DRAFT: EXECUTIVE SUMMARY: SKIPJACK TUNA (*KATSUWONUS PELAMIS*)
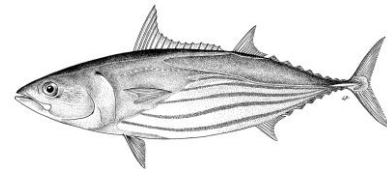
Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
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Status of the Indian Ocean Skipjack Tuna (SKJ: *Katsuwonus pelamis*) Resource

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

Area[1]	Indicators		2012 stock status determination
Indian Ocean	Catch 2011:	398,240 t	
	Average catch 2007–2011:	435,527 t	
	MSY (1000 t):	478 t (359–598 t)	
	F_{2011}/F_{MSY}:	0.80 (0.68–0.92)	
	SB_{2011}/SB_{MSY}:	1.20 (1.01–1.40)	
	SB_{2011}/SB_0:	0.45 (0.25–0.65)	

[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($C_{year}/MSY > 1$)		
Stock not subject to overfishing ($C_{year}/MSY \leq 1$)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. The results suggest that the stock is not overfished ($B > B_{MSY}$) and that overfishing is not occurring ($C < MSY$ and $F < F_{MSY}$) (Table 1 and Fig. 1). Spawning stock biomass was estimated to have declined by approximately 45 % in 2011 from unfished levels (Table 1).

Outlook. The recent declines in catches are thought to be caused by a recent decrease in purse seine effort as well as due to a decline in CPUE of large skipjack tuna in the surface fisheries. 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_{2011}/SB_{MSY} based on all runs examined. The WPTT does not fully understand the recent declines of pole-and-line catch and CPUE, which may be due to the combined effects of the fishery and environmental factors affecting recruitment or catchability. Catches in 2010 (428,000 t) and 2011 (398,240 t) as well as the average level of catches of 2007–2011 (435,527 t) are below MSY targets though may have exceeded them in 2005 and 2006.

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 2011, there is a low risk of exceeding MSY-based reference points by 2020 if catches are maintained at the current levels (< 20 % risk that $B_{2019} < B_{MSY}$ and 30 % risk that $C_{2019} > MSY$ as proxy of $F > F_{MSY}$) and even if catches are maintained below the 2005–2010 average (500,000 t) based on the analysis done in 2011 (the 2012 reference point indicates that 500,000 t levels maybe too high for the Indian Ocean skipjack tunastock). The following key points should be noted:

- The mean estimates of the Maximum Sustainable Yield for the skipjack tuna Indian Ocean stock is 478,190 t (Table 1) and considering the average catch level from 2007–2011 was 435,527 t, the stock appears to be in no immediate threat of breaching target and limit reference points.
- If the recent declines in effort continue, and catch remains substantially below the estimated MSY, then urgent management measures are not required. However, recent trends in some fisheries, such as Maldivian pole-and-line, suggest that the situation of the stock should be closely monitored.
- The Kobe strategy matrix (Table 2: from the 2011 assessment) 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 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).

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).
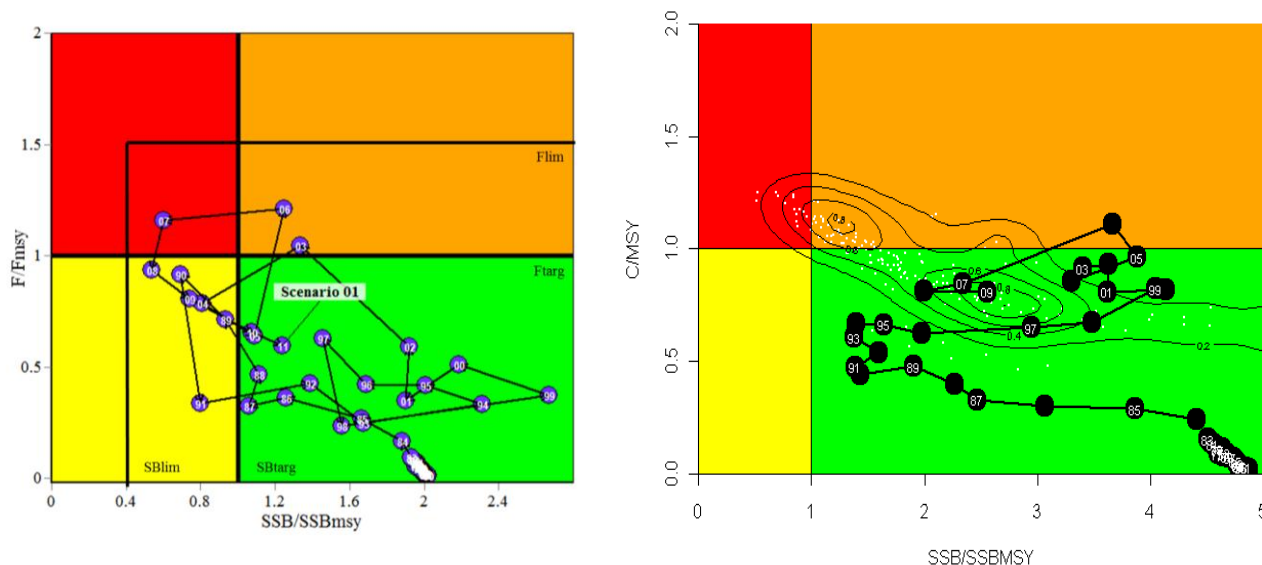

