Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi

IOTC–2018–WPB16–07

REVIEW OF THE STATISTICAL DATA AND FISHERY TRENDS FOR BILLFISH

PREPARED BY: IOTC SECRETARIAT[1], 23 AUGUST 2018

PURPOSE

To provide the Working Party on Billfish (WPB) with a review of the status of the information available on billfish species in the databases at the IOTC Secretariat as of **August 2018**, as well as a range of fishery indicators, including catch and effort trends, for fisheries catching billfish in the IOTC area of competence. It covers data on nominal catches (retained and discards), catch-and-effort, and size-frequency.

BACKGROUND

Prior to each WPB meeting the IOTC Secretariat develops a series of tables, figures, and maps that highlight historical and emerging trends in the fisheries data held by the IOTC Secretariat. This information is used during each WPB meeting to inform discussions around stock status and in developing advice to the Scientific Committee.

This document summarises the standing of a range of information received for the billfish species under the IOTC Mandate (Table 1), in accordance with IOTC Resolution 15/02 *Mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's)*[2], for the period 1950–2015.

The document also provides: summaries of any important reviews to series of historical catches for billfish species; a range of fishery indicators, including catch and effort trends, for fisheries catching billfish in the IOTC area of competence (**Appendix I**).

The report is split into the following sections:

- **Section 1**: Overview of data for billfish species in the Indian Ocean.
- **Section 2**: Data issues related to the statistics reported to the IOTC for billfish species.
- **Section 3**: Main fisheries and catch data available for each billfish species.
- **Appendix I**: Review of fisheries trends for billfish species.

Major data categories covered by the report

Nominal catches: Total annual retained catches and discards (in live weight) by fleet, IOTC Area, species, and gear. If these data are not reported the IOTC Secretariat, estimates of total retained catch are made from a range of sources (including: partial catch-and-effort data, data in the FAO FishStat database, catches estimated by the IOTC from data collected through port sampling, data published through web pages or other means, or data reported by parties on the activity of vessels under their flag (IOTC Resolution 10/08; IOTC Resolution 14/06) or other flags (IOTC Resolution 13/07; IOTC Resolution 05/03).

Catch-and-effort data: Refers to fine-scale data, usually from logbooks, reported in aggregated format: per fleet, year, gear, type of school, month, grid and species. Information on the use of fish aggregating devices (FADs) and activity of vessels that assist industrial purse seiners to locate tuna schools (supply vessels) is also collected.

Length frequency data: Individual body lengths of IOTC species per fleet, year, gear, type of school, month and area.

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[2] This Resolution superseded IOTC Resolutions 98/01, 05/01 and 08/01.

TABLE 1. Billfish species under the IOTC mandate.

IOTC code	English name	Scientific name
BLM	Black marlin	*Makaira indica*
BUM	Blue marlin	*Makaira nigricans*
MLS	Striped marlin	*Tetrapturus audax*
SFA	Indo-Pacific sailfish	*Istiophorus platypterus*
SWO	Swordfish	*Xiphias gladius*

SECTION 1: OVERVIEW OF DATA FOR BILLFISH SPECIES IN THE INDIAN OCEAN

Fisheries and catch trends for billfish species

- Main species: Indo-Pacific sailfish and swordfish account for around two thirds of total catches of billfish species in recent years; followed by black marlin, blue marlin and striped marlin (**Fig. 1d**).

  The importance of some billfish species – in terms of share of total catches of billfish – has changed over time (**Fig. 1c**), mostly as a result of changes to the number of longline vessels active in the Indian Ocean. Catches of swordfish in particular increased during the 1990s as a result of changes in targeting by Taiwan,China, and the arrival of European longline fleets, increasing the swordfish share of total billfishes catch from 20–30% in the early 1990s to as much as 50% by the early-2000s. Catches of swordfish over the last decade have since declined back to around a third of total billfish catches, largely as a result of declines in the number of longline vessels operated by Taiwan,China. However in recent years the catches of swordfish have shown an increasing trend, which may be partly due to improvements in the estimation of catch-by-species reported by Taiwan,China.

  Relatively large catches of marlins have also been recorded since 2012 from increased activities by longliners in waters of the western central and northwest Indian Ocean as a consequence of improvements in security in the area off Somalia.

