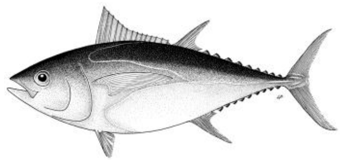
DRAFT : EXECUTIVE SUMMARY – BIGEYE TUNA (*THUNNUS OBESUS*)

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			2012 stock status determination
Indian Ocean	Catch in 2011: Average catch 2007–2011:	87,420 t 101,639 t		(green)
		SS3[3]	ASPM[4]	
	MSY (1000 t):	114 (95–183)	103t (87–119)	
	F_{curr}/F_{MSY}:	0.79 (0.50–1.22)	0.67 (0.48–0.86)	
	SB_{curr}/SB_{MSY} :	1.20 (0.88–1.68)	1.00 (0.77–1.24)	
	SB_{curr}/SB_0:	0.34 (0.26–0.40)	0.39	

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

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

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No new stock assessment was carried out in 2012. Revised stock status indicators (e.g. standardised CPUE series) do not show any substantial differences from those carried out in 2011 that would warrant a change in the overall stock status advice. Both of the stock assessments carried out in 2010 and 2011 indicate that the stock is above a biomass level that would produce MSY in the long term and that current fishing mortality is below the MSY-based reference level (i.e. $SB_{current}/SB_{MSY}$ > 1 and $F_{current}/F_{MSY}$ < 1) (Table 1 and Fig. 1). Current spawning stock biomass was estimated to be 34–40 % (Table 1) of the unfished levels. The central tendencies of the stock status results from the WPTT 2011 when using different values of steepness were similar to the central tendencies presented in 2010. Catches in 2011 (87,420 t) remain lower than the estimated MSY values from the 2010 and 2011 stock assessments (Table 1). The average catch over the previous five years (2007–2011; 101,639 t) also remains below the estimated MSY. On the weight of stock status evidence available, the bigeye tuna stock is therefore not overfished, and is not subject to overfishing.

Outlook. The recent declines in longline effort, 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 (Combined SS3 and ASPM) illustrates the levels of risk associated with varying catch levels over time and could be used to inform future management actions (Table 2). Based on the ASPM projections from the 2011 assessment, with steepness 0.5 value for illustration, there is relatively a low risk of exceeding MSY-based reference points by 2020 both when considering current catches of 87,420 t (approximately 11% risk of $SB<SB_{MSY}$) or even if catches increase to around 100,000 t (<41% risk that $B_{2020}<B_{MSY}$ and $F_{2020}>F_{MSY}$).

Moreover, the SS3 projections from the 2010 assessment show that there is a low risk of exceeding MSY-based reference points by 2019 if catches are maintained at the lower range of MSY levels or at the catch level of 102,000 t (< 30% risk that $B_{2019}<B_{MSY}$ and < 25% risk that F_{2019}>FMSY) (Table 1). The following key points should be noted:

- The Maximum Sustainable Yield estimate for the Indian Ocean ranges between 102,000 and 114,000 t (range expressed as the median value for 2010 SS3 and steepness value of 0.5 for 2011 ASPM for illustrative purposes (see Table 1 for further description)). Annual catches of bigeye tuna should not exceed the lower range of this estimate which corresponds to the 2009 catches and last year's management advice.

- If the recent declines in effort continue, and catch remains substantially below the estimated MSY of 102,000–114 000 t, then immediate management measures are not required. However, continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in assessments.
- provisional reference points: Noting that the Commission in 2012 agreed to Recommendation 12/14 *on interim target and limit reference points*, 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).

