ALBACORE

SUPPORTING INFORMATION

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

CONSERVATION AND MANAGEMENT MEASURES

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

- Resolution 15/01 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 15/02 *mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPC's)*
- Resolution 15/06 *On a ban on discards of bigeye tuna, skipjack tuna, yellowfin tuna and a recommendation for non-targeted species caught by purse seine vessels in the IOTC area of competence*
- Resolution 15/10 *On target and limit reference points and a decision framework*
- Resolution 15/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*
- 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 13/09 *on the conservation of albacore caught in the IOTC area of competence*
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Albacore: General

Overall, the biology of the albacore stock in the Indian Ocean is not well known and there is relatively little new information on albacore stocks. Albacore (*Thunnus alalunga*) life history characteristics, including a relatively late maturity, long life and sexual dimorphism, make the species vulnerable to over exploitation. **Table 1** outlines some of the key life history traits of albacore specific to the Indian Ocean.

TABLE 1. Albacore: Biology of Indian Ocean albacore (*Thunnus alalunga*).

Parameter	Description
Range and stock structure	A temperate tuna living mainly in the mid oceanic gyres of the Pacific, Indian and Atlantic oceans. In the Pacific and Atlantic oceans there is a clear separation of southern and northern stocks associated with the oceanic gyres that are typical of these areas. In the Indian Ocean, there is probably only one southern stock, distributed from 5°N to 40°S, because there is no northern gyre. Albacore is a highly migratory species and individuals swim large distances during their lifetime. It can do this because it is capable of thermoregulation, has a high metabolic rate, and advanced cardiovascular and blood/gas exchange systems. Pre-adults (2–5 year old albacore) appear to be more migratory than adults. In the Pacific Ocean, the migration, distribution availability, and vulnerability of albacore are strongly influenced by oceanographic conditions, especially oceanic fronts. It has been observed on all albacore stocks that juveniles concentrate in cold temperate areas (for instance in a range of sea-surface temperatures between 15 and 18°C), and this has been confirmed in the Indian Ocean where albacore tuna are more abundant north of the subtropical convergence (an area where these juvenile were heavily fished by driftnet fisheries during the late 1980's). It appears that juvenile albacore show a continuous geographical distribution in the Atlantic and Indian oceans in the north edge of the subtropical convergence. Albacore may move across the jurisdictional boundary between ICCAT and IOTC. It is likely that the adult Indian Ocean albacore tunas do yearly circular counter-clockwise migrations following the surface currents of the south tropical gyre between their tropical spawning and southern feeding zones. In the Atlantic Ocean, large numbers of juvenile albacore are caught by the South African pole-and-line fishery (catching about 10,000 t yearly) and it has been hypothesized that these juveniles may be taken from a mixture of fish born in the Atlantic (north east of Brazil) and from the Indian Ocean. For the purposes of stock assessments, one pan-ocean stock has been assumed.
Longevity	10+ years

Maturity (50%)	**Age**: females 5–6 years; males 5–6 **Size**: females n.a.; males n.a.
Spawning season	Little is known about the reproductive biology of albacore in the Indian Ocean but it appears, based on biological studies and on fishery data, that the main spawning grounds are located east of Madagascar between 15° and 25°S during the 4th and 1st quarters of each year. Like other tunas, adult albacore spawn in warm waters (SST>25°C).
Size (length and weight)	Reported to 128 cm FL in the Indonesian longline fishery $W = aL^b$ with $a = 5.691 \times 10^{-5}$, $b = 2.7514$.

n.a. = not available. Sources: Lee & Kuo 1988, Lee & Liu 1992, Lee & Yeh 2007, Froese & Pauly 2009, Xu & Tian 2011, Setyadji et al. 2012

Albacore Fisheries and main catch trends

- Main fishing gear: albacore tuna are currently caught almost exclusively using drifting longlines (accounting for over 90% of the total catches) (**Table 2; Fig.1**), with remaining catches recorded using purse seines and other gears. Catches from the longline fisheries are split between deep-freezing longliners, and fresh-tuna longliners:

  Deep-freezing longline fishery:

  - Deep-freezing longliners from Japan and Taiwan,China have been operating in the Indian Ocean since the early 1950s (Fig.3). Although the Japanese albacore catch ranged from 8,000 t to 18,000 t in the period 1959 to 1969, in 1972, catches rapidly decreased to around 1,000 t due to a change in the target species, mainly to southern bluefin tuna and bigeye tuna. Albacore became a bycatch species for the Japanese fleet with catches between 200 t and 2,500 t. In recent years the Japanese albacore catch has been around 2,000 to 4,000 t.
  - Catches by Taiwan,China deep-freezing longliners increased steadily from the 1950's to average around 10,000 t by the mid-1970s. Between 1998 and 2002 catches ranged between 20,000 t to 26,000 t, equating to just over 55% of the total Indian Ocean albacore catch. Since 2006 albacore catches by Taiwan,China deep freezing longliners have been between 1,500 and 5,000 t, with the lowest catches recorded in 2012.

  Fresh-tuna longline fishery:

  - Unlike deep-freezing longliners, the catch levels of albacore for the fresh-tuna longline fishery of Taiwan,China have increased in recent years, leading to a shift in the proportion of catches of albacore by deep-freezing and fresh-tuna longliners. Catches by fresh-tuna longliners currently account for between 80% - 90% of catches by Taiwanese longliners.
  - Catches of albacore reported for the fresh tuna longline fishery of Indonesia have also increased considerably since 2003, ranging over 9,000 t in recent years.

- Main fleets (i.e., highest catches in recent years):

  In recent years nearly three-quarters of the total catches of albacore in the Indian Ocean are accounted for by Taiwan,China and Indonesia, followed by Japan – with the majority of catches reported by fresh-tuna longline, and deep-freezing fisheries by each fleet (**Fig.2**).

- Main fishing grounds:

  While most of the catches of albacore have traditionally come from the southwest Indian Ocean (i.e., South of 20°S), in recent years a larger proportion of the catch has come from the southern and eastern Indian Ocean (**Table 3; Fig.3**). The relative increase in catches in the eastern Indian Ocean since the early 2000's is mostly due to increased activity of fresh-tuna longliners from Taiwan,China and Indonesia.