- Main fisheries: Up to the early-1980s longline vessels accounted for over 90% of the total billfish (largely as non-targeted catch); in the last 20 years the proportion has fallen to between 50% to 70% as billfish catches from offshore gillnet fisheries have become increasingly important for a number of fleets, such as I.R. Iran and Sri Lanka (**Fig. 2b-c**).

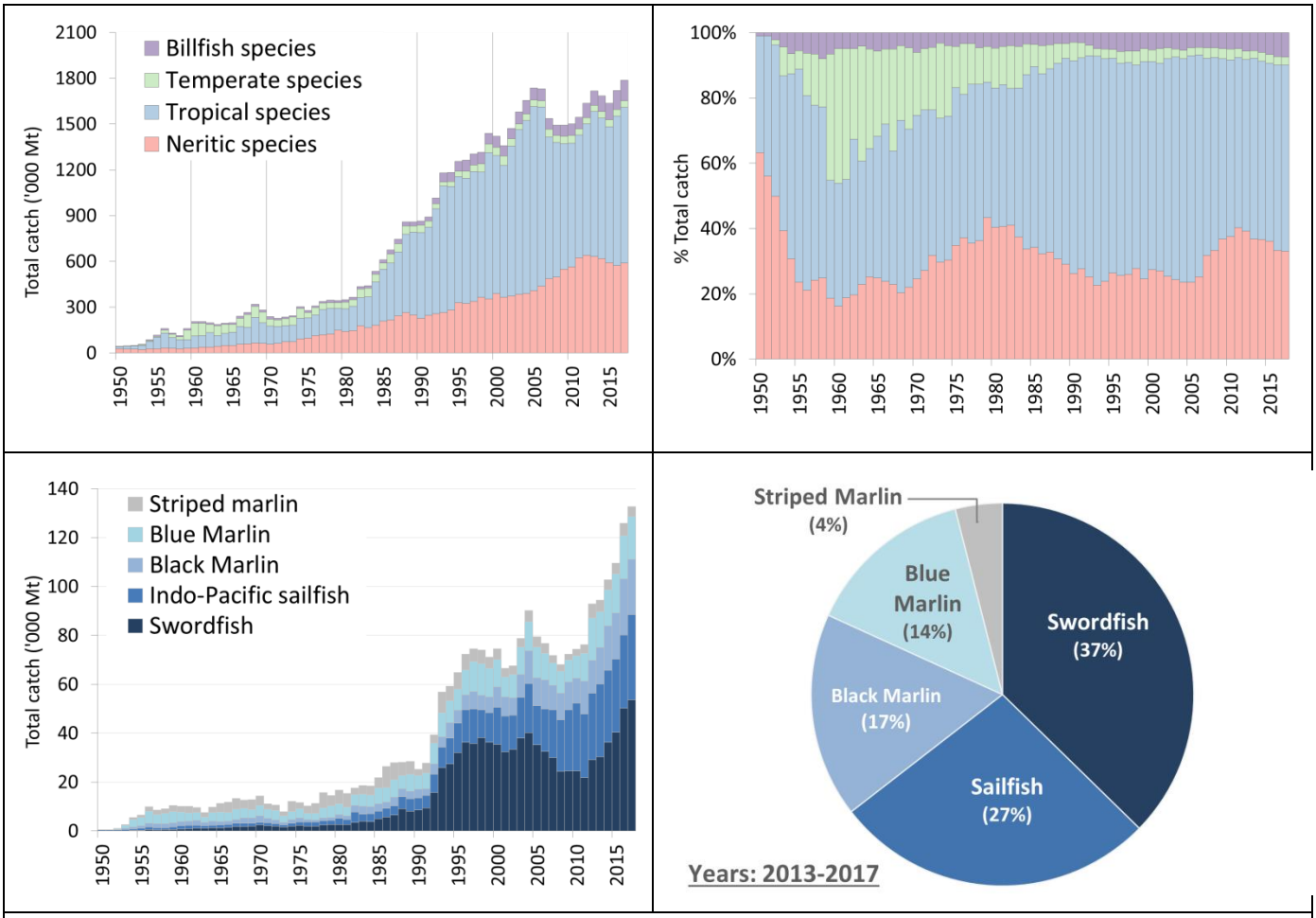
  In addition the number of longline vessels has also declined in recent years in response to the threat of Somali piracy in the western tropical Indian Ocean. Nevertheless, billfish catches are still dominated by a small number of longline fleets – namely Taiwan,China and European fleets[3] – that now appear to be resuming fishing activities in their main fishing grounds.