Fig. 1. Skipjack tuna: 2012 SS3 Indian Ocean assessment Kobe plot (left; mean values of the weighted models used in the analysis in 2012). Circles indicate the trajectory of the point estimates for the SB ratio and F/FMSY ratio for each year 1950–2011. 2011 SS3 Aggregated Indian Ocean assessment Kobe plot (right). Black circles indicate the trajectory of the weighted median of point estimates for the SB ratio and C/MSY ratio for each year 1950–2009. Probability distribution contours are provided only as a rough visual guide of the uncertainty (e.g. the multiple modes are an artifact of the coarse grid of assumption options). Due to numerical problems in the F_{MSY} calculations for this population, the proxy reference point C/MSY is reported instead of F/F_{MSY}, which should be interpreted with caution for the reasons given under Table 1 above

TABLE 2. Skipjack tuna: 2011 SS3 Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Weighted probability (percentage) of violating the MSY-based reference points for five constant catch projections (2009 catch level, ± 20% and ± 40%) projected for 3 and 10 years. Note: from the 2011 stock assessment using catch estimates at that time

Reference point and projection timeframe	Alternative catch projections (relative to 2009) and weighted probability (%) scenarios that violate reference point				
	60% (274,000 t)	80% (365,000 t)	100% (456,000 t)	120% (547,000 t)	140% (638,000 t)
$SB_{2013} < SB_{MSY}$	<1	5	5	10	18
$C_{2013} > MSY$ (proxy for F_{2009}/F_{MSY})	<1	<1	31	45	72
$SB_{2020} < SB_{MSY}$	<1	5	19	31	56
$C_{2020} > MSY$ (proxy for F_{2009}/F_{MSY})	<1	<1	31	45	72

SUPPORTING INFORMATION

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

CONSERVATION AND MANAGEMENT MEASURES

Skipjack tuna (*Katsuwonus pelamis*) in the Indian Ocean is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 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

General

Skipjack tuna (*Katsuwonus pelamis*) life history characteristics, including a low size and age at maturity, short life and high productivity/fecundity, make it resilient and not easily prone to overfishing. Table 3 outlines some of the key life history traits of skipjack tuna.

TABLE 3. Skipjack tuna: Biology of Indian Ocean skipjack tuna (*Katsuwonus pelamis*)

Parameter	Description
Range and stock structure	Cosmopolitan species found in the tropical and subtropical waters of the Indian, Pacific and Atlantic Oceans. It generally forms large schools, often in association with other tunas of similar size such as juveniles of yellowfin tuna and bigeye tuna. The tag recoveries from the RTTP-IO provide evidence of rapid, large scale movements of skipjack tuna in the Indian Ocean, thus supporting the current assumption of a single stock for the Indian Ocean. Skipjack recoveries indicate that the species is highly mobile, and covers large distances. The average distance between skipjack tagging and recovery positions is estimated at 640 nautical miles. Skipjack tuna in the Indian Ocean are considered a single stock for assessment purposes.
Longevity	7 years
Maturity (50%)	Age: females and males <2 years. Size: females and males 41–43 cm. Unlike in *Thunnus* species, sex ratio does not appear to vary with size. Most of skipjack tuna taken by fisheries in the Indian Ocean have already reproduced.
Spawning season	High fecundity. Spawns opportunistically throughout the year in the whole inter-equatorial Indian Ocean (north of 20°S, with surface temperature greater than 24°C) when conditions are favourable.
Size (length and weight)	Maximum length: 110 cm FL; Maximum weight: 35.5 kg. The average weight of skipjack tuna caught in the Indian Ocean is around 3.0 kg for purse seine, 2.8 kg for the Maldivian baitboats and 4–5 kg for the gillnet. For all fisheries combined, it fluctuates between 3.0–3.5 kg; this is larger than in the Atlantic, but smaller than in the Pacific. It was noted that the mean weight for purse seine catch exhibited a strong decrease since 2006 (3.1 kg) until 2009 (2.4 kg), for both free (3.8 kg to 2.4 kg) and log schools (3.0 kg to 2.4 kg).

Sources: Collette & Nauen 1983, Froese & Pauly 2009, Grande et al. 2010, Dortel et al. 2012, Eveson et al. 2012
NOAA http://www.nmfs.noaa.gov/fishwatch/species/atl_skipjack.htm 14/12/2011

Skipjack tuna: Fisheries and catch trends

Catches of skipjack increased slowly from the 1950s, reaching around 50,000 t during the mid-1970s, mainly due to the activities of fleets using pole-and-lines and gillnets (Table 4; Fig. 2). The catches increased rapidly with the arrival of the purse seiners in the early 1980s, and skipjack became one of the most important commercial tuna species in the Indian Ocean. Annual catches peaked at over 600,000 t in 2006 (Fig. 2). Though preliminary, the catch levels estimated for 2011, at around 400,000 t, represent the lowest catches recorded since 1998.