  In the western Indian Ocean, the catches of albacore mostly result from the activities of deep-freezing longliners and purse seiners. One consequence of Somali maritime piracy in the western tropical Indian Ocean in recent years has been the movement of part of the deep-freezing longline fleets from this area, for which the target species were tropical tunas or swordfish, to operate in southern waters of the Indian Ocean which has led to an increased contribution of albacore to the total catches of some longline fleets.

  Offshore gillnet vessels from I.R. Iran and Pakistan, as well as gillnet-longline vessels from Sri Lanka have extended their area of operation in recent years, and are now thought to operate on the high seas closer to the equator. However the lack of catch-and-effort data from these fleets makes it impossible to assess whether they are operating in areas where catches of juvenile albacore are likely to occur.

- Retained catch trends:

  Between the early 1960s until the mid-1980s, catches of albacore remained relatively stable at around 15,000 – 20,000 t, except for high catches recorded in 1973 and 1974. From the mid-1980s catches increased markedly due to the use of drifting gillnets by Taiwan,China, with total catches over 30,000 t, mostly targeting juvenile albacore in the southern Indian Ocean (30°S to 40°S). In 1992 the United Nations worldwide ban on the use of drifting gillnets effectively closed this gillnet fishery. Following the removal of the Taiwanese drifting gillnet fleet, catches dropped to less than 21,000 t by 1993.

  From 1993 catches increased to 46,000 t (in 2001) – the year in which the highest catches of albacore were reported – mostly as a result of increased fishing effort by the Taiwanese deep-freezing longline fleet. Since 2001, catches have been almost exclusively taken by deep-freezing longlines and fresh-tuna longlines.

- Discard levels: are thought to be low, although they are unknown for industrial fisheries other than European (EU) purse seiners (2003–07).

TABLE 2. Albacore: Best scientific estimates of the catches of albacore (*Thunnus alalunga*) by gear and main fleets [or type of fishery] by decade (1950s–2000s) and year (2007–2016), in tonnes.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
DN				5,895	3,735											
LL	3,715	17,313	17,136	15,602	22,992	21,350	12,451	13,043	13,971	20,211	12,318	9,855	9,474	14,991	12,683	11,802
FLL			80	314	1,309	11,701	23,736	19,332	21,662	21,380	18,361	20,547	21,528	22,943	20,014	22,785
PS				194	1,682	912	725	1,424	392	207	725	1,297	501	534	534	428
OT	20	33	94	413	754	1,375	1,649	2,091	2,181	2,338	2,498	1,653	1,152	1,039	1,010	981
Total	**3,736**	**17,347**	**17,310**	**22,418**	**30,472**	**35,339**	**38,561**	**35,890**	**38,205**	**44,135**	**33,902**	**33,352**	**32,655**	**39,507**	**34,241**	**35,996**

Fisheries: Driftnet (**DN**; Taiwan,China); Freezing-longline (**LL**); Fresh-tuna longline (**FLL**); Purse seine (**PS**); Other gears nei (**OT**).

TABLE 3. Albacore: Best scientific estimates of the catches of albacore (*Thunnus alalunga*) by fishing area by decade (1950s–2000s) and year (2007–2016), in tonnes. The areas used are shown in **Fig. 4**.

Area	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1-NORTHWEST	1,421	8,861	6,009	4,540	7,543	10,845	7,324	5,812	10,336	11,232	10,026	9,855	10,906	10,942	9,751	10,250
2-NORTHEAST	2,239	3,831	3,744	2,978	4,360	8,424	18,327	15,390	7,600	9,019	5,255	4,435	2,887	2,605	2,581	2,714
3-SOUTHWEST	73	4,197	5,868	6,353	11,075	8,169	7,218	6,586	9,116	8,851	8,406	7,120	11,371	13,697	11,998	12,613
4-SOUTHEAST	2	458	1,689	8,547	7,494	7,900	5,692	8,102	11,154	15,034	10,216	11,942	7,491	12,263	9,911	10,419
Total	**3,736**	**17,347**	**17,310**	**22,418**	**30,472**	**35,339**	**38,561**	**35,890**	**38,205**	**44,135**	**33,902**	**33,352**	**32,655**	**39,507**	**34,241**	**35,996**

Areas: 1-NORTHWEST (North of 25S, West of 75 E); 2-NORTHEAST (North of 25S, East of 75 E); 3-SOUTHWEST (South of 25S, West of 75 E); 4-SOUTHEAST (South of 25S, East of 75 E)

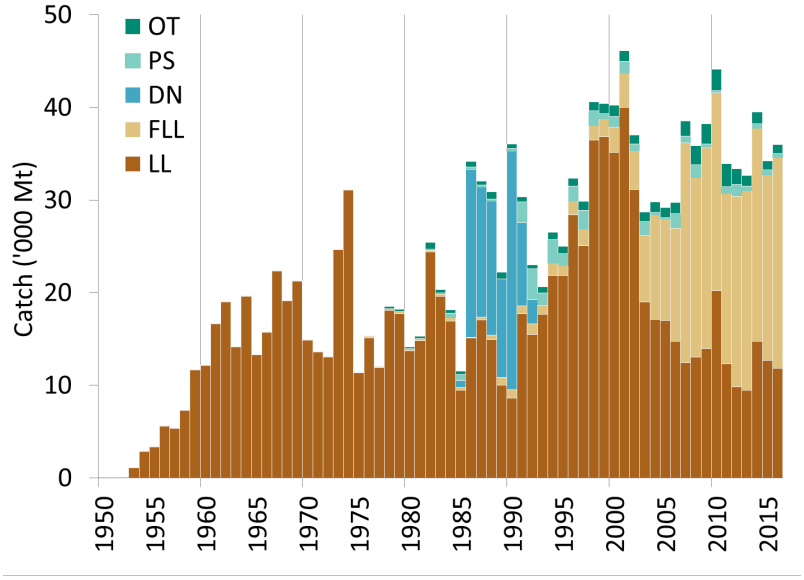


Fig. 1. Albacore: Catches of albacore by gear (1950-2016). Fisheries: Driftnet (DN; Taiwan,China); Freezing-longline (LL); Fresh-tuna longline (FLL); Purse seine (PS); Other gears nei (OT).