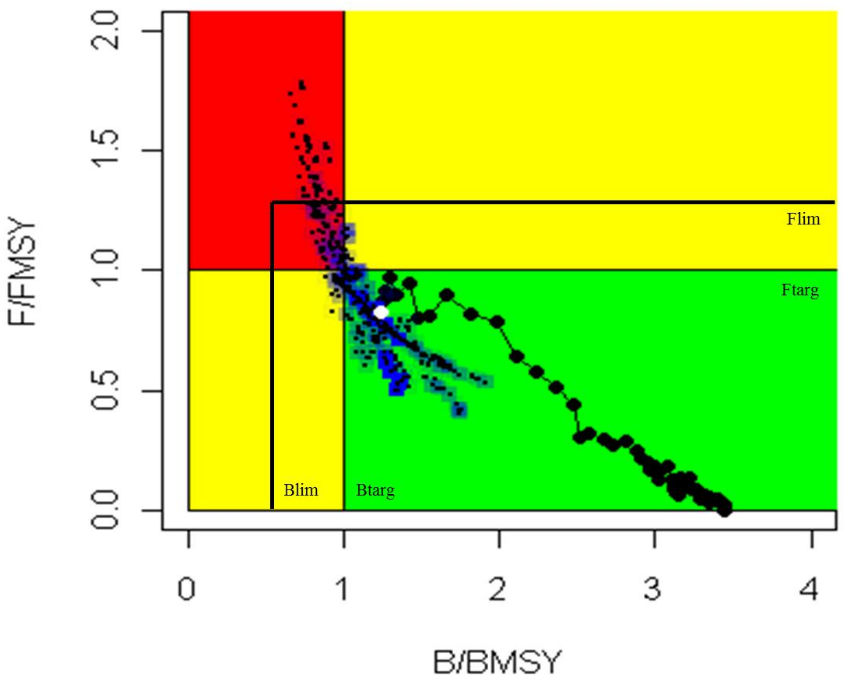


Fig. 1. Bigeye tuna: SS3 Aggregated Indian Ocean assessment Kobe plot. Black circles represent the time series of annual median values from the weighted stock status grid (white circle is 2009). Blue squares indicate the MPD estimates for 2009 corresponding to each individual grid C model, with colour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

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

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

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

SUPPORTING INFORMATION

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

CONSERVATION AND MANAGEMENT MEASURES

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

- Resolution 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*
- Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 12/07 *concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*
- Recommendation 10/13 *On the implementation of a ban on discards of skipjack tuna, yellowfin tuna, bigeye tuna, and non targeted species caught by purse seiners*
- Resolution 12/13 *for the conservation and management of tropical tunas stocks in the IOTC area of competence*.

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 (59% in 2011) and purse seine (26% in 2011) fisheries, with the remaining 15% of the catch is taken by other fisheries (Table 4; Fig. 2). However, in recent years the catches of bigeye tuna by gillnet fisheries are likely to be higher, due to the major changes experienced in some of these fleets, 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 are high.

Total annual catches have increased steadily since the start of the fishery, reaching the 100,000 t level in 1993 and peaking at 150,000 t in 1999 (Fig. 2). Catches dropped since then to values between 120,000–140,000 t (2000–07), further dropping in recent years, to values under 90,000 t in recent years (2010–11). The SC believes that the recent drop in catches could be related, at least in part, with the expansion of piracy in the northwest Indian Ocean, which has led to a marked drop in the levels of longline effort in the core fishing area of these species.

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 (2002–2011), in tonnes. Data as of September 2012. Catches by decade represent the average annual catch, noting that some gears were not used for all years (refer to Fig. 2)

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LL	6,488	21,970	30,462	45,940	88,106	93,721	109,895	104,613	113,940	94,094	90,668	93,493	69,947	66,761	46,371	51,587
FS	0	0	0	2,067	4,808	6,042	4,099	7,172	3,658	8,501	6,406	5,670	9,648	5,317	3,827	6,172
LS	0	0	0	4,234	18,224	20,147	24,944	15,662	18,749	17,568	18,249	18,066	19,831	24,773	18,440	16,636
OT	146	262	567	1,449	2,086	4,560	2,236	2,306	2,257	2,618	5,467	5,912	8,620	11,868	12,228	13,024
Total	6,634	22,231	31,030	53,690	113,225	124,470	141,174	129,753	138,604	122,782	120,791	123,141	108,047	108,719	80,866	87,420

Longline (LL); Purse seine free-school (FS); Purse seine associated school (LS); Other gears nei (OT)

Bigeye tuna have been caught by industrial longline fleets since the early 1950's, but before 1970 they only represented an incidental catch (Fig. 3). 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 becomes a primary target species for the main industrial longline fleets. Total catch 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). Bigeye tuna catches in recent years have been low representing less than half the catches of bigeye tuna recorded before the onset of piracy in the Indian Ocean. 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% of the total longline catch in the Indian Ocean (Fig. 3). However, the catches of longliners from Taiwan,China have decreased in recent years, with current catches of bigeye tuna (≈20,000 t) three times lower than those in 2003. Large bigeye tuna (averaging just above 40 kg) are primarily caught by longlines, in particular deep longlines.

