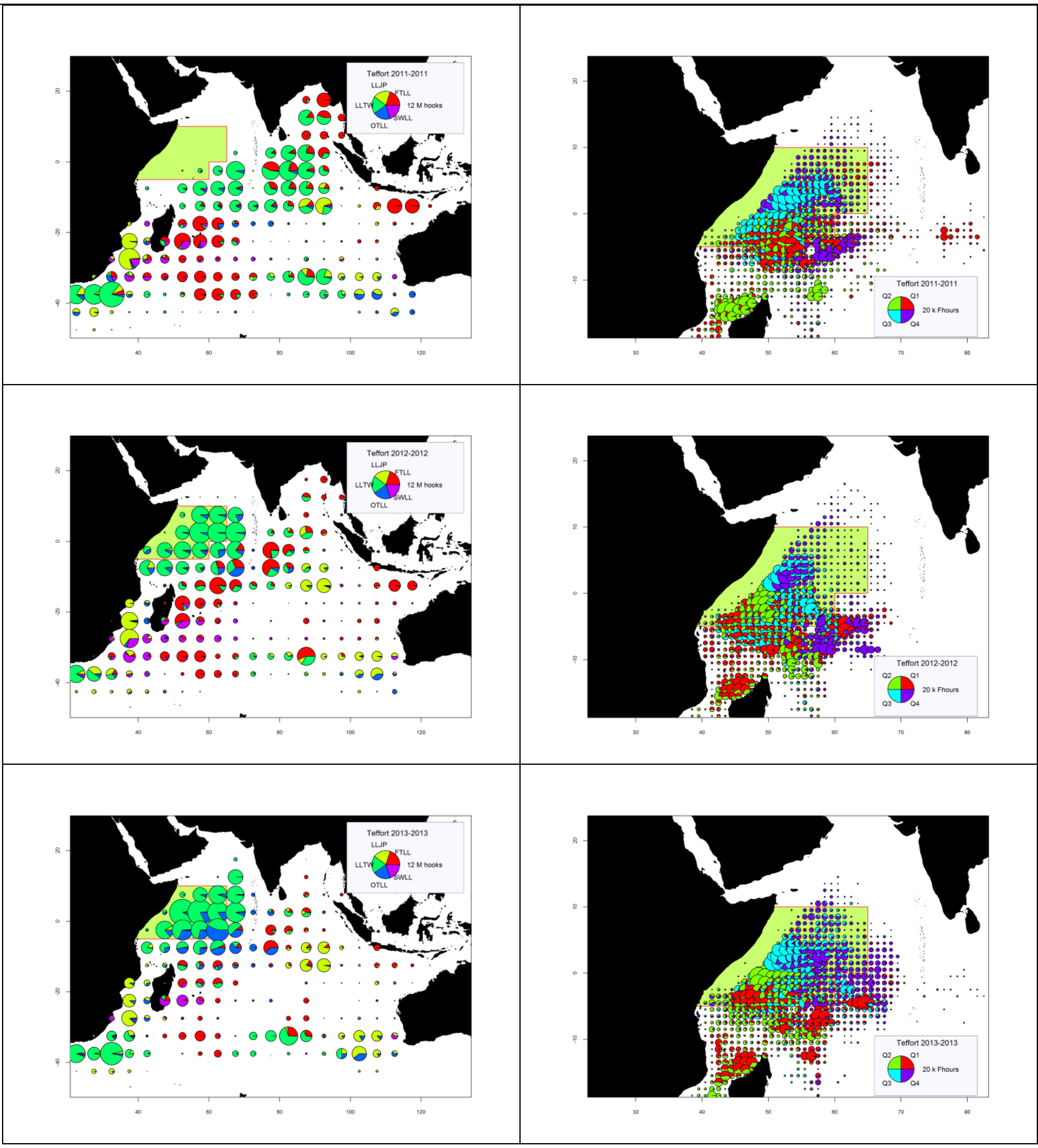

Fig. 12. Longline: The geographical distribution of fishing effort for longline (5 x 5 degrees; millions of hooks – left column) as reported for the longline fleets of Japan (LLJP), Taiwan,China (LLTW), fresh-tuna longline (FTLL), other longline (OTLL), and longline directed at swordfish (SWLL) in the IOTC area of competence (Data as of September 2014), for 2002–06, 2007–08, 2009–10, 2011, 2012 and 2013. Longline effort: LLJP (light green): deep-freezing longliners from Japan; LLTW (dark green): deep-freezing longliners from Taiwan,China; SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets); FTLL (red): fresh-tuna longliners (China, Taiwan,China and other fleets; OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets). **Purse seine:** The geographical distribution of fishing effort for purse seine (1 x 1 degrees; hours fished – right column) in the IOTC area of competence (Data as of September 2014), for 2002–06, 2007–08, 2009–10, 2011, 2012 and 2013. The area shaded in green is where piracy activities are considered highest. The area shaded in green is where piracy activities are considered highest.

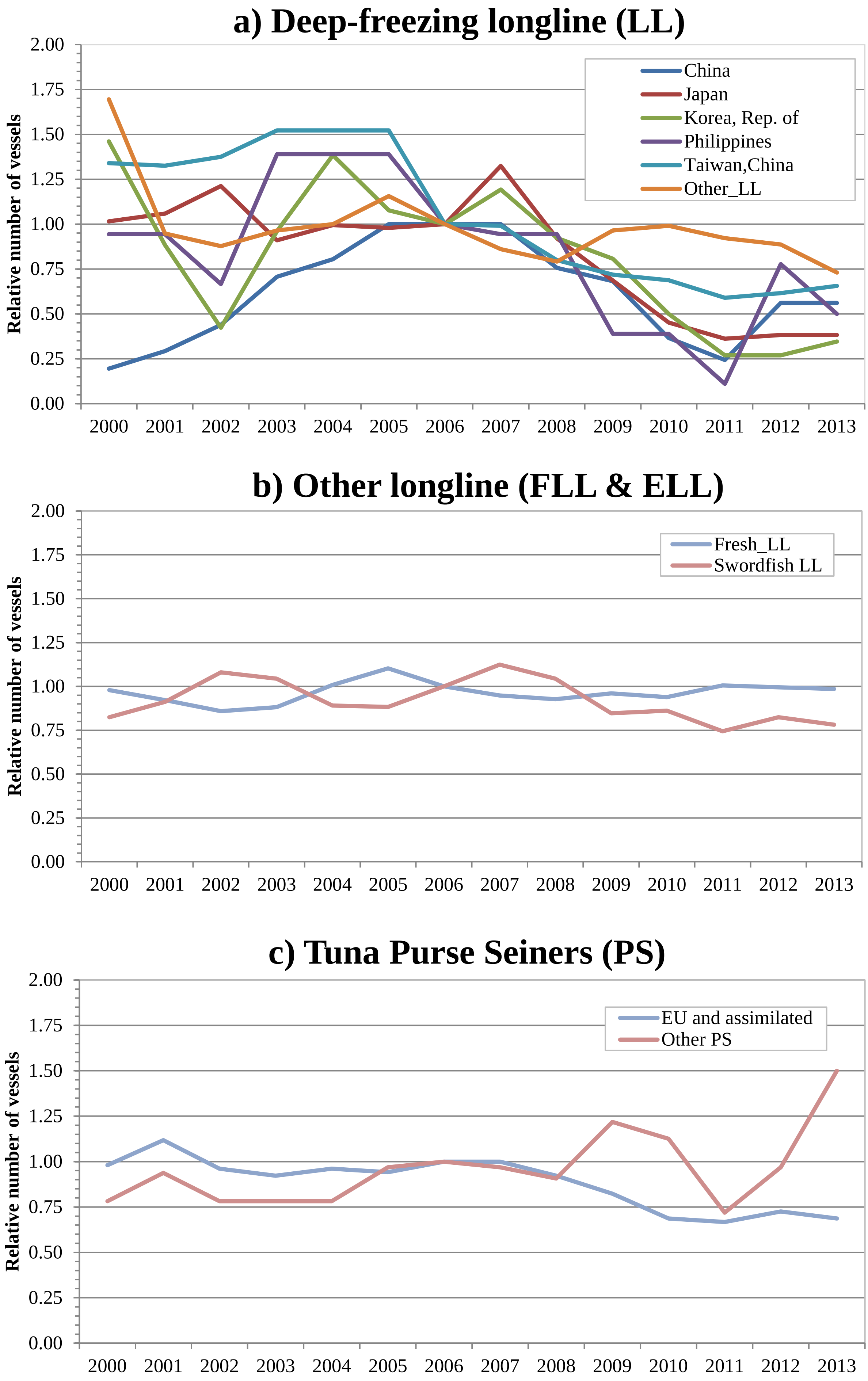

Fig. 13. The change in the relative number of some active a) deep freezing longline (numbers have been scaled to the number of active vessels in 2006), b) other longline and c) purse seine (PS) fleets since 2000 in the Indian Ocean.

227. The WPTT **RECALLED** that in the first half of 2011, 11 longline vessels from Taiwan,China, moved to the Atlantic Ocean and 2 to the Pacific Ocean. However, in the second half of 2011, 5 longline vessels returned from the Atlantic Ocean, and 1 longline vessel returned from the Pacific Ocean. The departure of the vessels from the Indian Ocean is reflected in the total effort deployed throughout not only the western Indian Ocean impacted by piracy, but also the entire Indian Ocean (Fig. 14a for longline and Fig. 14b for purse seine). In 2012, the trend was reversed, with a total of 15 longline vessels being transferred from the Atlantic Ocean back to the Indian Ocean, resulting in an overall increase in longline effort, particularly in the western Indian Ocean (Fig. 14a). Similarly, 6 longline vessels from Taiwan,China have been transferred from the Pacific Ocean back to the Indian Ocean in 2012. Although total levels of effort for the Taiwan,China longline fleet in the Indian Ocean remained low in 2012, effort levels in waters off Somalia increased markedly (Figs. 12 and 14a).

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

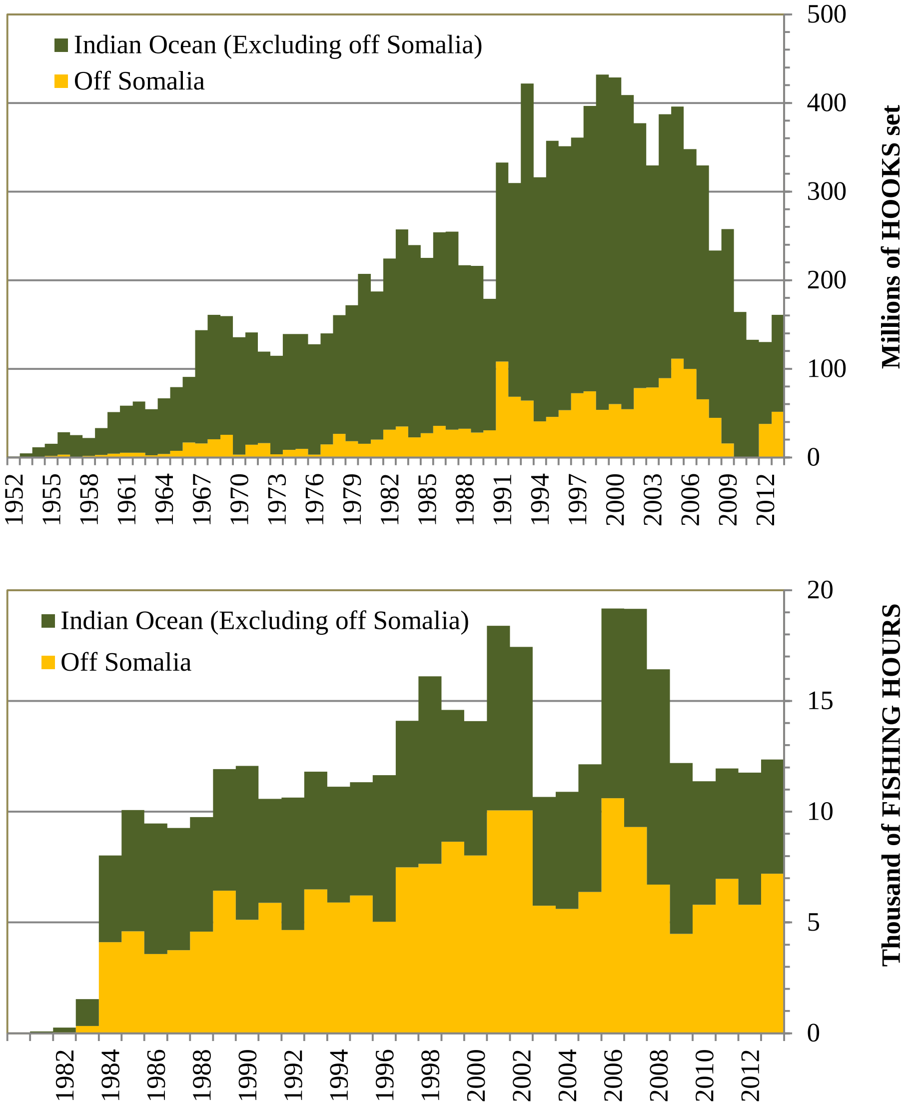

Fig. 14. Changes in total effort for top) longline (number of hooks set in millions), and bottom) purse seine (number of hours fished in thousands) vessels by year and geographical area: off the Somalia coastline (area shown in the insert of Fig. 12) and for the rest of the Indian Ocean.

9. Research Recommendations and Priorities

9.1 Revision of the WPTT Program of Work (2015–2019)

229. The WPTT **NOTED** paper IOTC–2014–WPTT16–08 which provided the WPTT16 with an opportunity to consider and revise the WPTT Program of Work (2015–2019), by taking into account the specific requests of the Commission, Scientific Committee, and the resources available to the IOTC Secretariat and CPCs.

230. The WPTT **RECALLED** that the SC, at its 16th Session, requested that all Working Parties provide their work plans with items prioritised based on the requests of the Commission or the SC. (SC16. para. 194). Similarly, at

the 18th Session of the Commission, the Scientific Committee was requested to provide its Program of Work on a multi-year basis, with project priorities clearly identified. In doing so, the SC should consider the immediate and longer term needs of the Commission.

231. The WPTT **NOTED** the range of research projects on tropical tunas, currently underway, or in development within the IOTC area of competence, and reminded participants to ensure that the projects described are included in their National Reports to the SC.

Data exchange and schedule

232. The WPTT **NOTED** the severe constraints on time and personnel capacity for the 2014 skipjack tuna stock assessment and that these constraints may have impacted the uncertainty around, and confidence in, the results.

233. The WPTT **AGREED** on the importance of appropriately scheduling and resourcing stock assessments to ensure the best possible use of the available data in providing advice to the Commission. The WPTT **RECOMMENDED** that stock assessments be resourced to a level that is commensurate with their fundamental importance in the management of IOTC stocks.

234. **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 **AGREED** that exchanges of data (CPUE indices and coefficient of variation) should be made as early as possible, but **no later than** 30 days prior to a working party meeting, so that stock assessment analysis can be provided to the IOTC Secretariat no later than 15 days before a working party meeting, as per the recommendations of the SC, which states: "*The SC also **ENCOURAGED** data to be used in stock assessments, including CPUE standardisations, be made available not less than three months before each meeting by CPCs and where possible, data summaries no later than two months prior to each meeting, from the IOTC Secretariat; and **RECOMMENDED** that data to be used in stock assessments, including CPUE standardisations be made available **not less than** 30 days before each meeting by CPCs*." (IOTC–2011–SC14–R; p68).

Consultants

235. **NOTING** the excellent work done by IOTC consultants in the past on tuna stock assessments, the WPTT **RECALLED** that the Commission has pre-approved a consultant to undertake a yellowfin tuna stock assessment in 2015, by the inclusion of funds in the 2015 budget. The budget is provided at Table 12 for implementation by the IOTC Secretariat.

TABLE 12. Budget for an IOTC consultant to conduct an SS3 stock assessment on yellowfin tuna in 2015

Description	**Unit price**	**Units required**	**Total**
Tropical tuna Stock Assessment (fees)	US$500	35	17,500
Tropical tuna Stock Assessment (travel)	US$8,000	1	8,000
Total estimate (US$)			**25,500**

Summary

236. The WPTT **RECOMMENDED** that the SC consider and endorse the WPTT Program of Work (2015–2019), as provided at Appendix IX.

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

237. 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.

238. 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 2015, by an Invited Expert:

- **Expertise**: Stock assessment; including from regions other than the Indian Ocean; tagging analysis; size data analysis; and CPUE standardisation.
- **Priority areas for contribution**: Providing expert advice on stock assessments; refining the information base, tagging data analysis, historical data series and indicators for tropical tuna species for stock assessment purposes (species focus: yellowfin tuna).

239. The WPTT **RECALLED** that at its 18th Session, the Commission approved funding for one invited expert within the IOTC regular budget for 2014 and one for 2015. However, the Invited Expert at the current WPTT16 meeting was known to be entirely funded by ISSF. In view of the highly technical nature of the stock assessment issues and limitation of experts from CPCs attending the meeting, the question was raised as to why the IOTC Secretariat did not fund the attendance of the Invited Expert, for providing alternative views and advice for the difficult issues that the skipjack tuna assessment was facing. The WPTT was informed that it was an issue with

late contributions from Members and the need to allocate available funds accordingly. However, the WPTT **RECOMMENED** that if the Commission allocated funds to such a high priority task, that the IOTC Secretariat may not re-allocate other than what it was originally allocated for, unless prior approvals have been sought from Chair of the Commission.

10. Other Business

10.1 Election of a Chairperson of the WPTT for the next biennium

240. The WPTT **NOTED** that the second term of the current Chairperson, Dr Hilario Murua (EU,Spain) is due to expire at the closing of the current WPTT meeting and as per the IOTC Rules of Procedure (2014), participants are required to elected a new Chairperson for the next biennium.

241. The WPTT **THANKED** Dr Murua for his Chairmanship over the past four years and looked forward to his continued engagement in the activities of the WPTT in the future.

242. **NOTING** the Rules of Procedure (2014), the WPTT **CALLED** for nominations for the newly vacated position of Chairperson of the IOTC WPTT for the next biennium. Dr M.Shiham Adam (Maldives) was nominated, seconded and elected as Chairperson of the WPTT for the next biennium.

243. **NOTING** the Rules of Procedure (2014), the WPTT **CALLED** for nominations for the newly vacated position of Vice-Chairperson (as Dr Adam was the Vice-Chairperson) of the IOTC WPTT for the next biennium. Dr Gorka Merino (EU,Spain) was nominated, seconded and elected as Vice-Chairperson of the WPTT for the next biennium.

244. The WPTT **RECOMMENDED** that the SC note that Dr M.Shiham Adam (Maldives) and Dr Gorka Merino (EU,Spain) were elected as Chairperson and Vice-Chairperson of the WPTT for the next biennium.

10.2 Date and place of the 17th Session of the WPTT

245. The WPTT participants were unanimous in **THANKING** Indonesia for hosting the 16th Session of the WPTT and commended Indonesia on the warm welcome, the excellent facilities and assistance provided to the IOTC Secretariat in the organisation and running of the Session.

246. The WPTT **AGREED** that each meeting of the WPTT should be fixed, to start within the third week of October each year, thereby allowing participants to be better plan and prepare for this meeting, and potentially other IOTC meetings. The exact dates should continue to be flexible.

247. The WPTT **AGREED** on the importance of having IOTC working party meetings within key CPCs catching species of relevance to the working party, in this case on tropical tuna. Following a discussion on who would host the 17th and 18th Sessions of the WPTT in 2015 and 2016 respectively, the WPTT **REQUESTED** that the IOTC Secretariat liaise with EU,France to confirm that they would be able to host the 17th Session in 2015, and also with other CPCs for the 18th Session in 2016. The meeting locations will be communicated by the IOTC Secretariat to the SC for its consideration at its next session to be held in December 2014, as detailed in Table 13.

Table 13. Draft meeting schedule for the WPTT (2015 and 2016)

Meeting	2015		2016	
	Date	**Location**	**Date**	**Location**
Working Party on **Tropical Tunas**	Third week in October (6 d)	EU,France	Third week in October (6 d)	TBD

248. The WPTT **NOTED** the importance of having a degree of stability in the participation of CPCs to each of the working party meetings and **ENCOURAGED** participants to regularly attend each meeting to ensure as much continuity as possible.

10.3 Review of the draft, and adoption of the Report of the 16th Session of the WPTT

249. The WPTT **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPTT16, 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 2014 (Fig. 15):
   - Bigeye tuna (*Thunnus obesus*) – Appendix VI
   - Skipjack tuna (*Katsuwonus pelamis*) – Appendix VII
   - Yellowfin tuna (*Thunnus albacares*) – Appendix VIII

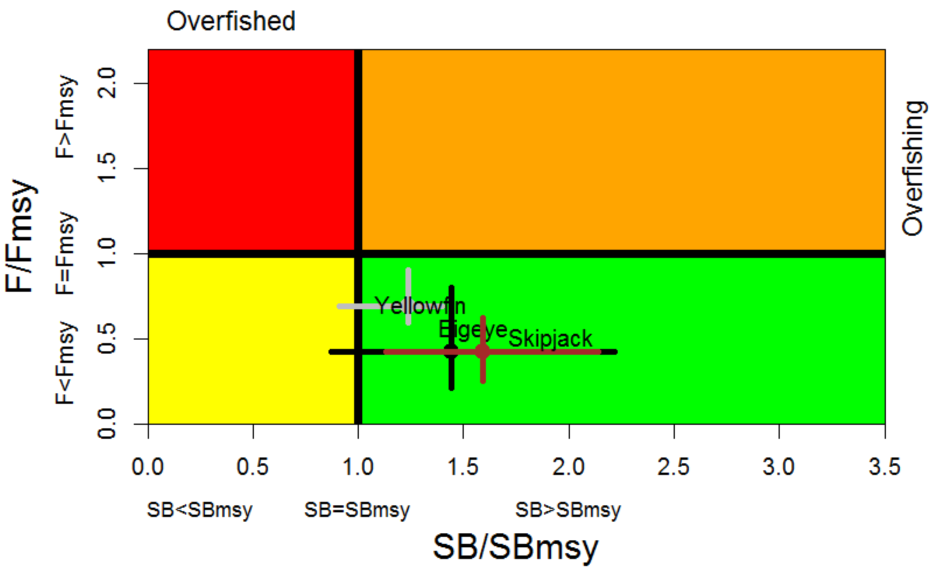

Fig. 15. Combined Kobe plot for bigeye tuna (black: 2013), skipjack tuna (brown: 2014) and yellowfin tuna (grey: 2012) showing the estimates of current stock size (SB) and current fishing mortality (F) in relation to optimal spawning stock size and optimal fishing mortality. Cross bars illustrate the 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.

250. The report of the 16th Session of the Working Party on Tropical Tunas (IOTC–2014–WPTT16–R) was **ADOPTED** on the 19 November 2014.