- Main fleets (i.e., highest catches in recent years):
  In recent years five fleets (Indonesia, I.R. Iran, India, Sri Lanka, and Taiwan,China) have reported around 75% of the total catches of billfish species from all IOTC fleets combined (Fig. 2a).

- Retained catch trends:
  The importance of catches of billfish species to the total catches of IOTC species in the Indian Ocean has remained relatively constant over the years (**Figs. 1a-b**) at between 5% – 7% of the total catch of IOTC species.

  Total catches of billfish species have generally increased in line with other species groups under the mandate of IOTC, increasing from around 25,000 t in the early 1990s to nearly 75,000 t in the mid-1990s. Since then, average catches per annum have remained relatively stable at between 70,000 t and 75,000 t. However since 2012 catches over 90,000 t have been reported, with the largest increases reported by I.R. Iran, Pakistan, and Taiwan,China (**Fig. 2a**).

[3] EU,Spain, EU,Portgual, EU,France(La Réunion), and EU,UK.



Figs. 1a-d. Billfish (all species):

Top: Contribution of the five billfish species under the IOTC mandate to the total catches of IOTC species in the Indian Ocean, over the period 1950–2017 (a. Top left: total catch; b. Top right percentage, same colour key as Fig. 1a).

Bottom: Contribution of each billfish species to the total combined catches of billfish (c. Bottom left: nominal catch of each species, 1950–2015; d. Bottom right: share of billfish catch by species, 2013–17 average catch)**.**

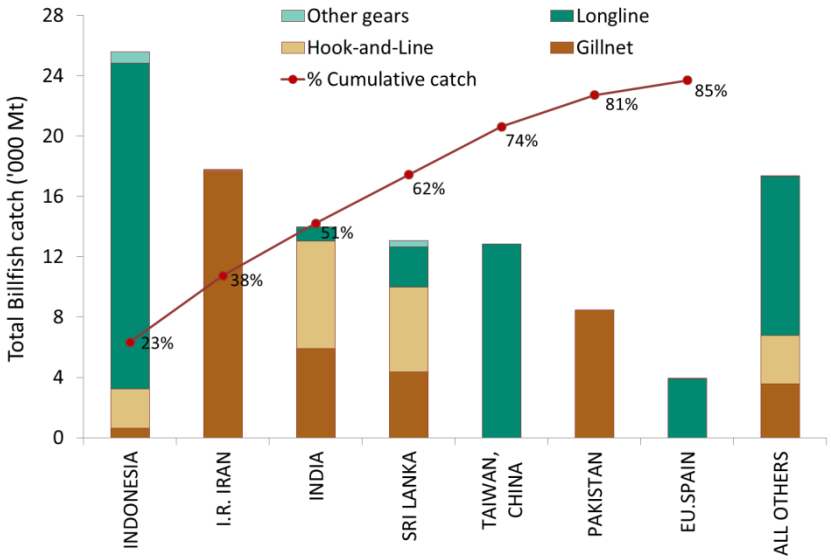


Fig. 2a: Billfish (all species): average catches in the Indian Ocean over the period 2013–17, by fleet and gear.

Fleets are ordered from left to right, according to the volume of catches reported. The red line indicates the (cumulative) proportion of catches of all billfish species for the fleets concerned, over the total combined catches reported from all fleets and gears.