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 (≈40,000 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) whereas longliners catch much larger and heavier fish; and 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).

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 (Fig. 3). 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 (Fig. 3, Indonesia). However, the 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.

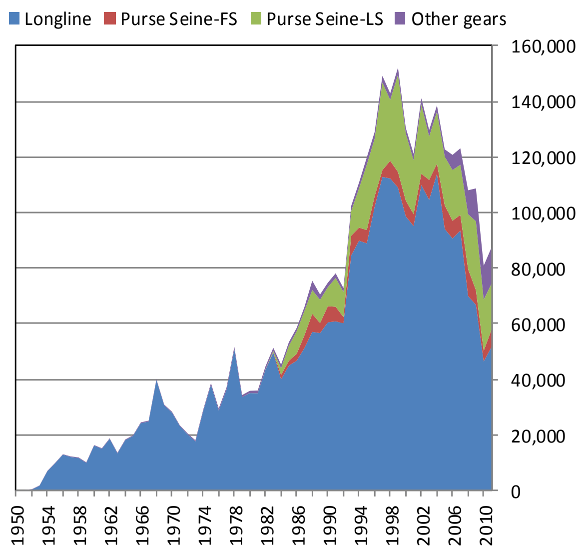


Fig. 2. Bigeye tuna: Annual catches of bigeye tuna by gear (1950–2011) (Data as of September 2012)

Fig. 3. Bigeye tuna: Annual catches of bigeye tuna by fleet (1950–2011) (Data as of September 2012)

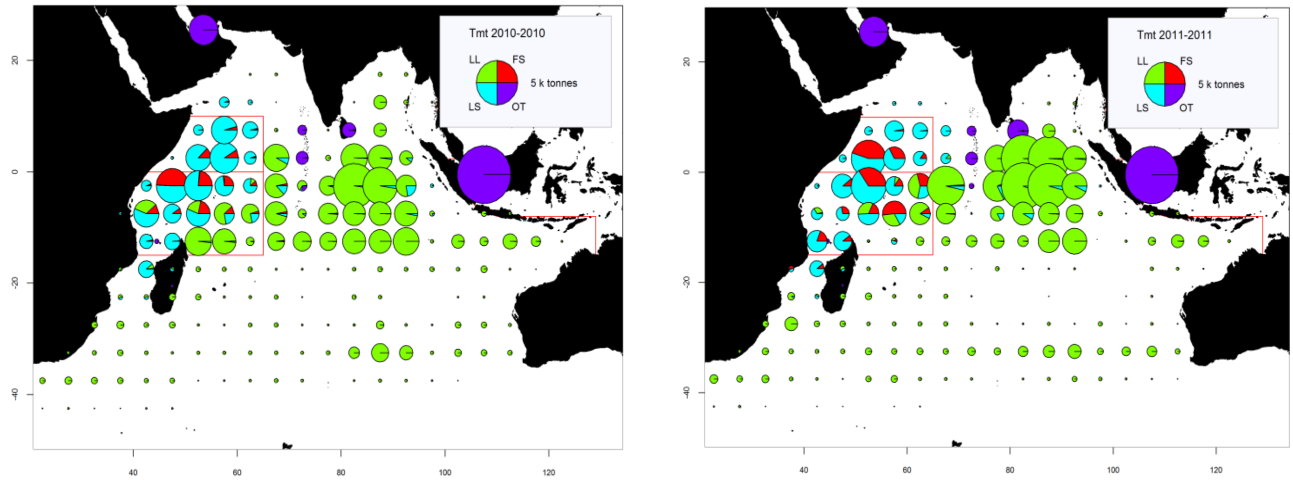


Fig. 4. Bigeye tuna: Time-area catches (total combined in tonnes) of bigeye tuna estimated for 2010 (left) and 2011 (right) by gear. Longline (LL), Purse seine free-schools (FS), Purse seine associated-schools (LS), and other fleets (OT), including pole-and-line, drifting gillnets, and various coastal fisheries (Data as of September 2012). 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 – uncertainty of catches