APPENDIX I
LIST OF PARTICIPANTS

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APPENDIX II
AGENDA FOR THE 16TH WORKING PARTY ON TROPICAL TUNAS

Date: 15–19 November 2014
Location: Ramada Bintang Bali Resort, Jalan Kartika Plaza, Tuban, Kuta
Bali, Indonesia
Time: 09:00 – 17:00 daily
Chair: Dr. Hilario Murua; **Vice-Chair**: Dr. Shiham Adam

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 16th Session of the Scientific Committee (IOTC Secretariat)
   - 3.2 Outcomes of the 18th 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 WPTT15 (IOTC Secretariat)
4. **NEW INFORMATION ON FISHERIES AND ASSOCIATED ENVIRONMENTAL DATA RELATING TO TROPICAL TUNAS**
   - 4.1 Review new information on fisheries and associated environmental data (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 the biology, ecology, stock structure, their fisheries and associated environmental data for bigeye tuna (CPC papers)
   - 5.3 Data for input into stock assessments (indicators):
     - o Catch and effort
     - o Catch at size
     - o Growth curves and age-length key
     - o Catch at age
     - o CPUE indices and standardised CPUE indices
     - o Tagging data
   - 5.4 Stock assessments
   - 5.5 Selection of Stock Status indicators
   - 5.6 Development of technical advice on the status of bigeye tuna
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 the biology, ecology, stock structure, their fisheries and associated environmental data for skipjack tuna (CPC papers)
   - 6.3 Data for input into stock assessments (indicators):
     - o Catch and effort
     - o Catch at size
     - o Growth curves and age-length key
     - o Catch at age
     - o CPUE indices and standardised CPUE indices
     - o Tagging data
   - 6.4 Stock assessments
   - 6.5 Selection of Stock Status indicators
   - 6.6 Development of technical advice on the status of skipjack tuna
   - 6.7 Progress on the development of Management Strategy Evaluation (MSE) and Harvest Control Rules (HCR) for skipjack tuna
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 the biology, ecology, stock structure, their fisheries and associated environmental data for yellowfin tuna (CPC papers)
   - 7.3 Data for input into stock assessments (indicators):

- Catch and effort
- Catch at size
- Growth curves and age-length key
- Catch at age
- CPUE indices and standardised CPUE indices
- Tagging data

7.4 Stock assessments

7.5 Selection of Stock Status indicators

7.6 Development of technical advice on the status of yellowfin tuna

8. EFFECT OF PIRACY ON TROPICAL TUNA CATCHES

9. RESEARCH RECOMMENDATIONS AND PRIORITIES

9.1 Revision of the WPTT Program of Work (2015–2019)

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

10. OTHER BUSINESS

10.1 Election of a Chairperson of the WPTT for the next biennium

10.2 Date and place of the 17th Session of the WPTT

10.3 Review of the draft, and adoption of the Report of the 16th Session of the WPTT

APPENDIX III
LIST OF DOCUMENTS

Document	Title	Availability
IOTC–2014–WPTT16–01a	Draft: Agenda of the 16th Working Party on Tropical Tunas	✓(6 August 2014)
IOTC–2014–WPTT16–01b	Draft: Annotated agenda of the 16th Working Party on Tropical Tunas	✓(10 November 2014)
IOTC–2014–WPTT16–02	Draft: List of documents for the 16th Working Party on Tropical Tunas	✓(31 October 2014)
IOTC–2014–WPTT16–03	Outcomes of the 16th Session of the Scientific Committee (IOTC Secretariat)	✓(14 October 2014)
IOTC–2014–WPTT16–04	Outcomes of the 18th Session of the Commission (IOTC Secretariat)	✓(14 October 2014)
IOTC–2014–WPTT16–05	Review of Conservation and Management Measures relevant to tropical tunas (IOTC Secretariat)	✓(14 October 2014)
IOTC–2014–WPTT16–06	Progress made on the recommendations of WPTT15 (IOTC Secretariat)	✓(15 October 2014)
IOTC–2014–WPTT16–07	Review of the statistical data and fishery trends for tropical tunas (IOTC Secretariat)	✓(30 October 2014)
IOTC–2014–WPTT16–08	Revision of the WPTT Program of Work (2015–2019) (IOTC Secretariat)	✓(14 October 2014)
IOTC–2014–WPTT16–09	Tuna longline fishery by Thai longliners in the Indian Ocean during 2009-2013 (Lirdwitayaprasit P, Luesrithawornsinand P & Wongkeaw A)	✓(27 October 2014)
IOTC–2014–WPTT16–10	Review of Japanese fisheries and tropical tuna catch in the Indian Ocean (Matsumoto T)	✓(31 October 2014)
IOTC–2014–WPTT16–11	Tropical tuna fisheries in the Indian Ocean of Iran (Akhondi M)	✓(2 November 2014)
IOTC–2014–WPTT16–12	Fishing activities of the French and associated flags purse seiners targeting tropical tunas in the Indian Ocean (1981-2013) (Chassot E, Floch L, Dewals P, Damiano A, Cauquil P & Chavance P)	✓(3 November 2014)
IOTC–2014–WPTT16–13	Statistics of the European Union and associated flags purse seine fishing fleet targeting tropical tunas in the Indian Ocean (1981-2013) (Chassot E, Delgado de Molina A, Assan C, Lucas V, Dewals P, Areso JJ, Rahombanjanahary DM, Soto M & Floch L)	✓(7 November 2014)
IOTC–2014–WPTT16–14	Modelling the spatial behaviour of a tropical tuna purse seine fleet (Davies TK, Mees CC & Milner-Gulland EJ)	✓(15 October 2014)
IOTC–2014–WPTT16–15	Statistics of the purse seine Spanish fleet in the Indian Ocean (1990-2013) (Delgado de Molina A, Ariz J & Soto M)	✓(7 November 2014)
IOTC–2014–WPTT16–16	Some new approaches for standardizing tropical purse seine CPUEs (Katara I & Gaertner D)	✓(11 November 2014)
IOTC–2014–WPTT16–17	Examining the impact of spatial closures on the behaviour of a tropical tuna purse seine fleet (Davies TK, Mees CC & Milner-Gulland EJ)	✓(15 October 2014)
IOTC–2014–WPTT16–18	Analysis of impact of non-entangling FADs on incidental catches in the Indian Ocean tuna fishery (Hernández-García V, Ortega ATS, Ganzedo-López U & Castro JJ)	✓(29 October 2014)
IOTC–2014–WPTT16–19 Rev_1	Spanish Fish Aggregating Device Management Plan. Preliminary data in the Indian Ocean (Delgado de Molina A, Ariz J, Murua H, Santana JC, Ramos L & Soto M)	✓(7 November 2014) ✓(15 November 2014)
IOTC–2014–WPTT16–20	The use of artificial fish aggregating devices by the French tropical tuna purse seine fleet: Historical perspective and current practice (Chassot E, Goujon M, Maufroy A, Cauquil P, Augustin E, Fonteneau A & Gaertner D)	✓(6 November 2014)
IOTC–2014–WPTT16–21	How many fish aggregating devices are currently drifting in the Indian Ocean? Combining sources of information to provide a reliable estimation (Maufroy A, Bez N, Kaplan D, Delgado de Molina A, Murua A & Chassot E)	✓(7 November 2014)
IOTC–2014–WPTT16–22	Managing tropical tuna purse seine fisheries through limiting the number of drifting fish aggregating devices in the Indian Ocean: food for thought (Fonteneau A & Chassot E)	✓(4 November 2014)
IOTC–2014–WPTT16–23	Ocean-climate interaction of eastern Indian Ocean for tuna fisheries and its socio-economy impacts (Pranowo WS, Tisiana A, Nugraha B, Novianto D & Muawanah U)	✓(1 November 2014)

Document	Title	Availability
IOTC–2014–WPTT16–24	Outline of climate and oceanographic conditions in the Indian Ocean: an update to August 2014 (Marsac F)	✓(15 November 2014)
IOTC–2014–WPTT16–25	Spatial and temporal distribution of bigeye tuna (*Thunnus obesus*) in eastern Indian Ocean on scientific observer data from 2005-2013 (Jatmiko I, Setyadji B & Novianto D)	✓(31 October 2014)
IOTC–2014–WPTT16–26	Notes on yellowfin/bigeye tuna ratio and size distribution in the Maldivian tuna fishery (Adam MS, Jauharee AR & Ahusan M)	✓(5 November 2014)
IOTC–2014–WPTT16–27 Rev_1	Spatial considerations in bigeye and yellowfin CPUE from Japanese and Taiwan,China longline fisheries in the Indian Ocean (Hoyle S)	✓(31 October 2014) ✓(15 November 2014)
IOTC–2014–WPTT16–28 Rev_1	Provisional study on comparison of CPUE trend of bigeye and yellowfin tuna between Japanese and Taiwan-China longline fisheries based on whole and shared strata in the Indian Ocean (Okamoto H)	✓(31 October 2014) ✓(11 November 2014)
IOTC–2014–WPTT16–29 Rev_1	Japanese longline CPUE for bigeye tuna in the Indian Ocean standardized by GLM (Ochi D, Matsumoto T, Satoh K & Okamoto H)	✓(31 October 2014) ✓(7 November 2014)
IOTC–2014–WPTT16–30	CPUE standardization of bigeye tuna caught by Korean tuna longline fishery in the Indian Ocean (Lee SI, Kim ZG, Lee MK, Ku JE, Park HE & Lee DW)	✓(10 November 2014)
IOTC–2014–WPTT16–31	CPUE of bigeye and yellowfin tuna caught by Japanese longliner in the Indian Ocean standardized by GLM considering several aspects of area, catchability and data resolution (Okamoto H)	✓(31 October 2014)
IOTC–2014–WPTT16–32	Analysis of skipjack tuna (*Katsuwonus pelamis*) landings made by Sri Lankan fishing vessels operated during 2005-2012 with special reference to the nature of the fishing operations (Haputhantri SSK)	✓(30 October 2014)
IOTC–2014–WPTT16–33	Size structure of skipjack (*Katsuwonus pelamis* - Linnaeus 1758) IN FMA 573 (Sulistyaningsih RK & Wujdi A)	✓(13 November 2014)
IOTC–2014–WPTT16–34	Withdrawn	Withdrawn
IOTC–2014–WPTT16–35	Reproductive biology of skipjack tuna (*Katsuwonus pelamis*) in eastern Indian Ocean (Tampubolon PARP, Jatmiko I, Hartaty H & Bahtiar A)	✓(31 October 2014)
IOTC–2014–WPTT16–36	On the movements and stock structure of skipjack (*Katsuwonus pelamis*) in the Indian ocean (Fonteneau A)	✓(4 November 2014)
IOTC–2014–WPTT16–37	Estimation of Indian Ocean skipjack fisheries’ productivity using a catch based method (Merino G, Murua H, Arrizabalaga H, Santiago J & Scott GP)	✓(6 November 2014)
IOTC–2014–WPTT16–38	Size based indicators of performance of Indian Ocean skipjack tuna towards developing specifically built Harvest Control Rules (Merino G, Murua H, Arrizabalaga H & Santiago J)	✓(6 November 2014)
IOTC–2014–WPTT16–39	Management strategy evaluation for Indian ocean skipjack tuna : first steps (Bentley N & Adam MS)	✓(10 November 2014)
IOTC–2014–WPTT16–40 Rev_2	Indicators of stock status for skipjack tuna in the Indian Ocean (Merino G, Murua H, Arrizabalaga H & Santiago J)	✓(6 November 2014) ✓(16 November 2014) ✓(18 November 2014)
IOTC–2014–WPTT16–41	Skipjack tuna CPUE trends using alternative indices from the French purse seine logbooks (Marsac F & Floch L)	✓(7 November 2014)
IOTC–2014–WPTT16–42	Maldives skipjack pole and line fishery catch rate standardization 2004–2012: Reconstructing historic CPUE until 1985 (Sharma R, Geehan J & Adam MS)	✓(30 September 2014)
IOTC–2014–WPTT16–43 Rev_2	Indian Ocean Skipjack Tuna Stock Assessment 1950-2013 (Stock Synthesis) (Sharma R & Herrera M)	✓(31 October 2014) ✓(7 November 2014) ✓(14 November 2014)
IOTC–2014–WPTT16–44	Distribution and biological aspect of yellowfin tuna (*Thunnus albacares*) caught by Indonesian tuna longline in the eastern Indian Ocean (Wujdi A, Jatmiko I, Setyadji B, Sulistyaningsih RK, Novianto D, Rochman F, Bahtiar A & Hartaty H)	✓(31 October 2014)
IOTC–2014–WPTT16–45 Rev_2	A comparison of biological characteristics of yellowfin tuna (*Thunnus albacares*) in the Western and Central Indian Ocean (Liu H, Song L, Chen H & Li Y)	✓(4 November 2014) ✓(7 November 2014) ✓(8 November 2014)

Document	Title	Availability
IOTC–2014–WPTT16–46	Weight-weight, length-weight relationships and condition factor of yellowfin tuna (*Thunnus albacares*) in eastern Indian Ocean (Jatmiko I, Hartaty H & Nugraha B)	✓(11 November 2014)
IOTC–2014–WPTT16–47 Rev_1	Japanese longline CPUE for yellowfin tuna in the Indian Ocean up to 2013 standardized by generalized linear model (Ochi D, Matsumoto T, Okamoto H & Kitakado T)	✓(31 October 2014) ✓(7 November 2014)
IOTC–2014–WPTT16–48 Rev_1	Exploration of area stratification for CPUE standardization of yellowfin tuna by Japanese longline (Satoh K)	✓(10 November 2014) ✓(16 November 2014)
IOTC–2014–WPTT16–49	CPUE standardization of yellowfin tuna caught by Korean tuna longline fishery in the Indian Ocean (Lee SI, Kim ZG, Lee MK, Jeong YK & Lee DW)	✓(10 November 2014)
IOTC–2014–WPTT16–50	Tentative sequential population analysis of Indian Ocean skipjack catch at size (Fonteneau A)	✓(4 November 2014)
IOTC–2014–WPTT16–51	Preliminary study about the suitability of an electronic monitoring system to record scientific and other information from the tropical tuna purse seine fishery (Monteagudo JP, Legorburu G, Justel-Rubio A & Restrepo V)	✓(16 October 2014)
IOTC–2014–WPTT16–52	Indian Ocean tropical tunas in MyFISH, an European FP7 project aiming to develop new MSY indicators (Merino G, Murua H, Arrizabalaga H & Santiago J)	✓(7 November 2014)
IOTC–2014–WPTT16–53 Rev_2	Kobe I (Kobe plot) + Kobe II (risk assessment) software (New version 3, 2014) (Nishida T, Kitakado T, Iwasaki K & Itoh K)	✓(6 November 2014) ✓(14 November 2014) ✓(18 November 2014)
IOTC–2014–WPTT16–54 Rev_1	AD model builder implemented age-structured production model (ASPM) software (version 3, 2014) (Nishida T, Kitakado T, Iwasaki, K & Itoh K)	✓(10 November 2014) ✓(15 November 2014)
IOTC–2014–WPTT16–55 Rev_1	Analysis of Taiwanese longline fisheries based on operational catch and effort data for bigeye and yellowfin tuna in the Indian Ocean (Yeh Y-M)	✓(13 November 2014) ✓(16 November 2014)
IOTC–2014–WPTT16–56	The impact of piracy on the tropical tuna fishery in Kenya (Ndegwa S)	✓(2 October 2014)
Information papers		
IOTC–2014–WPTT16–INF01	IOTC SC – Guidelines for the Presentation of Stock Assessment Models (IOTC Scientific Committee)	✓(30 September 2014)
IOTC–2014–WPTT16–INF02	On the recent steady decline of skipjack caught by purse seiners in free school sets in the eastern Atlantic and western Indian oceans (A. Fonteneau)	✓(7 October 2014)
IOTC–2014–WPTT16–INF03	Reproductive ecology of the yellowfin tuna (*Thunnus albacares*) in the western Indian Ocean (Balerdi IZ)	✓(7 November 2014)
IOTC–2014–WPTT16–INF04	The reproductive biology, condition and feeding ecology of the skipjack, *Katsuwonus pelamis*, in the Western Indian Ocean (Mendizabal MG)	✓(16 November 2014)
IOTC–2014–WPTT16–INF05	Standarized CPUE for skipjack tuna from the european purse Seine fleet in the Indian ocean from 1984 to 2013 (Soto M, Fernández F, Delgado de Molina A & Chassot E)	✓(16 November 2014)
Data sets		
IOTC–2014–WPTT16–DATA01	Tropical tuna datasets available (IOTC Secretariat)	✓(16 October 2014)
IOTC–2014–WPTT16–DATA02	Maldives standardised pole and line CPUE series 2004–2012	✓(30 September 2014)
IOTC–2014–WPTT16–DATA03	Skipjack tuna (SKJ) data for Stock Assessment	✓(15 October 2014)
IOTC–2014–WPTT16–DATA04	Nominal Catches per Fleet, Year, Gear, IOTC Area and species	✓(15 October 2014)
IOTC–2014–WPTT16–DATA05	Catch and Effort - Longline	✓(15 October 2014)
IOTC–2014–WPTT16–DATA06	Catch and Effort - vessels using pole and lines or purse seines	✓(15 October 2014)
IOTC–2014–WPTT16–DATA07	Catch and Effort - Coastal	✓(15 October 2014)
IOTC–2014–WPTT16–DATA08	Catch and Effort - all vessels	✓(15 October 2014)
IOTC–2014–WPTT16–DATA09	Catch and Effort - reference	✓(15 October 2014)
IOTC–2014–WPTT16–DATA10	Size Frequency - Tropical tuna species	✓(15 October 2014)
IOTC–2014–WPTT16–DATA11	Size frequency - reference	✓(15 October 2014)
IOTC–2014–WPTT16–DATA12	Catch-at-size - Tropical tuna species	✓(15 October 2014)
IOTC–2014–WPTT16–DATA13	Data - Catalogue	✓(15 October 2014)
IOTC–2014–WPTT16–DATA14	Bigeye tuna longline standardised CPUE series: Rep. of Korea	✓(10 November 2014)
IOTC–2014–WPTT16–DATA15	Yellowfin tuna longline standardised CPUE series: Rep. of Korea	✓(10 November 2014)

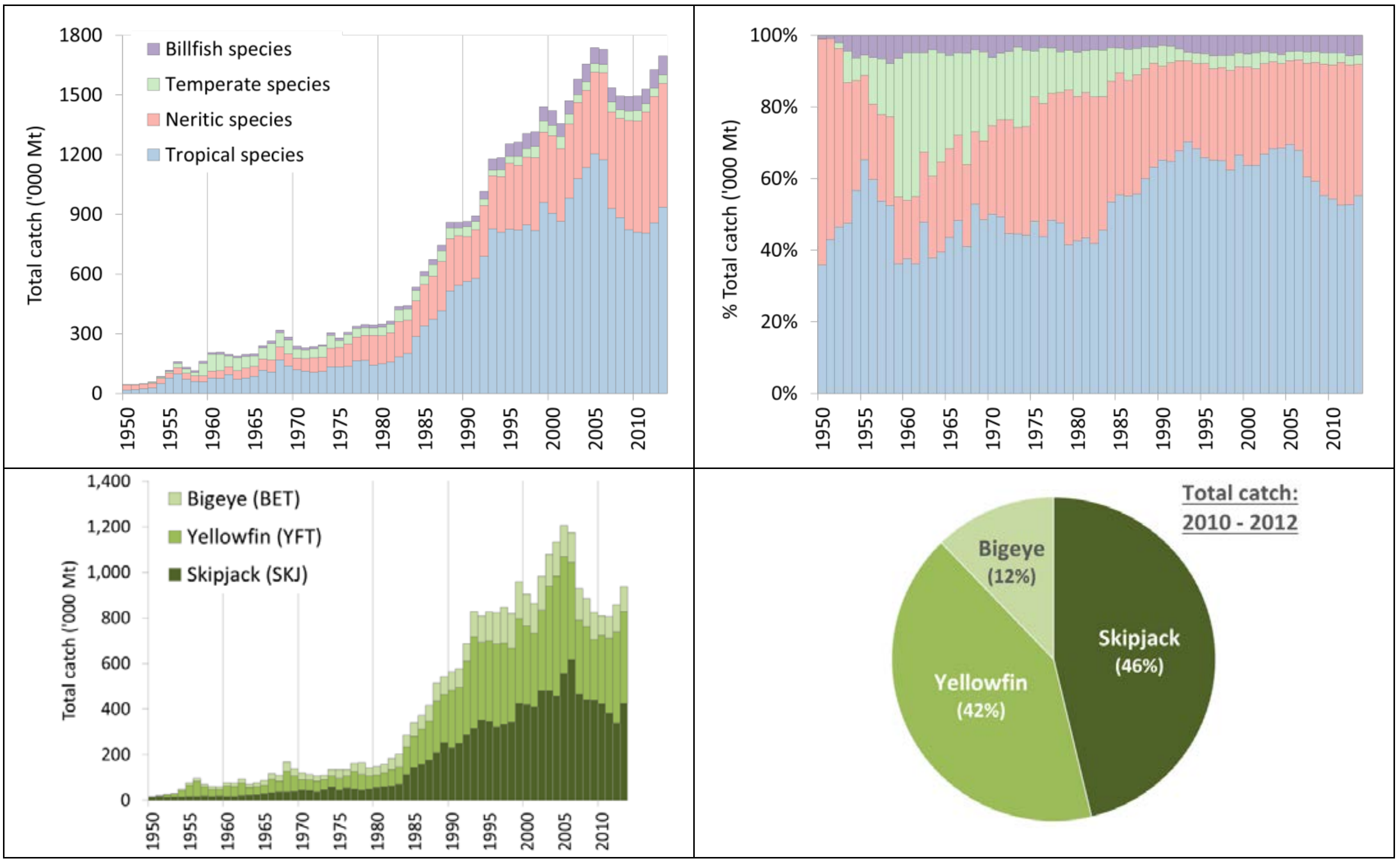
APPENDIX IVA
STATISTICS FOR TROPICAL TUNAS

Extracts from IOTC–2014–WPTT16–07 Rev_1

The contribution of tropical tunas to the total catches of IOTC species in the Indian Ocean has changed over the years (Fig. 1a, b.), in particular following the arrival of industrial purse seine fleets to the Indian Ocean in the early-1980s targeting tropical tunas which led to a significant increase in the amount of catch accounted for by tropical tuna species. 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 longline fleet targeting tropical tunas – leading to a relative decline in the proportion of catches from tropical tuna species. In recent years (2009–13), the catches of tropical tunas in the Indian Ocean have accounted for 54% of the combined catches of all IOTC species (compared to 60% over the period 1950–2013). Since 2012, catches of tropical tunas appear to show 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 fishing effort to the north-west Indian Ocean.

Among the tropical tuna species skipjack tuna dominate, with catches that account for 46% of the total combined catches of tropical tunas in recent years (2011–12; Fig. 1c.). While the catch levels of yellowfin tuna were also high during the same period (42%), the catches of bigeye tuna were at lower levels (12%). 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, Sri Lanka, Maldives, Iran, and India) have reported around 56% of the total catches of tropical tuna species from all countries and species combined, while the industrial purse seiners and longliners flagged in EU-Spain, Seychelles and EU,France reported around 29% of the total catches of these species (from 2010–12; Fig. 2).

The majority of the 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 retained by the fishermen for direct consumption. Tropical tunas are mainly caught using purse seines (accounting for 36% of the total catches of tropical tunas for 2011–13), with important catches also reported by several types of handlines and trolling (19%), gillnets (18%), longlines (15%), and pole-and-lines (11%), in both coastal waters and the high seas. Tropical tunas are the target of many fisheries although they are also caught as a bycatch of fisheries targeting other tunas, small pelagic species, or other non-tuna species (e.g. sharks).



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 1950–2013. Top left: total catch; Top right: percentage, same colour key as Top left; **Bottom:** Contribution of each tropical tuna species to the total combined catches of tropical tunas, Bottom left: nominal catch of each species, 1950–2013; Bottom right: share of tropical tuna catch by species, 2010–12).

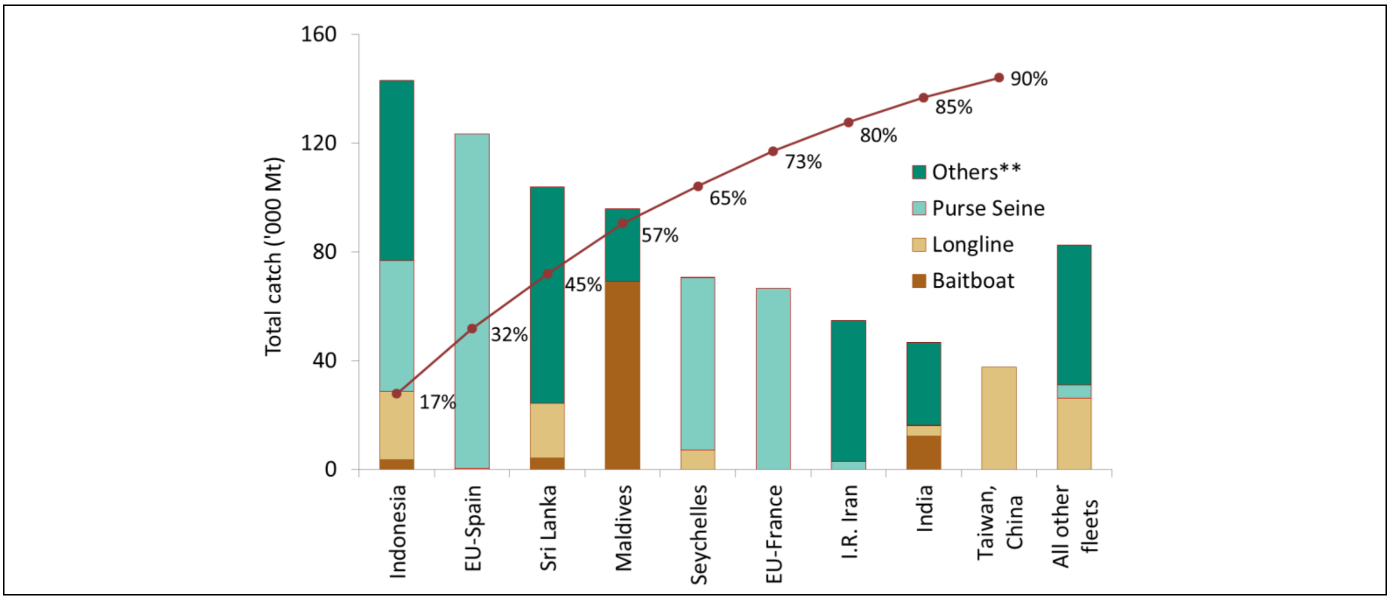


Fig. 2: All tropical tunas: average catches in the Indian Ocean over the period 2010–12, by fleet. Fleets are ordered from left to right, according to the importance of catches of tropical tunas reported. The red line indicates the (cumulative) proportion of catches of tropical tunas for the countries concerned, over the total combined catches of species reported from all fleets and fisheries. ** Other gears includes handline, gillnet, gillnet-longline, trawling.

