DRAFT: EXECUTIVE 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: Average catch 2009–2013:	109,343 t 105,924 t	
	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):	132 (98–207)[3] n.a. (n.a.–n.a.)[3] 474 (295–677)[3] 0.42 (0.21–0.80)[3] 1.44 (0.87–2.22)[3] 0.40 (0.27–0.54)[3]	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]The stock status refers to the most recent years' data used in the assessment.
[3]The point estimate is the median of the plausible models investigated in the 2013 SS3 assessment.

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

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

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

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

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: The median value of MSY from the model runs investigated was 132,000 t with a range between 98,000 and 207,000 t (range expressed as the different runs of SS3 done in 2013 using

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

- **Provisional reference points**: Noting that the Commission in 2013 agreed to Resolution 13/10 *on interim target and limit reference points and a decision framework*, the following should be noted:
  - **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%.

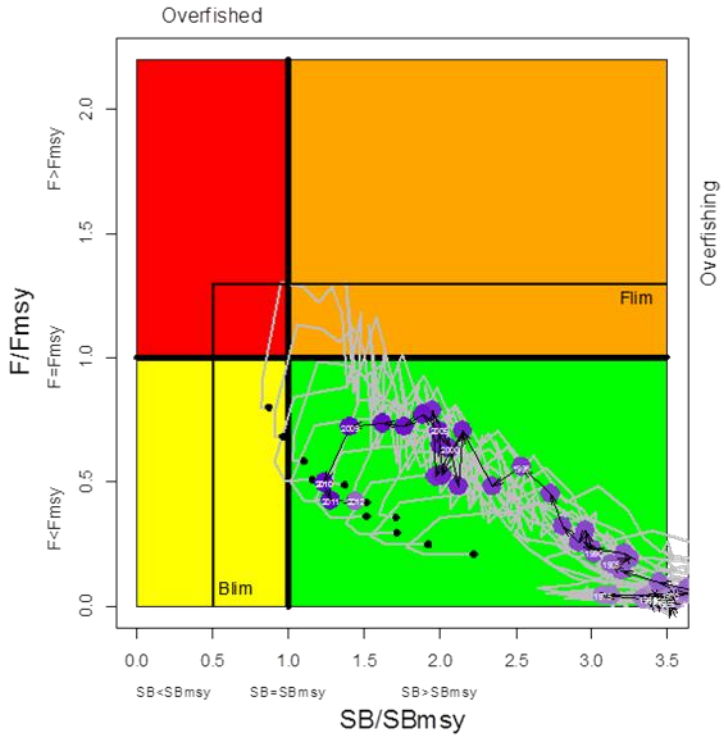


Fig. 1. Bigeye tuna: SS3 Aggregated Indian Ocean assessment Kobe plot. The Kobe plot presents the trajectories for the range of 12 plausible model options included in the formulation of the final management advice (grey lines with the black point representing the terminal year of 2012). The trajectory 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 I
SUPPORTING INFORMATION

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

CONSERVATION AND MANAGEMENT MEASURES

Bigeye tuna (*Thunnus obesus*) in the Indian Ocean is currently subject to a number of Conservation and Management Measures adopted by the Commission:

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

FISHERIES INDICATORS

Bigeye tuna – General

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

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

Parameter	**Description**
Range and stock structure	Inhabits the tropical and subtropical waters of the Pacific, Atlantic and Indian Oceans in waters down to around 300 m. Juveniles frequently school at the surface underneath floating objects with yellowfin and skipjack tunas. Association with floating objects appears less common as bigeye grow older. The tag recoveries from the RTTP-IO provide evidence of rapid and large scale movements of juvenile bigeye tuna in the Indian Ocean, thus supporting the current assumption of a single stock for the Indian Ocean. The average minimum distance between juvenile tag-release-recapture positions is estimated at 657 nautical miles. The range of the stock (as indicated by the distribution of catches) includes tropical areas, where reproduction occurs, and temperate waters which are believed to be feeding grounds.
Longevity	15 years

Maturity (50%)	Age: females and males 3 years. Size: females and males 100 cm.
Spawning season	Spawning season from December to January and also in June in the eastern Indian Ocean.
Size (length and weight)	Maximum length: 200 cm FL; Maximum weight: 210 kg. Newly recruited fish are primarily caught by the purse seine fishery on floating objects. The sizes exploited in the Indian Ocean range from 30 cm to 180 cm fork length. Smaller fish (juveniles) form mixed schools with skipjack tuna and juvenile yellowfin tuna and are mainly limited to surface tropical waters, while larger fish are found in sub-surface waters.

Sources: Nootmorn 2004, Froese & Pauly 2009

Bigeye tuna – Fisheries and catch trends

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

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

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

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

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

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

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

Total annual catches have increased steadily since the start of the fishery, reaching the 100,000 t level in 1993 and peaking at over 160,000 t in 1999 (Fig. 2). Catches dropped since then to values between 130,000–150,000 t (2000–07), before dropping even further in recent years to values under 90,000 t (e.g., 2010–11), before increasing in 2012 to nearly 120,000

t. The SC believes that the drop in catches between 2008 and 2011 could be related, at least in part, with the expansion of piracy in the northwest Indian Ocean (West A1, Table 5, Fig. 3b), which led to a marked drop in the levels of longline effort in the core fishing area of these species in 2010–11 (Fig. 3).

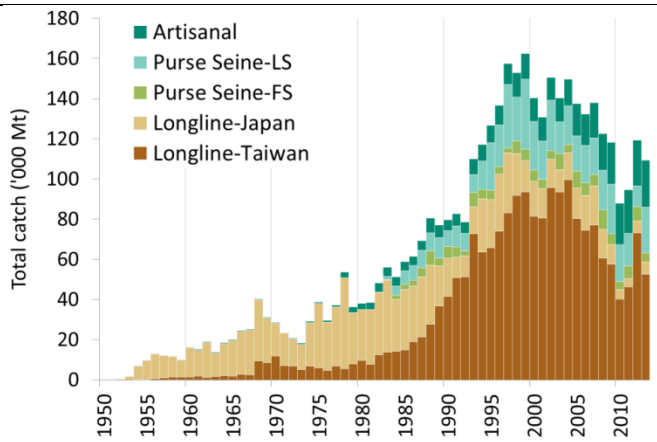
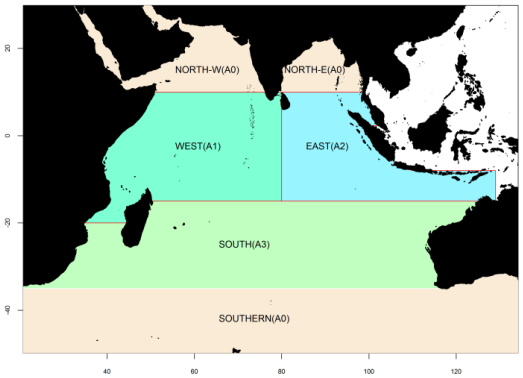