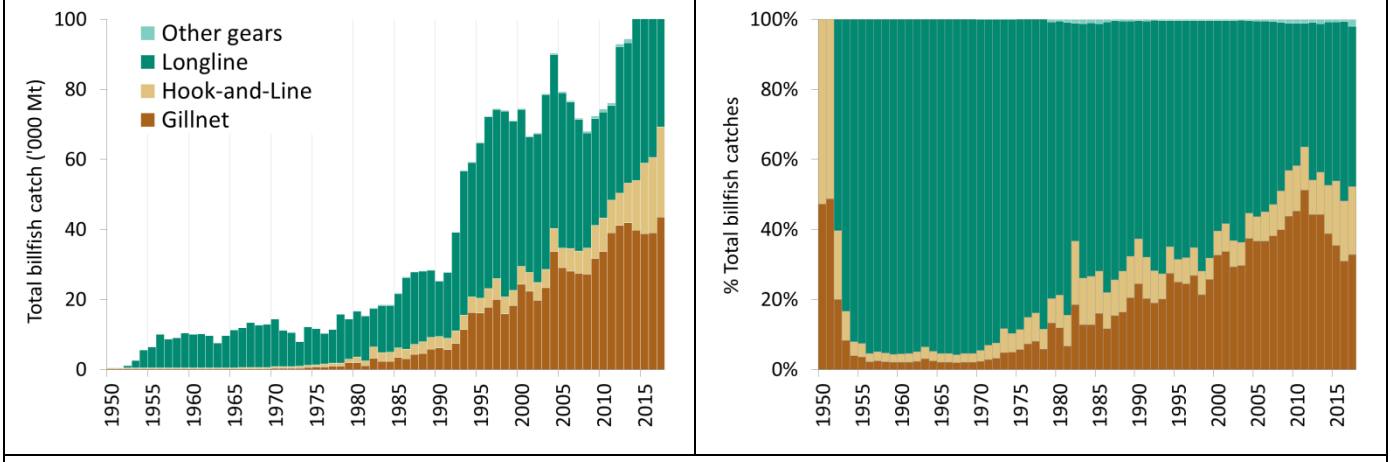


Fig. 2b-c: Billfish (all species): catches in the Indian Ocean over the period 1950–17, by gear. Fig 2b. Left: nominal catch of all billfish species, by gear; Fig. 2c. Right: percentage share of all billfish species catches, by gear.

SECTION 2: SUMMARY OF DATA ISSUES RELATED TO THE STATISTICS OF BILLFISH SPECIES REPORTED TO THE IOTC

The following section provides a summary of the main issues that the IOTC Secretariat considers to negatively affect the quality of billfish statistics available at the IOTC, by type of dataset, for the consideration of the WPB.

Nominal (retained) catches

Artisanal fisheries (including Sports Fisheries)

- Sri Lanka (gillnet/longline): In recent years, Sri Lanka has been estimated to catch over 15% of catches of marlins in the Indian Ocean. Although catches of marlins by species have been reported for its gillnet/longline fishery, the catch ratio of blue marlin to black marlin has changed dramatically in recent years. This is thought to be a sign of frequent mis-identification rather than the effect of changes in catch rates or species composition for this fishery. Although the IOTC Secretariat has adjusted the catches of marlins using proportions derived from years known to have reliable, the estimated catches remain uncertain.
- Indonesia (coastal fisheries): Catches of billfish reported by Indonesia for its artisanal fisheries in recent years are considerably higher than those reported in the past, at around 5% of the total catches of billfish in the Indian Ocean. In 2011 the Secretariat revised the nominal catch dataset for Indonesia, using information from various sources, including official reports. However the data quality of catches for artisanal fisheries of Indonesia is thought to be poor, with a likely underestimation of catches of billfish in recent years.
- Sport fisheries of Australia, France(La Réunion), India, Indonesia, Madagascar, Mauritius, Oman, Seychelles, Sri Lanka, Tanzania, Thailand and United Arab Emirates: Data has either never been submitted, or is available for only a limited number of years for sports fisheries in each of the referred CPCs. Sport fisheries are known to catch billfish species, and are particularly important for catches of blue marlin, black marlin and Indo-Pacific sailfish. Although some data are available from sport fisheries in the region (e.g., Kenya, Mauritius, Mozambique, South Africa), the information cannot be used to estimate levels of catch for other fisheries.

  To improve the quality and availability of data for sports fisheries, in 2017 the IOTC Secretariat commissioned a pilot project to develop tools and training materials to improve the collection of catch-and-effort and size frequency from sports fisheries in the Western Indian Ocean focused on a small number of CPCs, including La Réunion, Kenya, Mauritius and Seychelles.
- Drifting gillnet fisheries of I.R. Iran and Pakistan:

  In recent years both fisheries have reported catches of billfish at around 20,000 t (25% of the total catches). Catches for this component remain very uncertain:

  - I.R. Iran**:** In recent years I.R. Iran has reported catches of marlins and swordfish for it's gillnet fishery, (i.e., catches from 2012 onwards) which significantly revises the catch-by-species previously estimated by the IOTC Secretariat. While the IOTC Secretariat has used the new catch reports to re-build the historical series (pre-2012) for its offshore gillnet fishery, estimates for the historical series remain highly uncertain.
  - Pakistan: In 2017 Pakistan submitted revised catches dating back to the 1980s – however the data are significantly different to catches reported by WWF-Pakistan funded sampling in 2012, and also with previous official data reported by Pakistan to the IOTC Secretariat, particularly for swordfish, striped marlin and Indo-Pacific sailfish. Current IOTC catch estimates for Pakistan account for around 6% of the total catches of billfish in the Indian Ocean - however, based on the latest data submitted by Pakistan, catches are estimated to be much significantly lower. Verification of the data is currently being undertaken by the IOTC Secretariat to understand the reasons for the differences in reported data for Pakistan before further changes are made to the current estimates in the IOTC database.

Industrial (longline) fisheries

- Indonesia (fresh longline): Following issues with the reliability of catch estimates of Indonesia's fresh longline fleet in recent years, the IOTC Secretariat has provided the WPB-16 meeting with an alternative catch series, based on a new estimation methodology developed in collaboration with Indonesia (see IOTC-2018-WPB16-DATA03b available on the WPB meeting webpage). The revised catch series mostly affects Indonesia's catches of swordfish, striped marlin, and blue marlin estimated by the IOTC Secretariat.

  The revised catches are significantly lower for Indonesia's fresh longline fleet in recent years compared to previous IOTC estimates, while total catches across all fleets have also been revised downwards by as much as 30% for each species as a consequence of the new estimation methodology. Further details on the alternative catch series can be

found in paper IOTC-2018-WPB16-22. The alternative catch series will be discussed during the WPB and a recommendation made on which catch series to endorse for stock assessment purposes.

- Taiwan,China (fresh longline): The recent issues with IOTC's estimates of billfish for Indonesia relate to changes in the Taiwanese fresh-longline fleet, which in previous years has been used as a proxy fleet by the IOTC Secretariat to estimate the total catches and species composition (due to separate and unrelated issues with the reliability of Indonesia's officially reported catches).

  Despite a decrease in the number of Taiwanese fresh-longline vessels of around 30% between 2013-2016, catches have remained at similar levels, or even marginally increased as average catches per vessel have risen from 100 t per vessel in 2013 to around 175 t per vessel in 2016. Over the same period, the proportion of swordfish reported by the Taiwanese flesh longline fleet has risen from around 8% to over 30% due to improvements in the estimation of catches by species, according to official sources.

  Both these issues (i.e., the sharp increase in average catches per vessel, and also changes to the species composition) require further clarification before the changes are implemented within the IOTC database.

Catch-and-effort and CPUE series

For a number of fisheries important for billfish catches listed below, catch-and-effort remains either unavailable, incomplete (i.e., missing catches by species, gear, or fleet), or only partially reported according to the standards of IOTC Resolution 15/02, and therefore of limited value in deriving indices of abundance:

- EU,Spain (longline)**:** Incomplete catch-and-effort data is reported for the longline fishery of EU-Spain, which reports nominal catches for all billfish, but only time-area catches for swordfish.
- India (longline): In recent years, India has reported very incomplete catches and catch-and-effort data for its commercial longline fishery. The IOTC Secretariat has estimated total catches for this period using alternative sources, and the final estimated catches are significantly higher than those officially reported to the Secretariat.
- Republic of Korea (longline): The nominal catches and catch-and-effort data series for billfish for the longline fishery of Korea are conflicting, with nominal catches of swordfish and marlins lower than the catches reported as catch-and-effort for some years. Although in 2010 the IOTC Secretariat revised the nominal catch dataset to account for catches reported as catch-and-effort, the quality of the estimates remains unknown. However, the catches of longliners of the Republic of Korea in recent years are very small.

Size data from (all fisheries)

Size data for all billfish species is generally considered to be unreliable and insufficient to be of use for stock assessment purposes, as the numbers of samples for all species are below the minimum sampling coverage of one fish per tonne of catch recommended by IOTC. Also the quality of many of the samples collected by fishermen on commercial boats cannot be verified.