The increase in skipjack tuna catches by purse seiners (Table 4; Fig. 3) is due to the development of a fishery in association with Fish Aggregating Devices (FADs). In recent years, 85% of the skipjack tuna caught by purse seine

vessels is taken from around FADs (Table 4; Fig. 2). Catches by purse seiners increased steadily since 1984 with the highest catches recorded in 2002 and 2006 (>240,000 t). The catches 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. In 2007 purse seine catches declined by around 100,000 t, from those taken in 2006. The constant increase in catches and catch rates of purse seiners until 2006 are believed to be associated with increases in fishing power and in the number of FADs (and the technology associated with them) used in the fishery. The sharp decline in purse seine catches since 2007coincided with a similar decline in the catches by Maldivian baitboats.

Table 4. Skipjack tuna: Best scientific estimates of the catches of skipjack tuna (*Katsuwonus pelamis*) by gear and main fleets [or type of fishery] by decade (1950–2009) and year (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
BB	9,497	13,368	22,797	40,538	77,729	111,118	124,300	116,672	114,567	140,346	147,391	106,509	98,819	77,555	69,032	69,032
FS				1,626	1,602	897	22,801	30,992	18,565	43,123	34,954	24,198	16,277	10,458	8,853	8,906
LS				3,776	8,147	13,385	215,781	180,556	137,882	168,012	211,940	120,925	128,596	148,717	144,139	123,012
OT	6,596	16,809	30,752	52,490	101,765	185,519	137,693	172,988	204,444	195,670	223,817	211,689	205,587	208,144	199,899	197,291
Total	**16,093**	**30,177**	**53,549**	**98,430**	**189,244**	**310,918**	**500,575**	**501,209**	**475,457**	**547,151**	**618,102**	**463,321**	**449,278**	**444,874**	**421,923**	**398,240**

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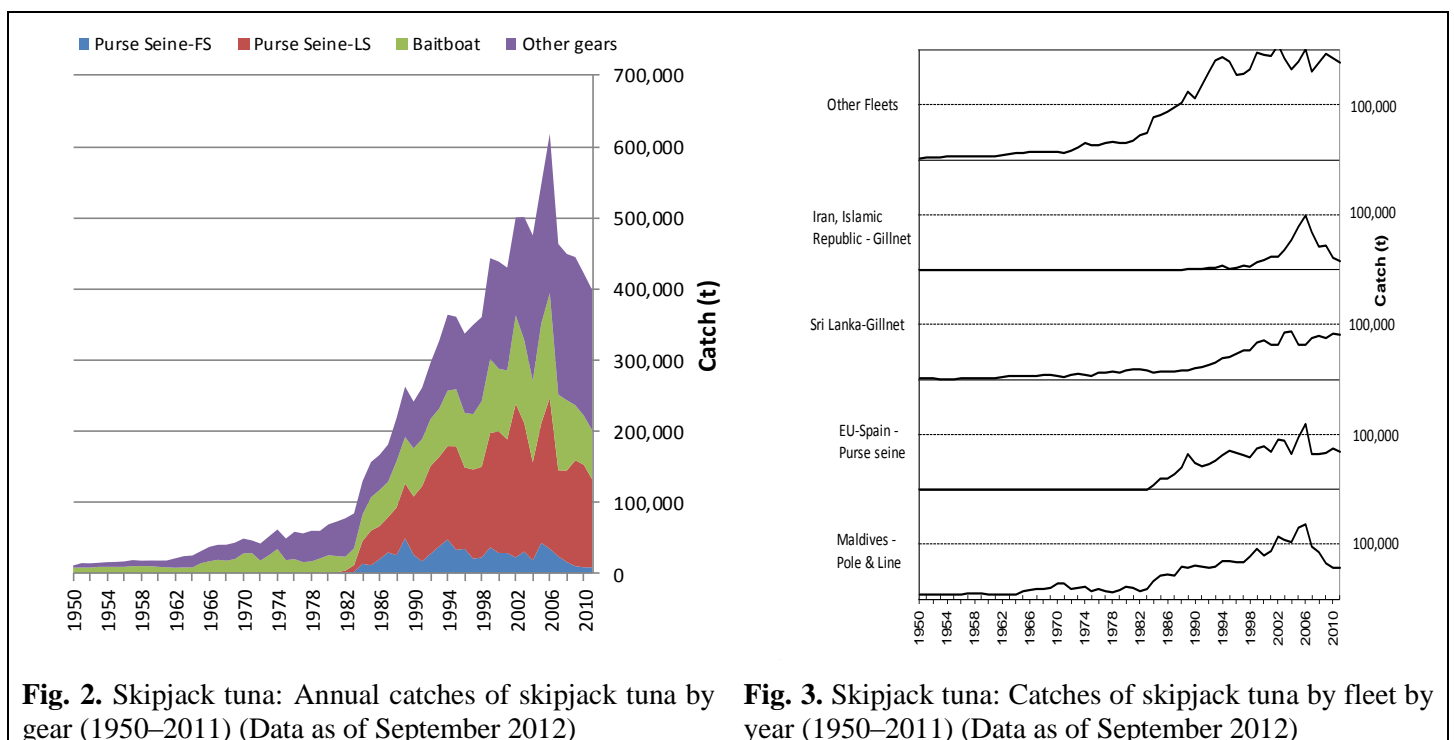