Fig. 2. Bigeye tuna: Annual catches of bigeye tuna by gear (1950–2012). Data as of September 2014. Gears (as agreed by WPTT): Longline Taiwan,China and associated fleets (Longline-Taiwan); Longline Japan and associated fleets (Longline-Japan); Purse seine free-school (FS); Purse seine associated school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



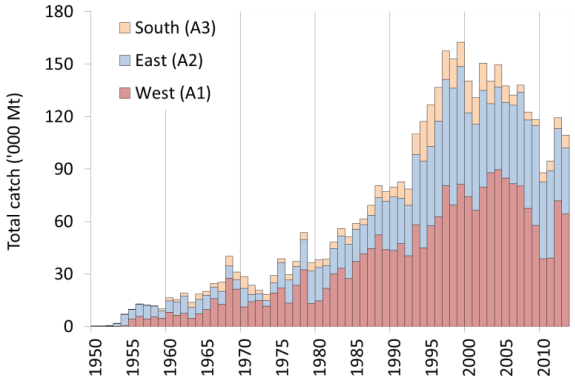


Fig. 3(a-b). Bigeye tuna: Catches of bigeye tuna by area by year estimated for the WPTT (1950–2012). Data as of September 2014. Catches outside the areas presented in the Map were assigned to the closest neighbouring area for the assessment. **Areas**: West Indian Ocean (**A1**); East Indian Ocean (**A2**);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

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

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

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

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

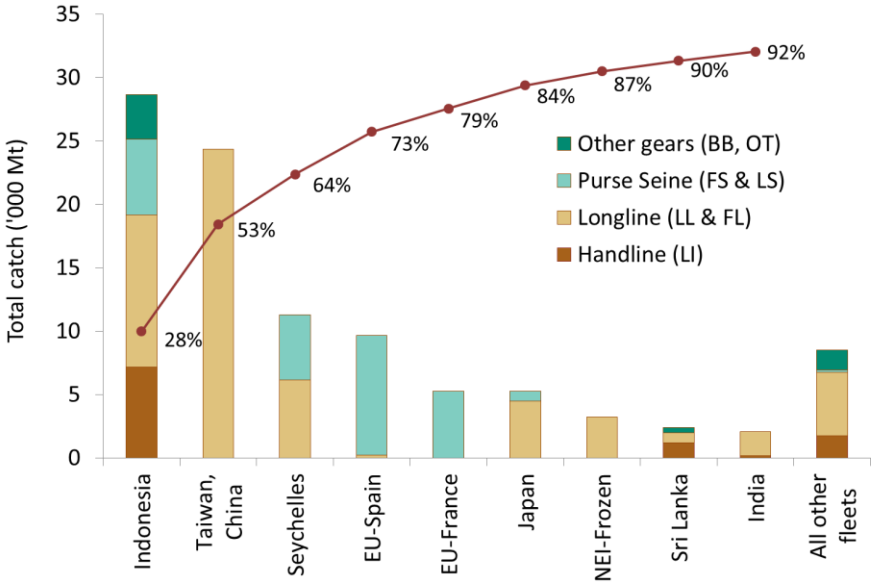


Fig. 4. Bigeye tuna: average catches in the Indian Ocean over the period 2010–12, by fleet. Fleets are ordered from left to right, according to the importance of catches of bigeye reported. The red line indicates the (cumulative) proportion of catches of bigeye for the fleets concerned, over the total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

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

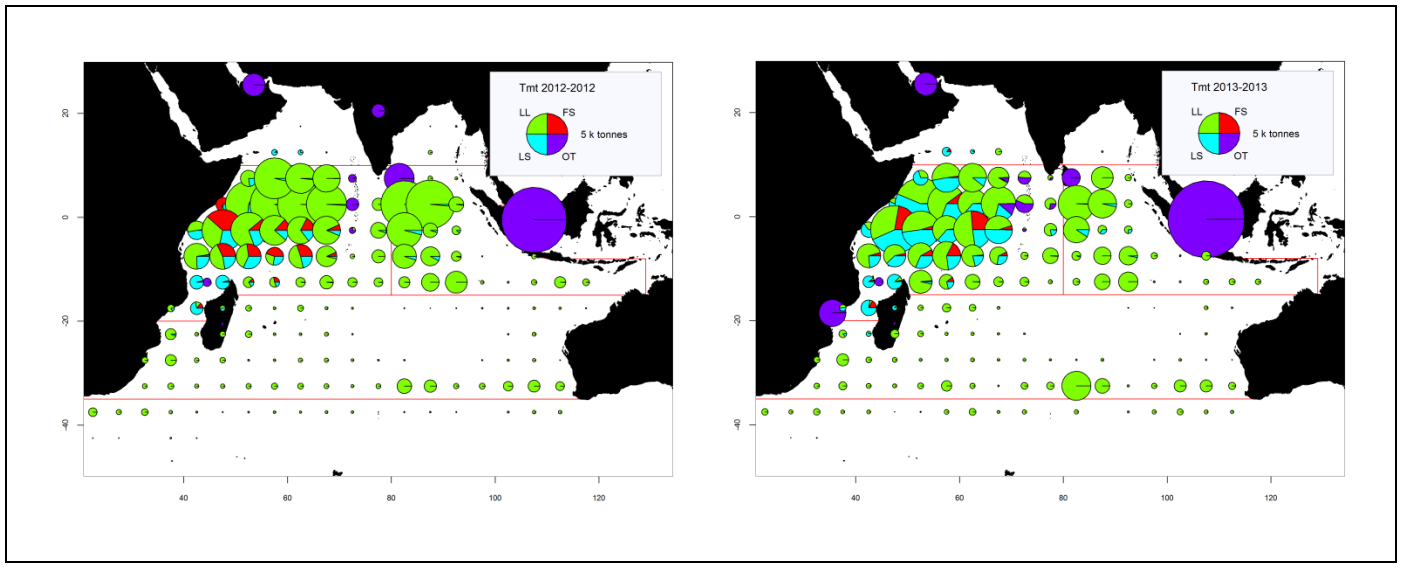


Fig. 5(a-b). Bigeye tuna: Time-area catches (total combined in tonnes) of bigeye tuna estimated for 2002 and 2013 by type of gear. Longline (**LL**), Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), and other fleets (**OT**), including pole-and-line, drifting gillnets, and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