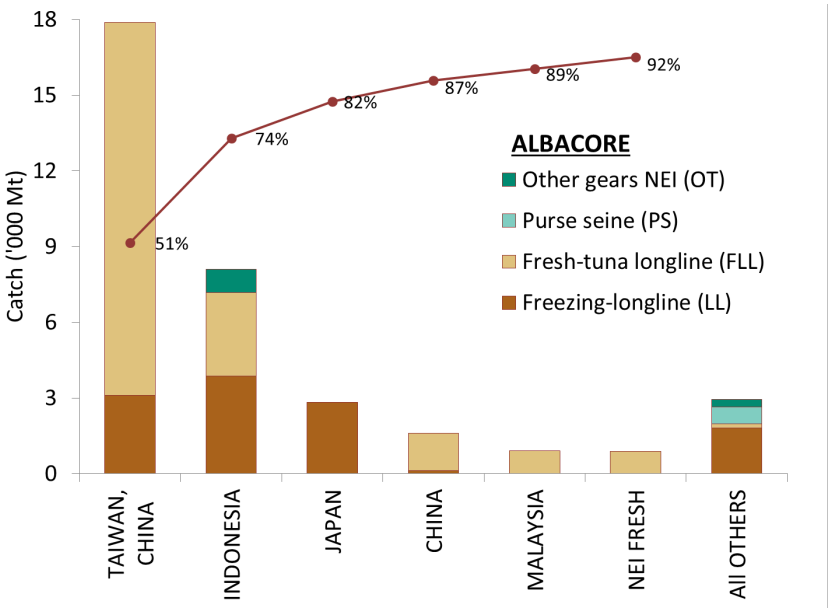
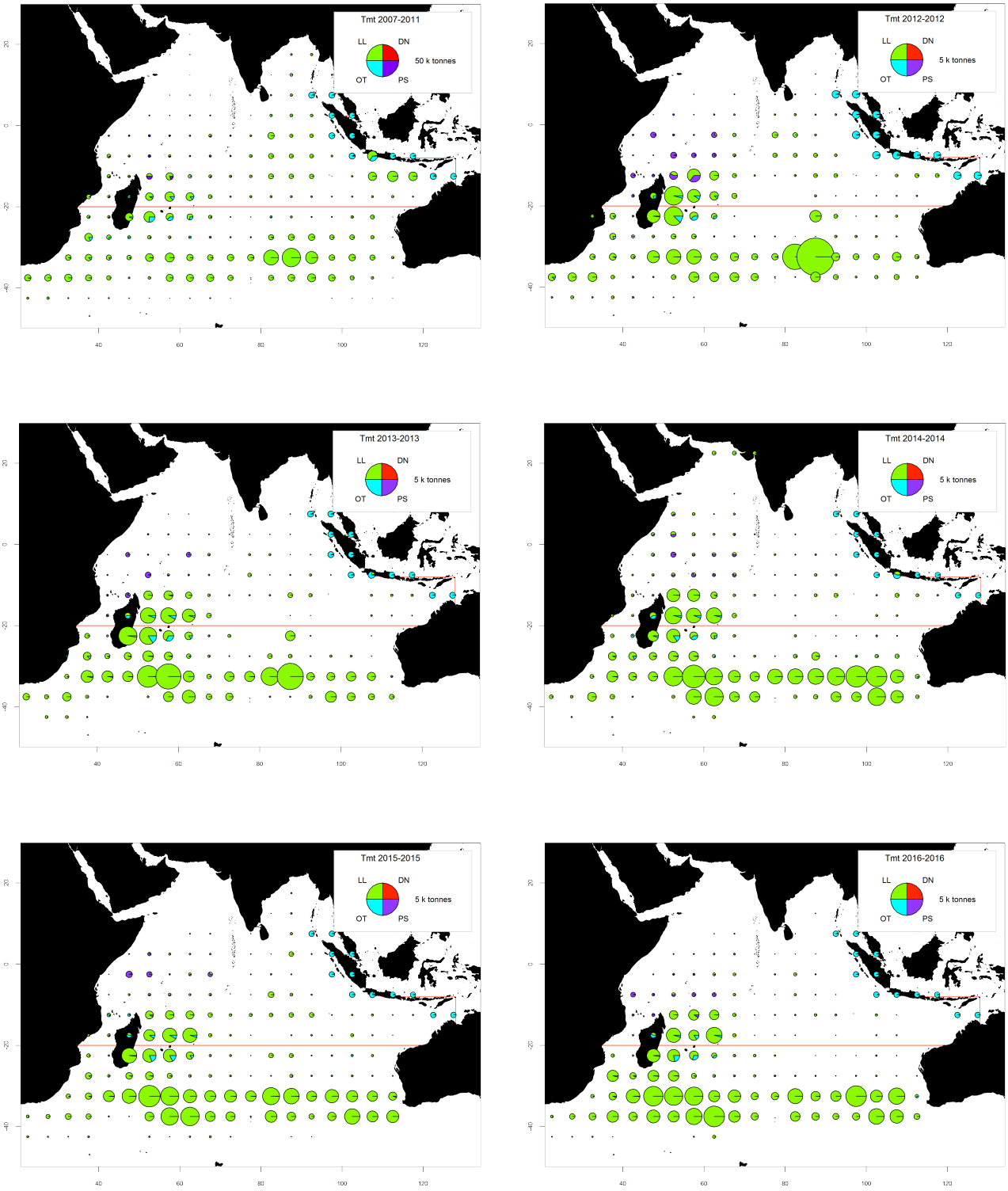


Fig. 2. Albacore: average catches in the Indian Ocean over the period 2012–16, ordered from left to right, according to the importance of catches of albacore reported. The red line indicates the (cumulative) proportion of catches of albacore for the countries concerned, over the total combined catches of albacore reported from all fisheries.



Figs. 3a–f. Albacore: Time-area catches (total combined in tonnes) of albacore estimated for the period 2007–11 by type of gear and for 2012–16, by year and type of gear. Albacore stock assessment areas shown in red.