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

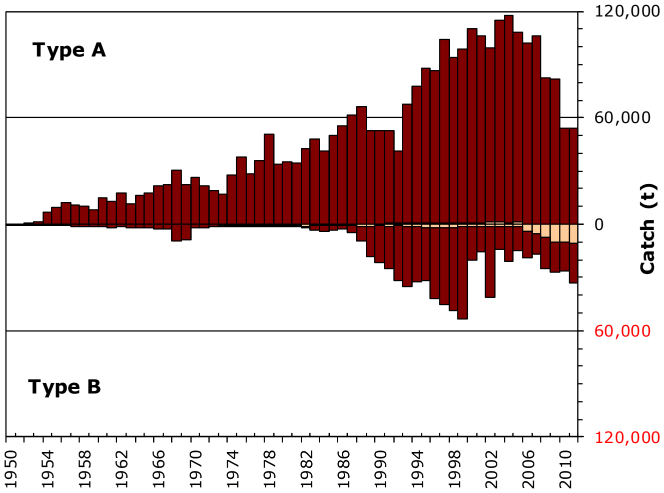


Fig. 5. Bigeye tuna: Uncertainty of annual catch estimates for bigeye tuna (Data as of September 2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

Discard levels: 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 not been significant changes to the catches of bigeye tuna since the WPTT in 2011.

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, 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.
- No data available for the driftnet fisheries of Iran and Pakistan and the gillnet/longline fishery of Sri Lanka, especially in recent years.

Bigeye tuna: Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2010 and 2011 are provided in Fig. 6, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2010 and 2011 are provided in Fig. 7. The total number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2009 and 2010 are provided in Fig. 8.