Fig. 2. Skipjack tuna: Annual catches of skipjack tuna by gear (1950–2011) (Data as of September 2012)

Fig. 3. Skipjack tuna: Catches of skipjack tuna by fleet by year (1950–2011) (Data as of September 2012)

The Maldivian fishery (Fig. 3) 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 some 75% of its total catch, and catch rates regularly increased between 1980 and 2006, the year in which the maximum catch was recorded for this fishery (≈135,000 t). The catches of skipjack tuna have declined since, with catches in recent years estimated to be at around 55,000 t, representing less than half the catches taken in 2006.

Several fisheries using gillnets have reported large catches of skipjack tuna in the Indian Ocean (Fig. 2), including the gillnet/longline fishery of Sri Lanka, driftnet fisheries of Iran and Pakistan, and gillnet fisheries of India and 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 (Fig. 3) 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.

The majority of the catches of skipjack tuna originate from the western Indian Ocean (Fig. 4). Since 2007 the 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 drop in catch rates and fishing effort by some fisheries due to the effects of piracy in the western Indian Ocean region, including all industrial purse seiners and fleets using driftnets from Iran (Fig. 3) and Pakistan; and the drop in the catches of skipjack tuna by Maldives baitboats (Fig. 3) following the introduction of handlines to target large specimens of yellowfin tuna.
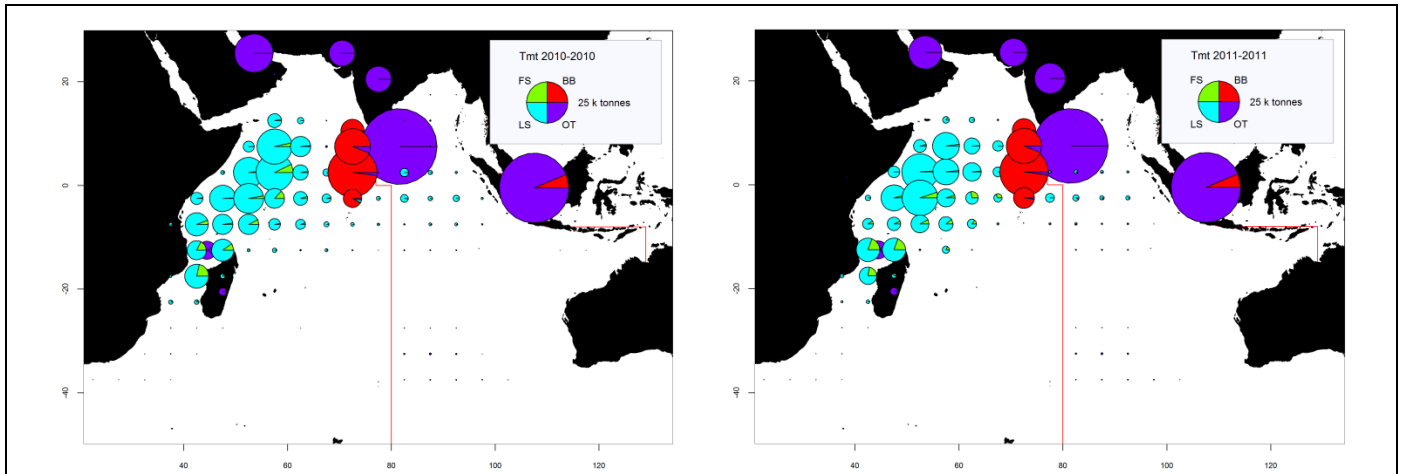

Fig. 4. Skipjack tuna: Time-area catches (total combined in tonnes) of skipjack tuna estimated for 2010 (left) ad 2011 (right) by gear. Purse seine free-schools (FS), Purse seine associated-schools (LS), pole-and-line (BB), and other fleets (OT), including longline, drifting gillnets, and various coastal fisheries. Data as of September 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 and Pakistan, gillnet and longline fishery of Sri Lanka, and coastal fisheries of Comoros, Indonesia and India.