- Taiwan,China (longline): Size data have been available since 1980; however, the IOTC Secretariat has identified issues in the length frequency distributions, in particular fish recorded under various types of size class bins (e.g. 1cm, 2cm, 10cm, etc.) that are reported under identical class bins (e.g. 2cm, with all fish between 10-20 cm reported as 10-12cm). For this reason, the average weights estimated for this fishery are considered unreliable.
- I.R. Iran and Pakistan (gillnet): no size data reported for billfish species for gillnet fisheries since the 1980s.
- Sri Lanka (gillnet/longline)**:** Although Sri Lanka has reported length frequency data for swordfish and marlins in recent years, the lengths reported are considered highly uncertain, due to mis-identification of marlins and likely sampling bias (large specimens of swordfish and marlins are highly processed and not sampled for lengths, while small specimens are sampled).
- India and Oman (longline)**:** To date, India and Oman have not reported size frequency data for billfish from their commercial longline fisheries.
- Indonesia (longline): size frequency data has been reported for its fresh-tuna longline fishery in recent years. However, the samples cannot be fully disaggregated by fishing area (i.e., 5 degree square grid) due to being sampled in port (rather than on-board). For this reason the quality of the samples in the IOTC database are considered to be of limited value.
- Taiwan,China (fresh-tuna longline)**:** Taiwan,China recently submitted size frequency data for the fresh tuna longline for marlins and swordfish. In the case of data available for marlins, the data are considered uncertain due to the small number of samples for some species, or discrepancies in the size frequency distributions.

- India and Indonesia (artisanal fisheries): To date, India and Indonesia have not reported any billfish size frequency data for their artisanal fisheries.

Biological data (all billfish species)

The IOTC Secretariat has previously used length-age keys, length-weight keys, and processed weight-live weight keys for billfish species from other oceans due to the general lack of biological data, and length frequency data by sex, available from the fisheries indicated below:

- Industrial longline fisheries: in particular Taiwan,China, Indonesia, EU(all fleets), China and the Republic of Korea.

Data issues: priorities and suggested actions

The IOTC Secretariat suggests the following actions as key to improving the quality of datasets for the assessment of billfish, with a focus on fleets considered important for catches of billfish and for which issues have been identified with the data reported or currently estimated by the IOTC Secretariat (as detailed above).

i. I.R. Iran (gillnet fisheries): In previous years I.R. Iran has reported aggregated catches for all billfish species, which were estimated by species and gear by the IOTC Secretariat. Since 2012 Iran has now begun to report catches by billfish species, and which significantly revise the catches-by-species previously estimated by the IOTC Secretariat. The main changes are higher proportions of black marlin, rather than blue marlin reported by I.R. Iran, assigned to the offshore gillnet fishery. As a result of changes in the catch series total catches of black marlin for I.R. Iran were revised upwards by as much as 30% to 50% during the mid-2000's.

   Following an IOTC Data Compliance and Support mission to Iran in late-2017, the IOTC Secretariat has begun to receive detailed time-area catches (i.e., catch-and-effort) in accordance with the reporting requirements of Resolution 15/02. Data is also expected to be reported for the historical time series, which in turn will be used to inform the recent revisions to the billfish catches reported by Iran, and whether catches need to be revised for years prior to 2012.

ii. Pakistan (gillnet fisheries): In 2017 Pakistan submitted a revised catch series, dating back to the 1980s, and which significantly reduces estimates for billfish for Pakistan in the IOTC database – particularly for Indo-Pacific sailfish. The data are currently pending upload to the IOTC database until further clarifications have been received regarding the catch revision estimation methodology, and particularly the scale of revisions for some billfish species. The IOTC Secretariat has also proposed an IOTC Data Compliance and Support mission to Pakistan to address the current inconsistencies between Pakistan's official catch estimates and the current estimates in the IOTC database.

iii. Indonesia (fresh longline): As previous mentioned above, due to issues with the reliability of catch estimates of Indonesia's fresh longline fleet in recent years, the IOTC Secretariat has provided the WPB-16 meeting with an alternative catch series, based on a new estimation methodology developed in collaboration with Indonesia (see IOTC-2018-WPB16-DATA03b available on the WPB meeting webpage). The revised catch series mostly affects Indonesia's catches of swordfish, striped marlin, and blue marlin estimated by the IOTC Secretariat.