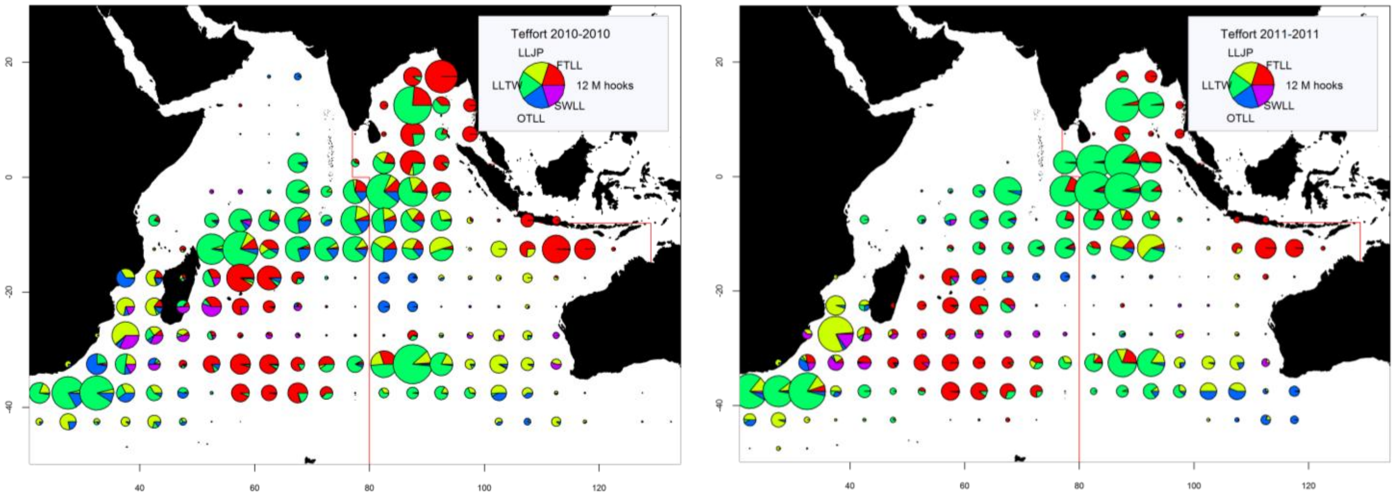


Fig. 6. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

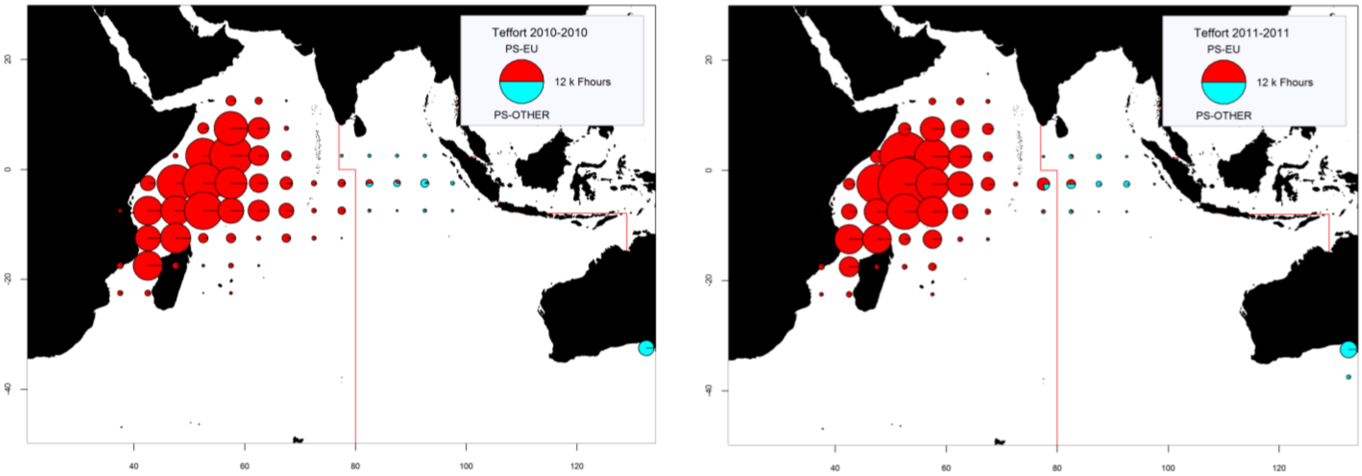


Fig. 7. Number of hours of fishing(Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