Bigeye tuna: Status of fisheries statistics at the IOTC

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

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

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

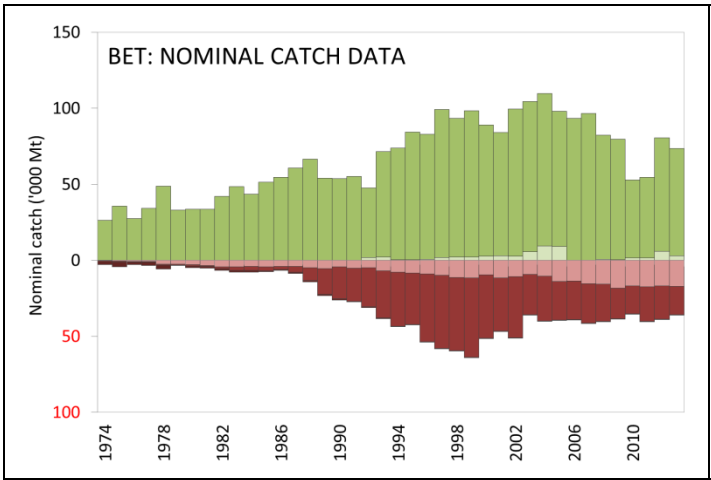
Catch-Per-Unit-Effort (CPUE) series: Catch-and-effort data are generally available from the major industrial fisheries. However, these data are not available from some fisheries or they are considered to be of poor quality, especially throughout the 1990s and in recent years (Fig. 6b), for the following reasons:

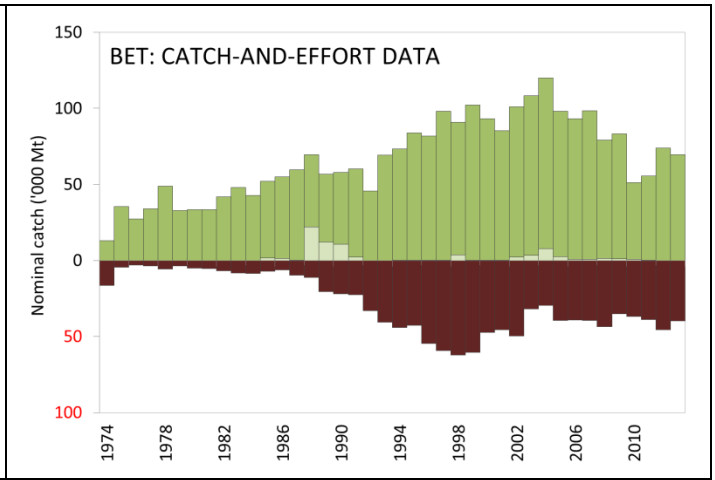
- non-reporting by industrial purse seiners and longliners (NEI)
- no data are available for the fresh-tuna longline fishery of Indonesia, over the entire time series, and data for the fresh-tuna longline fishery of Taiwan,China are only available since 2006
- uncertain data from significant fleets of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

Fish size or age trends (e.g. by length, weight, sex and/or maturity): Can be assessed for several industrial fisheries although they are incomplete or of poor quality for most fisheries before the mid-1980s and for some fleets in recent years (e.g. Japan and Taiwan,China longline) (Figs. 6, 7, 8, 9, 10)

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

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





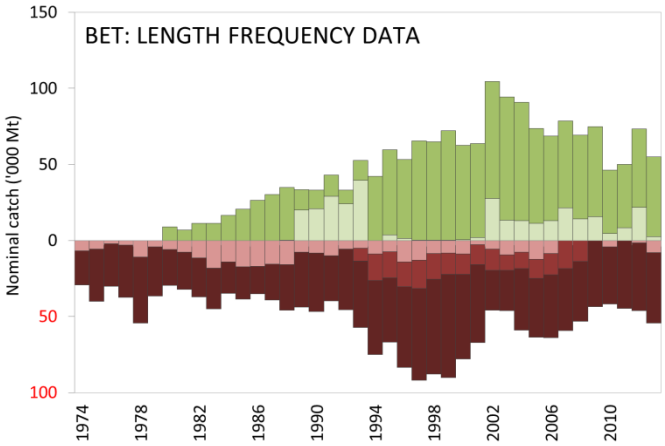


Fig. 6a-c. Bigeye tuna: data reporting coverage (1974–2013). Each IOTC dataset (a) nominal catch, b) catch-and-effort, and c) length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported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