   The alternative catch series is significantly lower for Indonesia's fresh longline fleet in recent years compared to previous IOTC estimates, while total catches across all fleets have also been revised downwards by as much as 30% for each species as a consequence of the new estimation methodology. Further details can be found in paper IOTC-2018-WPB16-22, while the issue will be fully discussed during the WPB meeting and a recommendation made on which catch series to endorse for the purpose of stock assessment.

iv. Taiwan,China (fresh longline): Despite a decrease in the number of Taiwanese fresh-longline vessels of around 30% between 2013-2016, catches have remained at similar levels, or even marginally increased, as average catches per vessel have risen from 100 t per vessel in 2013 to around 175 t per vessel in 2016. Over the same period, the proportion of swordfish reported by the Taiwanese flesh longline fleet has risen from around 8% to over 30% due to improvements in the estimation of catches by species, according to official sources.

   Both these issues (i.e., the sharp increase in average catches per vessel, and also changes to the species composition) require further clarification before changes to the data are implemented within the IOTC database.

SECTION 3: STATUS OF FISHERIES STATISTICS FOR BILLFISH SPECIES

Swordfish (SWO: Xiphias gladius)

Fisheries and main catch trends

- Main fishing gear (2013–17): Longline catches[4] are currently estimated to comprise approximately 75% of total swordfish catches in the Indian Ocean. (**Table 2; Fig. 3**)
- Main fleets (and primary gear associated with catches): percentage of total catches (2013–17):
  Indonesia (fresh longline): 32%; Taiwan,China (longline): 16%; Sri Lanka (longline-gillnet): 14%; EU,Spain (swordfish targeted longline): 9% (**Fig. 4**).
- Main fishing areas: Primary: Western Indian Ocean, in waters off Somalia, and the southwest Indian Ocean. In recent years (2009 – 2011) the fishery has moved eastwards due to piracy, a decrease in fish abundance, or a combination of both. Secondary: Waters off Sri Lanka, western Australia and Indonesia.
- Retained catch trends:
  Before the 1990s, swordfish were mainly a non-targeted catch of industrial longline fisheries; catches increased relatively slowly in tandem with the development of coastal state and distant water longline fisheries targeting tunas.

  After 1990, catches increased sharply (from around 8,000 t in 1991 to 36,000 t in 1998) as a result of changes in targeting from tunas to swordfish by part of the Taiwan,China longline fleet, along with the development of longline fisheries in Australia, France(La Réunion), Seychelles and Mauritius and arrival of longline fleets from the Atlantic Ocean (EU,Portugal, EU,Spain the EU,UK and other fleets operating under various flags[5]).

  Since the mid-2000s annual catches have fallen steadily, largely due to the decline in the number of Taiwanese longline vessels active in the Indian Ocean in response to the threat of piracy; however since 2012 catches appear to show signs of recovery as a consequence of improvements in security in the area off Somalia.
- Discard levels: Low, although estimates of discards are unknown for most industrial fisheries, mainly longliners. Discards of may also occur in the driftnet fishery of I.R. Iran, as this species has no commercial value in this country.

***Changes to the catch series*:** Following issues with the reliability of catch estimates of Indonesia's fresh longline fleet, the IOTC Secretariat has provided the WPB-16 meeting with an alternative catch series based on a new estimation methodology developed in collaboration with Indonesia (IOTC-2018-WPB16-DATA03b available on the WPB meeting webpage). The revised catch series mostly affects catches of swordfish, striped marlin, and blue marlin estimated by the IOTC Secretariat for Indonesia.

Estimates for all three species have been reduced significantly for Indonesia's fresh longline fleet in recent years, while total catches across all fleets have also been revised downwards by as much as 30% for each species. Further details on the estimation methodology can be found in paper IOTC-2018-WPB16-22, but in the case of swordfish catches have been revised down in recent years from over 50,000 t to less than 35,000 t directly as a result of the revision to Indonesia's catches. A decision on which catch series to endorse will be discussed during the WPB meeting.