Skipjack tuna – uncertainty of catches

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

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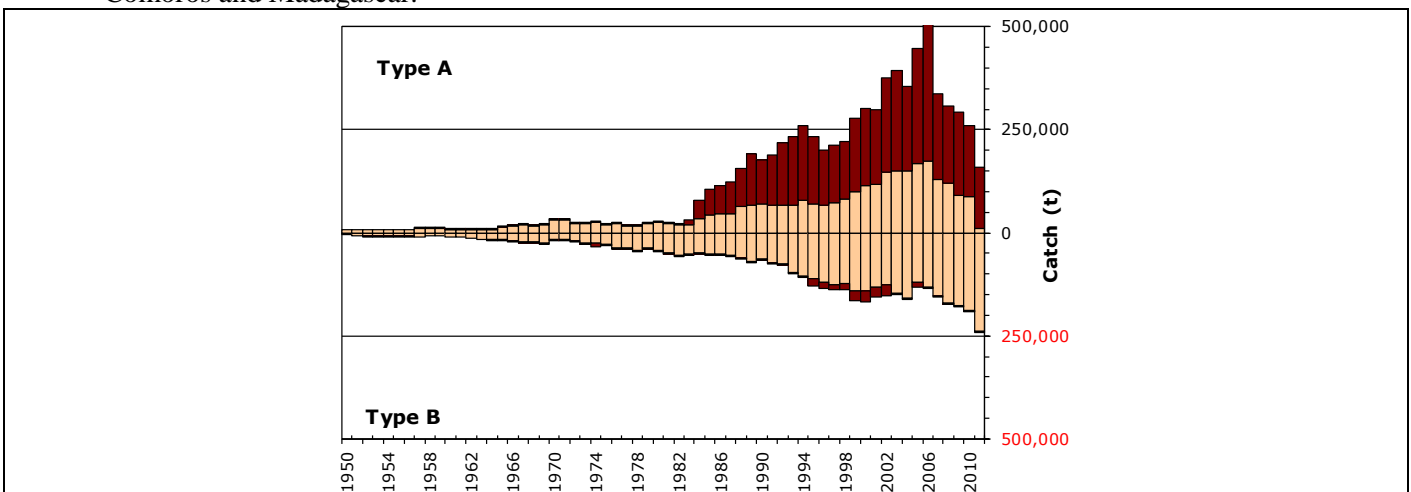

Fig. 5. Skipjack tuna: Uncertainty of annual catch estimates for skipjack tuna (Data as of September 2012). Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear 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 been no major changes to the catches of skipjack tuna, as a whole, since the WPTT in 2011. However, the IOTC Secretariat used new information compiled during 2011-12 to rebuild the catch

series for the coastal fisheries operated in some countries, in particular Madagascar, Sri Lanka, and India. In general, the new catches of skipjack tuna estimated by the IOTC Secretariat are lower than those used in the past by the WPTT.

CPUE Series: Catch and effort data are available from various industrial and artisanal fisheries. However, these data are not available from some important fisheries or they are considered to be of poor quality for the following reasons:
- no data are 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, Madagascar and Comoros.

Skipjack tuna – Effort trends

Total effort from purse seine vessles 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. 6. 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 2010 and 2011 are provided in Fig. 7.
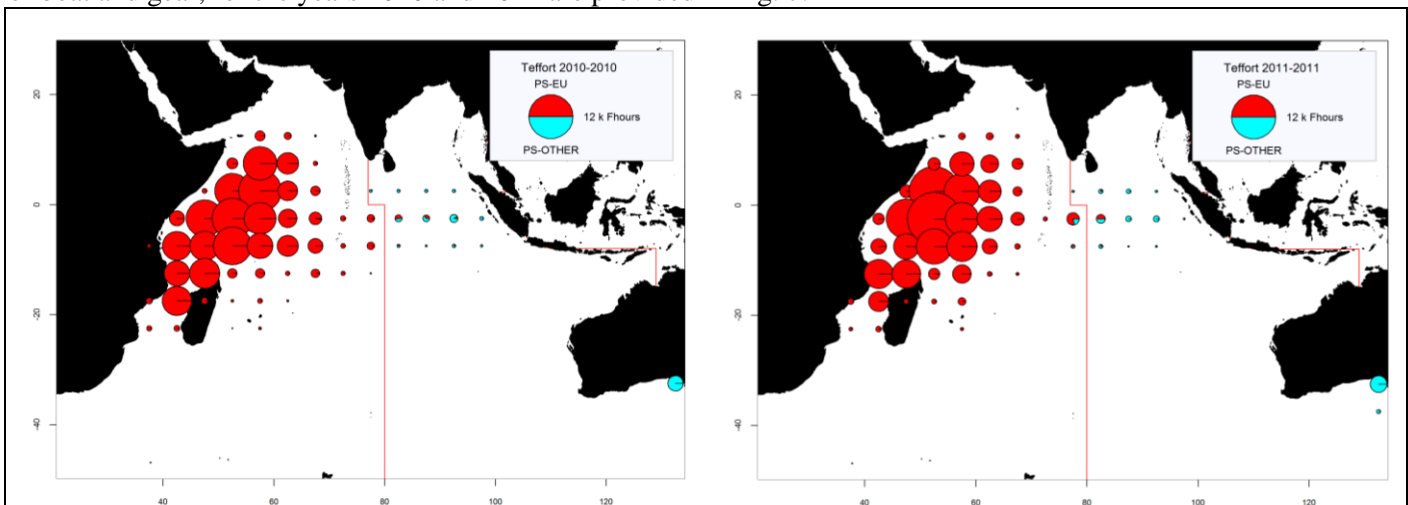