Key to IOTC Scoring system

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

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

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

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

Key to colour coding

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

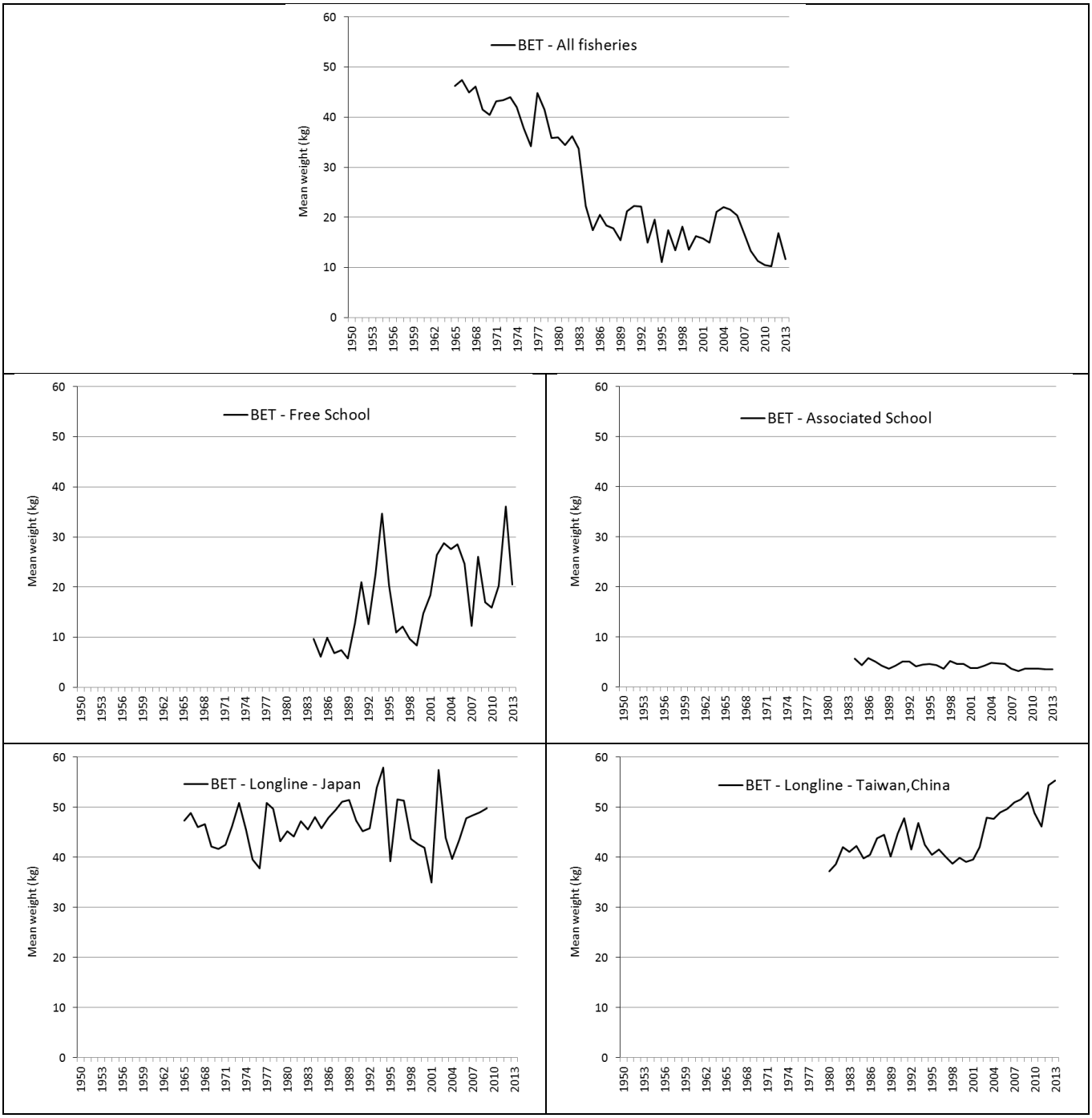
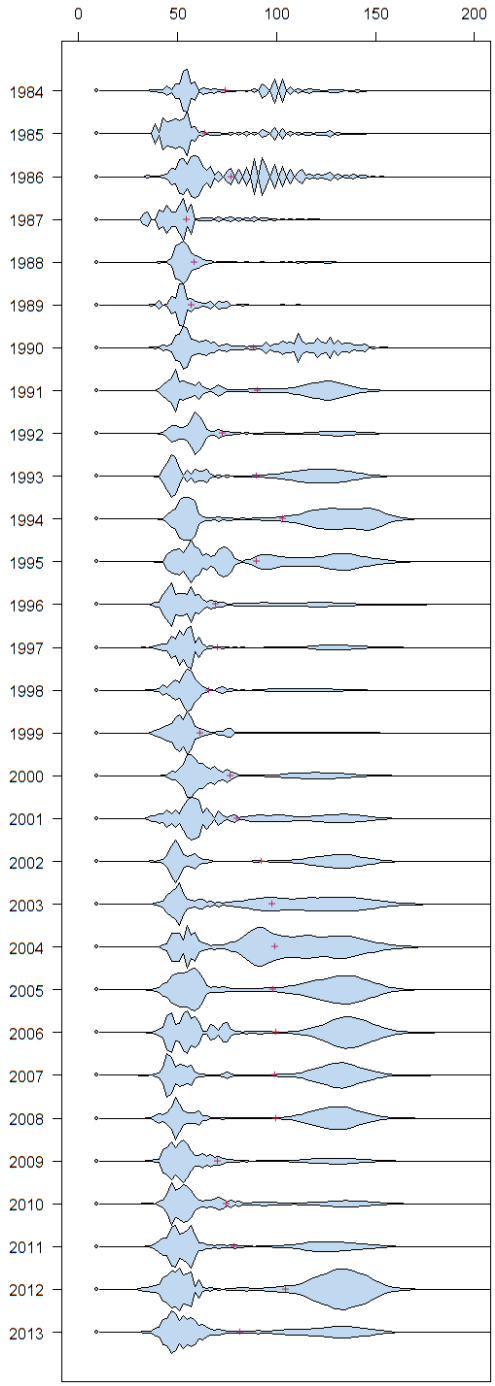


Fig. 7. Bigeye tuna: Average weight of bigeye tuna (BET) taken by: All fisheries combined (top) Purse seine on free (top left) and associated (top right) schools, Longlines from Japan (botom left) and Taiwan,China (bottom right)

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



Bigeye tuna (PS FS): no. of specimens (‘000)
(raised to total catch)

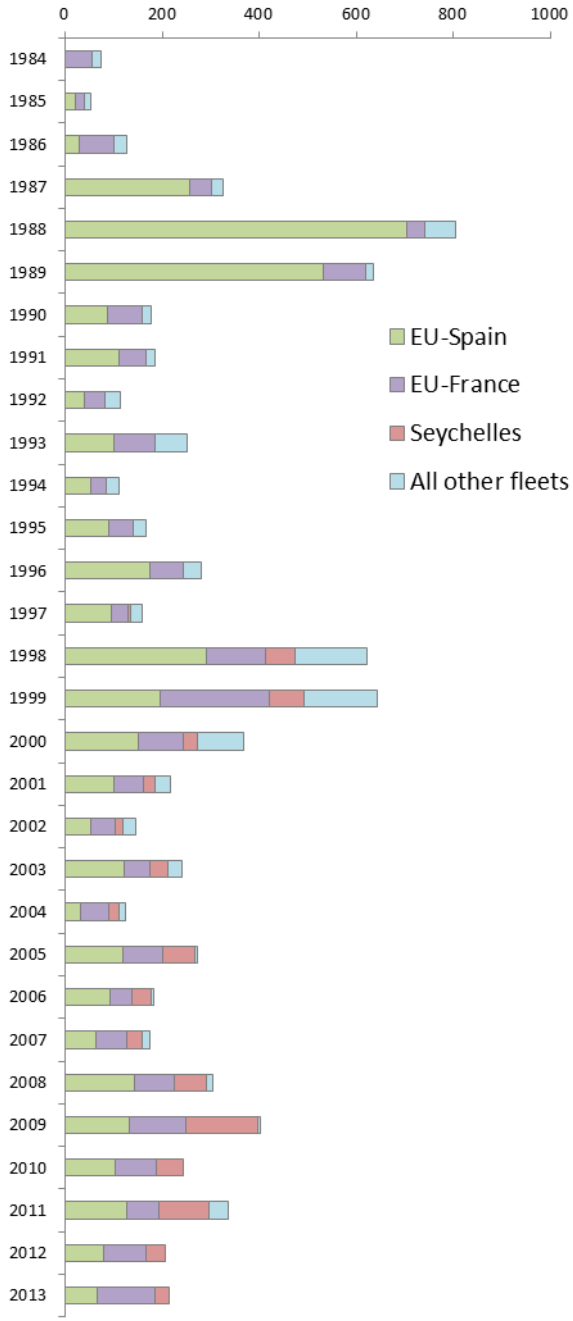


Fig. 8. Bigeye tuna (PS Free school): **Left:** length frequency distributions for PS Free School fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of bigeye tuna specimens sampled for lengths (raised to total catch),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