Longline (**LL**, green), Driftnet (**DN**, red), Purse seine (**PS**, purple), Other fleets (**OT**, blue)

Time-area catches are not available for all fleets; catches for those were assigned by 5x5 square and month using information from other fleets. Source: Catch-and-effort, raised to total (nominal) catches.

Albacore tuna: data availability and related data quality issues

Nominal (retained) catches

Retained catches are considered to be fairly reliable until the early-1990s (**Fig.4a**); since then the quality of catch estimates since then has been compromised due to poor catch reports from some fleets, in particular:

- Fisheries of Indonesia: Catches of albacore tuna for the fisheries of Indonesia – including fresh-tuna longliners and deep-freezing longliners and coastal fisheries – are estimated to account for around 26% of total catches of albacore in the Indian Ocean in recent years. However the quality of the catch estimates is generally considered of poor quality.
- Malaysia (longliners): In previous years, Malaysia has reported incomplete catches of albacore for its longline fleet, as monitoring of the fishery by Malaysia did not include the large component of the longline fleet that is based in ports outside Malaysia (e.g., in particular unloadings of albacore in Port Louis, Mauritius). In recent years Malaysia has reported around 5 longliners in the Indian Ocean, while catches of albacore range between nil and 2,000 t for the same period. To compensate the under-reporting of catches, an additional 500–2,000 t of albacore have been estimated in previous years for Malay longliners not based in Malaysia, unloaded in foreign ports (with catches instead reported as NEI longline fleet).
- Other longline fleets (e.g., India, Oman, and Philippines)**:** The catches of albacore for the longline fisheries of India, Oman, and Philippines appear to be only partially reported (i.e., compared to the number of active vessels operating), with current estimates accounting for 3% of the total catches of albacore in the Indian Ocean in recent years.
- Non-reporting industrial longliners (NEI): catches from longliners operating under flags of non-reporting countries (e.g., Malaysia, foreign unloadings) have been estimated by the IOTC Secretariat. While the catches were moderately high during the 1990s, they have not exceeded 3,000 t in recent years.
- Offshore gillnets operating on the high seas (e.g., I.R. Iran, Pakistan and Sri Lanka): No catches for offshore gillnets have been reported to the IOTC Secretariat, although catches are thought to be less than 1000 t.
- Taiwan,China (fresh-tuna longliners): catches of albacore estimated for the fresh-tuna longline fishery of are only available from 2001 onwards. Prior to 2000, catches for the Taiwanese fleet remain relatively uncertain.

Albacore tuna – Catch-per-unit-effort (CPUE) trends

- Availability: Standardized catch-and-effort series are available from the various industrial fisheries. Nevertheless, catch-and-effort reported to the IOTC Secretariat are not available from some fisheries or are considered to be of poor quality, especially during the last decade, for the following reasons (**Fig.4b**):
    - uncertain data from significant fleets of longliners, including: India, Indonesia, Malaysia, Oman, and Philippines;
    - no catch-and-effort data for fresh-tuna longliners flagged as Taiwan,China, from 1990 (i.e., the start of the fishery) up to 2009;
    - non-reporting by industrial purse seiners and longliners (NEI).
- Main CPUE series available: Rep. of Korea (longline), Japan (longline), Taiwan,China (longline).

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

- Average fish weight: In general, the amount of catch for which size data is available for albacore before 1980 is very low. The deep-freezing longline fleets account for the majority of size data for albacore in the IOTC database (**Figs. 4c**). Size data are also available for industrial purse seiners flagged in EU countries and the Seychelles, however few data are available for all other fleets.

  Average fish weights can be assessed for several industrial fisheries although they are incomplete or of poor quality due to the issues identified below:

i. Tawain,China longliners: size frequency data is available for the period 1980–2014. However, the length distributions of albacore available for Taiwan,China since 2003 are different than compared to earlier years. In addition, since 2003 higher average weights derived from length data have also been reported, compared to average weights from catch-and-effort (for the same time-periods and areas), which suggests changes in the sampling protocols of specimens measured for lengths – particularly the proportion of smaller sized fish measured for lengths.

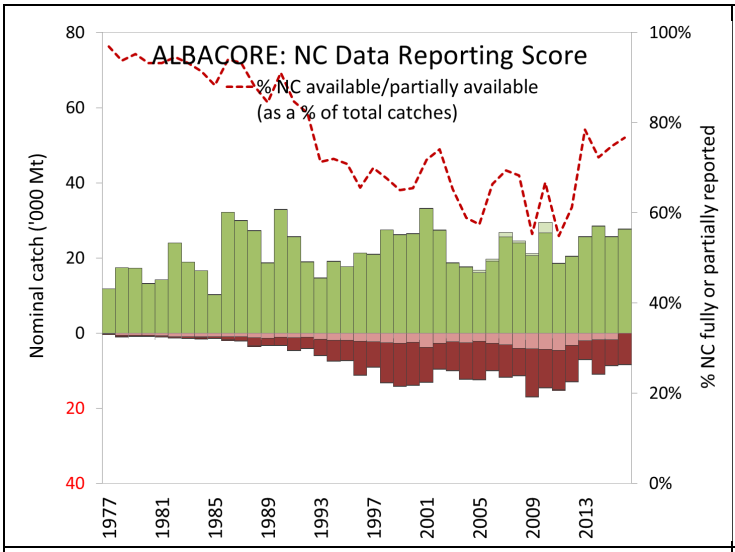
ii. Japan longliners: data for the Japanese longline fleet is available; however, the number of specimens measured per stratum has been decreasing since the early-1990s.