Fig. 6. Number of hours of fishing(Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2010 (left) and 2011 (right) (Data as of October 2012)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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)
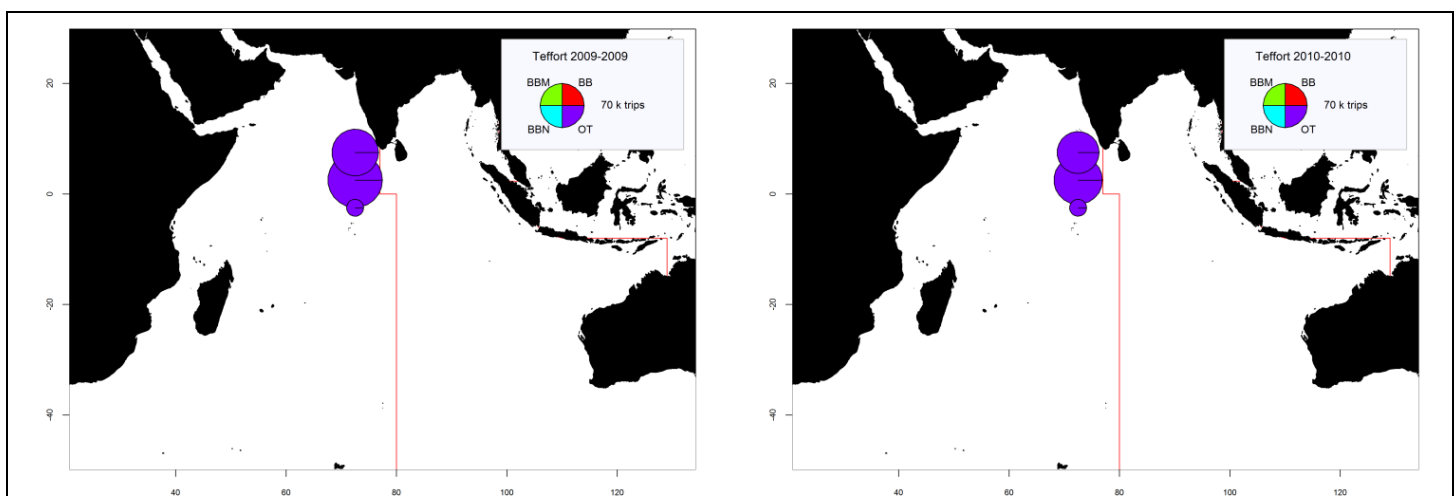

Fig. 7. Number of fishing trips by vessels flagged to the Maldives by 5 degree square grid, type of boat and gear, for the years 2009 (left) and 2010 (right) (Data as of September 2012)
BBN (blue): Baitboat non-mechanized; BBM (Green): Baitboat mechanized; BB (Red): Baitboat unspecified; UN (Purple): 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.

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

The CPUE series available for assessment purposes are listed below, although only the standardised pole-and-line series from 2004 to 2010 was used in the stock assessment model for 2012. The other two series were explored (shown in Fig. 8).

- Maldives nominal pole and line: 1970–2003 from document IOTC–2012–WPTT14–29 Rev_1.
- Maldives standardised pole-and-line: (2004–2009): Series1 (PL – preferred) from document IOTC–2011–WPTT13–29 and 31 and IOTC–2012–WPTT14–29 Rev_1.
- EU,France purse seine free school data (1991–2010): Series from document IOTC–2011–WPTT13–20 and IOTC–2012–WPTT14–29 Rev_1. This series was not used in the assessment because it was not standardised and likely subject to problems as noted in the sections above.
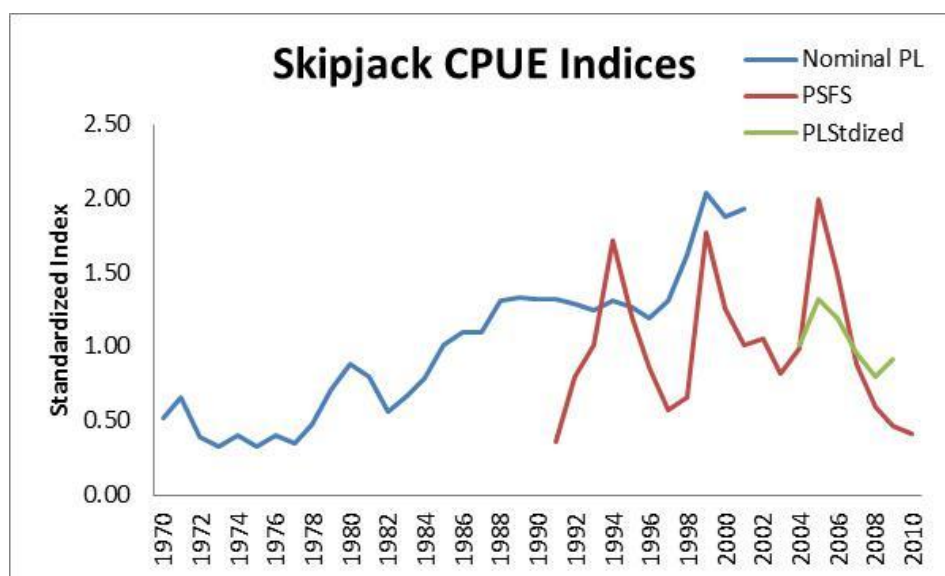