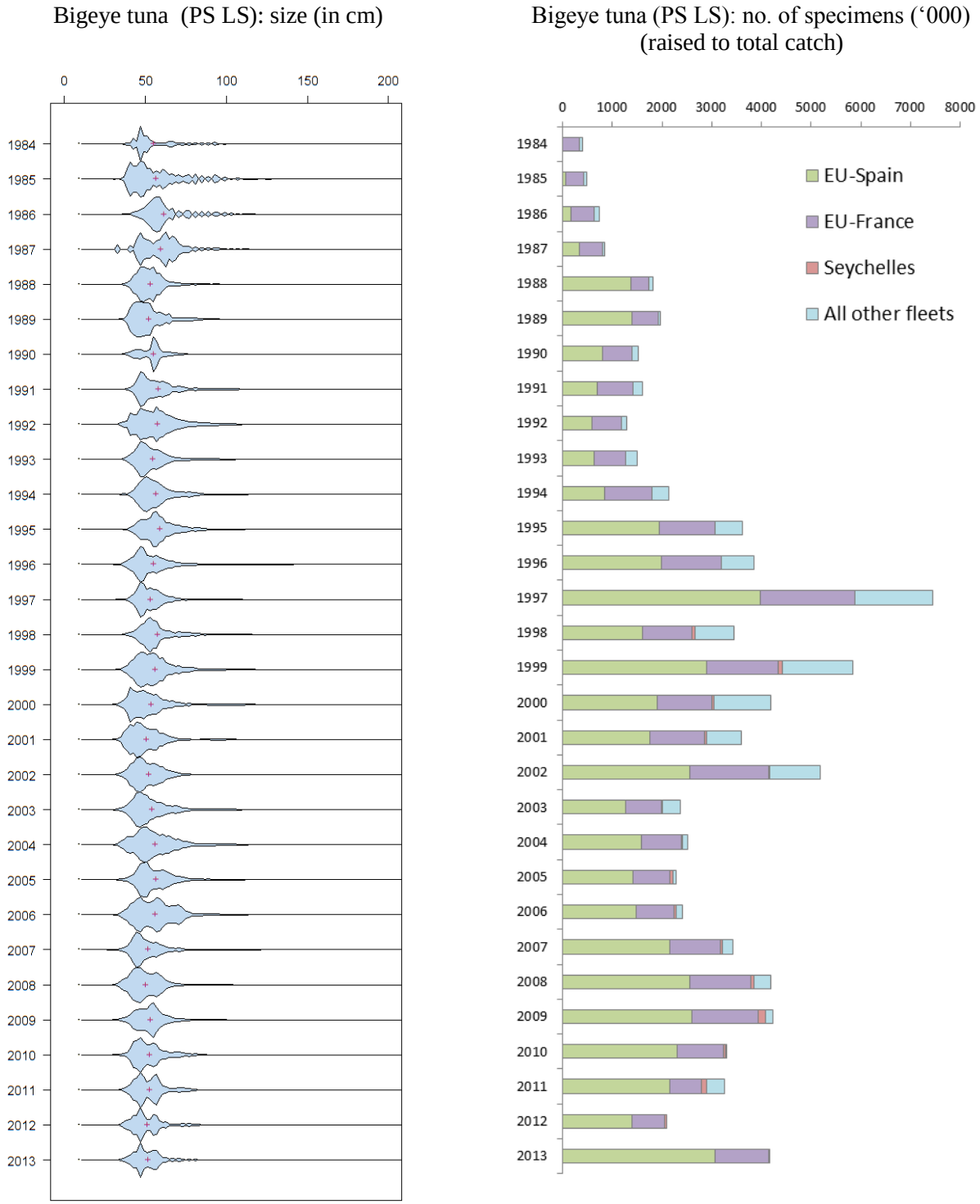
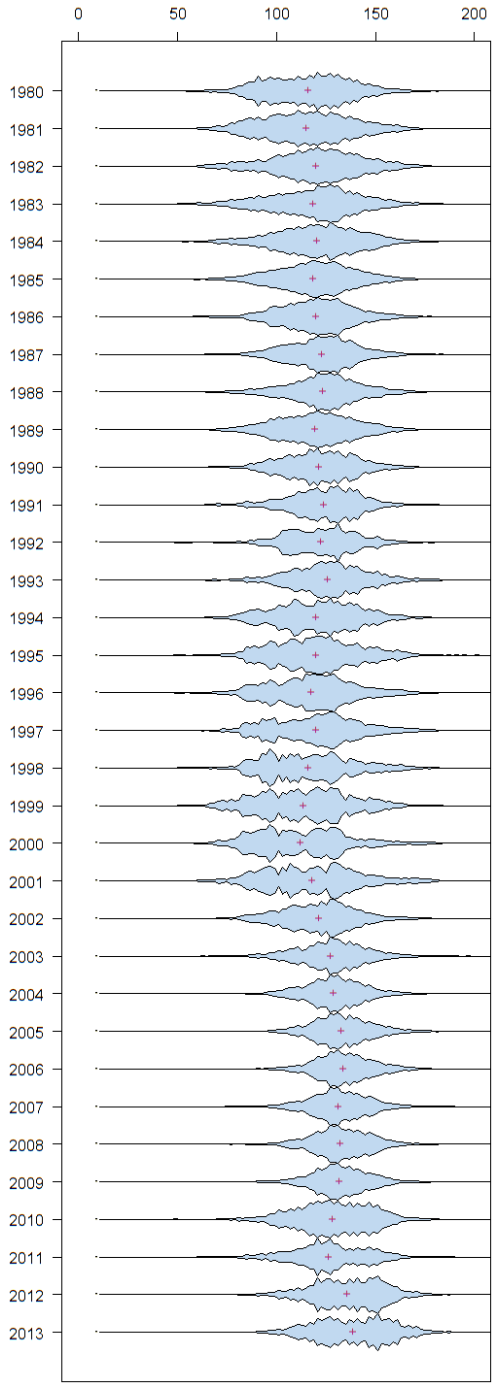