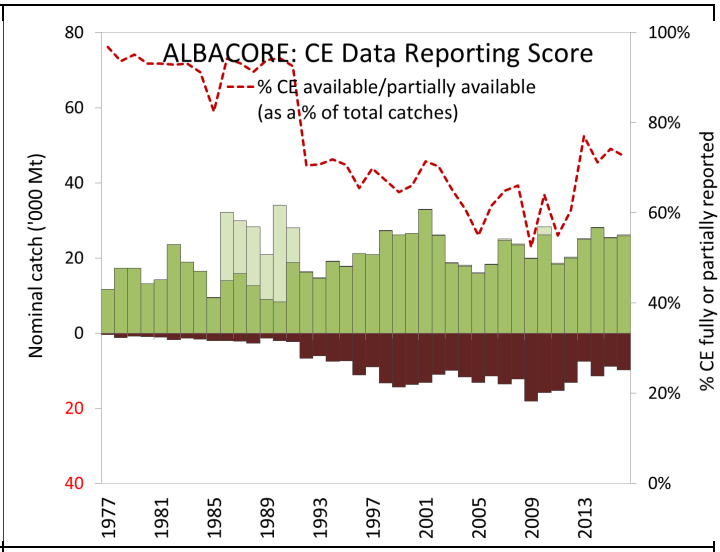
In 2010, the IOTC Scientific Committee noted several issues concerning the reliability size frequency statistics available for Japan and Taiwan,China, and which remain unresolved. In 2013 the IOTC Secretariat presented a paper to the Working Party on Tropical Tunas documenting the current data quality issues and inconsistencies between the length frequency data and catch-and-effort reported in particular by Taiwan,China since the mid-2000s[1].

- Catch-at-Size(Age) table: are available but estimates are highly uncertain for some periods and fisheries, including:
  i. all industrial longline fleets before the mid-60s, from the early-1970s up to the early-1980s and most fleets in recent years, in particular fresh-tuna longliners;
  ii. no size samples from the driftnet fishery of Taiwan,China over the entire fishing period (1982–92);
  iii. lack of size data for some industrial fleets (Taiwan,China (fresh longline), NEI, India, Indonesia, and NEI fleets).

- Catch at length trends: **Fig. 5** shows the length frequency distributions for longliners.

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





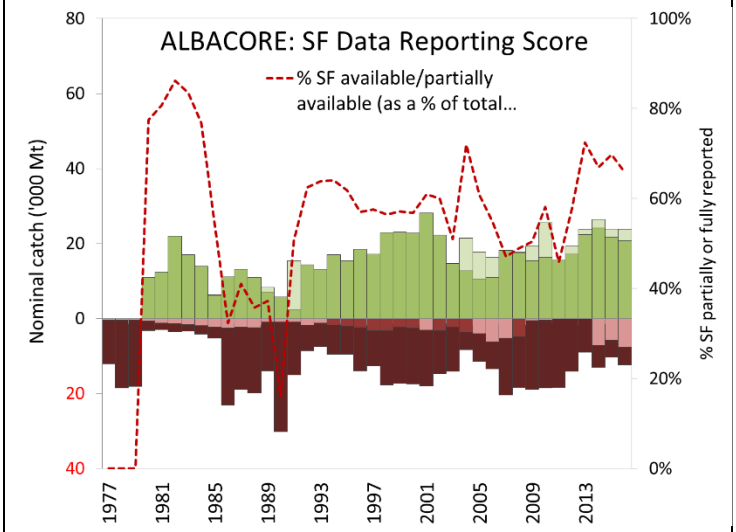


Fig. 4a-c. Albacore tuna: data reporting coverage (1977–2016).

Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where:

- *Score 0: indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards;*
- *Scores: 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;*
- *Score: 8 refers to the amount of nominal catch associated with catch-and-effort or size frequency data that is not available.*

The red dotted line indicates the proportion of data (in terms of total catches) fully or partially reported for each dataset.

IOTC Data reporting score:

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

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

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

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

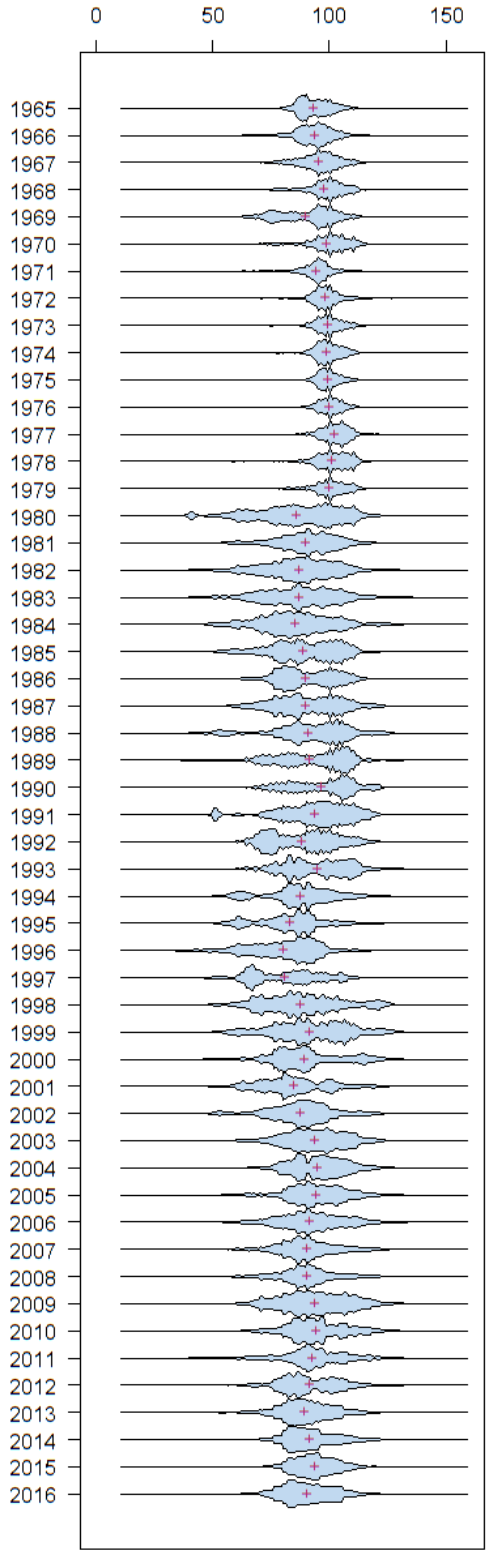
Size frequency data	Time-period	Area
Fully available according to the minimum reporting standards	0	0
Patially available according to the minimum reporting standards*	2	2
Low coverage (less than 1 fish measured by metric ton of catch)	2	
Not available at all	8	