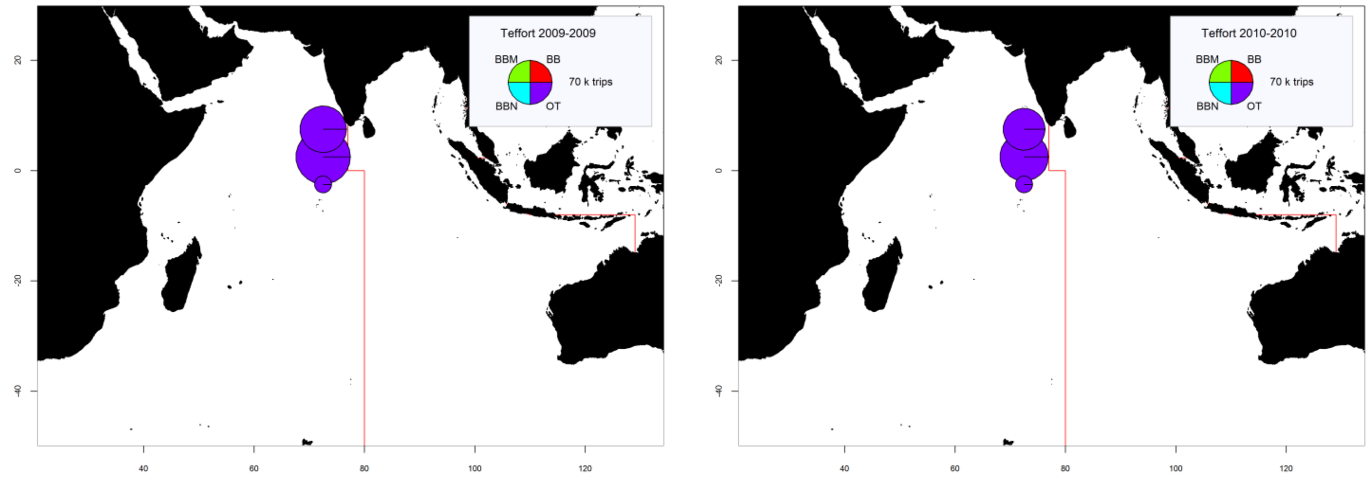


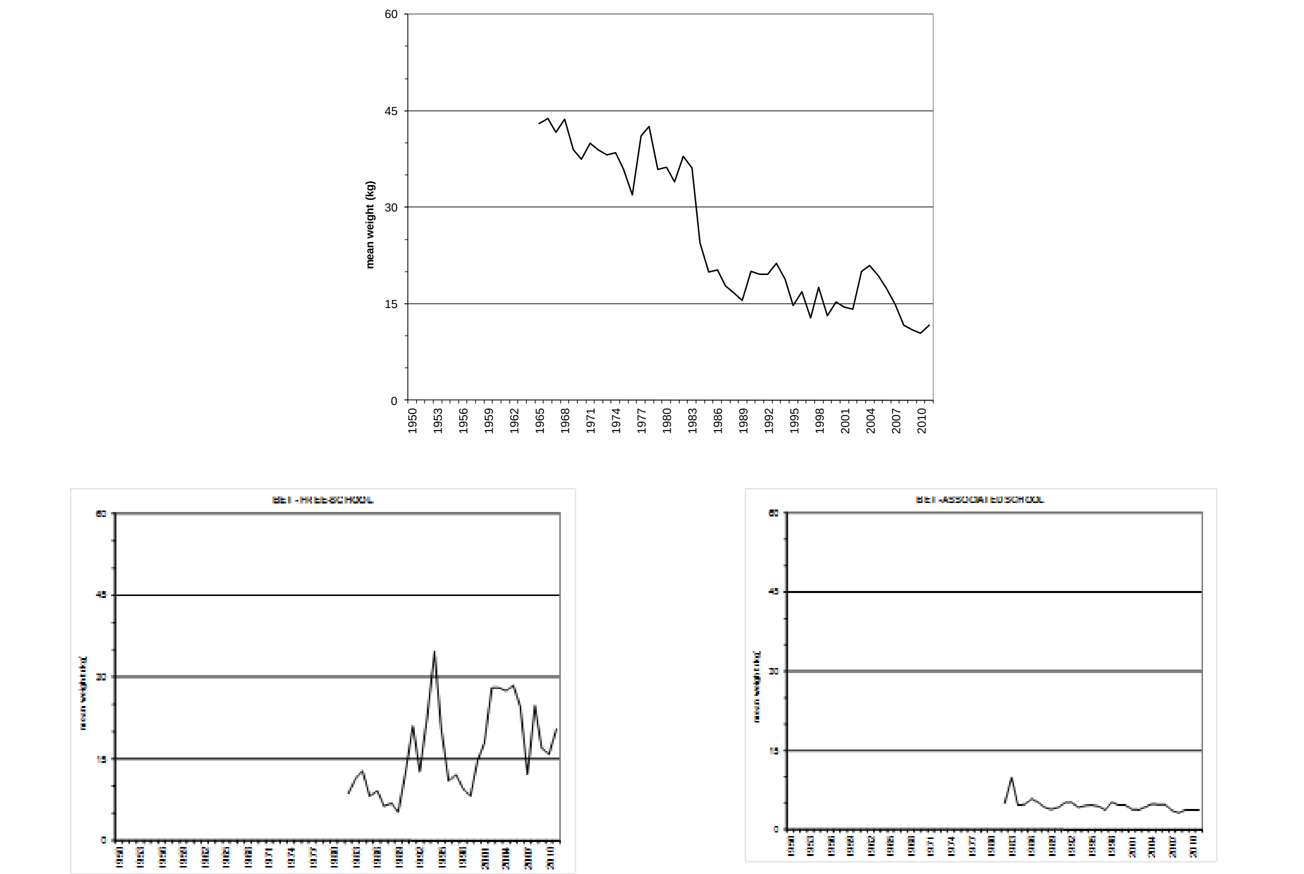
Fig. 8. Number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2009 (left) and 2010 (right) (Data as of September 2012)
BBN (blue): Baitboat non-mechanized; BBM (Green): Baitboat mechanized; BB (Red): Baitboat unspecified; UN (Purple): Unclassified gears
Note that the above maps were derived using the available catch-and-effort data in the IOTC database, which is limited to the number of baitboat calls (trips) by atoll by month for Maldivian baitboats for the period concerned. Note that some trips may be fully devoted to handlining, trolling, or other activities (data by gear type are not available since 2002). No data are available for the pole-and-line fisheries of India (Lakshadweep) and Indonesia.