Fig. 9. Bigeye tuna (PS Associated school): **Left:** length frequency distributions for PS Associated school fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of bigeye tuna specimens sampled for lengths (raised to total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

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



Bigeye tuna (LL): no. of samples ('000)

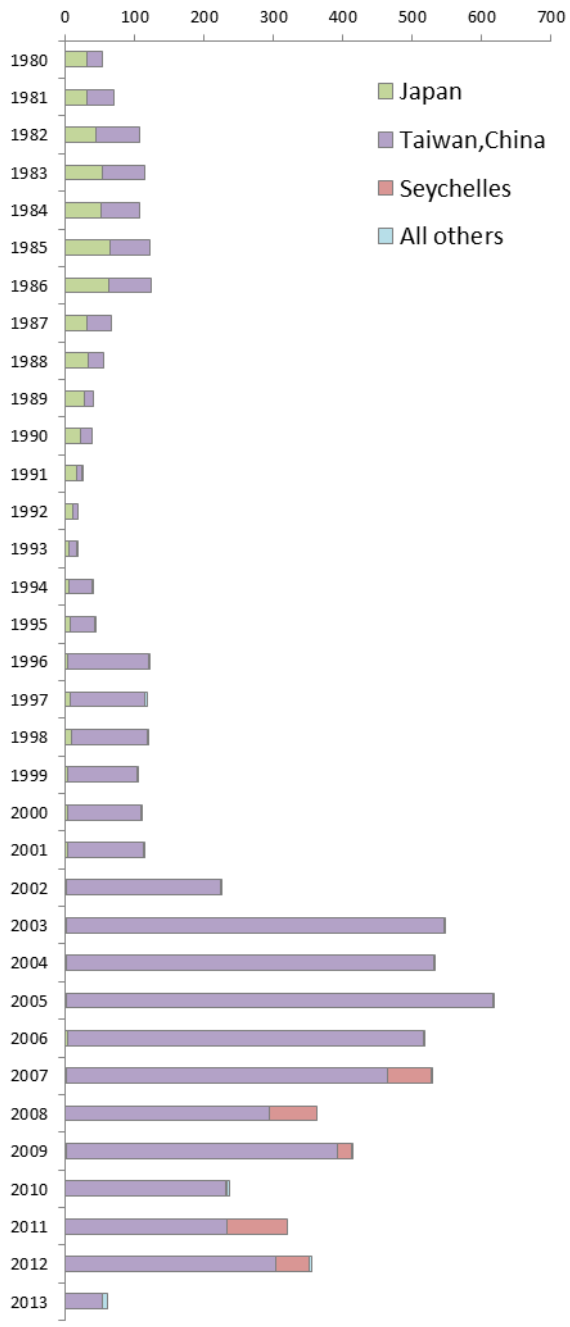


Fig. 10. Bigeye tuna (LL: longline): **Left:** length frequency distributions for longline fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of bigeye tuna specimens sampled for lengths, by fleet (longline only).

Bigeye tuna – Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2012 and 2013 are provided in Fig. 11, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2012 and 2013 are provided in Fig. 12. Total effort exerted by pole-and-line fleets in the Indian Ocean for the years 2011 and 2012 are providedin Fig 13. Effort data for 2013 has not yet been reported.