APPENDIX IVB
MAIN STATISTICS OF BIGEYE TUNA

(Extracts from IOTC–2014–WPTT16–07 Rev_1)

Bigeye tuna (*Thunnus obesus*)

Bigeye tuna – Fisheries and catch trends

Bigeye tuna is mainly caught by industrial longline (54% in 2013) and purse seine (31% in 2013) fisheries, with the remaining 16% of the catch taken by other fisheries (Table 1). However, in recent years the catches of bigeye tuna by gillnet fisheries are likely to be higher, due to major changes experienced in some of these fleets (e.g., Sri Lanka and I.R. Iran) - notably changes in boat size, fishing techniques and fishing grounds, with vessels using deeper gillnets on the high seas in areas where catches of bigeye tuna by other fisheries are important.

Table 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 (2004–2013), in tonnes. Data as of September 2014. Catches by decade represent the average annual catch, noting that some gears were not used since the beginning of the fishery (refer to Fig. 1).

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

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

Table 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 (2004–2013), in tonnes. Data as of September 2014. Catches by decade represent the average annual catch.

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

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

Total annual catches have increased steadily since the start of the fishery, reaching the 100,000 t level in 1993 and peaking at over 160,000 t in 1999 (Fig. 1). Catches dropped since then to values between 130,000–150,000 t (2000–07), before dropping even further in recent years to values under 90,000 t (e.g., 2010–11), before increasing in 2012 to nearly 120,000 t. The SC believes that the drop in catches between 2008 and 2011 could be related, at least in part, with the expansion of piracy in the northwest Indian Ocean (West A1, Table 2, Fig. 2b), which led to a marked drop in the levels of longline effort in the core fishing area of these species in 2010–11 (Figs. 2 and 3).

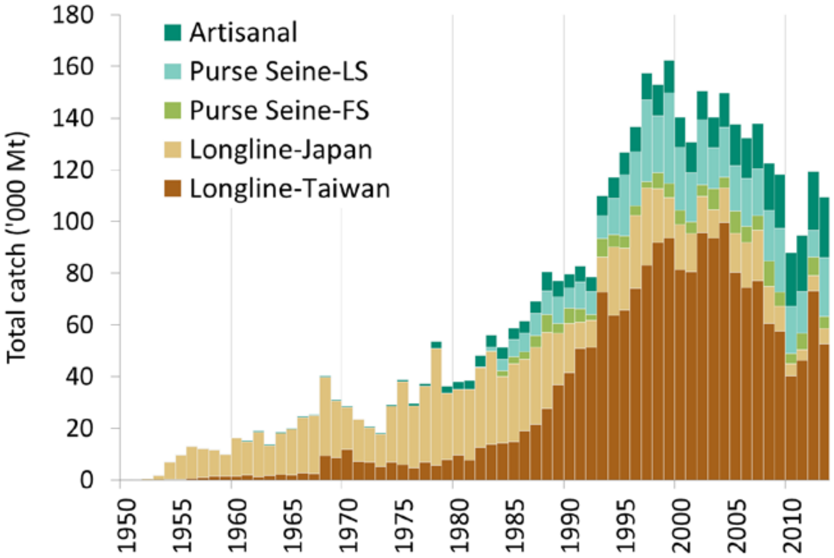
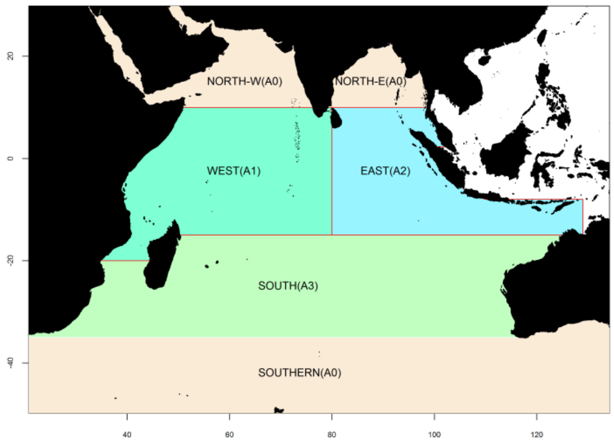


Fig. 1. Bigeye tuna: Annual catches of bigeye tuna by gear (1950–2012). Data as of September 2014. Gears (as agreed by WPTT): Longline Taiwan,China and associated fleets (Longline-Taiwan); Longline Japan and associated fleets (Longline-Japan); Purse seine free-school (FS); Purse seine associated school (LS); Other gears nei (Pole-and-Line, handline, small longlines, gillnet, trolling & other minor artisanal gears) (Artisanal).



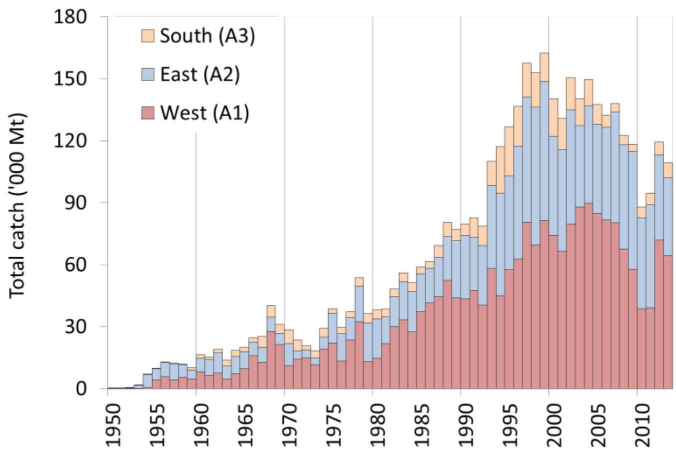


Fig. 2(a-b). Bigeye tuna: Catches of bigeye tuna by area by year estimated for the WPTT (1950–2012). Data as of September 2014. Catches outside the areas presented in the Map were assigned to the closest neighbouring area for the assessment. **Areas**: West Indian Ocean (**A1**); East Indian Ocean (**A2**); Southwest and Southeast Indian Ocean (**A3**). Catches in Areas (**0**) were assigned to the closest neighbouring area for the assessment.

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

Total catches of bigeye tuna by longliners in the Indian Ocean increased steadily from the 1970's attaining values over 90,000 t between 1996 and 2007, and dropping markedly thereafter (Fig. 1). Since 2007 catches of bigeye tuna by longliners have been relatively low, with catches less than half the catch levels recorded before the onset of piracy in the Indian Ocean (e.g., ≈50,000 t). Since 2012 longline catches appear to show signs of recovery (e.g., 79,000 t in 2012), as a result of a reduction in the threat of piracy and return of fleets that appear to be resuming fishing activities in their main fishing grounds in the north-west Indian Ocean (West (A1), Fig. 2b).

Since the late 1980's Taiwan,China has been the major longline fleet fishing for bigeye tuna in the Indian Ocean, taking as much as 40-50% of the total longline catch in the Indian Ocean (Fig. 3). However, catches of longliners from Taiwan,China between 2007 and 2011 decreased markedly (≈20,000 t), to values three times lower than those from the early-2000's. Although catches in 2012 were higher than in recent years, they still remain far below levels recorded in 2003 and 2004.

Since the late 1970's, bigeye tuna has been caught by purse seine vessels fishing on tunas aggregated on floating objects and, to a lesser extent, associated to free swimming schools (Fig. 1) of yellowfin tuna or skipjack tuna. The highest catch of bigeye tuna by purse seiners in the Indian Ocean was recorded in 1999 (≈44,000 t). Catches since 2000 have been between 20,000 and 30,000 t. Purse seiners under flags of EU countries and Seychelles take the majority of purse seine caught bigeye tuna in the Indian Ocean (Fig. 3). Purse seiners mainly take small juvenile bigeye (averaging around 5 kg) compared to longliners which catch much larger and heavier fish. While purse seiners take lower tonnages of bigeye tuna compared to longliners, they take larger numbers of individual fish. Even though the activities of purse seiners have been affected by piracy in the Indian Ocean, the impacts have not been as marked as for longline fleets. The main reason for this is the presence of security personnel onboard purse seine vessels of the EU and Seychelles, which has made it possible for purse seiners under these flags to continue operating in the northwest Indian Ocean (Fig. 4).

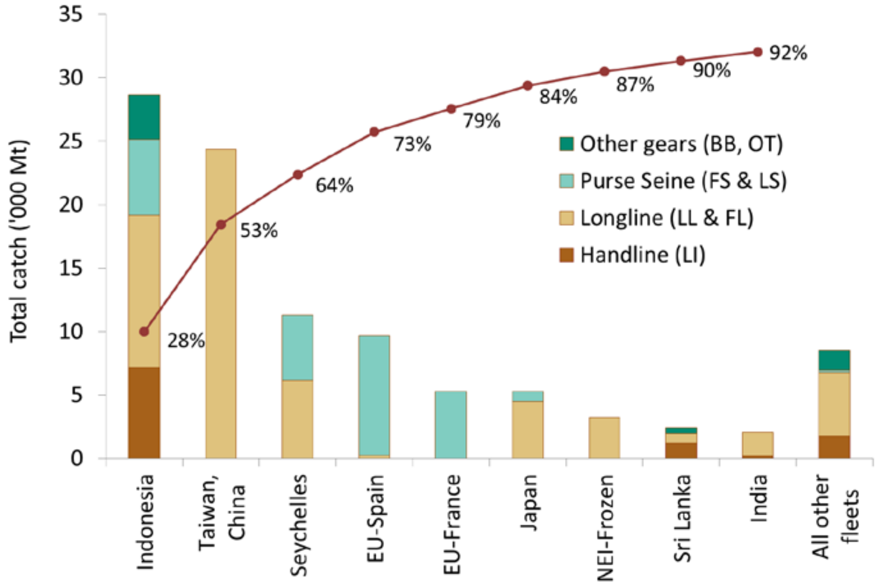


Fig. 3. Bigeye tuna: average catches in the Indian Ocean over the period 2010–12, by fleet. Fleets are ordered from left to right, according to the importance of catches of bigeye reported. The red line indicates the (cumulative) proportion of catches of bigeye for the fleets concerned, over the total combined catches of this species reported from all fleets and fisheries. Data as of September 2014.

By contrast with yellowfin tuna and skipjack tuna, for which the major catches are taken in the western Indian Ocean, bigeye tuna is also exploited in the eastern Indian Ocean (East (A2**)**, Fig. 2 and Table 2). The relative increase in catches in the eastern Indian Ocean in the late 1990's was mostly due to increased activity of small longliners fishing tuna to be marketed fresh. This fleet started its operation in the mid 1970's. However, catches of bigeye tuna in the eastern Indian Ocean have shown a decreasing trend in recent years, as some of the vessels moved south to target albacore.

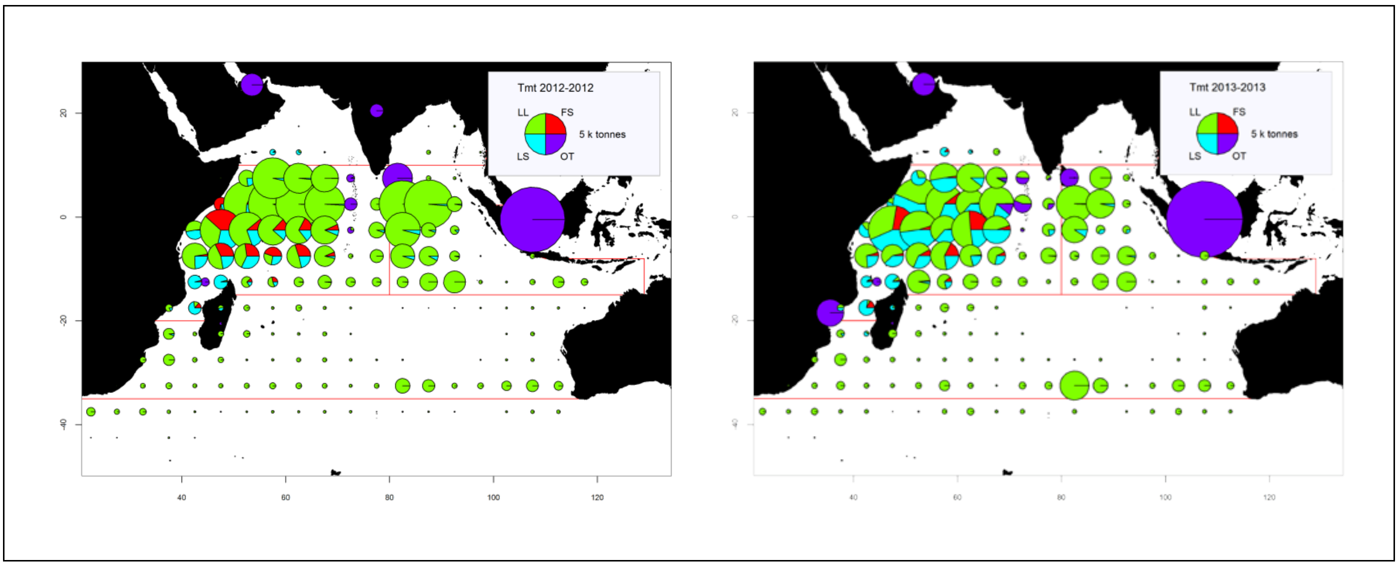


Fig. 4(a-b). Bigeye tuna: Time-area catches (total combined in tonnes) of bigeye tuna estimated for 2002 and 2013 by type of gear. Longline (**LL**), Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), and other fleets (**OT**), including pole-and-line, drifting gillnets, and various coastal fisheries; Data as of September 2014. The catches of fleets for which the flag countries do not report detailed time and area data to the IOTC are recorded within the area of the countries concerned, in particular driftnets from Iran, gillnet and longline fishery of Sri Lanka, and coastal fisheries of Indonesia.

Bigeye tuna: Status of fisheries statistics at the IOTC

Retained catches: Thought to be well known for the major fleets (Fig. 5a); but are less certain for non-reporting industrial purse seiners and longliners (NEI) and for other industrial fisheries (e.g. longliners of India). Catches are also uncertain for some artisanal fisheries including the pole-and-line fishery in the Maldives, the gillnet fisheries of I.R. Iran (before 2012) and Pakistan, the gillnet and longline combination fishery in Sri Lanka and the artisanal fisheries in Indonesia, Comoros (before 2011) and Madagascar.

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

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

Catch-Per-Unit-Effort (CPUE) series: Catch-and-effort data are generally available from the major industrial fisheries. However, these data are not available from some fisheries or they are considered to be of poor quality, especially throughout the 1990s and in recent years (Fig. 5b), for the following reasons:

- non-reporting by industrial purse seiners and longliners (NEI)
- no data are available for the fresh-tuna longline fishery of Indonesia, over the entire time series, and data for the fresh-tuna longline fishery of Taiwan,China are only available since 2006
- uncertain data from significant fleets of industrial purse seiners from Iran and longliners from India, Indonesia, Malaysia, Oman, and Philippines.
- incomplete data for the driftnet fisheries of I.R. Iran and Pakistan and the gillnet/longline fishery of Sri Lanka, especially in recent years.

Fish size or age trends (e.g. by length, weight, sex and/or maturity): Can be assessed for several industrial fisheries although they are incomplete or of poor quality for most fisheries before the mid-1980s and for some fleets in recent years (e.g. Japan and Taiwan,China longline) (Figs. 6, 7, 8, 9)

Catch-at-Size(Age) (Fig. 5c): This is available but the estimates are more uncertain for some years and some fisheries due to:

- the paucity of size data available from industrial longliners before the mid-60s, from the early-1970s up to the mid-1980s and in recent years (Japan and Taiwan,China)
- the paucity of catch by area data available for some industrial fleets (NEI, India, Indonesia, I.R. Iran, Sri Lanka)

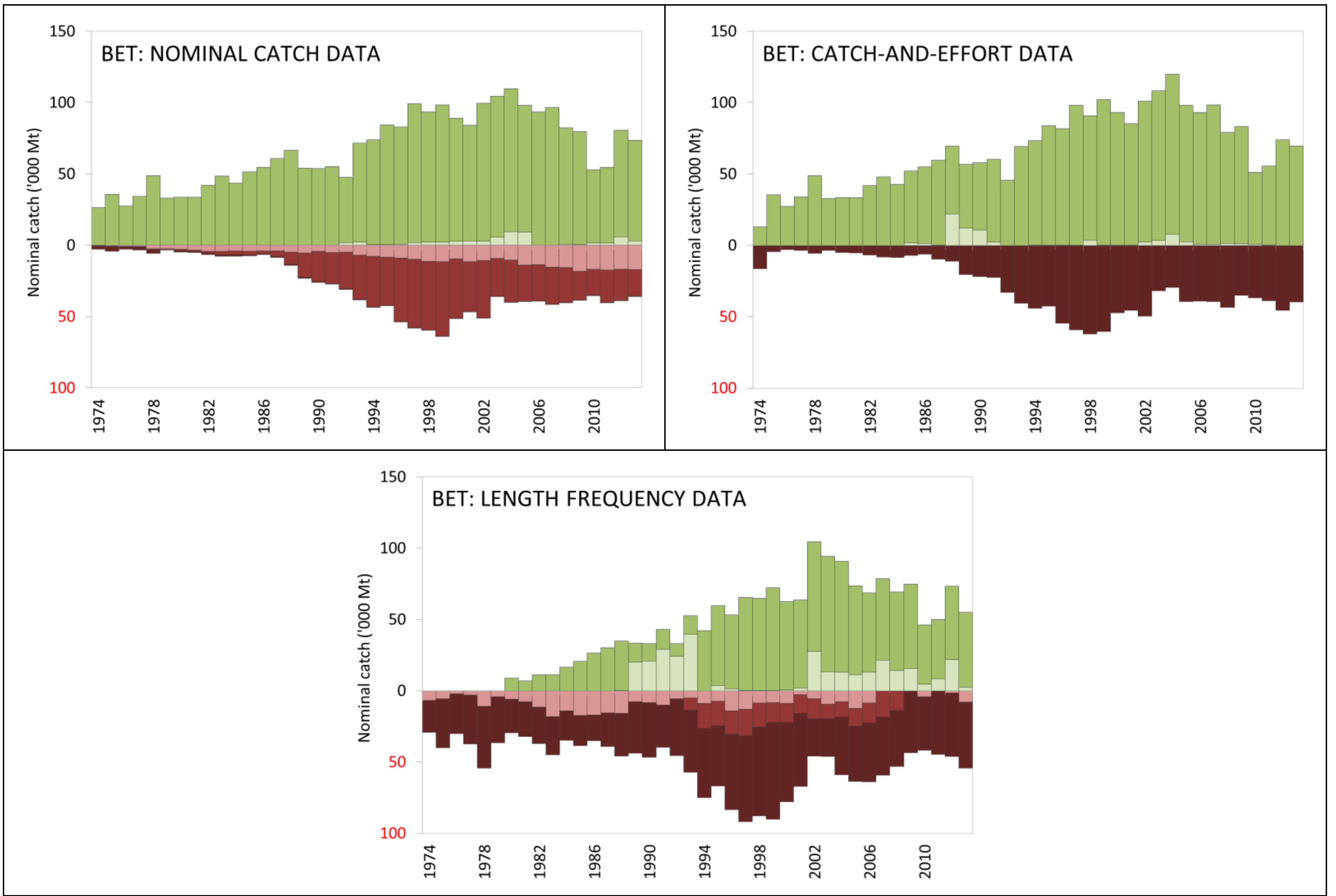


Fig. 5a-c. Bigeye tuna: data reporting coverage (1974–2013). Each IOTC dataset (a) nominal catch, b) catch-and-effort, and c) length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available. Data as of September 2014.

Key to IOTC Scoring system

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

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

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

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

Key to colour coding

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

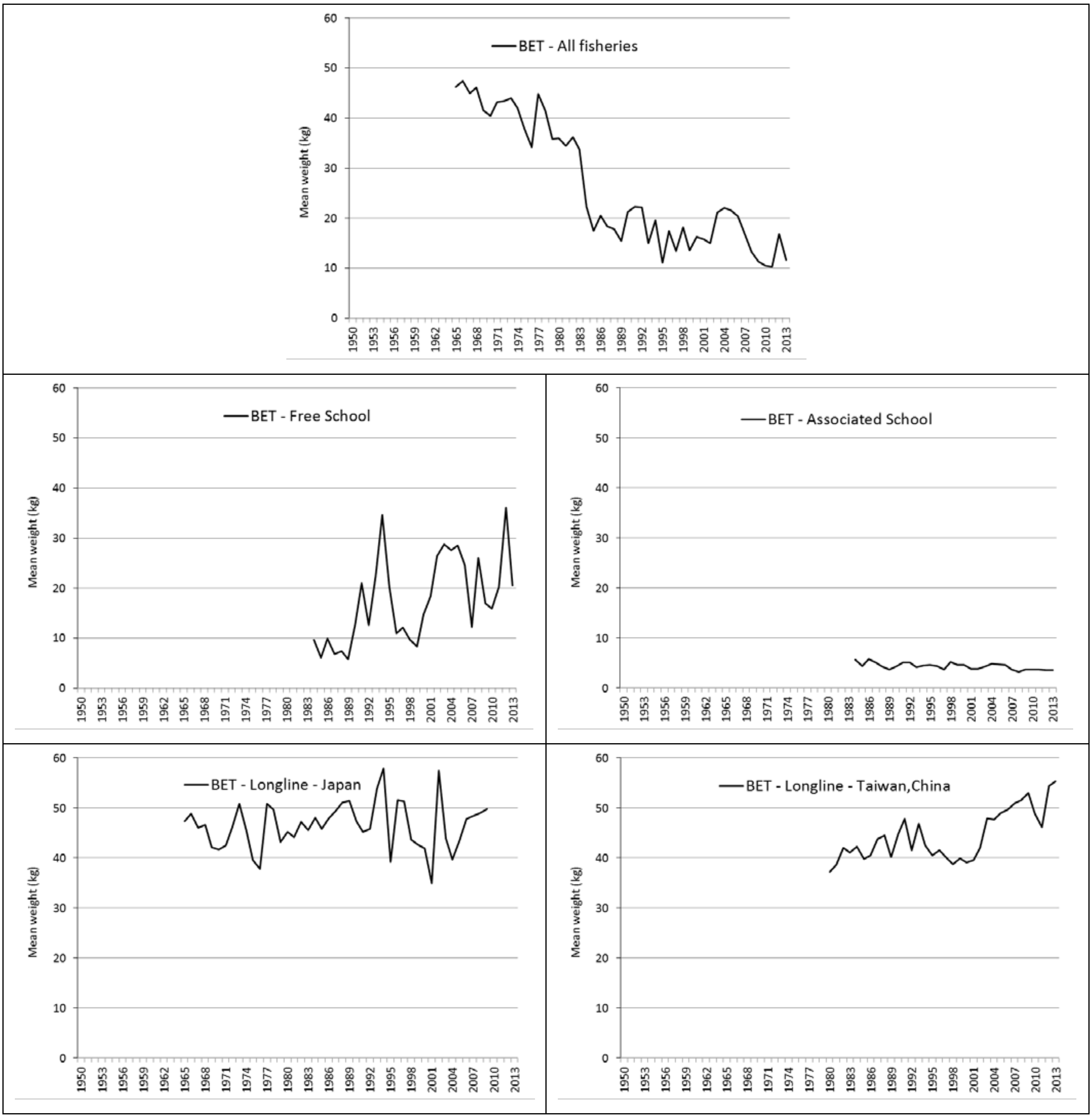


Fig. 6. Bigeye tuna: Average weight of bigeye tuna (BET) taken by: All fisheries combined (top) Purse seine on free (top left) and associated (top right) schools, Longlines from Japan (botom left) and Taiwan,China (bottom right)