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

Trends in average weight: Can be assessed for several industrial fisheries although they are incomplete or of poor quality for most fisheries before the mid-1980s and for some fleets in recent years (e.g. Japan longline) (Fig. 9).

Catch-at-Size table: 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, Iran, Sri Lanka).



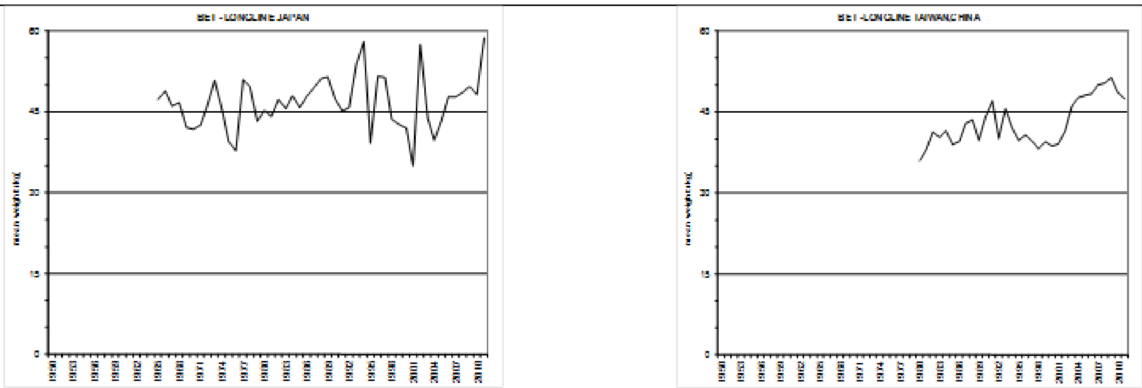


Fig. 9. Bigeye tuna: Changes in average weight (kg) of bigeye tuna from 1950 to 2010 – all fisheries combined (top) and by main fleet (Data as of September 2012)

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

The CPUE series presented at the WPTT14 meeting in 2012 are listed below and shown in Fig. 10, noting that the Japanese series from the tropical areas and the Indian Ocean as a whole, showed very similar trends and are therefore not shown separately:

- Japan data (1960–2011): Series 2 from document IOTC–2012–WPTT14–26. Whole Indian Ocean (Fig. 10).
- Taiwan,China data (1979–2011): Series from document IOTC–2012–WPTT14–27 (Fig. 10).
- Rep. of Korea data (1978–2011): Series from document IOTC–2012–WPTT14–25 (Fig. 10).
- Japan data (1960–2011): Series 1 from document IOTC–2012–WPTT14–26. Tropical area of Indian Ocean.