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

Key to colour coding

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

Albacore (longline samples): size (in cm)



Albacore (longline): no. of samples ('000)

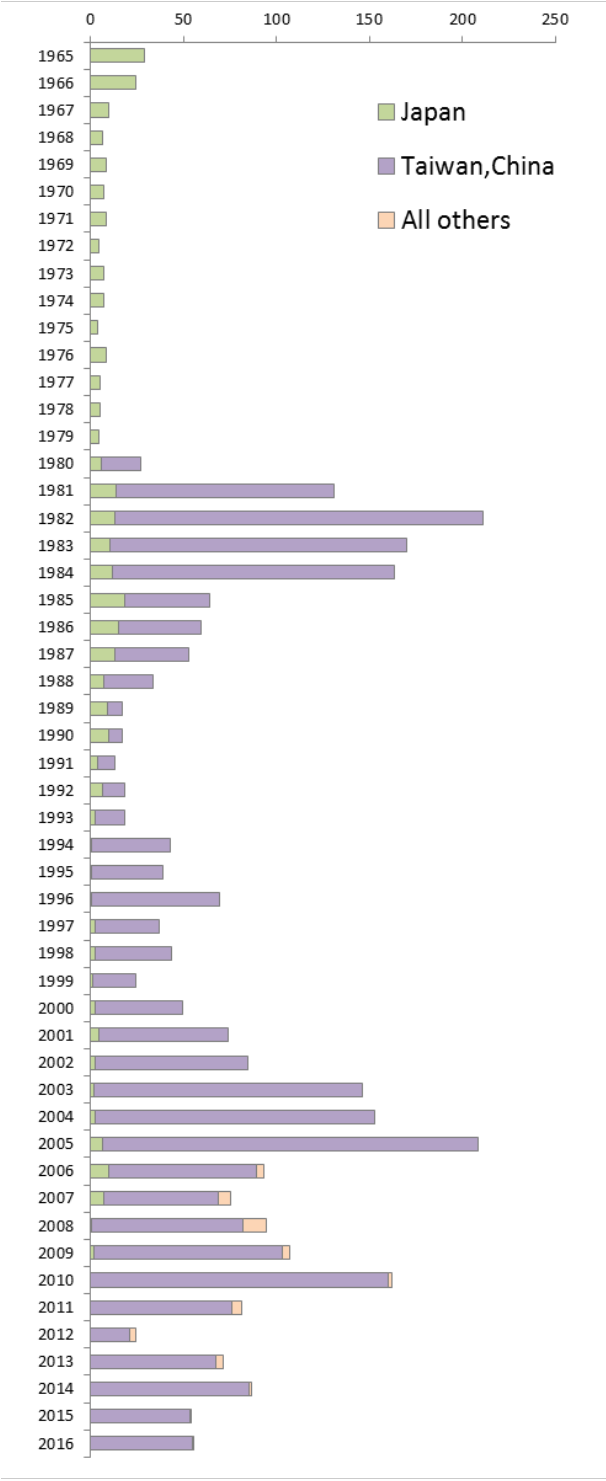


Fig. 5. Albacore: Left - Length frequency distributions (total amount of fish measured by 1 cm length class) derived from the data available at the IOTC Secretariat for freezing longline fisheries, by year. Right - Number of specimens sampled for lengths by the main longline fleets.

Fishing effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2015 and 2016 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 in 2015 and 2016 are provided in **Fig. 7**.

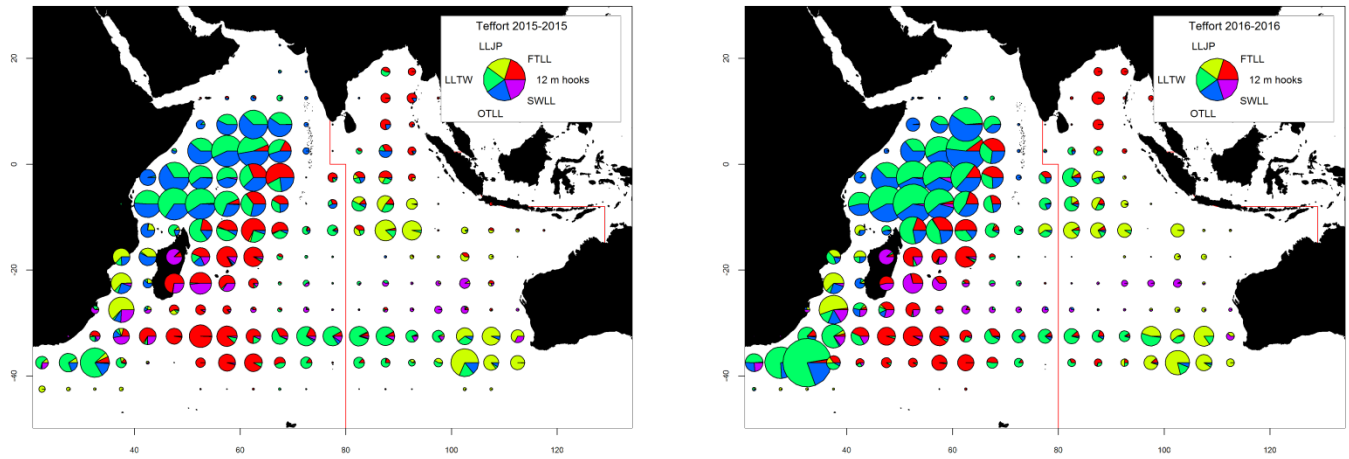


Fig. 6. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2015 (left) and 2016 (right). **LLJP** (light green): deep-freezing longliners from Japan; **LLTW** (dark green): deep-freezing longliners from Taiwan,China; **SWLL** (turquoise): swordfish 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).