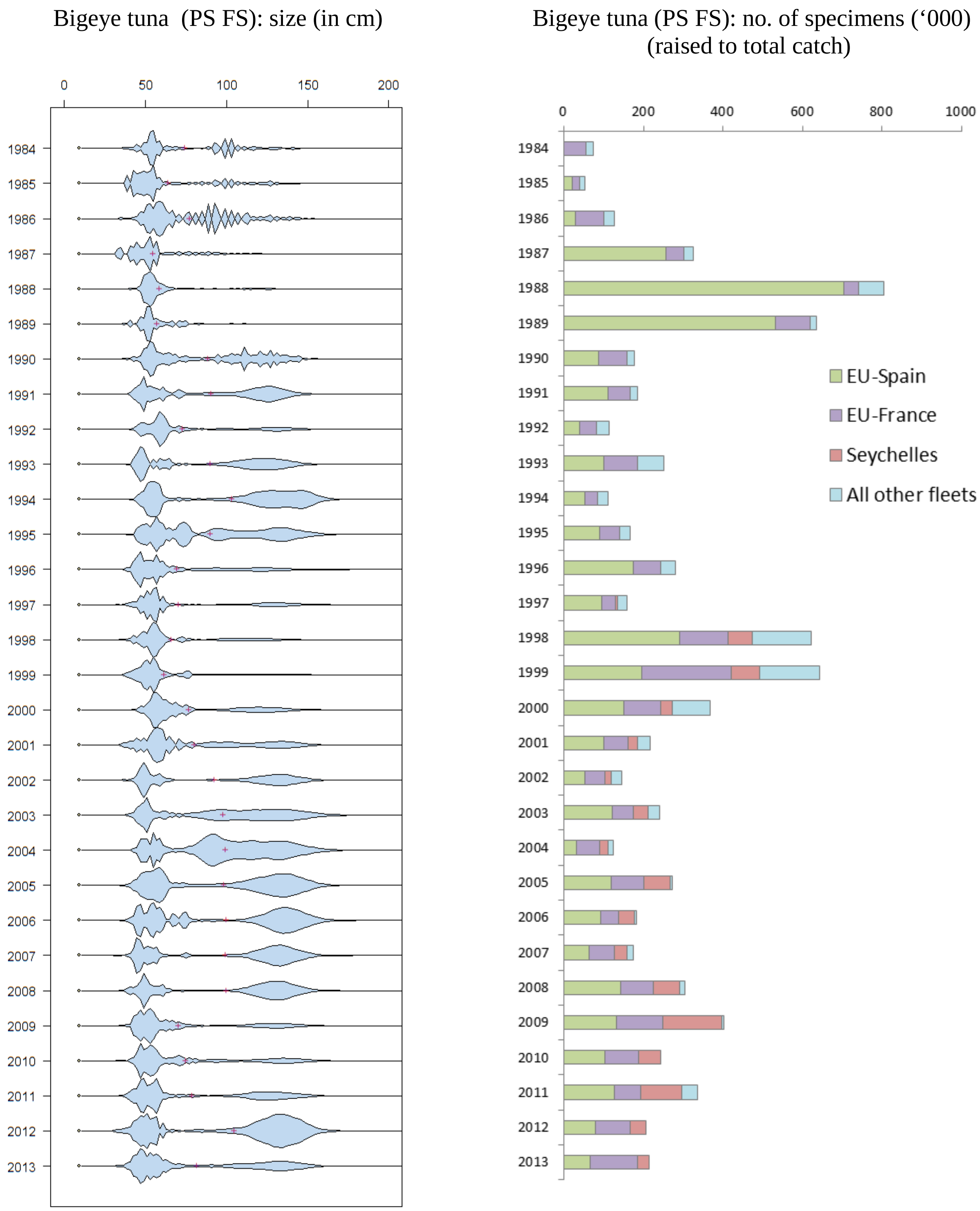
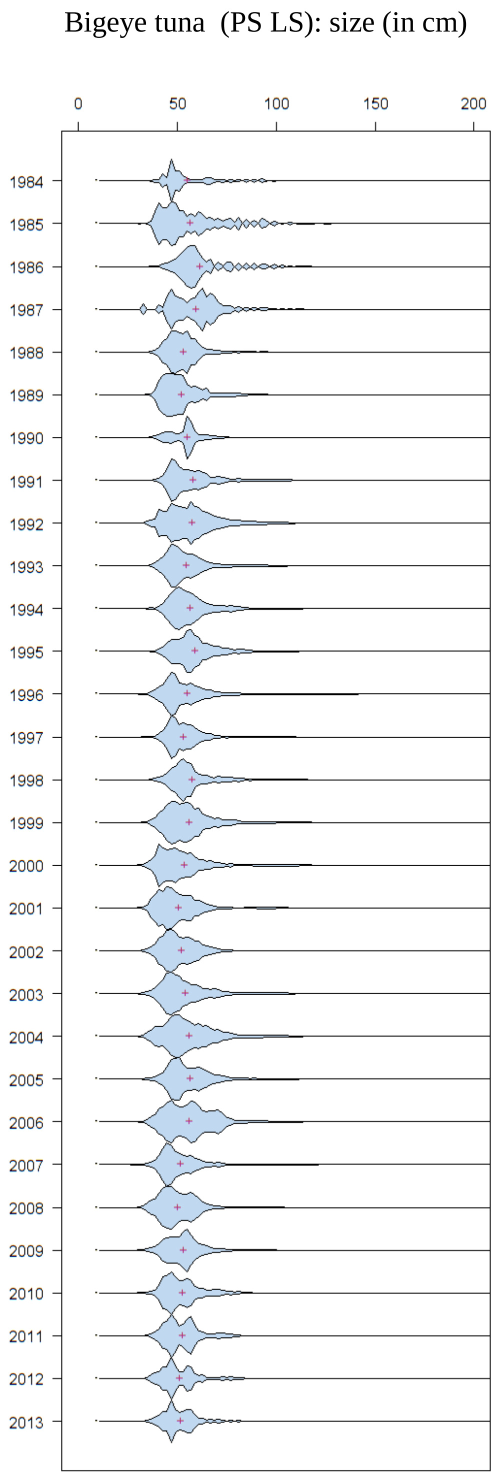


Fig. 7. Bigeye tuna (PS Free school): **Left:** length frequency distributions for PS Free School fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of bigeye tuna specimens sampled for lengths (raised to total catch), by fleet (PS Free School only). FS: Free swimming school.



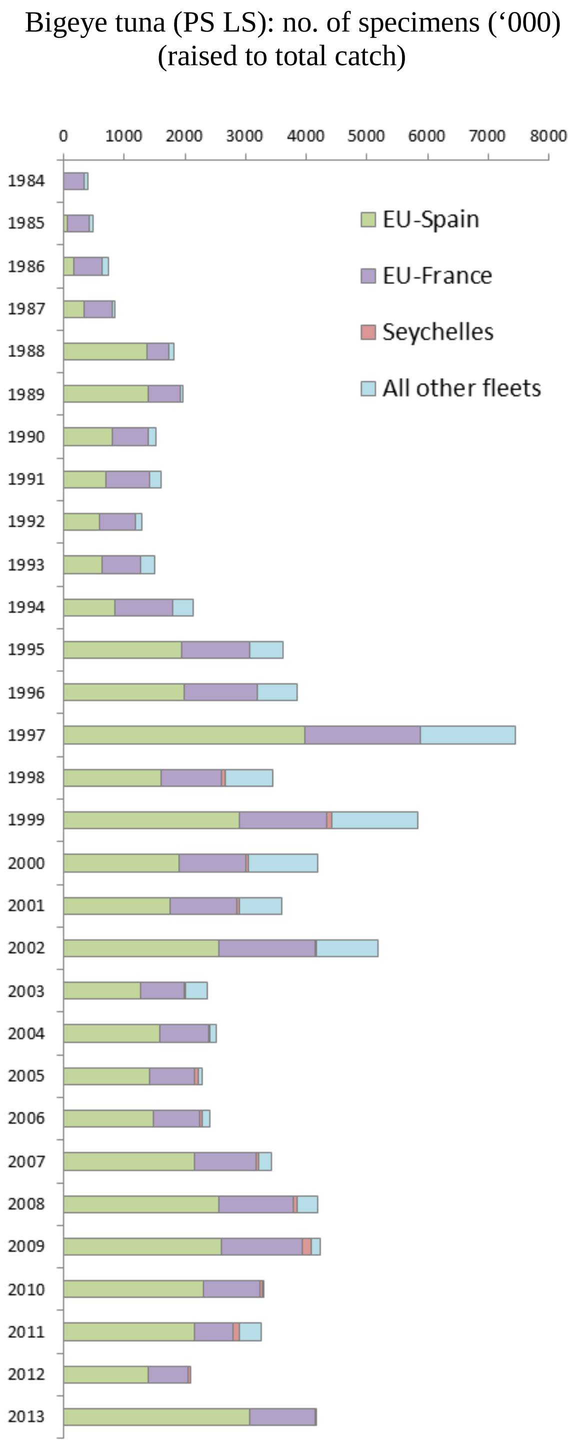


Fig. 8. Bigeye tuna (PS Associated school): **Left:** length frequency distributions for PS Associated school fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of bigeye tuna specimens sampled for lengths (raised to total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

Bigeye tuna (LL samples): size (in cm) | Bigeye tuna (LL): no. of samples ('000)

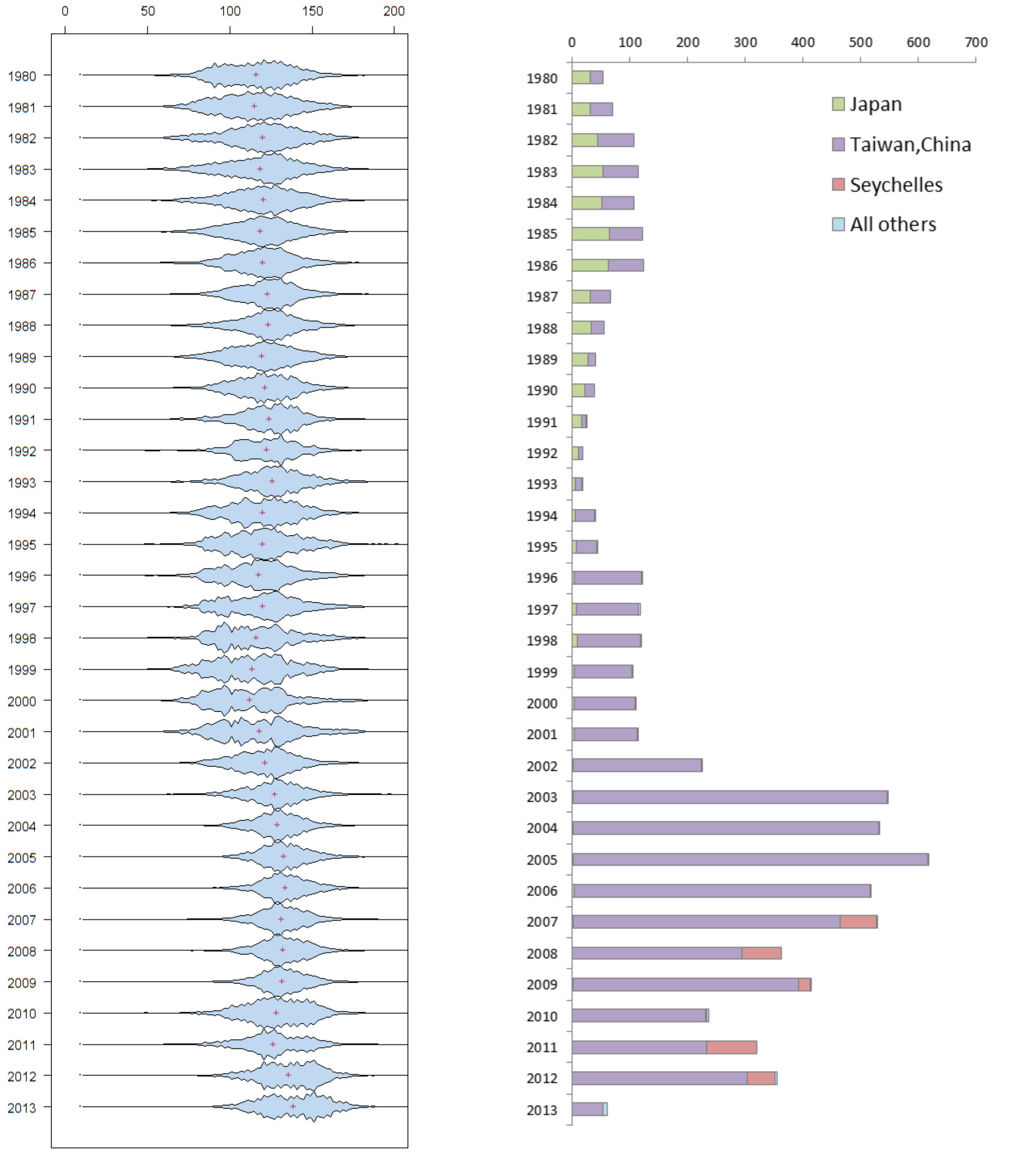


Fig. 9. Bigeye tuna (LL: longline): **Left:** length frequency distributions for longline fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of bigeye tuna specimens sampled for lengths, by fleet (longline only).

Bigeye tuna: 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. 10). The remaining were tagged during small-scale projects, and by other institutions with the support of the IOTC Secretariat, in the Maldives, India, and in the south west and the eastern Indian Ocean. To date, 5,806 specimens (16.1% of releases for this species) have been recovered and reported to the IOTC Secretariat. These tags were mainly reported from the purse seine fleets operating in the Indian Ocean (90.9%), while 5.3% were recovered from longline vessels.

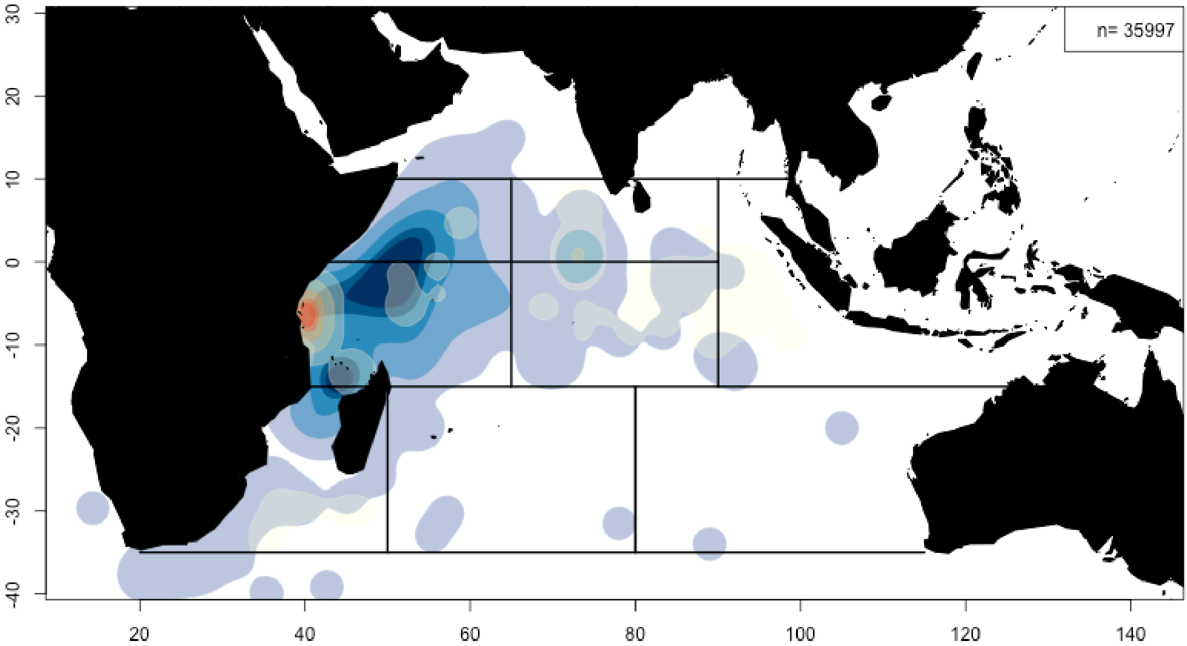


Fig. 10. Bigeye tuna: Densities of releases (in red) and recoveries (in blue). The black line represents the stock assessment areas. Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s. Data as of September 2012.

APPENDIX IVC
MAIN STATISTICS OF SKIPJACK TUNA

(Extracts from IOTC–2014–WPTT16–07 Rev_1)

Skipjack tuna (*Katsuwonus pelamis*)

Skipjack tuna: Fisheries and catch trends

Catches of skipjack tuna increased slowly from the 1950s, reaching around 50,000 t during the mid-1970s, mainly due to the activities of fleets using pole-and-lines and gillnets (Table 1; Fig. 1). The catches increased rapidly with the arrival of the purse seiners in the early 1980s, and skipjack became one of the most important commercial tuna species in the Indian Ocean. Annual catches peaked at over 600,000 t in 2006 (Table 1). Since 2006 catches have declined to around 340,000 t in 2012 – the lower catches recorded since 1998 – although preliminary figures for 2013 indicate an increase in catch levels to around 424,000 t.

Table 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 (2004–2013), in tonnes. Data as of September 2014. Catches by decade represent the average annual catch, noting that some gears were not used since the beginning of the fishery.

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

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

The increase in skipjack tuna catches by **purse seiners** (Fig. 1) is due to the development of a fishery in association with drifting Fish Aggregating Devices (FADs) (Table 1) in the 1980s. In recent years, over 90% of the skipjack tuna caught by purse seine vessels is taken from around FADs. Catches by purse seiners increased steadily since 1984 with the highest catches recorded in 2002 and 2006 (>240,000 t). Catches of skipjack dropped in the years 2003 and 2004, probably as a consequence of high purse seine catch rates on free schools of yellowfin tuna during those years. The constant increase in catches and catch rates of purse seiners until 2006 are believed to be associated with increases in fishing power and in the number of FADs (and the technology associated with them) used in the fishery. In 2007 purse seine catches declined by around 100,000 t (from around 245,000 t in 2005 145,000 t in 2007). The sharp decline in purse seine catches since 2007 coincided with a similar decline in the catches by Maldivian baitboats.

Table 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 (2004–2013), in tonnes. Data as of September 2014. Catches by decade represent the average annual catch.

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

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

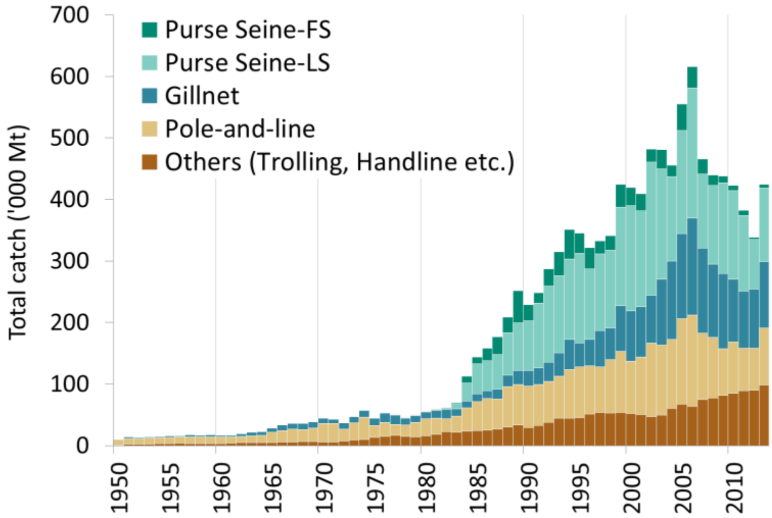


Fig. 1. Skipjack tuna: Annual catches of skipjack tuna by gear (1950–2013). Data as of Sept. 2014.

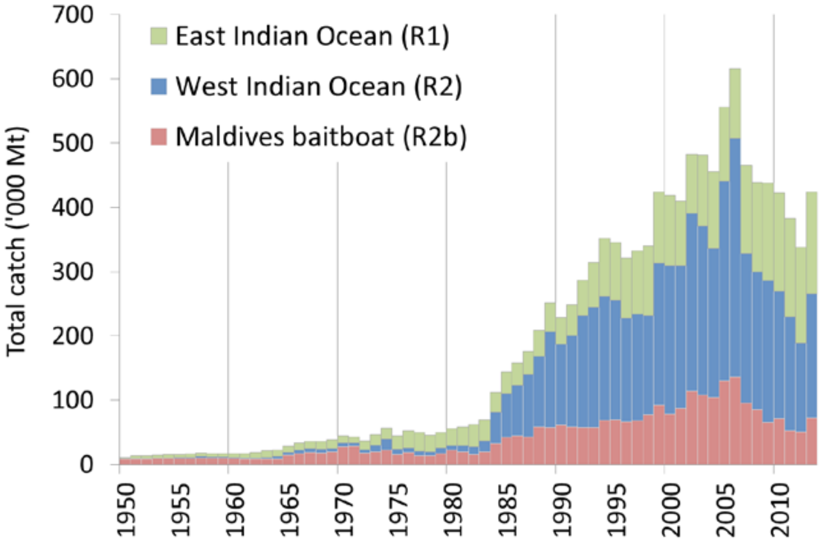


Fig. 2. Skipjack tuna: Catches of skipjack tuna by area by year estimated for the WPTT (1950–2013). Data as of September 2014. **Areas**: East Indian Ocean (**R1**); West Indian Ocean (**R2**); Maldives baitboat (**R2b**)

The Maldivian fishery (Fig. 1) has effectively increased its fishing effort with the mechanisation of its pole-and-line fleet since 1974, including an increase in boat size and power and the use of anchored FADs since 1981. Skipjack tuna represents around 80% of the total catch of Maldives, where skipjack catch rates regularly increased between 1980 and 2006 – the year in which the highest skipjack catch was recorded for this fishery (≈140,000 t). Catches of skipjack tuna reported by Maldives have since declined in recent years to as low as 55,000 t, representing less than half the catches taken in 2006, although catches of around 75,000 t have been reported in 2013. The recent decline in skipjack catches by Maldives is, in part, related to the introduction of handlines targeting large specimens of yellowfin tuna.

Several fisheries using gillnets have reported large catches of skipjack tuna in the Indian Ocean (Figs. 3, 4), including the gillnet/longline fishery of Sri Lanka, driftnet fisheries of Iran and Pakistan, and gillnet fisheries of Indonesia. In recent years gillnet catches have represented as much as 20% to 30% of the total catches of skipjack tuna in the Indian Ocean. Although it is known that vessels from Iran and Sri Lanka have been using gillnets on the high seas in recent years, reaching as far as the Mozambique Channel, the activities of these fleets are poorly understood, as no time-area catch-and-effort series have been made available for those fleets to date.

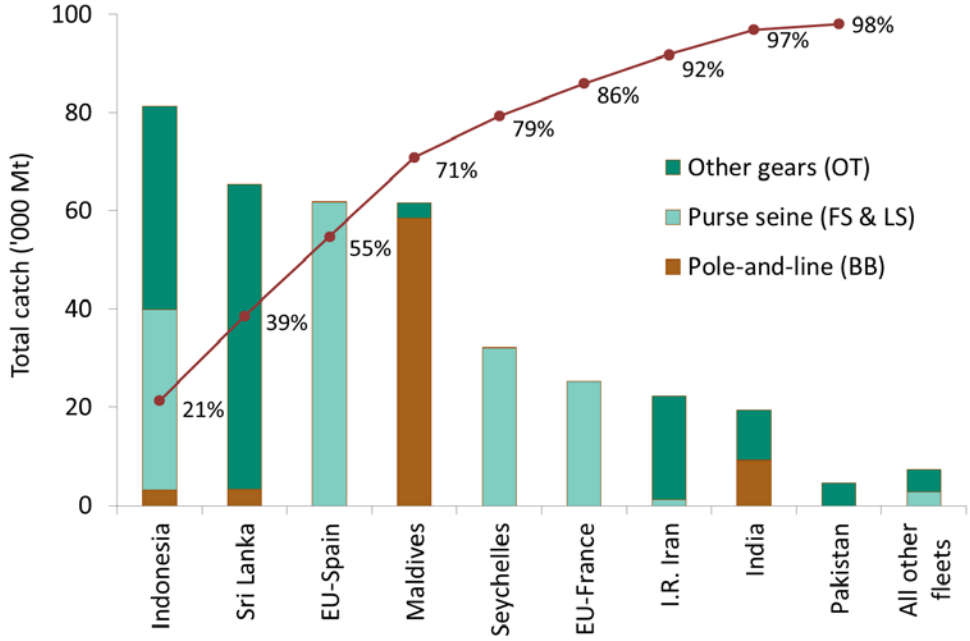


Fig. 3. Skipjack tuna: average catches in the Indian Ocean over the period 2010–12, by fleet. Fleets are ordered from left to right, according to the importance of catches of skipjack tuna reported. The red line indicates the (cumulative) proportion of catches of skipjack tuna for the fleets concerned, over the total combined catches of this species reported from all fleets and fisheries. Data as of September 2014.