Fig. 8. Skipjack tuna: CPUE Indices based on different fisheries, and methods examined

The EU purse seine free-school CPUE is not a good indicator of the skipjack tuna population abundance as this fishery is seasonal and mainly located in the Mozambique Channel. As such, it would not be as representative as the Maldivian pole-and-line CPUE series of the overall population abundance. The FAD-associated school purse seine fishery should be used in future assessments which may better represent the abundance index trends of the population.

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

Trends in average weight 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) (Fig. 9).

Catch-at-Size table: CAS are available but the estimates are uncertain for some years and fisheries due to:
- 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).
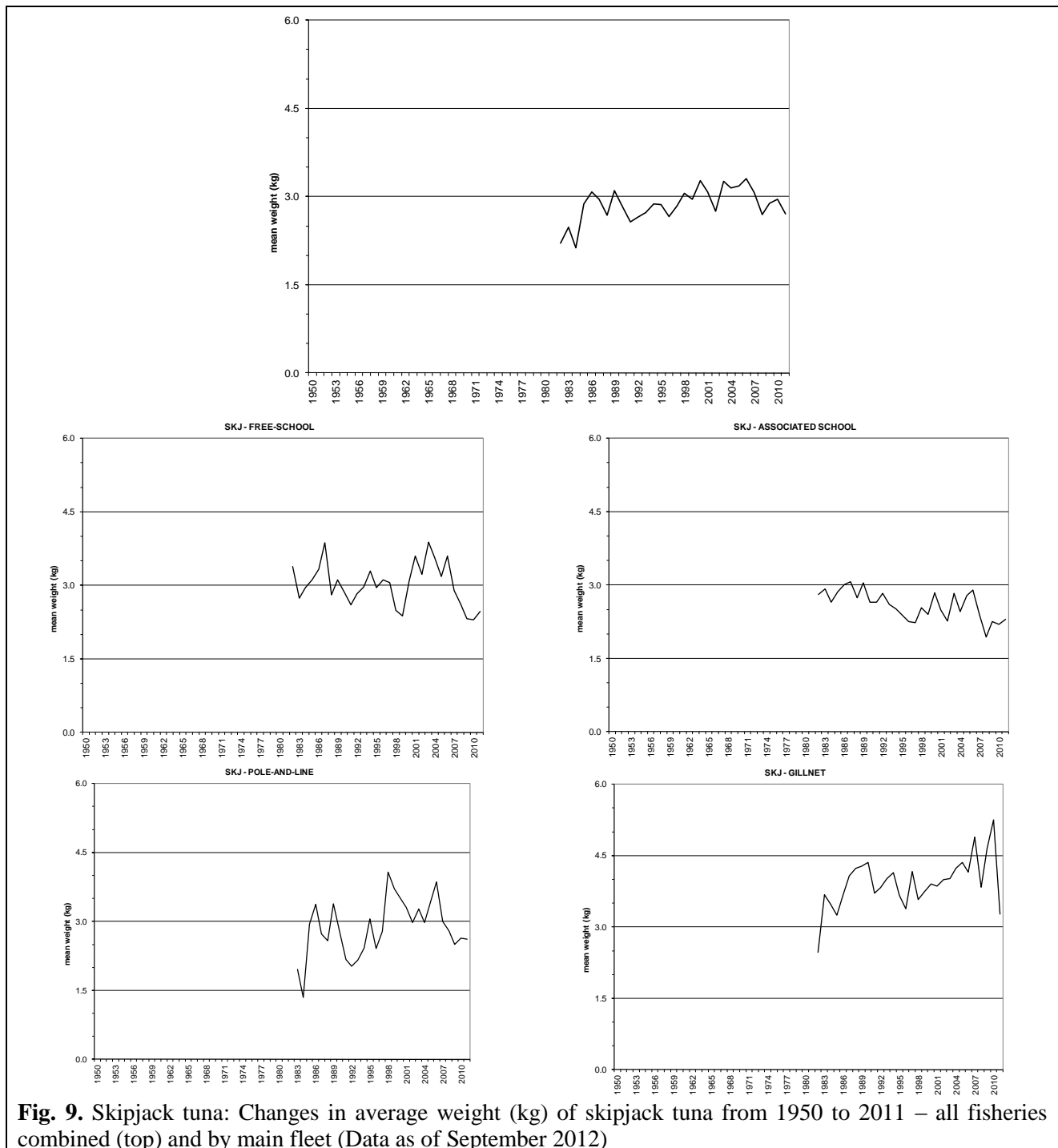
Fig. 9. Skipjack tuna: Changes in average weight (kg) of skipjack tuna from 1950 to 2011 – all fisheries combined (top) and by main fleet (Data as of September 2012)