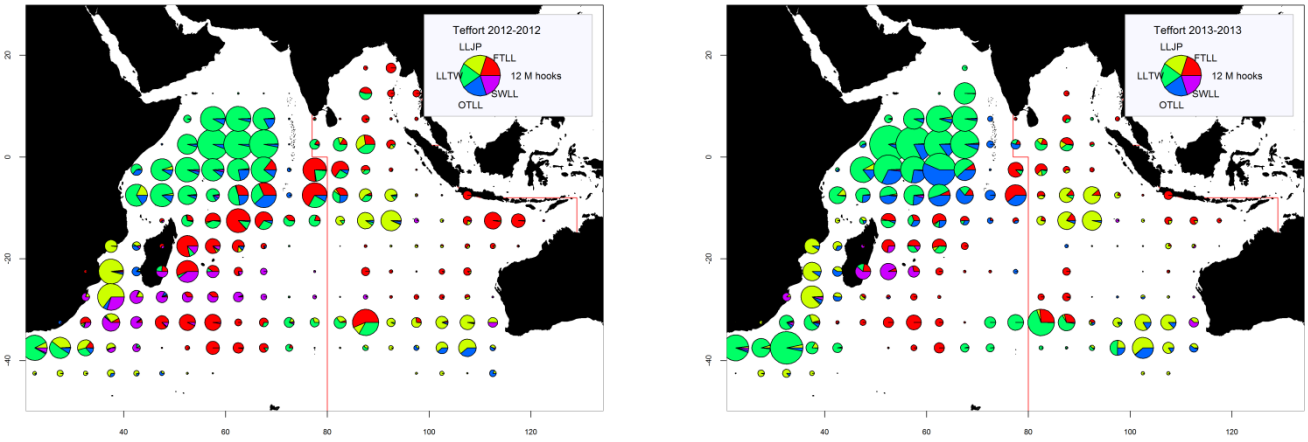


Fig. 11. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

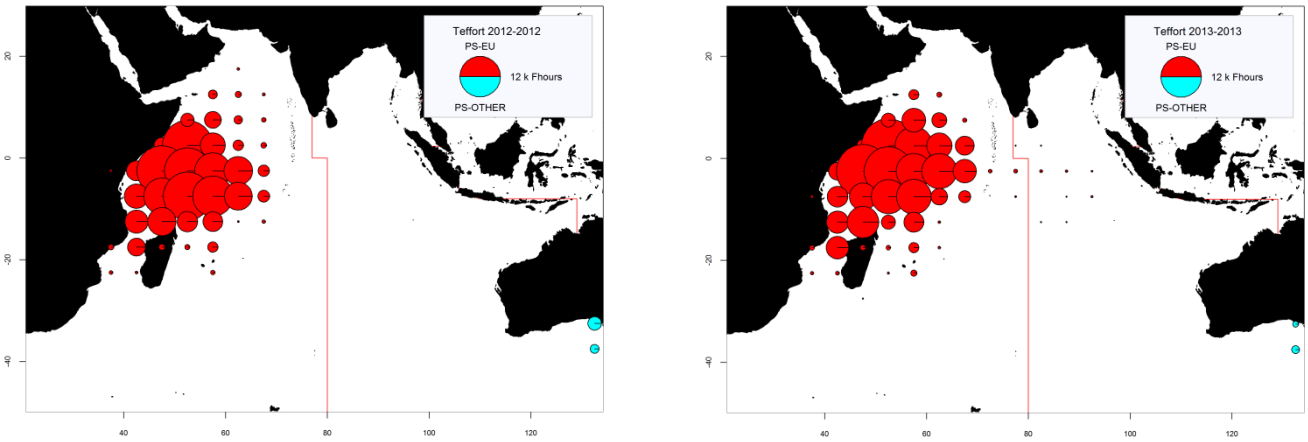


Fig. 12. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

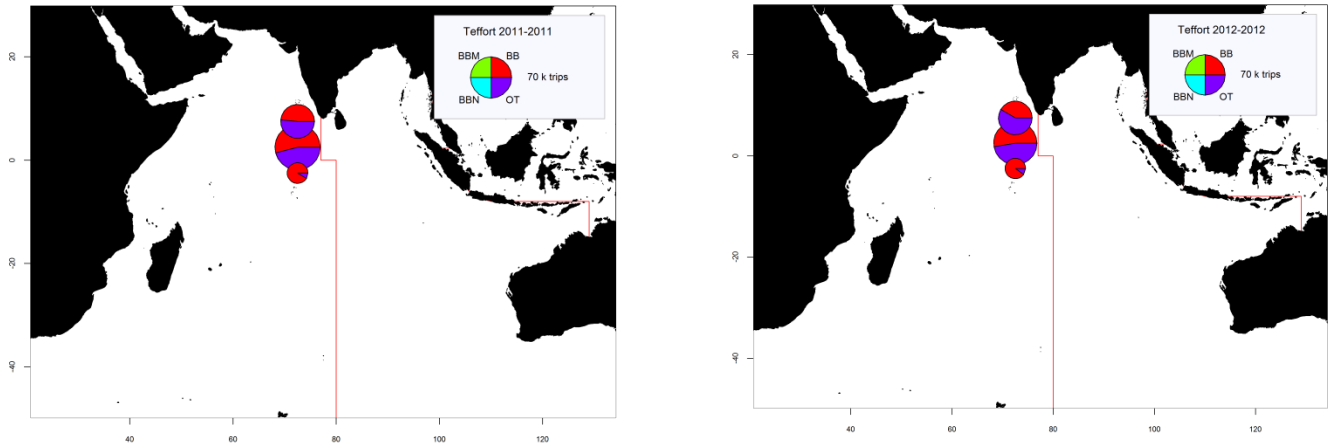


Fig. 13. Effort exerted by pole-and-line fleets in the Indian Ocean, in thousands (k) of trips (equivalent to fishing days), for the years 2011 (left) and 2012 (right) (Data as of September 2014). Note: Effort data for 2014 has not yet been reported. BBM (green): Pole-and-line (mechanized baitboats); BBN (blue): Pole-and-line (non-mechanized baitboats) BB (red): Pole-and-line (all types of baitboat, especially mechanized); OT (purple): Pole-and-line and other gears unidentified (effort not available by gear).
Note that the above maps were derived using the available catch-and-effort data in the IOTC database, which is limited to the number of baitboat calls (trips) by atoll by month for Maldivian baitboats for the period concerned. Note that some trips may be fully devoted to handlining, trolling, or other activities (data by gear type are not available since 2002). No data are available for the pole-and-line fisheries of India (Lakshadweep) and Indonesia.