The majority of the catches of skipjack tuna originate from the western Indian Ocean (Fig. 2). Since 2007 however, catches of skipjack tuna in the western Indian Ocean have dropped considerably, especially in areas off Somalia, Kenya, Tanzania and around the Maldives. The drop in catches are considered by the SC to be partially explained by the reduction in fishing effort by some fisheries due to the effects of piracy in the western Indian Ocean region, including industrial purse seiners and fleets using driftnets from Iran and Pakistan; and, as already noted, a decrease in catches of skipjack tuna by Maldivian baitboats following the introduction of handlines targeting yellowfin tuna.

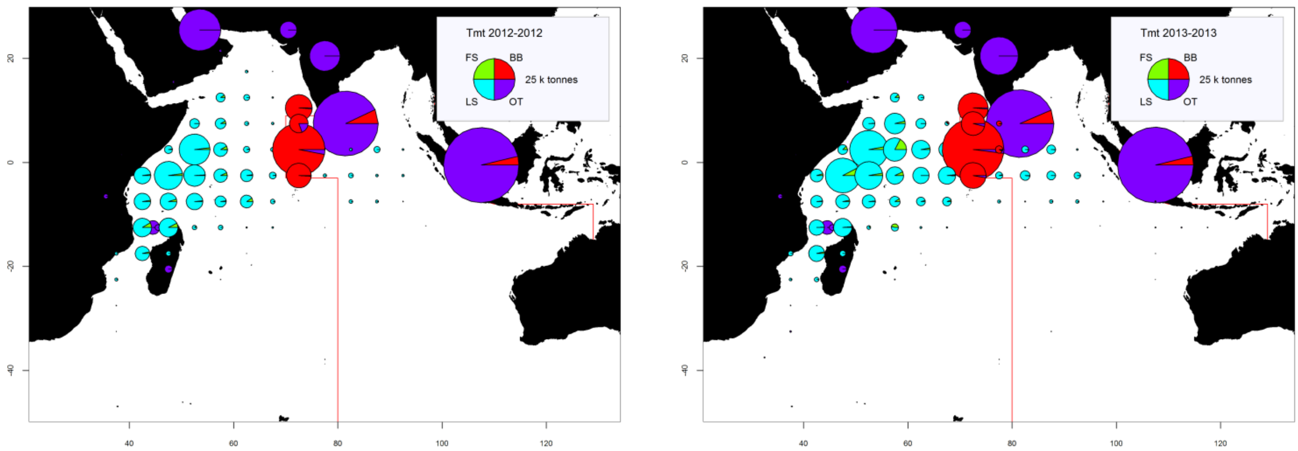


Fig. 4 (a-f). Skipjack tuna: Time-area catches (total combined in tonnes) of skipjack tuna estimated for the period 2004–08 by type of gear and for 2009–13, by year and type of gear. Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (BB), and other fleets (**OT**), including longline, drifting gillnets, and various coastal fisheries. Data as of September 2014. The catches of fleets for which the flag countries do not report detailed time and area data to the IOTC are recorded within the area of the countries concerned, in particular driftnets from Iran and Pakistan, gillnet and longline fishery of Sri Lanka, and coastal fisheries of Comoros, Indonesia and India.

Skipjack tuna: Status of Fisheries Statistics at the IOTC

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

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

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

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

Catch–per–unit–effort (CPUE) Series: Catch and effort data are available from various industrial and artisanal fisheries (Fig. 5b). However, these data are not available from some important fisheries or they are considered to be of poor quality for the following reasons:

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

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

Fish size or age trends (e.g. by length, weight, sex and/or maturity) (Figs. 6, 7, 8): Cannot be assessed before the mid-1980s and are incomplete for most artisanal fisheries thereinafter, namely hand lines, troll lines and many gillnet fisheries (Indonesia).

Catch-at-Size table: CAS are available but the estimates are uncertain for some years and fisheries due to (Fig. 5c):

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

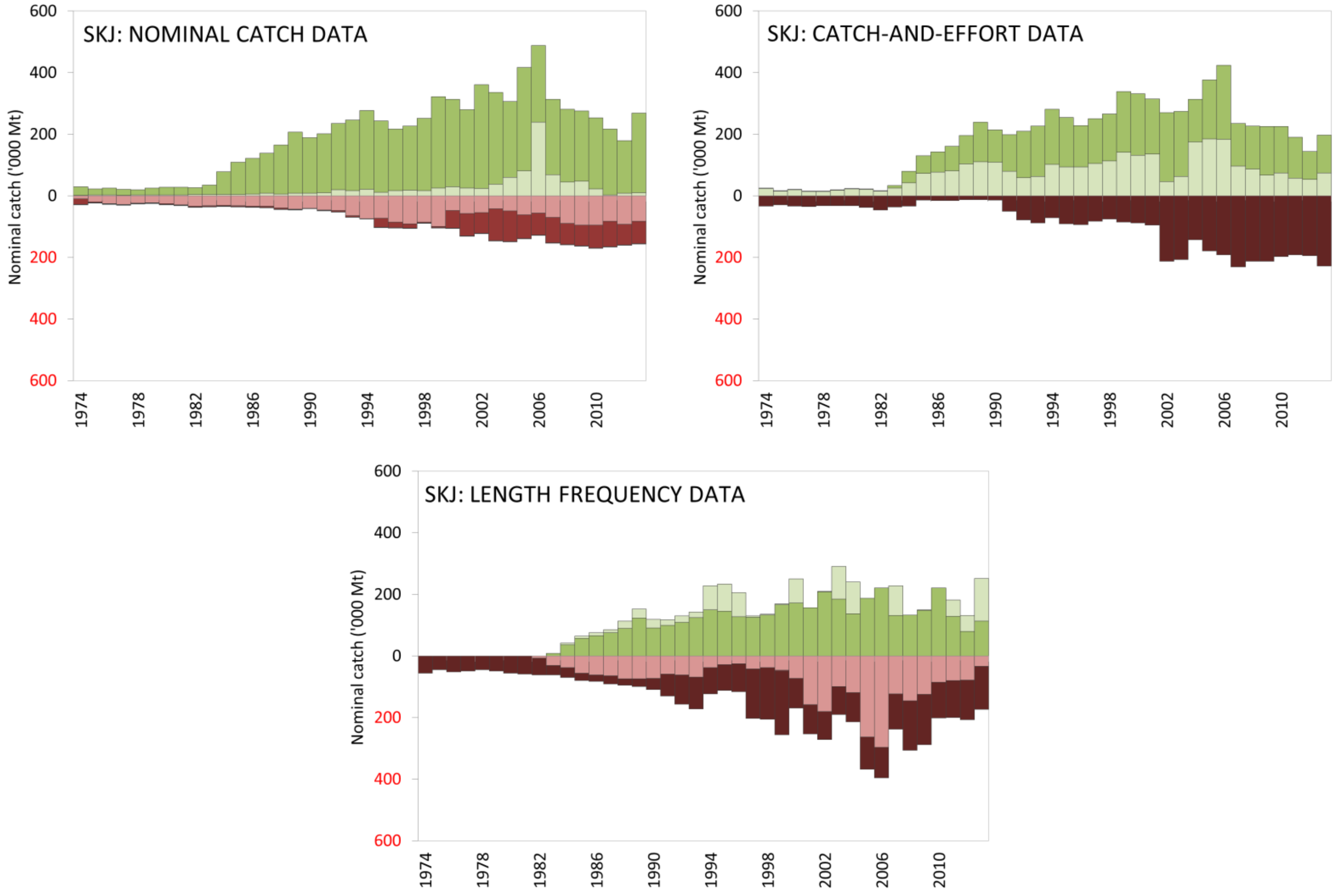


Fig. 5a-c. Skipjack tuna: data reporting coverage (1974–2013). Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available. Data as of September 2014.

Key to IOTC Scoring system

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

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

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

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

Key to colour coding

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

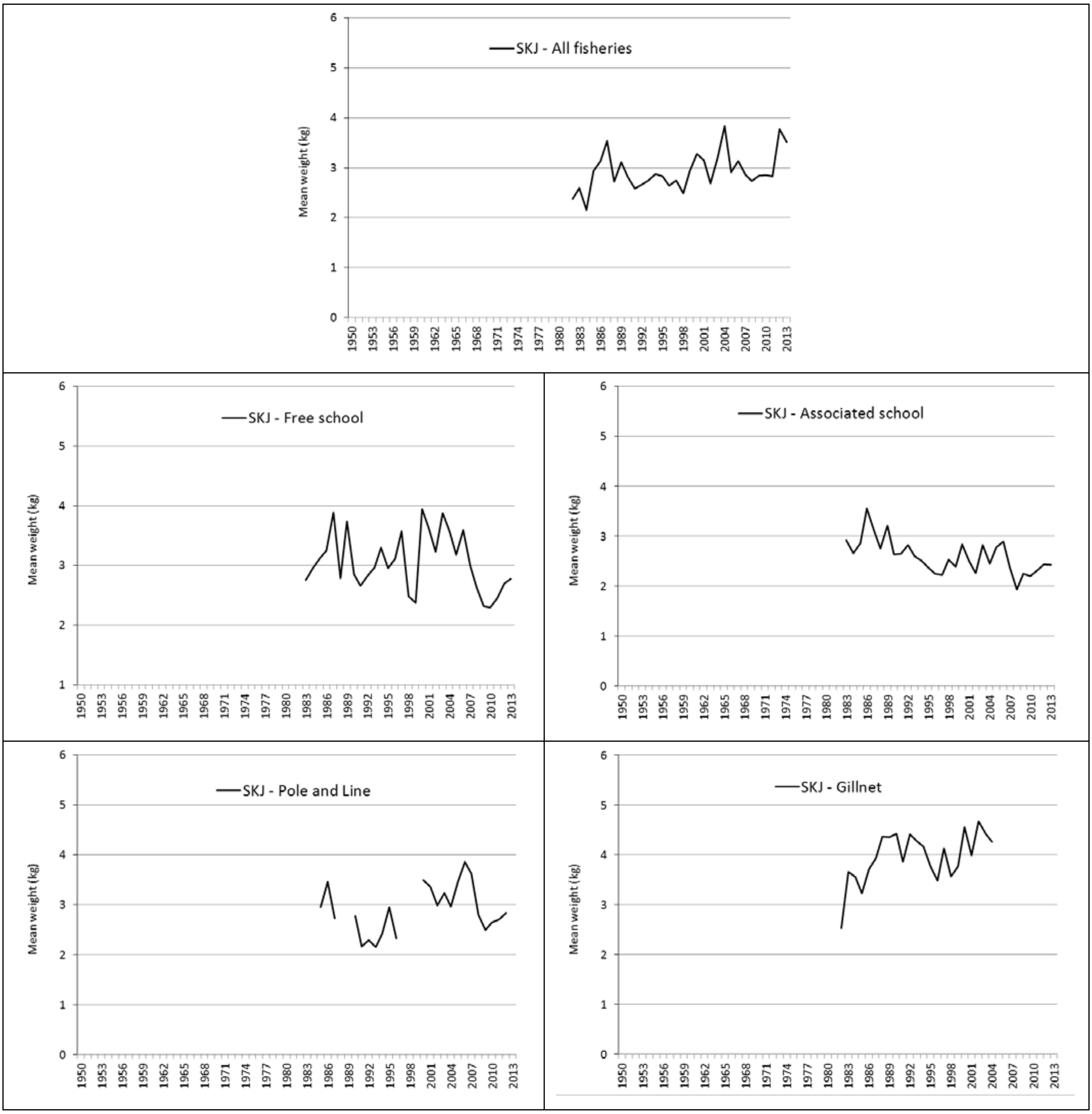
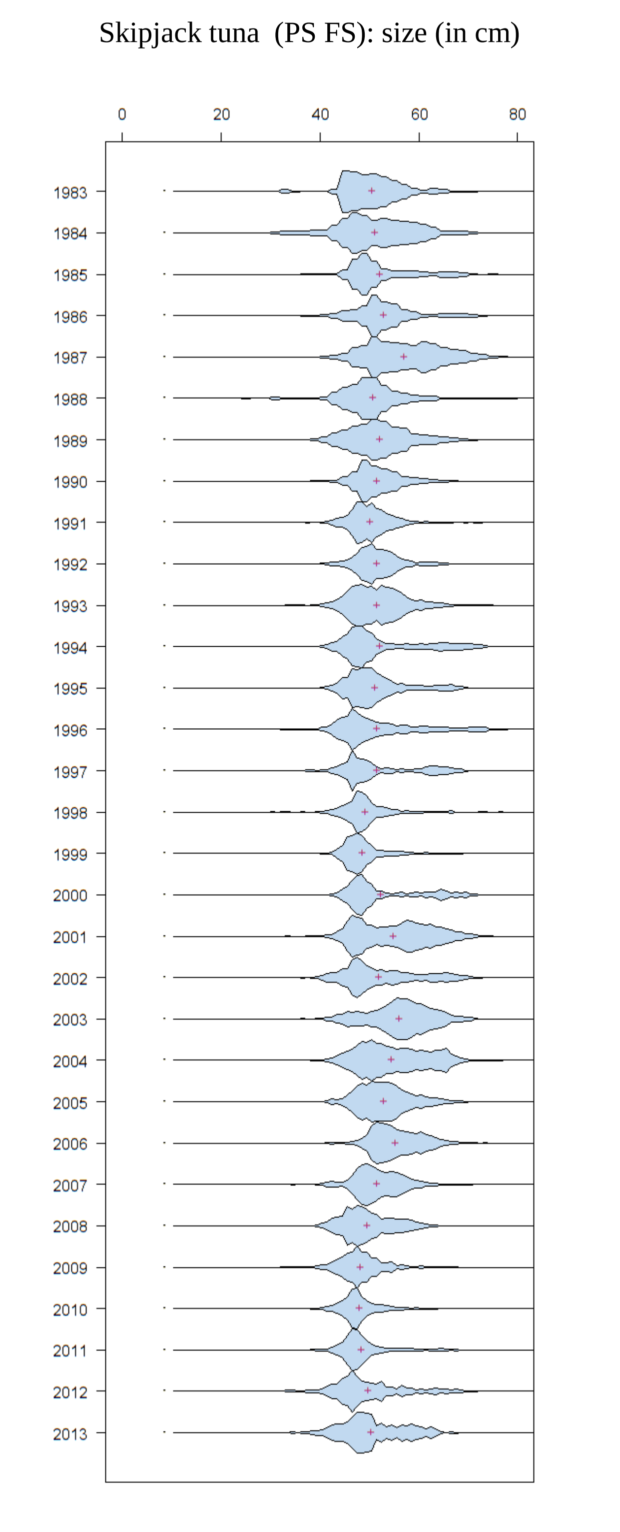


Fig. 6. Skipjack tuna: Average weight of skipjack tuna (SKJ) taken by All fleets combined (top), Purse seine on free (top left) and associated (top right) schools, Pole-and-line from Maldives and India (bottom left), Gillnets from Sri Lanka, Iran, and other countries (bottom right).

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

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

Fig. 7. Skipjack tuna (PS Associated school): **Left:** length frequency distributions for PS Associated school fisheries (total amount of fish measured by 1 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of skipjack tuna specimens sampled for lengths (raised to total catch), by fleet (PS Associated school only). LS: Log school.



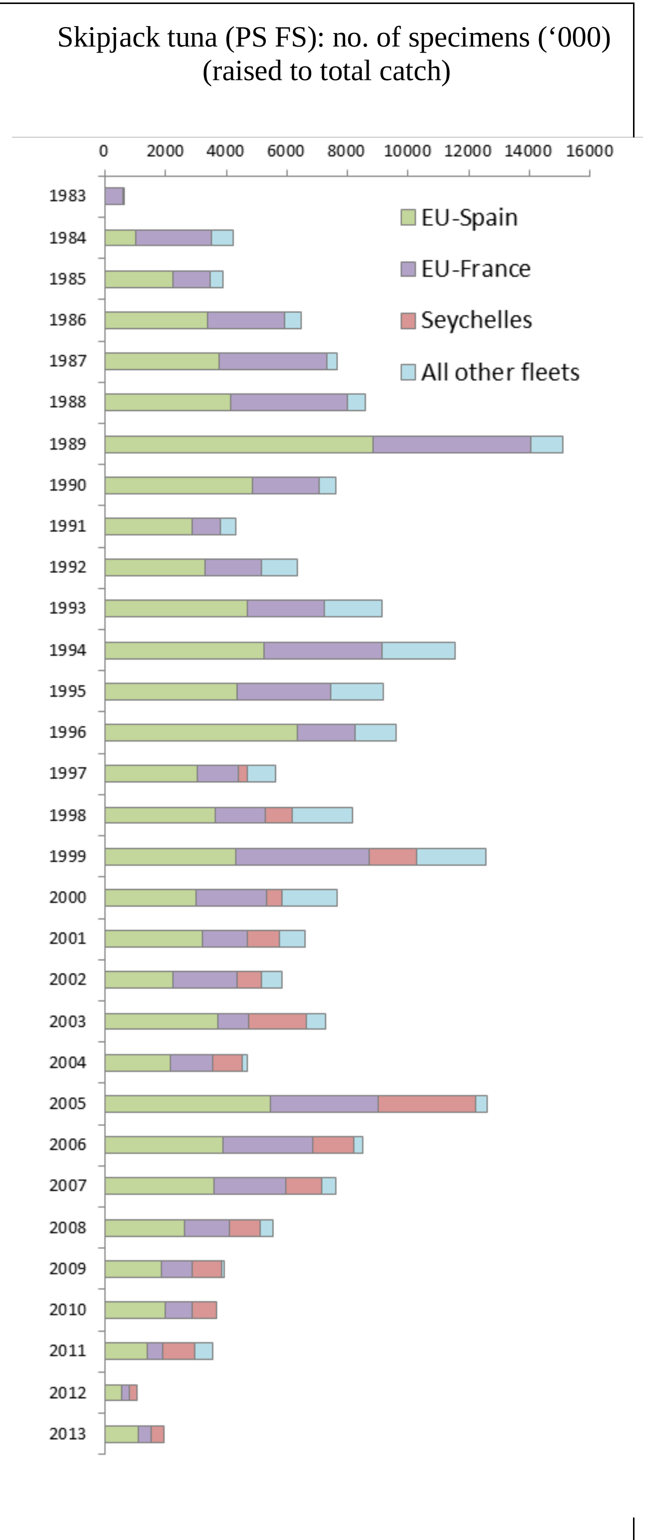


Fig. 8. Skipjack tuna (PS Free school): **Left:** length frequency distributions for PS Free school fisheries (total amount of fish measured by 1 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of skipjack tuna specimens sampled for lengths (raised to total catch),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

Skipjack tuna: 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. 9). 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.

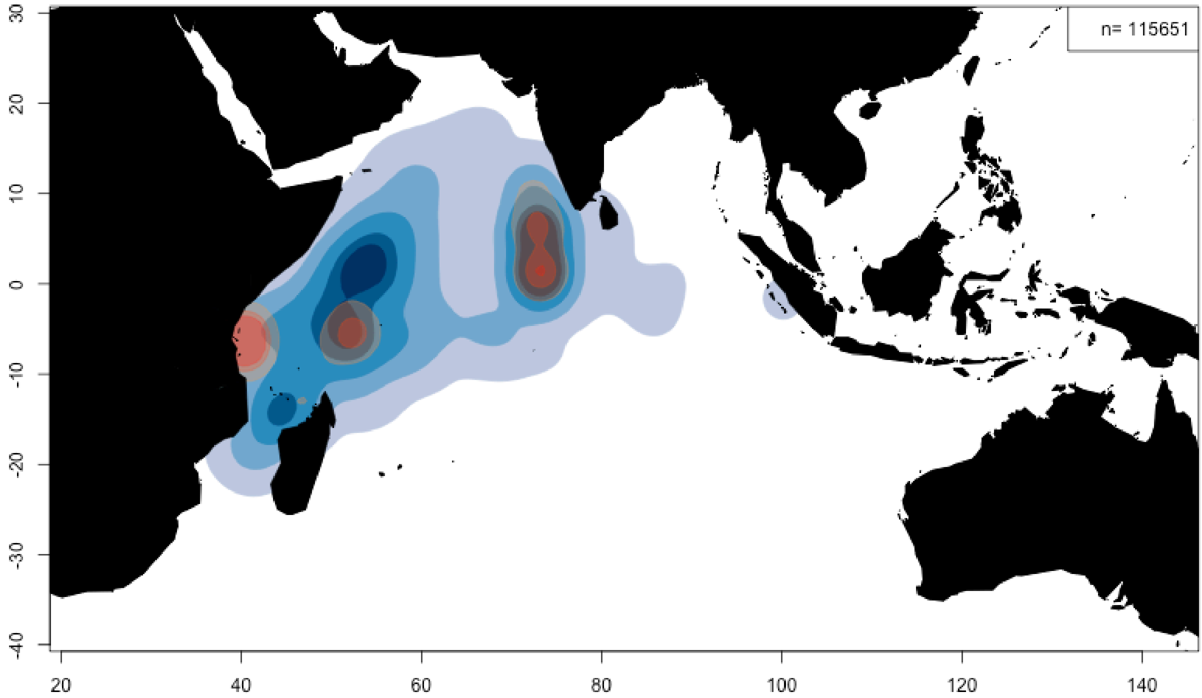


Fig. 9. **Skipjack tuna:** Densities of releases (in red) and recoveries (in blue). Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s. Data as of September 2012.

APPENDIX IVD
MAIN STATISTICS OF YELLOWFIN TUNA

(Extracts from IOTC–2014–WPTT16–07 Rev_1)

Yellowfin tuna *(Thunnus albacares)*

Yellowfin tuna – Fisheries and catch trends

Catches of yellowfin tuna (Table 1; Fig. 1) remained more or less stable between the mid-1950s and the early-1980s, ranging between 30,000 and 70,000 t, owing to the activities of longliners and, to a lesser extent, gillnetters. The catches increased rapidly with the arrival of the purse seiners in the early 1980s and increased activity of longliners and other fleets, reaching over 400,000 t in 1993. Catches of yellowfin tuna between 1994 and 2002 remained stable, between 330,000 and 350,000 t. Yellowfin tuna catches during 2003, 2004, 2005 and 2006 were much higher than in previous years, with the highest catches ever recorded in 2004 (over 525,000 t), while catches of bigeye tuna which are generally associated with the same fishing grounds as yellowfin tuna remained at average levels. After 2006 catches of yellowfin tuna dropped markedly, with the lowest catches recorded in 2009 at less than 270,000 t. Since 2009 catches of yellowfin tuna have once again been increasing, with catches over 400,000 t recorded in 2012 and 2013.

Table 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 (2004–2013), in tonnes. Data as of September 2014. Catches by decade represent the average annual catch, noting that some gears were not used since the beginning of the fishery.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
FS	0	0	18	31,555	64,956	89,204	168,146	123,997	85,044	53,526	74,986	36,050	32,136	36,453	64,594	34,458
LS	0	0	17	17,616	56,293	61,892	59,901	69,877	74,612	43,778	41,546	51,352	73,383	76,659	66,166	101,905
LL	22,131	42,460	31,016	37,274	76,926	76,814	108,277	137,677	94,955	71,439	45,764	41,893	43,720	38,842	43,417	30,606
LF	0	0	615	4,286	47,572	34,149	32,938	35,949	31,751	33,303	34,343	23,125	21,501	20,510	27,182	36,326
BB	2,111	2,318	5,810	8,295	12,805	16,076	15,876	16,843	18,043	16,327	18,279	16,826	14,098	14,003	15,506	24,119
GI	1,572	4,115	7,838	11,899	39,420	49,243	74,001	61,210	62,488	43,452	47,978	41,945	50,780	51,053	63,626	56,843
HD	588	566	3,236	8,301	20,705	36,647	44,249	43,373	35,154	36,465	33,840	32,079	36,660	62,093	83,543	78,585
TR	1,102	1,981	4,335	6,912	11,568	16,010	20,609	17,186	18,180	19,783	18,221	16,586	19,717	19,940	28,049	31,007
OT	80	193	453	1,871	3,373	5,424	4,834	5,831	5,804	6,837	6,611	7,401	7,717	7,901	8,209	8,236
Total	**27,584**	**51,633**	**53,339**	**128,008**	**333,619**	**385,459**	**528,832**	**511,945**	**426,033**	**324,911**	**321,567**	**267,255**	**299,713**	**327,453**	**400,292**	**402,084**

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

Table 2. Yellowfin tuna: Best scientific estimates of the catches of yellowfin tuna (*Thunnus albacares*) by area by decade (1950–2009) and year (2004–2013), in tonnes. Data as of September 2014. Catches by decade represent the average annual catch. The areas are presented in Fig. 2a.