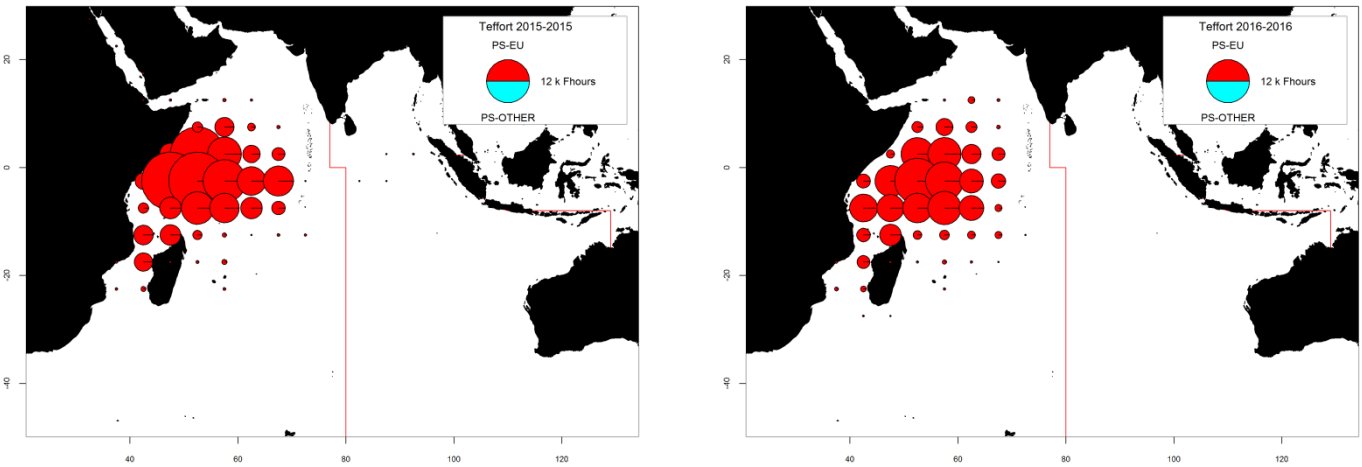


Fig. 7. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2015 (left) and 2016 (right). **PS-EU** (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags); **PS-OTHER** (light blue): 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).

Standardised catch–per–unit–effort (CPUE) trends

The CPUE series presented at the WPTmT06 meeting in 2016 are listed below (**Fig.8**):

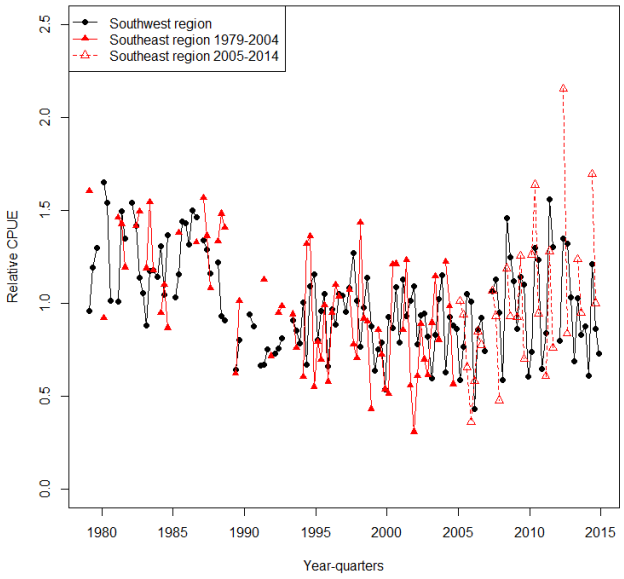
- Joint Taiwan, China; Japan, Rep. of Korea CPUE (1954-2014, and 1979-2014).
- Japan (1954–2014): 4 series from document IOTC–2016–WPTmT06–15.
- Taiwan,China (1980–2014): 2 series from document IOTC–2016–WPTmT06–17.

The joint series (southwest and southeast area; Fig.1a) was utilized for the final stock assessment model runs and in the development of management advice.

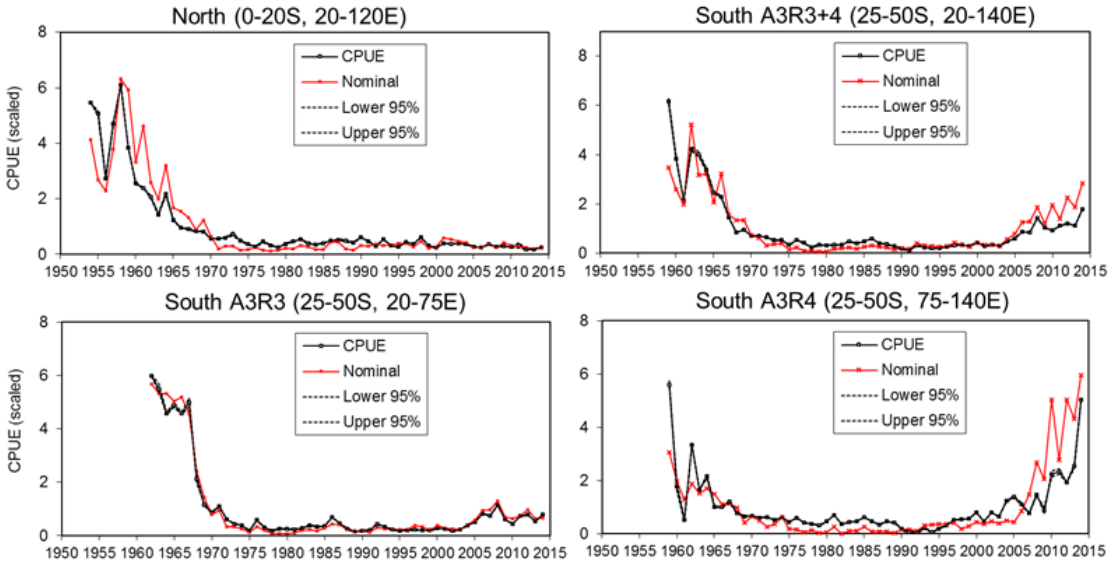
The WPTmT agreed that a joint CPUE standardisation analysis should be continued in the future by combining the data available for the main longline fleets in one analysis. In addition, Taiwan,China CPUE should be analysed for comparison. The WPTmT proposed that the following issues are considered in the joint analysis of CPUE standardization:

- Clustering approaches and other ways to define targeting should be further explored. Also the effect of these analyses in defining a subset of operational data (sets/hauls) and its effects on the standardization should be tested.
- Time-area interactions within regions requires further examination.
- A subset of vessels to examine Vessel-Year interactions over time would be important to understand vessel-dynamics, and their reasons for their change in efficiency over time.