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. 10). 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, 15,729 (15.5%), have been recovered and reported to the IOTC Secretariat. Around 78% of the recoveries were from the purse seine fleets operating from the Seychelles, and around 20% 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.
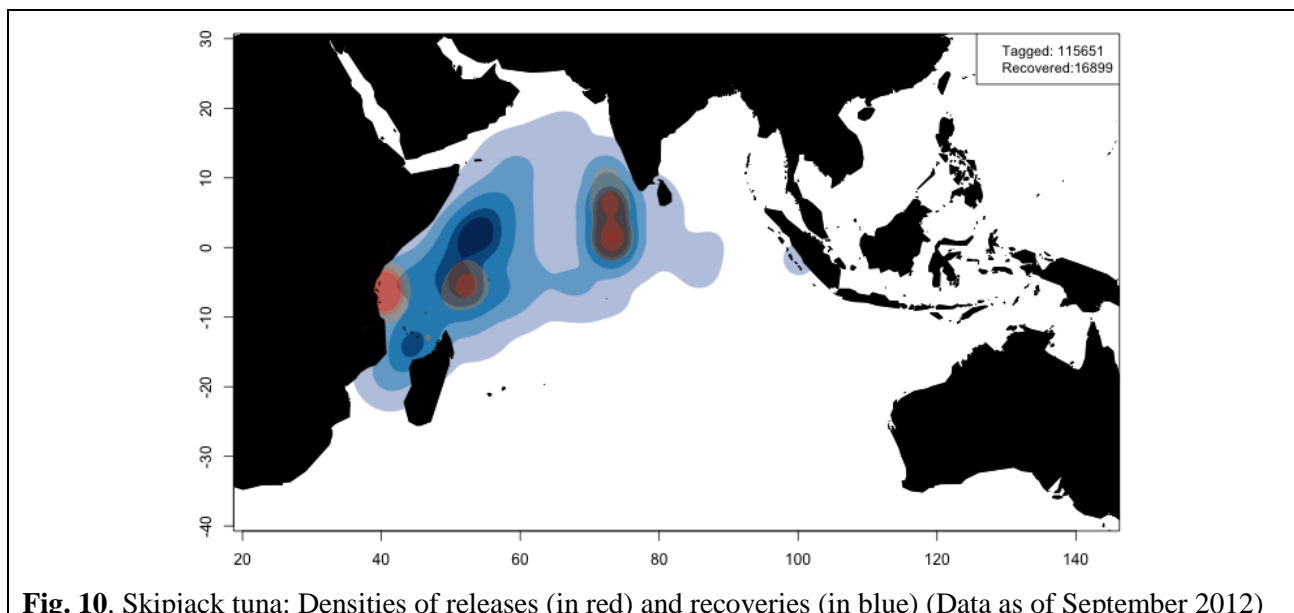
Fig. 10. Skipjack tuna: Densities of releases (in red) and recoveries (in blue) (Data as of September 2012)

STOCK ASSESSMENT

Despite the difficulties facing the assessment of skipjack tuna in the Indian Ocean, the comparison of various fishery indicators with their historical levels may provide a basis to infer the status of the stock in the absence of traditional reference points. However, the interpretation of the fishery indicator trends should take into account several caveats and incorporate expert knowledge.

In general the indicators obtained for skipjack tuna in this study are partially conflicting and highly variable. The average size indicators from the purse seine fleets have dropped for both free and associated schools in recent years. In the long term, however, there does not appear to be an overall major change in mean weight. For the pole-and-line fishery, the average weight indices have also been decreasing over the last three years. However, the gillnet fishery showed an increasing trend during recent years.

The catch rates on associated schools are increasing for both the EU,Spain and EU,France fleets. It is difficult to interpret these results, however, it seems that the increase in catch rate is associated with a decrease in effort which could be interpreted as a positive signal. It is possible that the high catch rates for associated schools may be caused by hyperstability (i.e. the aggregating effect of the FADs is masking decreasing population numbers), which is not relevant for free schools of tuna.

The advice on the status of skipjack tuna in 2012 was derived from models using an integrated statistical assessment method from 2011 and 2012. Model formulations were explored to ensure that various plausible sources of uncertainty were explored 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 of different model runs were presented.

Table 5. Key management quantities from the 2012 SS3 assessment, for the aggregate Indian Ocean

Management Quantity	Aggregate Indian Ocean
2011 catch estimate	398,240 t
Mean catch from 2007–2011	435,527 t
MSY (95% CI)	478,190 t (358,900–597,500 t)
Data period used in assessment	1950–2011
F_{2011}/F_{MSY} (95% CI)	0.80 (0.68–0.92)
B_{2011}/B_{MSY}	–
SB_{2011}/SB_{MSY} (95% CI)	1.2 (1.01–1.43)
B_{2011}/B_0	–
SB_{2011}/SB_0 (95% CI)	0.45 (0.25–0.65)
$B_{2011}/B_{1950, F=0}$	–
$SB_{2011}/SB_{1950, F=0}$	0.45 (0.25–0.65)

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