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

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

Although some Japanese purse seine vessels have fished in the Indian Ocean since 1977, the purse seine (Fig. 1) fishery developed rapidly with the arrival of European vessels between 1982 and 1984. Since then, there has been an increasing number of yellowfin tuna caught, with a larger proportion of the catches consisting of adult fish, as opposed to catches of bigeye tuna, which are mostly composed of juvenile fish. Purse seine vessels typically take fish ranging from 40 to 140 cm fork length (FL), while smaller fish are more common in catches taken north of the equator.

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

The purse seine fishery is characterised by the use of two different fishing modes (Table 1 and Fig. 1). The fishery on floating objects (FADs) catches large numbers of small yellowfin tuna in association with skipjack tuna and juvenile bigeye tuna, compared to the fishery on free swimming schools, which catches larger yellowfin tuna on multi-specific or mono-specific sets. Between 1995 and 2003, the FAD component of the purse seine fishery represented 48–66% of the sets undertaken (60–80% of the positive sets) and accounted for 36–63% of the yellowfin tuna catch by weight (59–76% of the total catch). The proportion of yellowfin tuna caught (in weight) on free-schools during 2003–06 (64%) was much higher than in previous or following years (at around 50%).

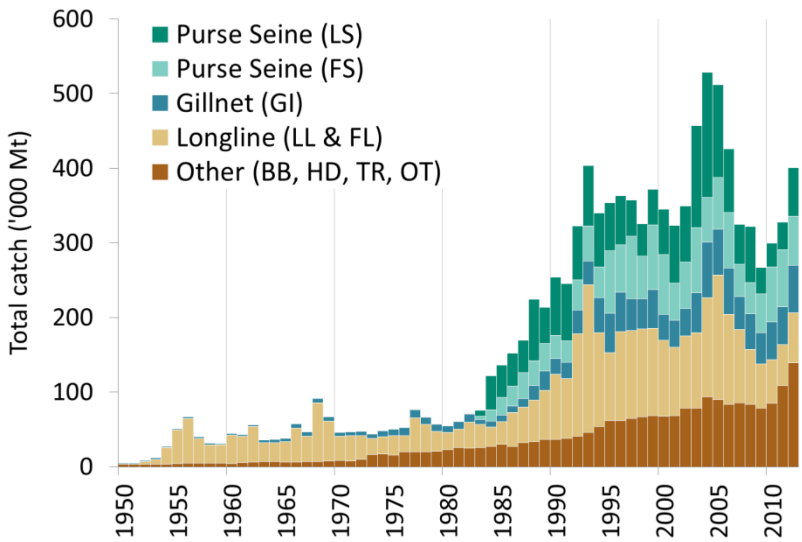


Fig. 1. Yellowfin tuna: Annual catches of yellowfin tuna by gear (1950–2012). Data as of September 2014.

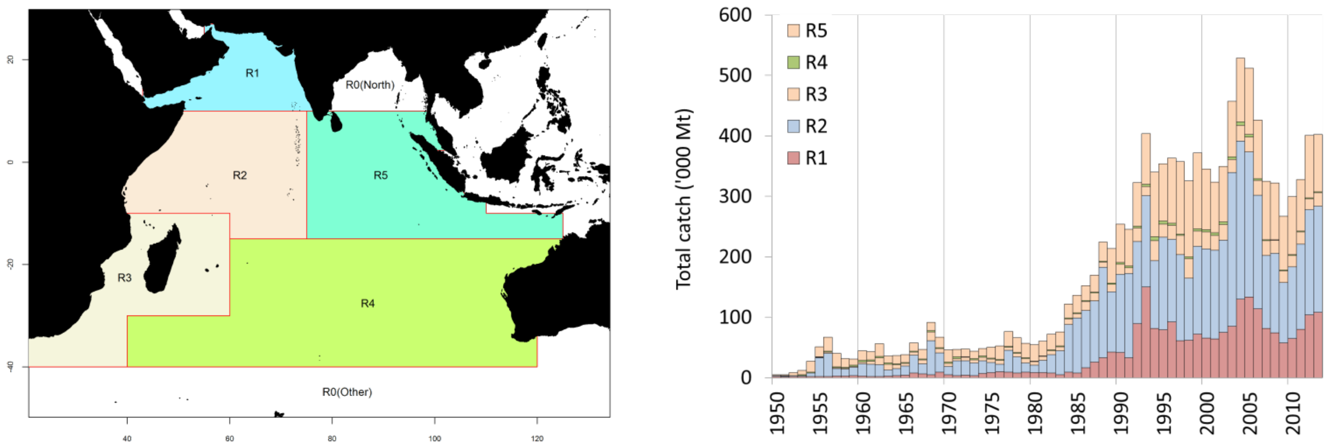


Fig. 2a, b. Yellowfin tuna: Catches of yellowfin tuna by area by year estimated for the WPTT (1950–2013). Data as of September 2014. Catches in areas R0 were assigned to the closest neighbouring area for the assessment. **Areas:** Arabian Sea (**R1**); Off Somalia (**R2**); Mozambique Channel, including southern (**R3**); South Indian Ocean including southern (**R4**); East Indian Ocean, including Bay of Bengal (**R5**).

The longline fishery (Table 1; Fig. 1) started in the early 1950's and expanded rapidly over throughout the Indian Ocean. Longline gear mainly catches large fish, from 80 to 160 cm FL, although smaller fish in the size range 60 cm – 100 cm (FL) have been taken by longliners from Taiwan,China since 1989 in the Arabian Sea. The longline fishery targets several tuna species in different parts of the Indian Ocean (Fig. 2), with yellowfin tuna and bigeye tuna being the main target species in tropical waters. The longline fishery can be subdivided into a deep-freezing longline component (large scale deep-freezing longliners operating on the high seas from Japan, Rep. of Korea and Taiwan,China) and a fresh-tuna longline component (small to medium scale fresh tuna longliners from Indonesia and Taiwan,China) (Fig. 3).

The total longline catch of yellowfin tuna reached a maximum in 1993 (≈200,000 t). Catches between 1994 and 2004 fluctuated between 85,000 t and 130,000 t. The second highest catches of yellowfin tuna by longliners were recorded in 2005 (≈165,000 t). Similar to the trend for the purse seine fleets, since 2005 longline catches have declined with current catches estimated to be at around 60,000 t – more than a 60% decrease in catch levels compared to 2005. The recent drop in longline catches could be related, at least in part, with the expansion of piracy in the northwest Indian Ocean, which led to a marked drop in the levels of longline effort in one of the core fishing areas of the species (i.e., Area R2) (Fig. 2**)**.

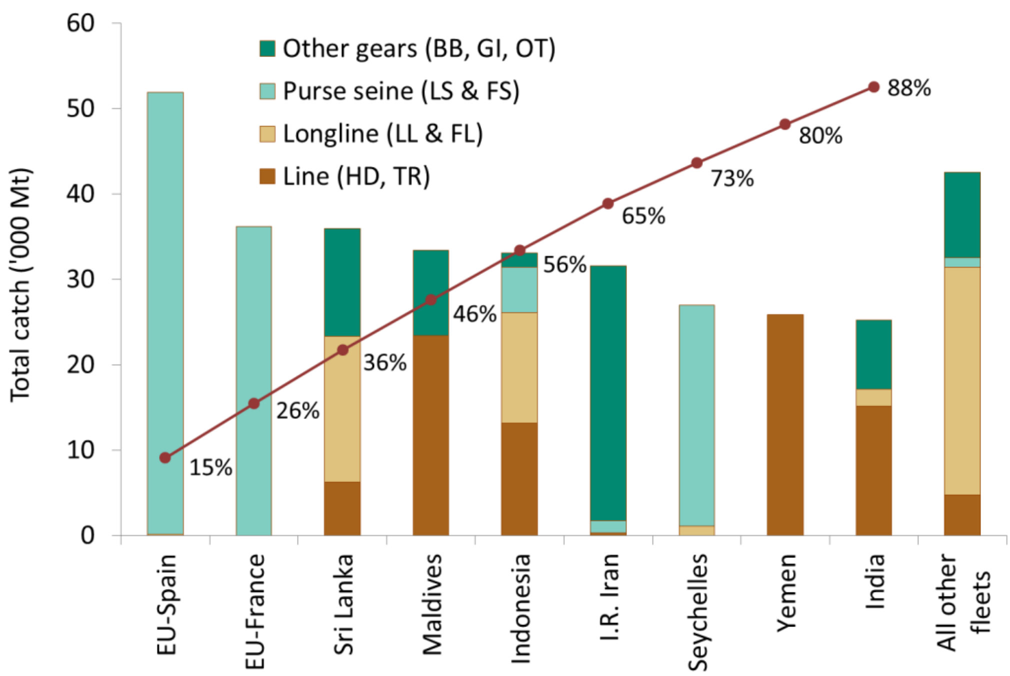


Fig. 3. Yellowfin tuna: average catches in the Indian Ocean over the period 2010–12, by fleet. Fleets are ordered from left to right, according to the importance of catches of yellowfin tuna reported. The red line indicates the (cumulative) proportion of catches of yellowfin tuna for the fleets concerned, over the total combined catches of this species reported from all fleets and fisheries. Data as of September 2014.

Catches by other gears, namely pole-and-line, gillnet, troll, hand line and other minor gears, have increased steadily since the 1980s (Table 1; Fig. 1). Contrary to the situation in other oceans, the artisanal fishery component of catches in the Indian Ocean are substantial, accounting for around 30% of the total catches of yellowfin tuna until the early 2000s. In recent years artisanal catches of yellowfin tuna have been around 135,000 t, increasing to over 200,000 t in 2012 and 2013 – more than half the total catches of yellowfin tuna in each of the last two years. Artisanal catches of yellowfin tuna are dominated by gillnets, with catches of around 50,000 t since 2011.

Purse seiners currently take the bulk of the yellowfin tuna catch, mostly from the western Indian Ocean, around Seychelles and off the coast of Somalia (area R2) and Mozambique Channel (area R3) (Tables 1, 2; Fig. 2). However in recent years the catches of yellowfin tuna in the western Indian Ocean have dropped considerably, especially in areas off Somalia, Kenya and Tanzania between 2007 and 2011 (Fig. 4). The drop in catches is, in part, the consequence of a drop in fishing effort due to the effect of piracy in the western Indian Ocean region – although the effects have not been as marked as with longliners. The main reason for this is the presence of security personnel onboard purse seine vessels of the EU and Seychelles, which has made it possible for purse seiners under these flags to continue operating in the northwest Indian Ocean. Longline effort levels in the western tropical area have also increased in 2012 and 2013, as a consequence of increased security in the region.

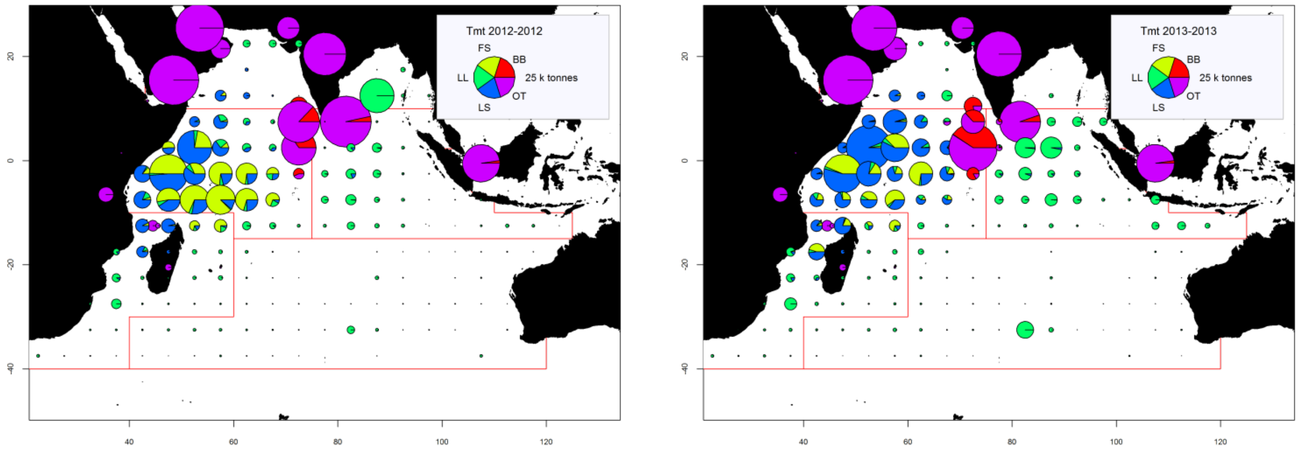


Fig. 4a, b. Yellowfin tuna: Time-area catches (total combined in tonnes) of yellowfin tuna estimated for the period 2004–08 by type of gear and for 2009–13, by year and type of gear. Longline (**LL**), Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (**BB**), and other fleets (**OT**), including drifting gillnets, and various coastal fisheries. Data as of September 2013. The catches of fleets for which the flag countries do not report detailed time and area data to the IOTC are recorded within the area of the countries concerned, in particular driftnets from I.R. Iran and Pakistan, gillnet and longline fishery of Sri Lanka, and coastal fisheries of Yemen, Oman, Comoros, Indonesia and India.

Yellowfin tuna: Status of Fisheries Statistics at the IOTC

Retained catches are generally well known (**Fig. 5a**); however, catches are less certain for:

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

Discard levels are believed to be low although they are unknown for most industrial fisheries, excluding industrial purse seiners flagged in EU countries for the period 2003–2007.

CPUE Series: Catch-and-effort data are available from the major industrial and artisanal fisheries (**Fig. 5b**). However, these data are not available for some important fisheries or they are considered to be of poor quality for the following reasons:

- no data are available for the fresh-tuna longline fishery of Indonesia, over the entire time series, and data for the fresh-tuna longline fishery of Taiwan,China are only available since 2006
- insufficient data for the gillnet fisheries of Iran and Pakistan
- the poor quality effort data for the significant gillnet/longline fishery of Sri Lanka
- no data are available from important coastal fisheries using hand and/or troll lines, in particular Yemen, Indonesia, and Madagascar.

Trends in average weight (Figs. 6, 7, 8, 9): Can be assessed for several industrial fisheries but they are very incomplete or of poor quality for some fisheries, namely hand lines (Yemen, Comoros, Madagascar), troll lines (Indonesia) and many gillnet fisheries.

Catch-at-Size table: This is available (**Fig. 5c**) although the estimates are more uncertain in some years and some fisheries due to:

- size data not being available from important fisheries, notably Yemen, Pakistan, Sri Lanka and Indonesia (lines and gillnets) and Comoros and Madagascar (lines)
- the paucity of size data available from industrial longliners from the late-1960s up to the mid-1980s, and in recent years (Japan and Taiwan,China)
- the paucity of catch by area data available for some industrial fleets (NEI, Iran, India, Indonesia, Malaysia).

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

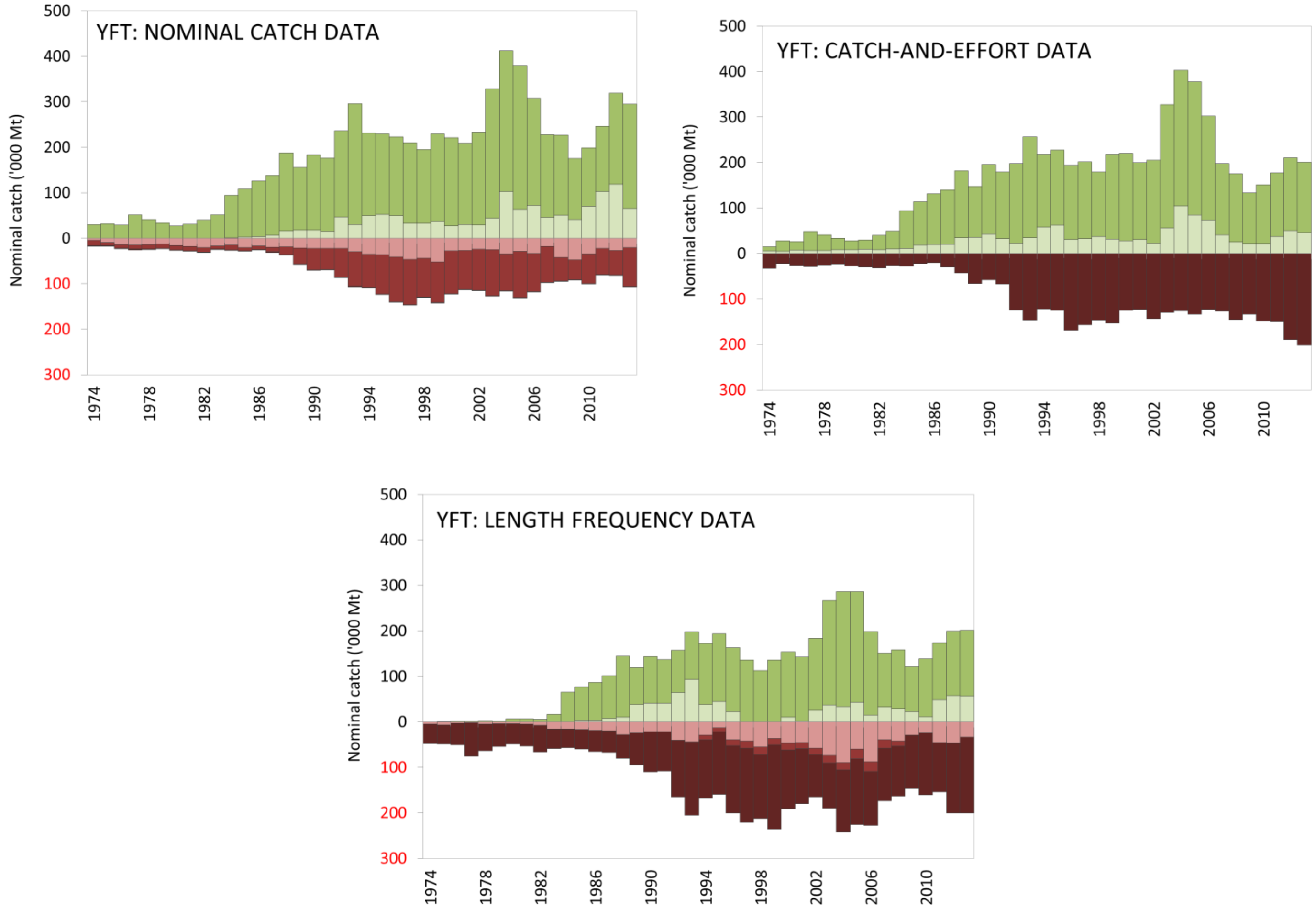


Fig. 5a-c. Yellowfin tuna: data reporting coverage (1974–2013). Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available. Data as of September 2014.

Key to IOTC Scoring system

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

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

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

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

Key to colour coding

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

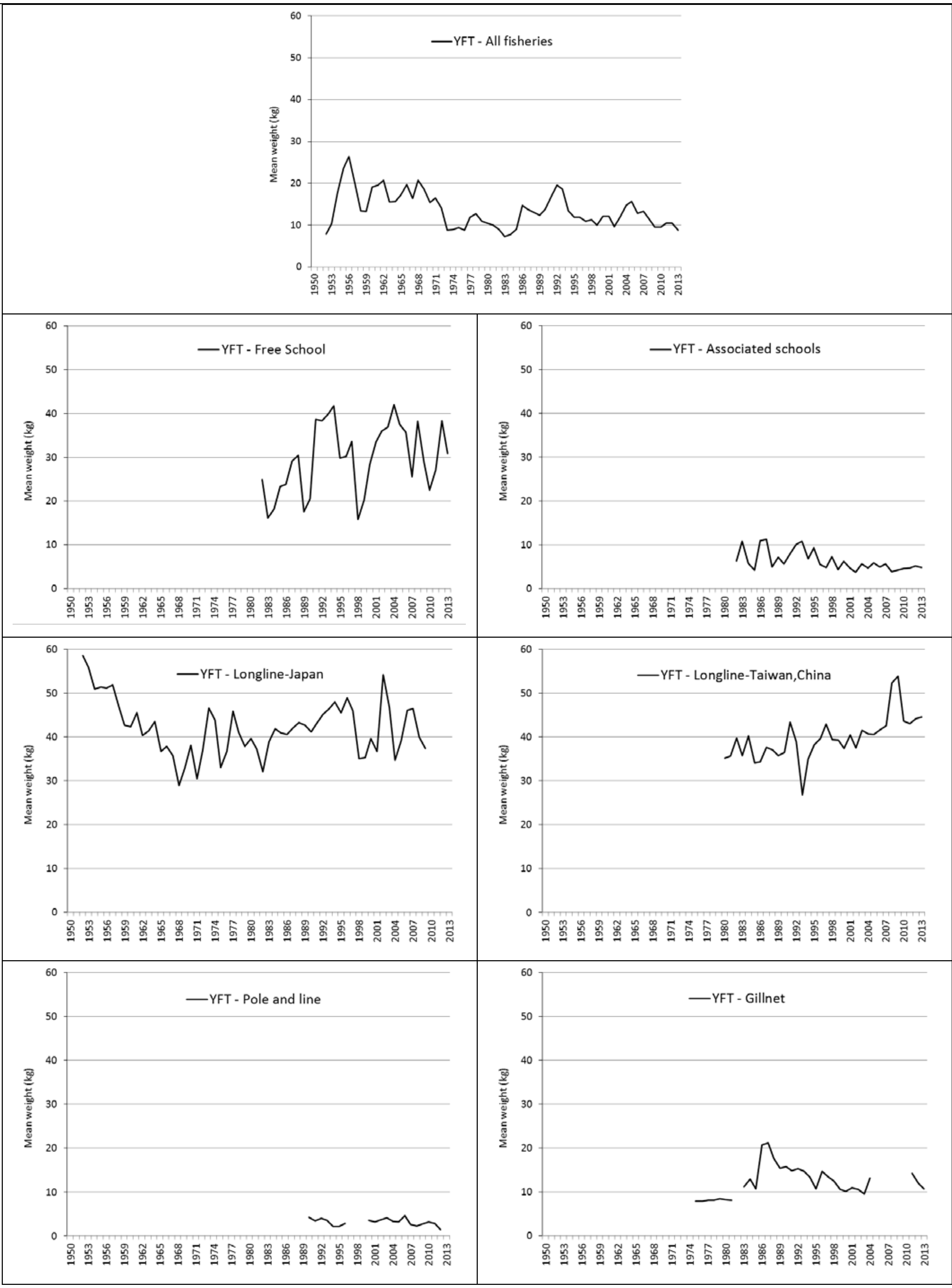
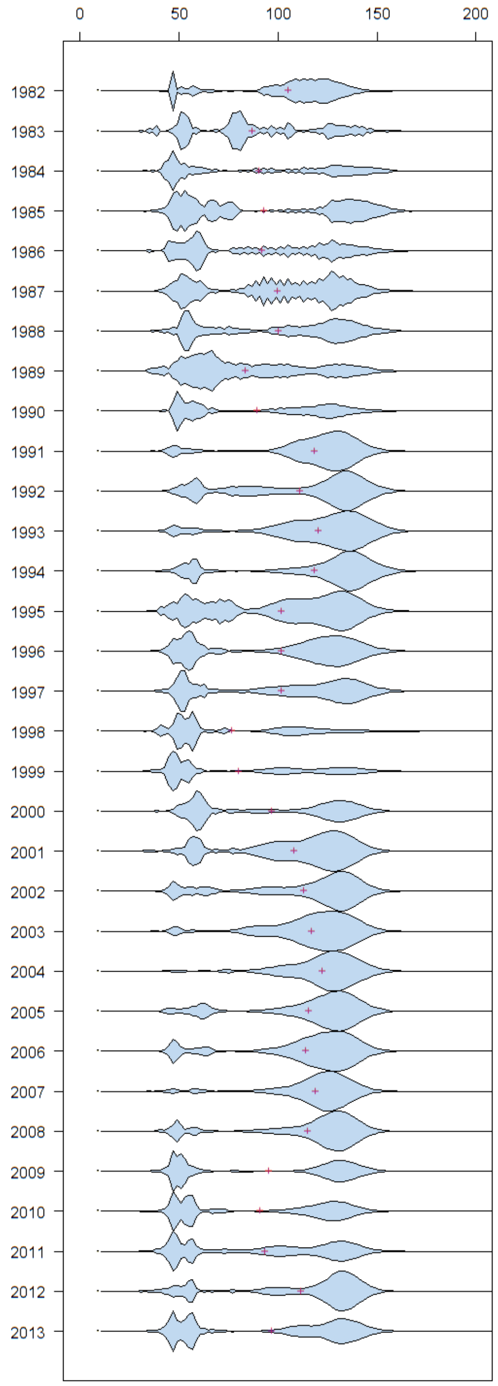


Fig. 6. Yellowfin tuna: Average weight of yellowfin tuna (YFT) taken by All fisheries combined (top), Purse seine on free (top left) and associated (top right) schools, Longlines from Japan (mid left) and Taiwan,China (mid right), Pole-and-line from Maldives and India (bottom left), Gillnets from Sri Lanka, Iran, and other countries (bottom right).