a)



b)



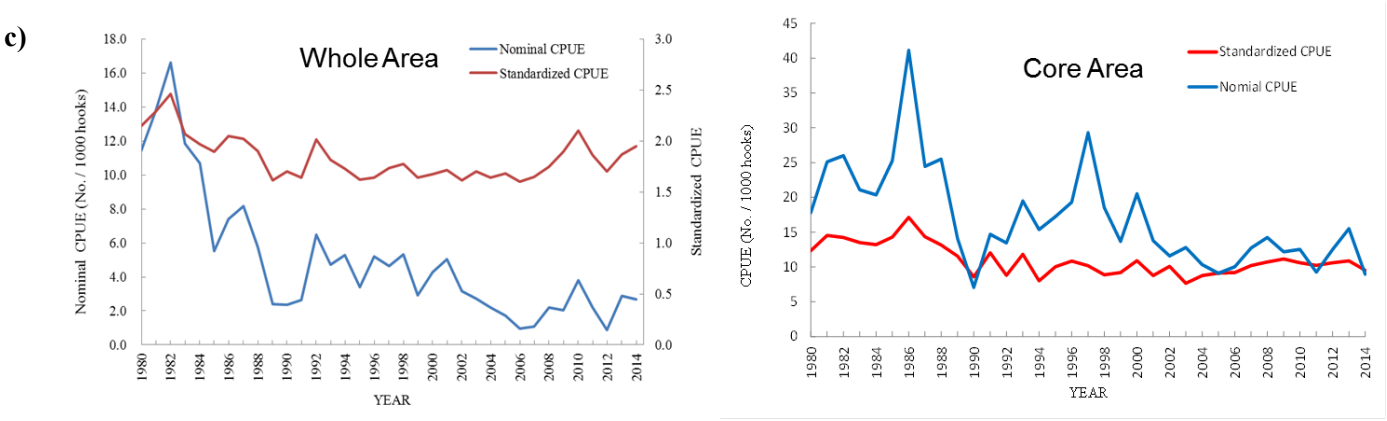


Fig.8. Comparison of the CPUE series for longline fleets fishing for albacore in the IOTC area of competence:
a) Joint CPUE (southwest (1979-2014), southeast (1979-2005), southeast (2006-2014));
b) Japanese CPUE (Areas: North, South A3R3+4, South A3R3, South A3R4);
c) Taiwan,China CPUE (whole Indian Ocean area, and Core Area).
Series have been rescaled relative to their respective means (time period varies according to each CPUE).

STOCK ASSESSMENT

A range of quantitative modelling methods as detailed below (BBDM, BSPM, ASPIC, SCAA, and SS3) were applied to the assessment of albacore in 2016, ranging from the highly aggregated ASPIC surplus production model to the age-, sex- and spatially-structured SS3 analysis.

The WPTmT noted the following with respect to the various modelling approaches used in 2016:

- There was more confidence in the abundance indices this year due to the joint CPUE analyses using operational data from Taiwan,China, Japan and Rep. of Korea. This in turn led to improved confidence in the range of stock assessment models overall.
- The joint CPUE in the southwest area and southeast area, truncated to 2005, are most likely to represent the abundance of albacore tuna at this time, as the cluster analysis used to identify targeting allows the identification of fleet that have always targeted albacore in the southern area.
- Conversely, the Japanese CPUE seems to demonstrate very strong targeting shifts away from albacore (i.e., during the 1960s) and back towards albacore in recent years since 2006 (e.g., as a consequence of piracy in the western Indian Ocean, reduced or increased TAC for southern bluefin tuna, and increases in the commercial value for albacore). Similar trends are seen in the Rep. of Korea CPUE series. However, cluster analysis using operational data to identify targeting in the standardization process has to some extents accounted for this problem.
- It was agreed that all the stock assessment modelling approaches use the joint standardized CPUE for southwest area as well as southeast area truncated to 2005.

The WPTmT noted the value of comparing different modelling approaches. The structured models are capable of a more detailed representation of complicated population and fishery dynamics, and integrate several sources of data and biological research that cannot be considered in the simple production models. However, there are a number of uncertainties in the basic albacore biology (e.g. growth rates, M, stock recruitment relationship), and it is difficult to represent all of these uncertainties. In contrast, the production models often provide robust estimates regardless of uncertainties in basic biological characteristics. However, the ASPIC model can sometimes have difficulty fitting long time series, and production models in general cannot represent some important dynamics (e.g. arising from complicated recruitment variability).

The WPTmT noted a thorough and in-depth analysis of SS3 was presented with a complete set of diagnostics, in comparison to other stock assessments for which some key diagnostics were not provided. Therefore, the WPTmT agreed that albacore stock status should be determined by the results of the SS3 stock assessments undertaken in 2016 and that the results of the other models should be presented for informative purpose supporting the results of the SS3.

Key assessment results for the 2016 SS3 stock assessment are shown in **Table 4**.

TABLE 4. Albacore (*Thunnus alalunga*) key management quantities from the 2016 SS3 stock assessment.

Management Quantity	Indian Ocean
2014 catch estimate*	40,233 t
Mean catch from 2010–2014*	36,855 t
MSY (1000 t) (80% CI)	38.8 (34.0–43.6)
Data period used in assessment	1950–2014
F_{MSY} (80% CI)	n.a
SB_{MSY} (1000 t) (80% CI)	30.0* (26.1–34.0)
F_{2014}/F_{MSY} (80% CI)	0.85 (0.57–1.12)
B_{2014}/B_{MSY} (80% CI)	n.a.
SB_{2014}/SB_{MSY} (80% CI)	1.80 (1.38–2.23)
B_{2014}/B_{1950} (80% CI)	n.a.
SB_{2014}/SB_{1950}	0.37 (0.28–0.46)
$B_{2014}/B_{1950, F=0}$	n.a.
$SB_{2014}/SB_{1950, F=0}$	n.a.

** IOTC catch estimates at the time of the last albacore assessment conducted in 2016.*

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