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

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

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

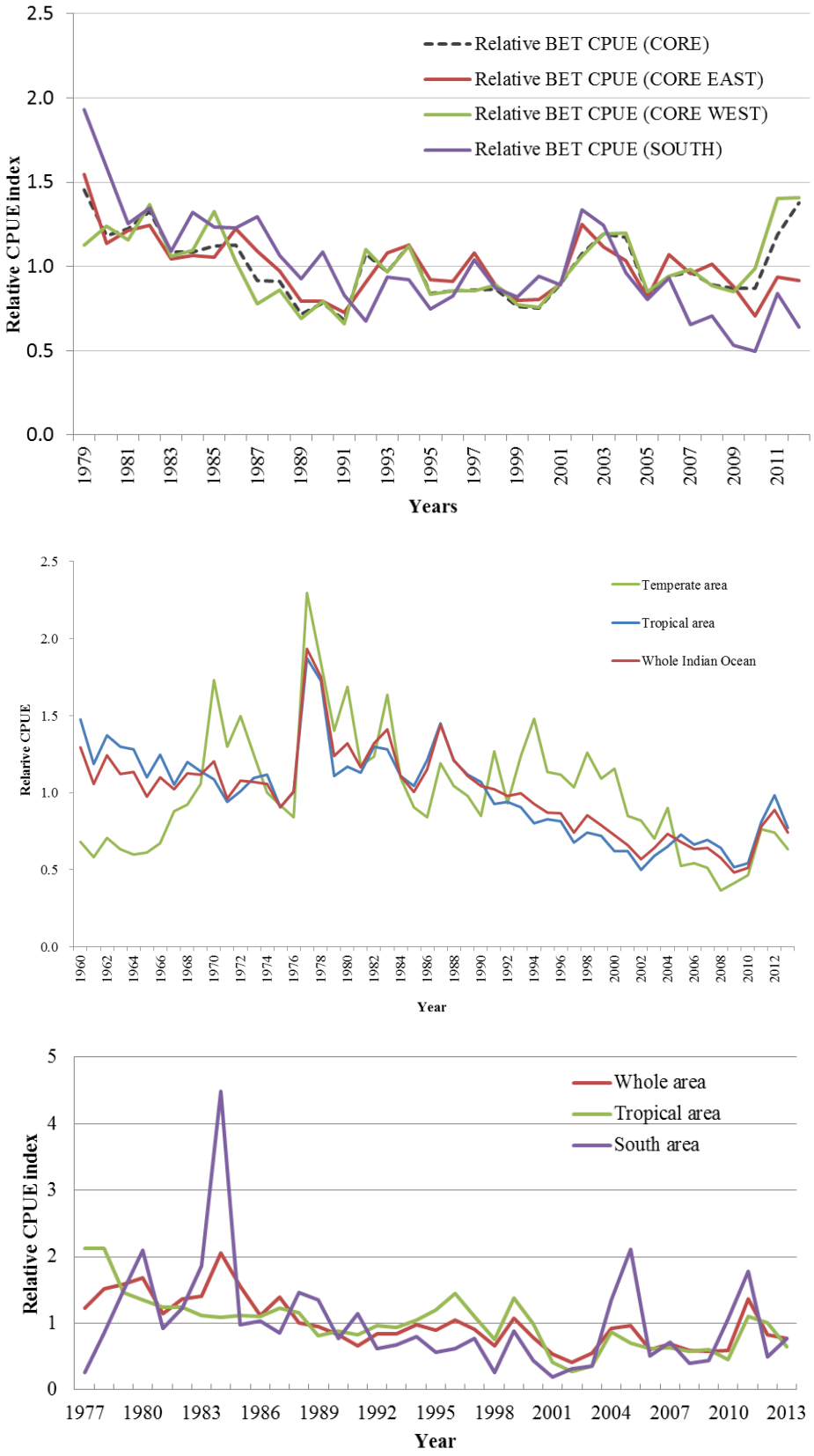


Fig. 14. Bigeye tuna: Standardised CPUE series for: top) Comparison of the standardised longline CPUE series (by area) for Taiwan,China. Series have been rescaled relative to their respective means from 1979–2012; middle) Comparison of the standardised longline CPUE series for Japan. Series have been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

Bigeye tuna: Tagging data

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

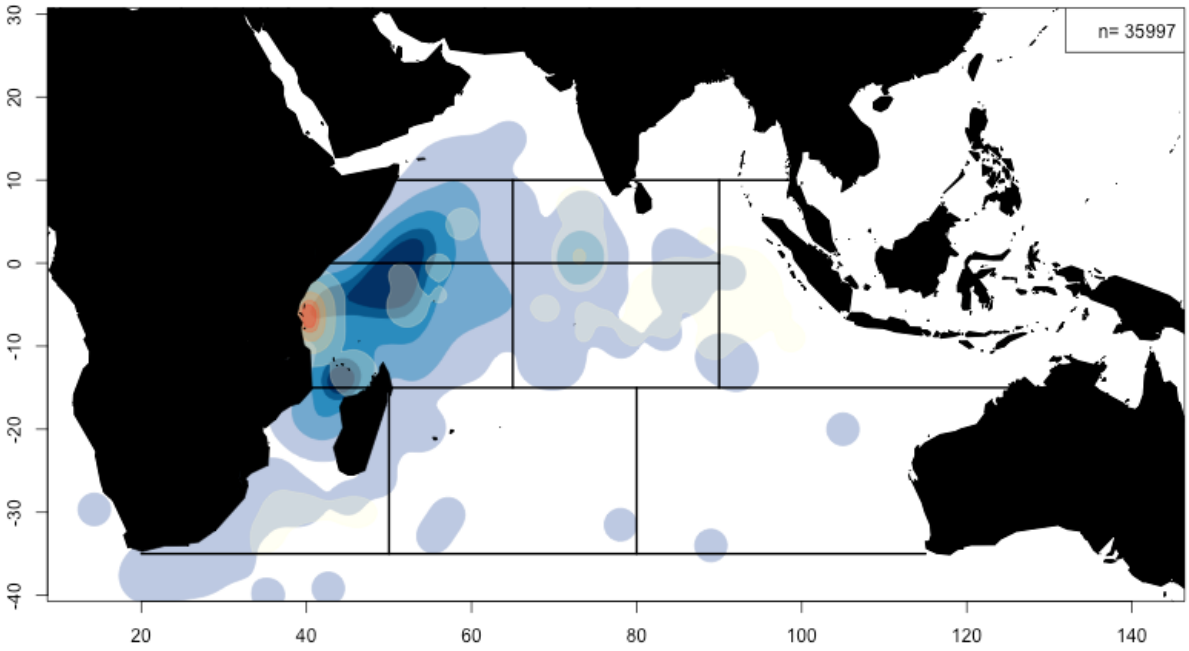


Fig. 15. Bigeye tuna: Densities of releases (in red) and recoveries (in blue). The black line represents the stock assessment areas. Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s. Data as of September 2012.

STOCK ASSESSMENT

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

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

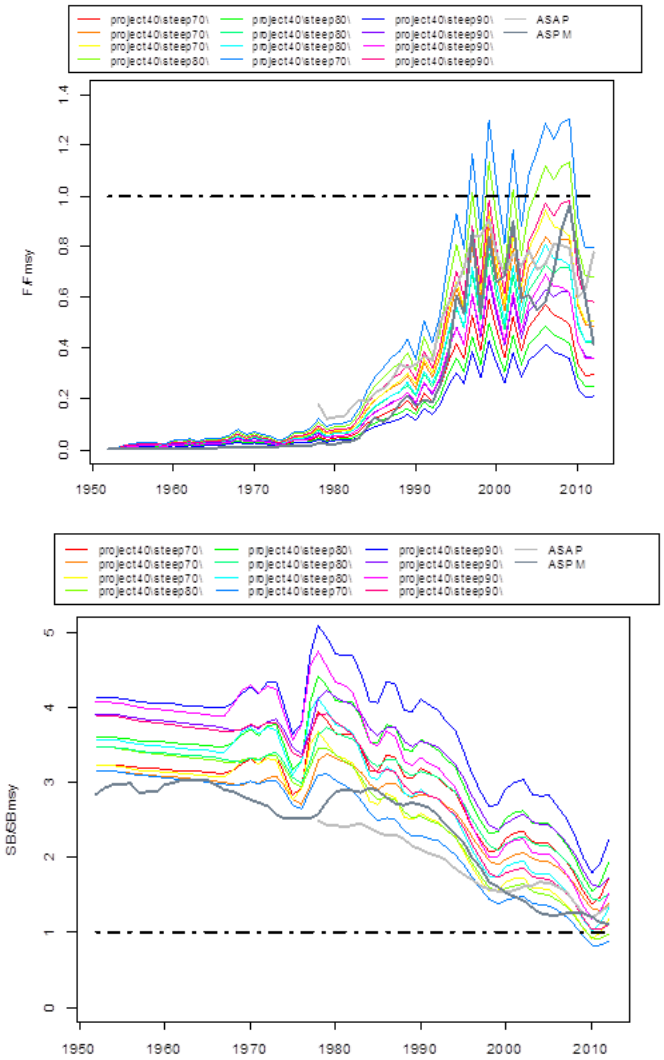


Fig. 16. Bigeye tuna: Ranges of F/F_{MSY} (top) and B/B_{MSY} (bottom) over time, indicating the range of uncertainty in stock assessment outcomes from the stock assessment models used in 2013 (SS3). ASAP and ASPM base cases are presented for comparative purposes.

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

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

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

LITERATURE CITED

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