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



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

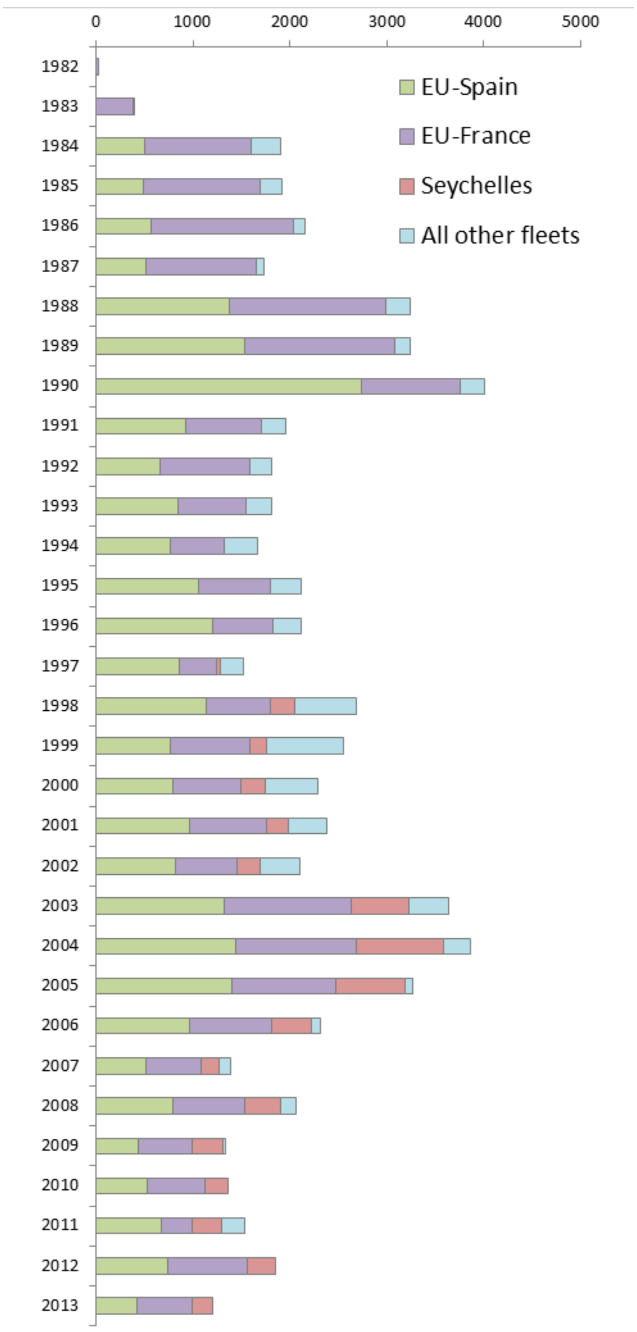
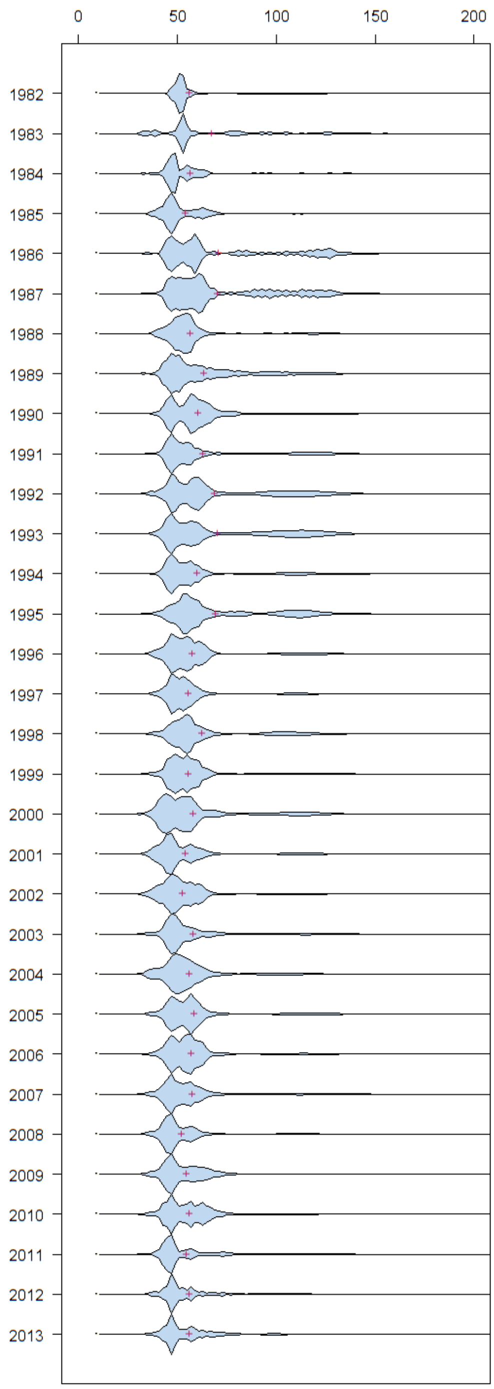


Fig. 7. Yellowfin tuna (PS Free school): **Left:** length frequency distributions for PS Free school fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of yellowfin tuna specimens sampled for lengths (raised to total catch), by fleet (PS Free school only). FS: Free swimming school.

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



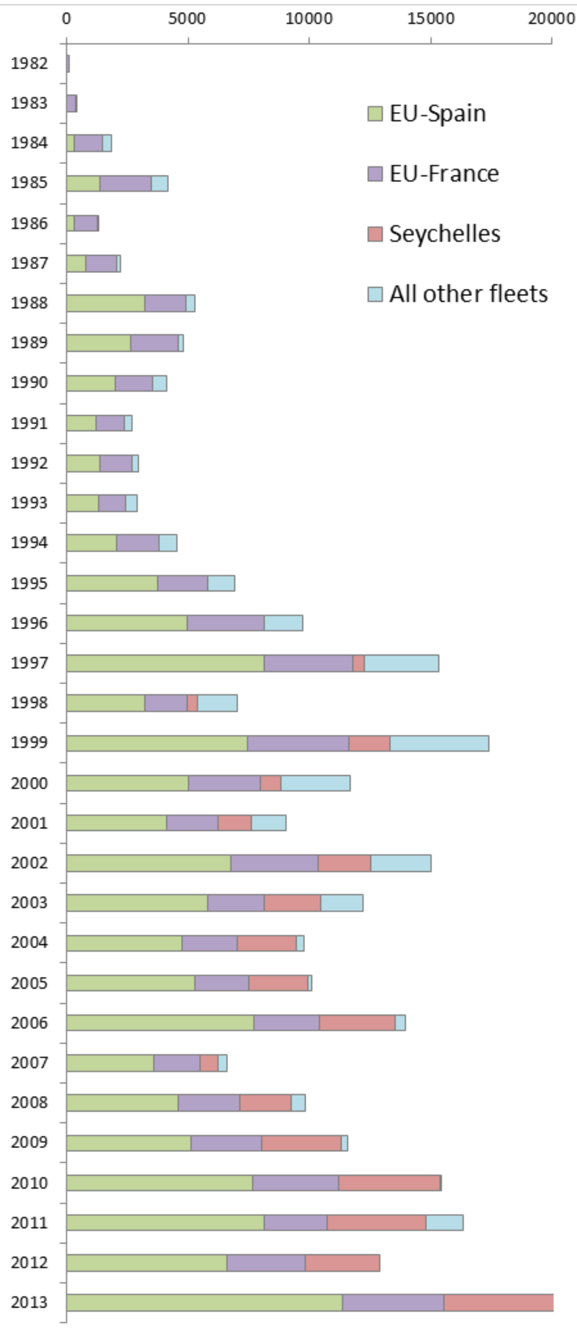


Fig. 8. Yellowfin tuna (PS Associated school): **Left:** length frequency distributions for PS Associated school fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of yellowfin tuna specimens sampled for lengths (raised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

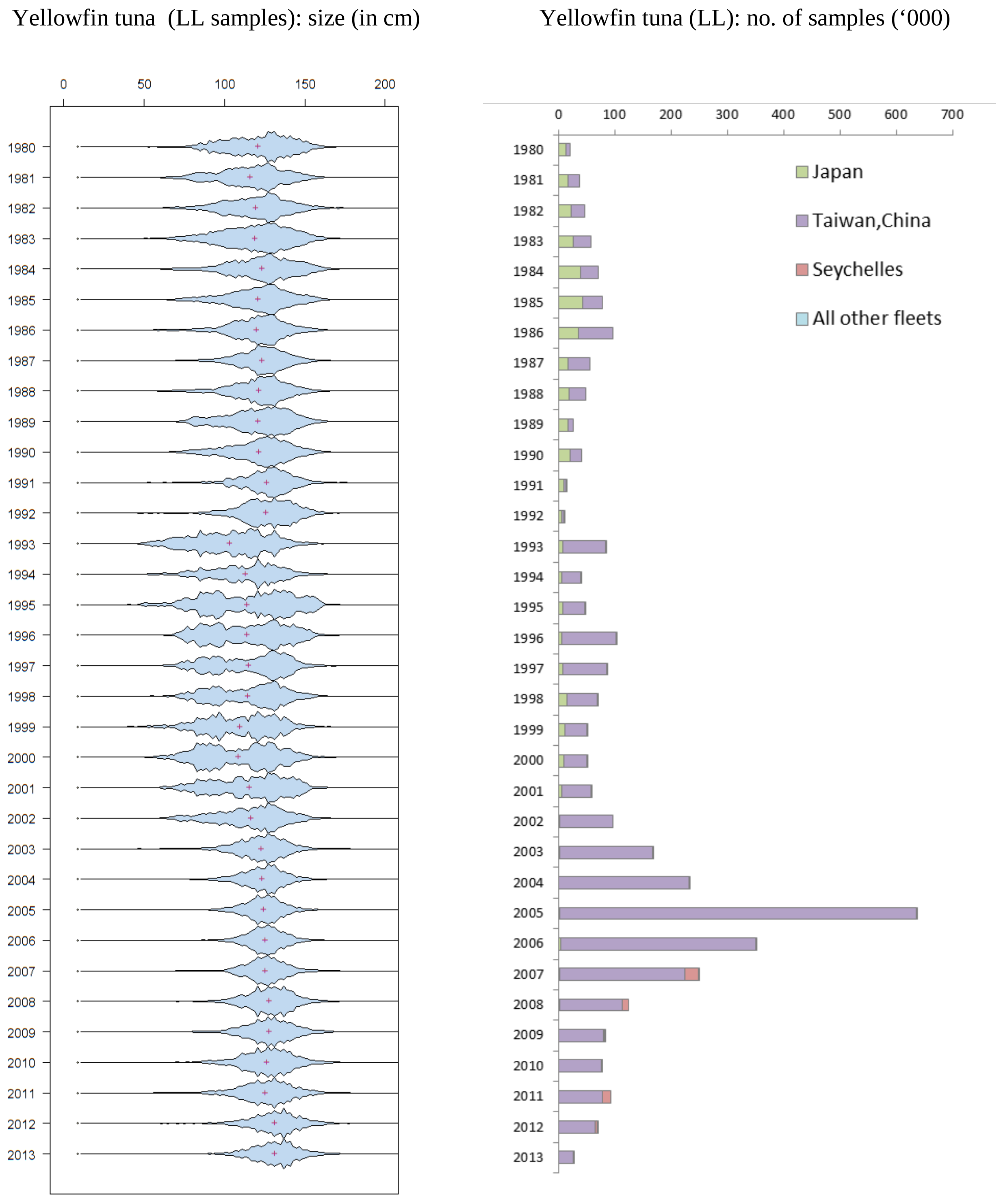


Fig. 9. Yellowfin tuna (longline: LL): **Left:** length frequency distributions for longline fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of yellowfin tuna specimens sampled for lengths, by fleet (longline only).

Yellowfin tuna: 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. 10). 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, 10,838 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.

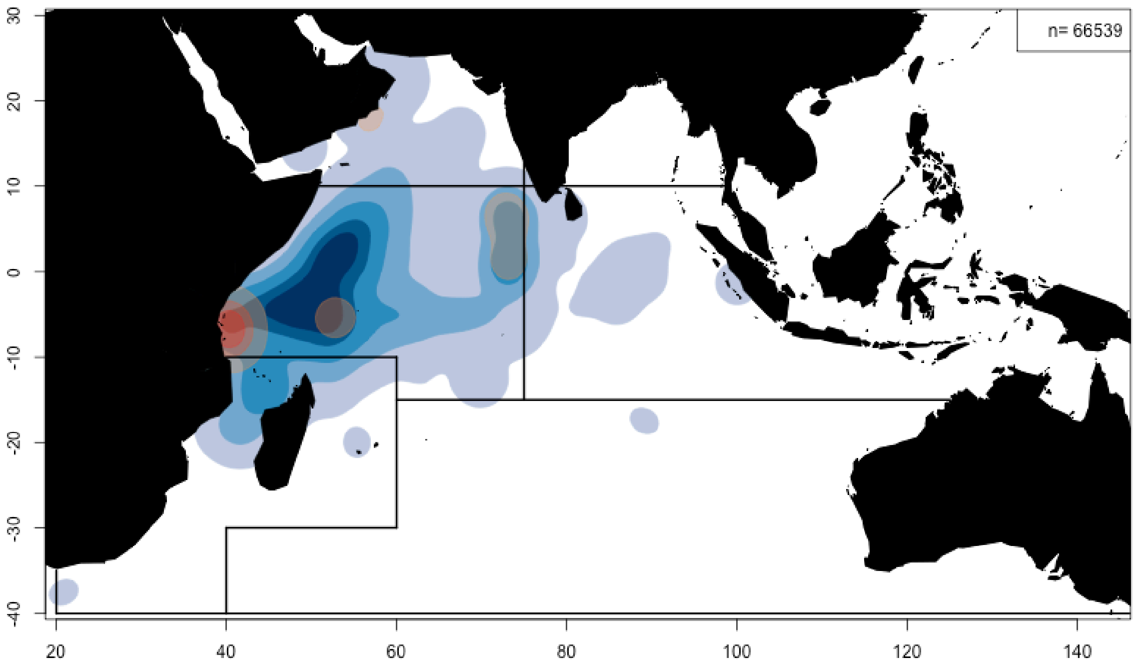


Fig. 10. Yellowfin tuna: Densities of releases (in red) and recoveries (in blue). The black line represents the stock assessment areas. Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s. Data as of September 2012.

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

Extract from IOTC–2013–WPTT15–07 Rev_2

The following list is provided by the Secretariat for the consideration of the WPTT. The list covers the main issues which the Secretariat considers affect the quality of the statistics available at the IOTC, by type of dataset and type of fishery.

1. Catch-and-Effort data from Coastal Fisheries:

- **Drifting gillnet** fishery of **Iran**: In 2013 Iran reported catches of bigeye tuna for its drifting gillnet fishery for the first time, for the years 2012 and 2013. Although Iran has reported catches of yellowfin tuna and skipjack tuna (average catches at around 60,000 t during 2008–12) it has not reported catch-and-effort data as per the IOTC standards, in particular for those vessels that operate outside of its EEZ. In addition, the IOTC Secretariat 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 bigeye tuna:yellowfin tuna recorded for industrial purse seiners on free-swimming tuna schools in the northwest Indian Ocean. Catches of bigeye tuna were estimated for the period 2005–11, at around 700 t per year.
- **Drifting gillnet** fishery of **Pakistan**: 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. In addition, Pakistan has not reported catch-and-effort data for its drifting gillnet fishery, in particular for those vessels that operate outside its EEZ. The IOTC Secretariat did not estimate catches of bigeye tuna for Pakistan. Pakistan reported catches of yellowfin tuna and skipjack tuna at around 9,500 t per year during 2008–13.
- **Gillnet/longline** fishery of **Sri Lanka**: Although Sri Lanka has reported catches of bigeye tuna for its gillnet/longline fishery the catches are considered to be too low (average catches at around 560 t during 2008–12). This is probably due to the mislabelling of catches of bigeye tuna as yellowfin tuna. The IOTC Secretariat estimated caches of bigeye tuna for Sri Lanka in 2012 with recent catches estimated at around 2,500 t per year. In addition, Sri Lanka has not reported catch-and-effort data as per the IOTC standards, including separate catch-and-effort data for longline and gillnet and catch-and-effort data for those vessels that operate outside its EEZ.
- **Pole-and-line** fishery of **Maldives**: Although the pole-and-line fishery of Maldives catches bigeye tuna, up to 2013 both yellowfin tuna and bigeye tuna were aggregated and reported as yellowfin tuna. The IOTC Secretariat has previously used the proportion of bigeye tuna in samples collected in the Maldives in the past to break the catches of yellowfin tuna, into yellowfin tuna and bigeye tuna, per year, with average catches of bigeye tuna estimated at around 850 t per year – although Maldives is currently developing more accurate estimates of catches of bigeye tuna based on tagging releases during the Regional Tuna Tagging Project.
- **Coastal** fisheries of **Indonesia, Madagascar, Sri Lanka**[1] (other than gillnet/longline) and **Yemen**: The catches of tropical tunas for these fisheries have been estimated by the IOTC Secretariat in recent years. The quality of the estimates is thought to be very poor due to the paucity of the information available about the fisheries operating in these countries. Since June 2014 the Directorate General for Capture Fisheries of Indonesia has been receiving support from BOBLME/OFCF and the IOTC for the implementation of Pilot sampling in North Sumatra and West Sumatra. The main goal is to assist Indonesia in the implementation of provisions of the IOTC Regional Observer Scheme for its artisanal fisheries, in particular to achieve the levels of coverage agreed by the Commission (sampling of at least 5% of the fishing activities). It is expected that Indonesia takes over sampling in North and West Sumatra at the end of the Project and considers extending sampling to other provinces in the Indian Ocean in the near future.
- **Coastal** fisheries of **Comoros:** 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

[1] 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.

(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. Catch-and-Effort data from Surface and Longline Fisheries:

- **Longline** fishery of **India**: In the past India informed the IOTC that it had not reported catches and catch-and-effort data for all of its commercial longline fishery, as a component of its longline fleet had not provided this information.. Although in recent years levels of reporting are improving, the IOTC Secretariat had to derive scientific estimates of catch for the component of the fleet not reporting catches, with total catches of tropical tunas at around 4,000 t per year (average for 2008-12).
- **Longline** fisheries of **Indonesia** and **Malaysia**: Indonesia and Malaysia have not reported catches for longliners under their flag that are not based in their ports. In addition Indonesia has not reported catch-and-effort data for its longline fishery to date.
- **Industrial tuna purse seine** fishery of **Iran**: Although Iran has reported catch-and-effort data for its purse seine fishery in recent years, data are not as per the IOTC standards.
- **Discard levels for 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 on 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.

3. Size data from All Fisheries:

- **Longline** fisheries of **Japan** and **Taiwan,China:** 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 WPTT-15 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[2]. 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. Arrangements and timing for the inter-sessional meeting are in the process of being confirmed.
- In addition, the number of specimens sampled for length onboard longliners flagged in Japan in recent years remains under the minimum recommended by the IOTC, which is at least 1 fish per metric ton of catch measured for length (0.06 fish per metric ton of catch for all tropical tuna species combined).
- **Gillnet** fisheries of **Iran** and **Pakistan:** Even though both countries have reported size frequency data for its gillnet fisheries in recent years, data are not reported by geographic area and the numbers measured are under the minimum sample size recommended by the IOTC (0.16 fish measured per metric ton of catch for Iran and 0.02 for Pakistan).
- **Longline** fisheries of **India and Oman:** To date, these countries have not reported size frequency data for their longline fisheries.
- **Gillnet/longline** fishery of **Sri Lanka:** Although Sri Lanka has reported length frequency data for tropical tunas in recent years, sampling coverage is below recommended levels (0.17 fish measured per metric ton of catch) and lengths are not available by gear type or fishing area[3].
- **Longline** fisheries of **Indonesia** and **Malaysia**: Indonesia and Malaysia have reported some size frequency data for its fresh-tuna longline fishery in recent years. However, the samples cannot be fully broken by month and fishing area (5x5 grid) and they refer exclusively to longliners based in ports in those countries.
- **Coastal** fisheries of **India, Indonesia** and **Yemen**: To date, these countries have not reported size frequency data for their coastal fisheries, although in the case of Indonesia size data is currently being collected by DGCF through the IOTC-OFCF, and BOBLME pilot sampling project and may be available in 2015. In addition size samples are also being collected in Indonesia in collaboration with CSIRO and USAID.

4. Biological data for all tropical tuna species:

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

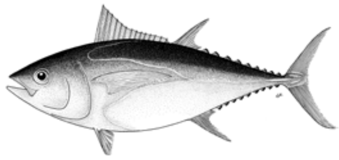
[3] In 2012-13 the Ministry of Fisheries and Aquatic Resources Development of Sri Lanka received support from IOTC, the OFCF and BOBLME to strengthen its data collection and processing system, including collection of more length frequency data from the fisheries.

- 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 paucity of biological data available from the Indian Ocean. A summary of the current biological length-weight equations and availability of alternative sources are documented in Appendix II for the consideration of the WPTT, following the recommendation of the SC.

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		2014 stock status[2] determination
Indian Ocean	Catch in 2013:	109,343 t	
	Average catch 2009–2013:	105,924 t	
	MSY (1000 t) (plausible range):	132 (98–207)[3]	
	F_{MSY} (plausible range):	n.a. (n.a.–n.a.)[3]	
	SB_{MSY} (1,000 t) (plausible range):	474 (295–677)[3]	
	F_{2012}/F_{MSY} (plausible range):	0.42 (0.21–0.80)[3]	
	SB_{2012}/SB_{MSY} (plausible range):	1.44 (0.87–2.22)[3]	
	SB_{2012}/SB_0 (plausible range):	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}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

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

Outlook. Declines in longline effort since 2007, particularly from the Japanese, Taiwan,China and Republic of Korea longline fleets, as well as purse seine effort have lowered the pressure on the Indian Ocean bigeye tuna stock, indicating that current fishing mortality would not reduce the population to an overfished state in the near future. The Kobe strategy matrix based on all plausible model runs from SS3 in 2013 illustrates the levels of risk associated with varying catch levels over time and could be used to inform future management actions (Table 2). The SS3 projections from the 2013 assessment show that there is a low risk of exceeding MSY-based reference points by 2015 and 2022 if catches are maintained at catch levels of 115,800 t at the time of the last assessment (0% risk that $B_{2022}<B_{MSY}$ and 0% risk that $F_{2022}>F_{MSY}$) (Table 2).

The following key points should be noted:

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

- **Provisional reference points**: Noting that the Commission in 2013 agreed to Resolution 13/104 *on interim target and limit reference points and a decision framework*, the following should be noted:
  - **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, and therefore below the provisional limit reference point of $1.4*F_{MSY}$ (Fig. 1).
  - **Biomass**: Current spawning biomass is considered to be above the target reference point of SB_{MSY}, and therefore above the limit reference point of $0.4*SB_{MSY}$ (Fig. 1).
- **Main fishing gear** (2009–13): Longline ≈56.7% (frozen ≈43.6%, fresh ≈13.1%); Purse seine ≈22.6% (log ≈17.5% and free swimming school ≈5.1%);
- **Main fleets**: Indonesia ≈28%; Taiwan,China ≈25%; European Union ≈15% (EU,Spain: ≈9%; EU,France: ≈6%); Seychelles ≈11%.