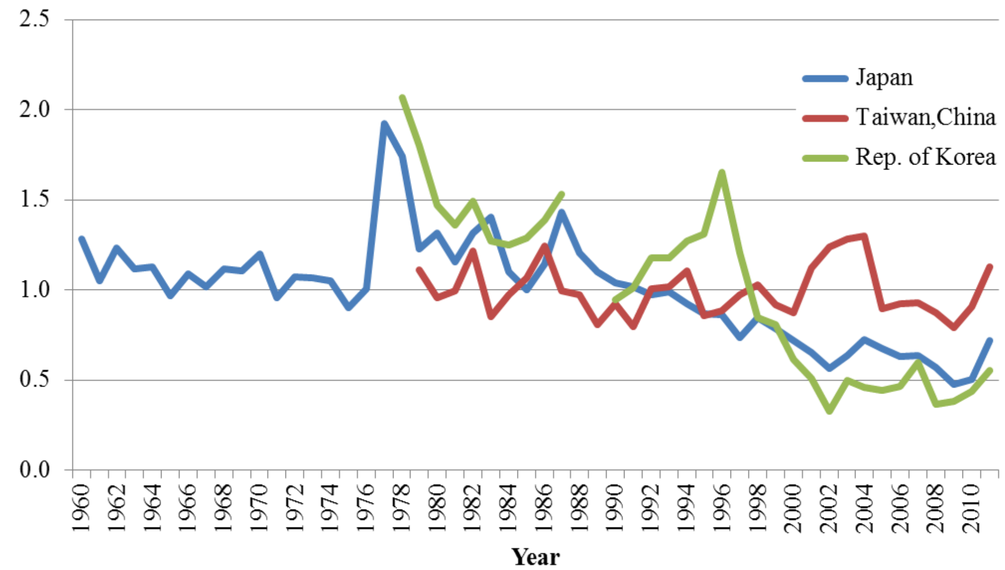


Fig. 10. Comparison of the three standardised CPUE series for Indian Ocean bigeye tuna. Series have been rescaled relative to their respective means from 1960–2011

The CPUE series for the Taiwan,China longline fleet conflicts with the declining trends of the Japanese and Rep. of Korea series, except for the most recent years. The recent decline in the Taiwan,China CPUE series and the divergence between nominal and standardised series was thought to be due to changes in targeting and in the spatial distribution of effort, likely related to piracy activities in the northwest Indian Ocean.

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. 11). The remaining were tagged during small-scale projects, and by other institutions with the support of the IOTC Secretariat, in the Maldives, Indian, and in the south west and the eastern Indian Ocean. To date, 5,740, (15.9%), have been recovered and reported to the IOTC Secretariat. These tags were mainly reported from the purse seine fleets operating in the Indian Ocean (91.5%), while 4.9% were recovered from longline vessels.

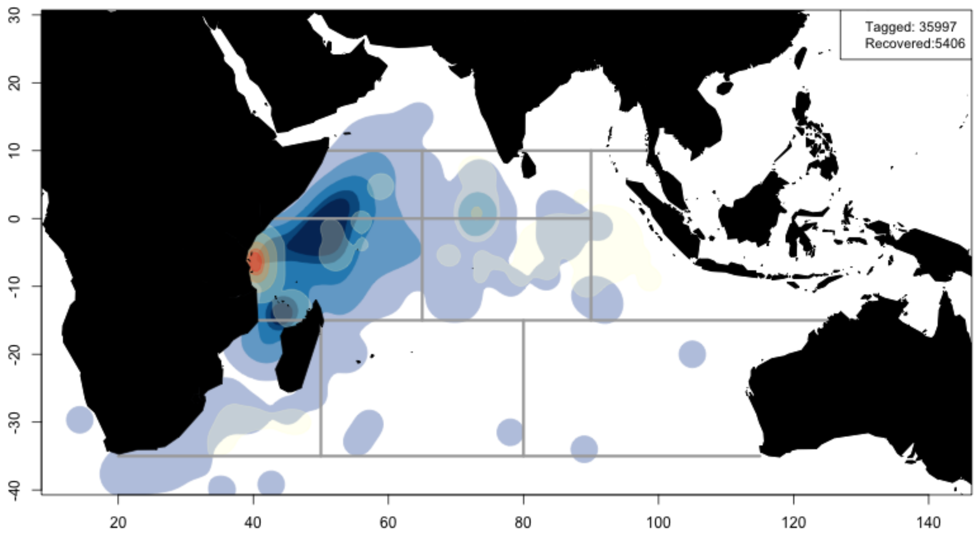


Fig. 11. Bigeye tuna: Densities of releases (in red) and recoveries (in blue). Data as of September 2012

STOCK ASSESSMENT

No stock assessment was carried out in 2012. The most up to date CPUE trends do not give a pessimistic view of the stock which would require a more thorough stock assessment in 2012. Management advice for bigeye tuna is based on the 2010 SS3 stock assessment and various steepness scenarios of the current 2011 ASPM stock assessment results. For last year's SS3 assessment, the data did not seem to be sufficiently informative to justify the selection of any individual model and the results were combined on the basis of a model weighting scheme that was proposed to, and agreed by, the WPTT in 2010.

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

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

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

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

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

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

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

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

LITERATURE CITED

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