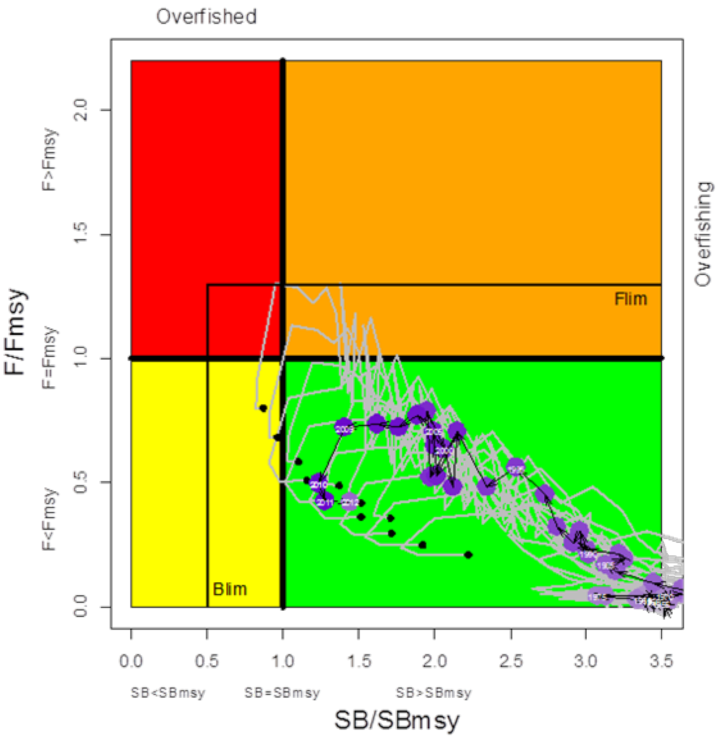


Fig. 1. Bigeye tuna: SS3 Aggregated Indian Ocean assessment Kobe plot. The Kobe plot presents the trajectories for the range of 12 plausible model options included in the formulation of the final management advice (grey lines with the black point representing the terminal year of 2012). The trajectory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

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

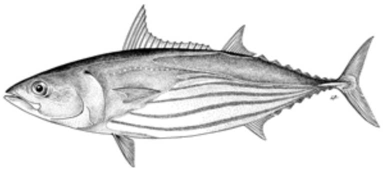
Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level for 2012) and probability (%) of violating MSY-based target reference points ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60% (69,480t)	**70%** (81,060t)	**80%** (92,640t)	**90%** (104,220t)	**100%** (115,800t)	**110%** (127,400t)	**120%** (139,000t)	**130%** (150,500t)	**140%** (162,100t)
$SB_{2015} < SB_{MSY}$	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% (69,480t)	**70%** (81,060t)	**80%** (92,640t)	**90%** (104,220t)	**100%** (115,800t)	**110%** (127,400t)	**120%** (139,000t)	**130%** (150,500t)	**140%** (162,100t)
$SB_{2016} < SB_{Lim}$	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		2014 stock status determination
Indian Ocean	Catch 2013: Average catch 2009–2013:	424,580 t 401,132 t	
	MSY (1000 t) (80% CI): C_{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 (0.69–0.75) 1.59 (1.13–2.14) 0.58 (0.53–0.62)	

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

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

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

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

Outlook. The recent declines in catch/sets on FADs (in parallel to the increased number of FADs deployed by the purse seine fleet) as well as the large decrease on free school skipjack tuna are thought to be of some concern as the WPTT does not fully understand the cause of those declines. There remains considerable uncertainty in the assessment, and the range of runs analysed illustrate a range of stock status to be between 0.73–4.31 of SB_{2013}/SB_{MSY} based on all runs examined. The Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions. Based on the SS3 assessment conducted in 2013, there is a low risk of exceeding MSY-based reference points by 2016 and 2023 if catches are maintained at the current levels of around 425,000 t (< 1 % risk that $B_{2016} < B_{MSY}$ and 1 % risk that C_{2023}>MSY as proxy of $F > F_{MSY}$).

The following key points should be noted:

- Maximum Sustainable Yield (MSY): The median MSY value from the model runs investigated was 684,000 t with a range between 550,000 and 849,000 t (Table 1); However, MSY reference levels from these models were not well determined. Historically, catches in excess of 6000,000 t were estimated to coincide with the time that the stock fell below 40% of the unfished level, which maybe a more robust proxy for MSY in this case. Considering the average catch level from 2009–2013 was 401,000 t, the stock appears to be in no immediate threat of breaching target and limit reference points. Current stock size is above $SB_{40\%}$ and predicted to increase on the short term. Catches at the level of 425,000 t have a low probability of reducing the stock below $SB_{40\%}$ in the short term (3–5 years) and medium term (10 years). However, taking into account the uncertainty related to current skipjack assessment as well as other indicators such the low catch rates of FADs and increased effort, it is recommended that annual catches of skipjack tuna should not exceed the lower value of MSY of the range (550,000 t) in order to ensure that stock biomass levels could sustain catches at the MSY level in the long term. If catch remains below the estimated MSY levels, then immediate management measures are not required. However, continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in assessments.

- The Kobe strategy matrix (Table 2) illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.
- **Provisional reference points:** Noting that the Commission in 2013 agreed to Resolution 13/10 *on interim target and limit reference points and a decision framework*, the following should be noted:
    - **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, and therefore below the provisional limit reference point of $1.5*F_{MSY}$ (Fig. 1). Based on the current assessment there is a very low probability that the limit reference points of $1.5*F_{MSY}$ at the current catch levels will be exceeded in 3 or 10 years.
    - **Biomass**: Current spawning biomass is considered to be above the target reference point of SB_{MSY}, and therefore above the limit reference point of $0.4*SB_{MSY}$ (Fig. 1). Based on the current assessment, there is a low probability that the spawning stock biomass, at the current catch levels, will be below the limit reference point of $0.4*SB_{MSY}$ in 3 or 10 years.
- **Main fishing gear** (2009–13): Other (NEI) ≈48%; Purse seine ≈32.6% (log ≈30.7% and free swimming school ≈1.8%); Pole-and-line ≈19.5%.;
- **Main fleets**: European Union ≈23% (EU,Spain: ≈16%; EU,France: ≈7%); Indonesia ≈21%; Sri Lanka ≈18%; ≈Maldives 16%; Seychelles ≈8%.

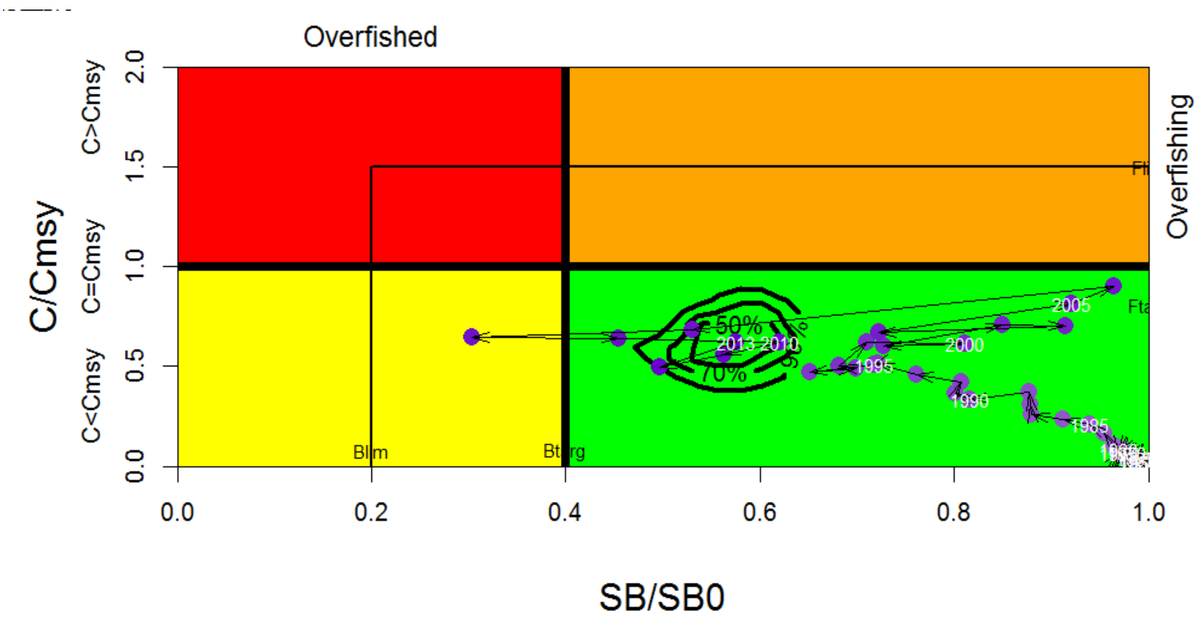


Fig. 1. Skipjack tuna: SS3 Aggregated Indian Ocean assessment Kobe plot (contours are the 50, 70 and 90 percentiles of the 2013 estimate). Blue circles indicate the trajectory of the point estimates for the SB/SB0 ratio and F proxy ratio for each year 1950–2013 estimated as C/C_{MSY}. Interim target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

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

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

$F_{2016} > F_{MSY}$	0		1		1		5		12
$SB_{2023} < SB_{MSY}$	0		1		1		6		25
$F_{2023} > F_{MSY}$	0		1		1		5		20

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

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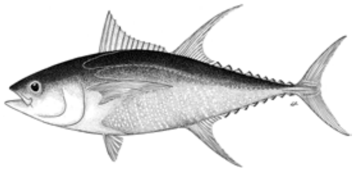
APPENDIX VIII
DRAFT RESOURCE STOCK STATUS SUMMARY – YELLOWFIN TUNA

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			2014 stock status determination
Indian Ocean	Catch 2013: Average catch 2009–2013:	402,084 t 339,359 t		(green)
		Multifan[2]	ASPM[3]	
	MSY (1000 t) (80% CI):	344 (290–453)	320 (283–358)	
	F_{MSY} (80% CI):	n.a (n.a.–n.a.)	n.a (n.a.–n.a.)	
	SB_{MSY} (1,000 t) (80% CI):	881 (784–986)	n.a (n.a.–n.a.)	
	F_{curr}/F_{MSY} (80% CI):	0.69 (0.59–0.90)	0.61 (0.31–0.91)	
	SB_{curr}/SB_{MSY} (80% CI):	1.24 (0.91–1.40)	1.35 (0.96–1.74)	
	SB_{curr}/SB_0 (80% CI):	0.38 (0.28–0.38)	–	

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

Colour key	Stock overfished ($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)	(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 yellowfin tuna in 2014, thus, stock status is determined on the basis of the 2012 assessment and other indicators presented in 2014. The stock assessment model results from 2012 did not differ substantively from the previous (2011) assessments; however, the final overall estimates of stock status differ somewhat due to the refinement in the selection of the range of model options due to increased understanding of key biological parameters (primarily natural mortality). Two trajectories are presented that compare the Kobe plots obtained from the MFCL and ASPM assessments. While the MFCL assessment indicates that fishing mortality is below the limit and target reference points during the whole time series, the ASPM model run indicates that the target reference points may have been exceeded during the period of high catches in the mid 2000's (2003–2006). However, estimates of total and spawning stock biomass show a marked decrease from 2004 to 2009 in both cases, corresponding to the very high catches of 2003–2006. Recent reductions in effort and, hence, catches resulted in a slight improvement in stock status in 2010. Spawning stock biomass in 2010 was estimated to be 38% (31–38%) (from Table 1) of the unfished levels. Total catch has continued to increase with 400,292 t and 402,084 t landed in 2012 and 2013, respectively, well in excess of previous MSY estimates (≈17% above the MSY level of 344,000 t; Table 1), in comparison to 327,453 t landed in 2011 and 299,713 t landed in 2010. Catches in 2010 (299,713) were within the lower range of MSY level and the last assessment indicated that catch of about the 2010 level were sustainable in the longer term. The previous assessment showed that the stock was unlikely to support substantially higher yields based on the estimated levels of recruitment from the last 15 years although higher yield would be expected if recruitment corresponds to the long term average. However, catch rates have improved in the purse seine fishery while remaining stable for the Japanese longline fleet. Therefore it is difficult to know whether the stock is moving towards a state of being subject to overfishing. Thus, on the weight-of-evidence available in 2014, the yellowfin tuna stock is determined to be **not overfished** and **not subject to overfishing** (Table 1 and Fig. 1).

Outlook. The decrease in longline and purse seine effort in recent years has substantially lowered the pressure on the Indian Ocean stock as a whole, indicating that current fishing mortality has not exceeded the MSY-related levels in recent years. If the security situation in the western Indian Ocean were to continue to improve, a rapid reversal in fleet activity in this region may lead to an increase in effort which the stock might not be able to sustain, as catches would then be likely to exceed MSY levels.

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

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

The following key points should be noted:

- **Maximum Sustainable Yield (MSY):** estimate for the whole Indian Ocean is 344,000 t with a range between 290,000–453,000 t for MFCL; 320,000 t with a range between 283,000 and 358,000 t for ASPM (Table 1). The management advice in 2012 indicated that annual catches of yellowfin tuna should not exceed the lower range of MSY (300,000 t) in order to ensure that stock biomass levels could sustain catches at the MSY level in the long term. Catches have exceeded this level in 2011, 2012 and 2013. Recent recruitment estimated by MFCL is estimated to be considerably lower than the whole time series average. If recruitment continues to be lower than average, catches below MSY would be needed to maintain stock levels. On the contrary, long term recruitment would give larger yield.
- **Provisional reference points**: Noting that the Commission in 2013 agreed to Resolution 13/10 *on interim target and limit reference points and a decision framework*, the following should be noted:
  - o **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, and therefore below the provisional limit reference point of $1.4*F_{MSY}$ (Fig. 1).
  - o **Biomass**: Current spawning biomass is considered to be above the target reference point of SB_{MSY}, and therefore above the limit reference point of $0.4*SB_{MSY}$ (Fig. 1).
- **Main fishing gear** (2009–13): Purse seine ≈33.8% (log ≈21.8% and free swimming school ≈12.0%); Longline ≈19.3% (frozen ≈11.7%, fresh ≈7.6%); Handline ≈17.3%; Gillnet ≈15.6%.
- **Main fleets**: European Union ≈26% (EU,Spain: ≈15%; EU,France: ≈11%); Sri Lanka ≈10%; Maldives ≈10%; Indonesia ≈10%; I.R. Iran ≈9%; Seychelles ≈8%.

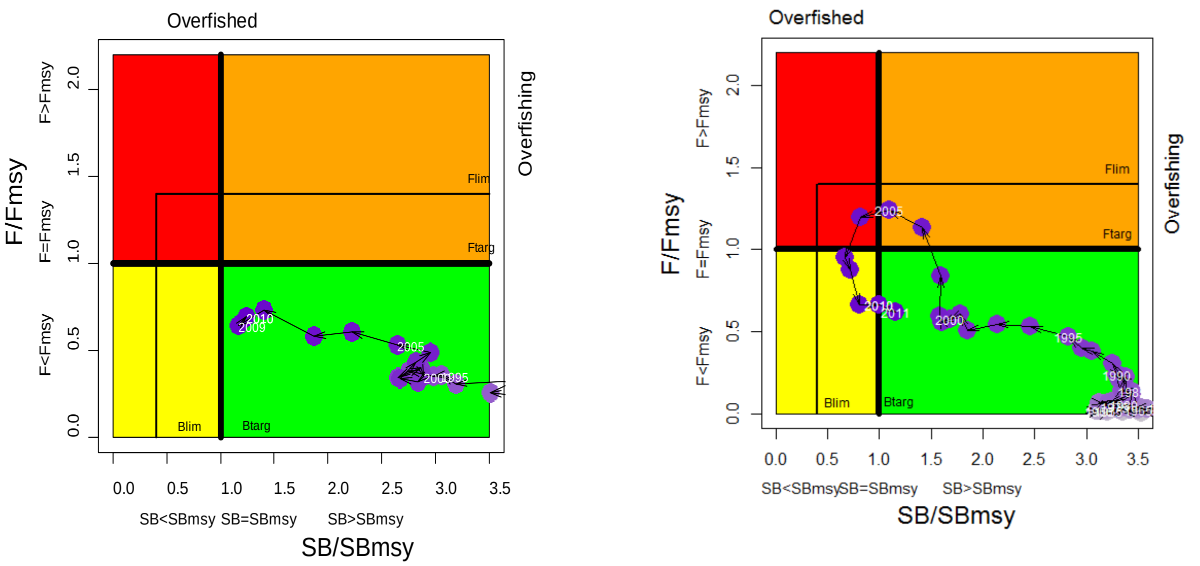


Fig. 1. Yellowfin tuna: MULTIFAN-CL and ASPM Indian Ocean yellowfin tuna stock assessment Kobe plots. Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1972–2010 for a steepness value of 0.8. The left panel is output obtained from the base case run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

TABLE 2. Yellowfin tuna: 2011 MULTIFAN-CL Indian Ocean yellowfin tuna stock assessment Kobe II Strategy Matrix. Percentage probability of violating the MSY-based reference points for five constant catch projections (2010 catch level, ±10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years. In the projection, however, 12 scenarios

were investigated: the six scenarios investigated above as well as the same scenarios but with a lower mean recruitment assumed for the projected period. Note: from the 2011 stock assessment using catch estimates at that time.

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

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

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APPENDIX IX
WORKING PARTY ON TROPICAL TUNAS PROGRAM OF WORK (2015–2019)

The Program of Work consists of the following, noting that a timeline for implementation would be developed by the SC once it has agreed to the priority projects across all of its Working Parties:

- **Table 1**: Priority topics for obtaining the information necessary to develop stock status indicators for tropical tunas in the Indian Ocean;
- **Table 2**: High priority topics, by project for tropical tunas in the Indian Ocean; and
- **Table 3**: 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	Priority
Stock structure (connectivity)	Research to describe the population structure and connectivity of tropical tunas within the Indian Ocean (and adjacent Pacific Ocean waters as appropriate)	High
	▪ Next Generation Sequencing (NGS) (function of new EU funding)	High
	▪ Otolith microchemistry/isotope research	Med
	▪ Tagging studies	High
Biological information (parameters for stock assessment)	Age and growth research	High
	Age-at-Maturity	High
	Fecundity-at-age/length relationships	Medium
Ecological information	Spawning time and locations	High
Historical data review	Changes in fleet dynamics	High
	FAD numbers and characteristics	High
	Species identification	Med
CPUE standardisation	Develop and/or revise standardised CPUE series for each tropical tuna species and fishery for the Indian Ocean	
	▪ Bigeye tuna: High priority fleets: High (2016)	High
	▪ Skipjack tuna: High priority fleets: High (2017)	High
	▪ Yellowfin tuna: High priority fleets: High (2015)	High
Stock assessment / Stock indicators	Develop and compare multiple assessment approaches to determining stock status for all tropical tunas	High
Target and Limit reference points	To advise the Commission, by end of 2016 at the latest on Target Reference Points (TRPs) and Limit Reference Points (LRPs).	High
Management measure options	To advise the Commission, by end of 2016 at the latest, on potential management measures having been examined through the Management Strategy Evaluation (MSE) process.	High

Table 2. High priority topics, by project for tropical tunas in the Indian Ocean.

Topic	Sub-topic and project	Priority
Stock structure (connectivity)	Research to describe the population structure and connectivity of billfish within the Indian Ocean (and adjacent Pacific and Atlantic waters as appropriate) ▪ Next Generation Sequencing (NGS) to determine tropical tuna stock structure, and migratory range. Determine the degree of shared stocks for tropical tunas in the Indian Ocean with the Pacific Ocean. ▪ Tagging movements and analysis to incorporate in stock assessments	High
Biological information (parameters for stock assessment)	Age and growth research ▪ CPCs to provide further research reports on tropical tuna biology, namely age and growth studies including using through the use of fish otoliths, either from data collected through observer programs or other research programs.	High
	Age-at-Maturity ▪ Quantitative biological studies are necessary for tropical tunas throughout their range to determine key biological parameters including age/size-at-maturity and fecundity-at-age/length relationships, which will be fed into future stock assessments.	High
Ecological information	Spawning time and locations ▪ Collect gonad samples from tropical tunas to confirm the spawning time and location of the spawning area that are presently hypothesized for each tropical tuna species	High
Historical data review	Changes in fleet dynamics need to be documented by fleet. ▪ Priority fleets: Japan and Taiwan,China LL ▪ FAD issues to be analysed for incorporation in CPUE series.	 High High
CPUE standardisation	Develop standardised CPUE series for each tropical tuna fleet/fishery for the Indian Ocean There is an urgent need to investigate the CPUE issues as detailed for bigeye tuna, skipjack tuna and yellowfin tuna in the WPTT15 report, and for these to be a high priority research activity for the tropical tuna resources in the Indian Ocean. That standardised CPUE index for juvenile yellowfin tuna and bigeye tuna caught by the EU purse seiner fleets, be estimated and submitted to the WPTT before the next round of stock assessments of tropical tunas. The standardisation of purse seine CPUE be made where possible using the operational data on the fishery. Develop and/or revise standardised CPUE series for each tropical tuna species and fishery for the Indian Ocean ▪ Bigeye tuna: High priority fleets: High (2016) ▪ Skipjack tuna: High priority fleets: High (2017) ▪ Yellowfin tuna: High priority fleets: High (2015)	High
Stock assessment / Stock indicators	Develop and compare multiple assessment approaches to determining stock status for tropical tunas	High
Target and Limit reference points	To advise the Commission, by end of 2016 at the latest on Target Reference Points (TRPs) and Limit Reference Points (LRPs). ▪ Used when assessing tropical tuna stock status and when establishing the Kobe plot and Kobe matrices	High
Management measure options	To advise the Commission, by end of 2016 at the latest, on potential management measures having been examined through the Management Strategy Evaluation (MSE) process. ▪ 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	High

to deliver MSY and (ii) the spawning biomass is maintained at or above its MSY level.

Table 3. Assessment schedule for the IOTC Working Party on Tropical Tunas (WPTT)

Species	2015	2016	2017	2018	2019
Working Party on Tropical Tunas					
Bigeye tuna	Indicators	**Full assessment**	Indicators	Indicators	**Full assessment**
Skipjack tuna	Indicators	Indicators	**Full assessment**	Indicators	Indicators
Yellowfin tuna	**Full assessment**	Indicators	Indicators	**Full assessment**	Indicators

APPENDIX X
CONSOLIDATED RECOMMENDATIONS OF THE 16TH SESSION OF THE WORKING PARTY ON TROPICAL TUNAS

Note: Appendix references refer to the Report of the 16th Session of the Working Party on Tropical Tunas (IOTC–2014–WPTT16–R)

Skipjack tuna indicators

WPTT16.01 (para. 139): The WPTT **ENCOURAGED** the production of such fishery indicators and **RECOMMENDED** that other indicators, such as the number of FADs deployed and active should also be examined in addition to existing environmental indices for the Indian Ocean.

Revision of the WPTT Program of Work (2015–2019)

WPTT16.02 (para. 233): The WPTT **AGREED** on the importance of appropriately scheduling and resourcing stock assessments to ensure the best possible use of the available data in providing advice to the Commission. The WPTT **RECOMMENDED** that stock assessments be resourced to a level that is commensurate with their fundamental importance in the management of IOTC stocks.

WPTT16.03 (para. 236): The WPTT **RECOMMENDED** that the SC consider and endorse the WPTT Program of Work (2015–2019), as provided at Appendix IX.

Election of a Chairperson of the WPTT for the next biennium

WPTT16.04 (para. 244): The WPTT **RECOMMENDED** that the SC note that Dr M.Shiham Adam (Maldives) and Dr Gorka Merino (EU,Spain) were elected as Chairperson and Vice-Chairperson of the WPTT for the next biennium.

Review of the draft, and adoption of the Report of the 16th Session of the WPTT

WPTT16.05 (para. 249): The WPTT **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPTT16, 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 2014 (Fig. 15):

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

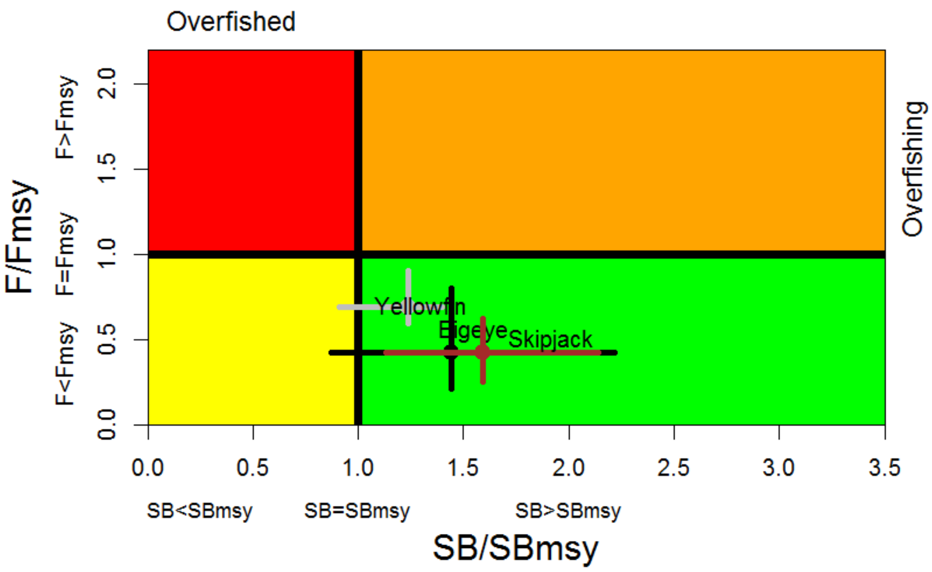

Fig. 15. Combined Kobe plot for bigeye tuna (black: 2013), skipjack tuna (brown: 2014) and yellowfin tuna (grey: 2012) showing the estimates of current stock size (SB) and current fishing mortality (F) in relation to optimal spawning stock size and optimal fishing mortality. Cross bars illustrate the 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.