TABLE 2. Swordfish: best scientific estimates of catches by type of fishery for the period 1950–2017 (in metric tons). Data as of August 2018.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ELL	-	-	-	9	1,841	9,736	7,655	7,637	9,031	6,835	7,643	7,876	7,420	6,618	6,257	6,181
LL	260	1,301	1,920	4,313	22,692	20,085	13,511	13,810	12,419	10,976	17,466	17,186	21,051	24,109	33,162	33,096
OT	37	39	186	807	1,989	2,819	3,261	3,019	3,033	4,061	4,068	5,275	7,868	9,595	10,858	14,381
Total	**297**	**1,340**	**2,106**	**5,130**	**26,521**	**32,640**	**24,427**	**24,466**	**24,483**	**21,872**	**29,177**	**30,338**	**36,339**	**40,322**	**50,278**	**53,658**

Definition of fisheries: Swordfish targeted longline (**ELL**); Longline (**LL);** Other gears (includes longline-gillnet, handline, gillnet, gillnet-longline, coastal longline, troll line, sport fishing, and all other gears) (**OT**).

[4] Including deep freezing longline (LL), exploratory longline (LLEX), fresh longline (FLL), longlines targeting sharks (SLL), and swordfish targeted longline (ELL).
[5] E.g., Senegal, Guinea, etc.

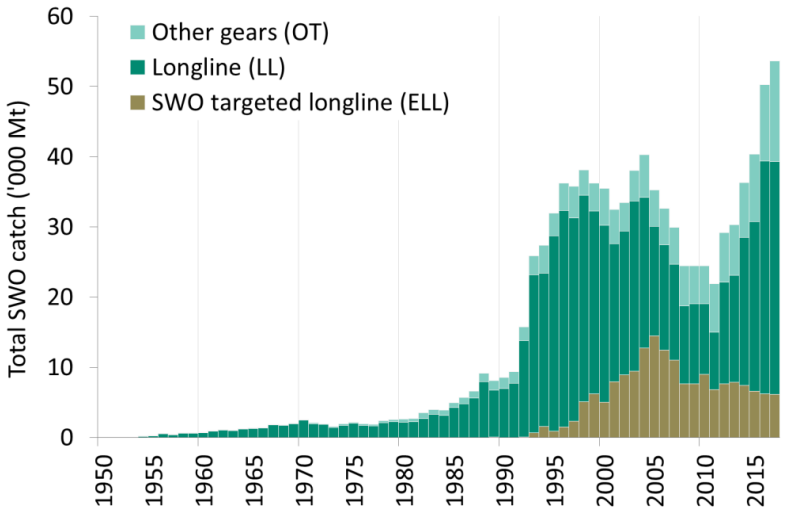


Fig. 3. Swordfish: catches by gear and year recorded in the IOTC Database (1950–2017).
Other gears includes: longline-gillnet, handline, gillnet, coastal longline, troll line, sport fishing, and all other gears.

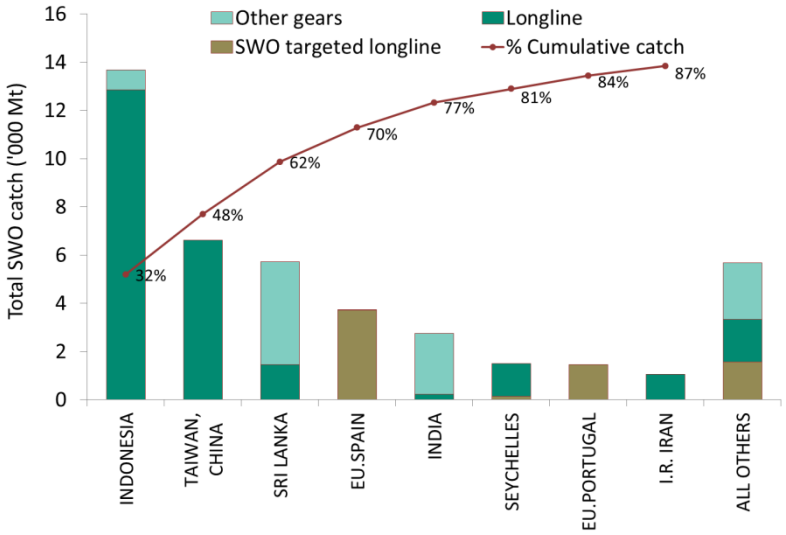


Fig. 4: Swordfish: average catches in the Indian Ocean over the period 2013–17, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported.

The red line indicates the (cumulative) proportion of catches of swordfish for the fleets concerned, over the total combined catches reported from all fleets and gears.

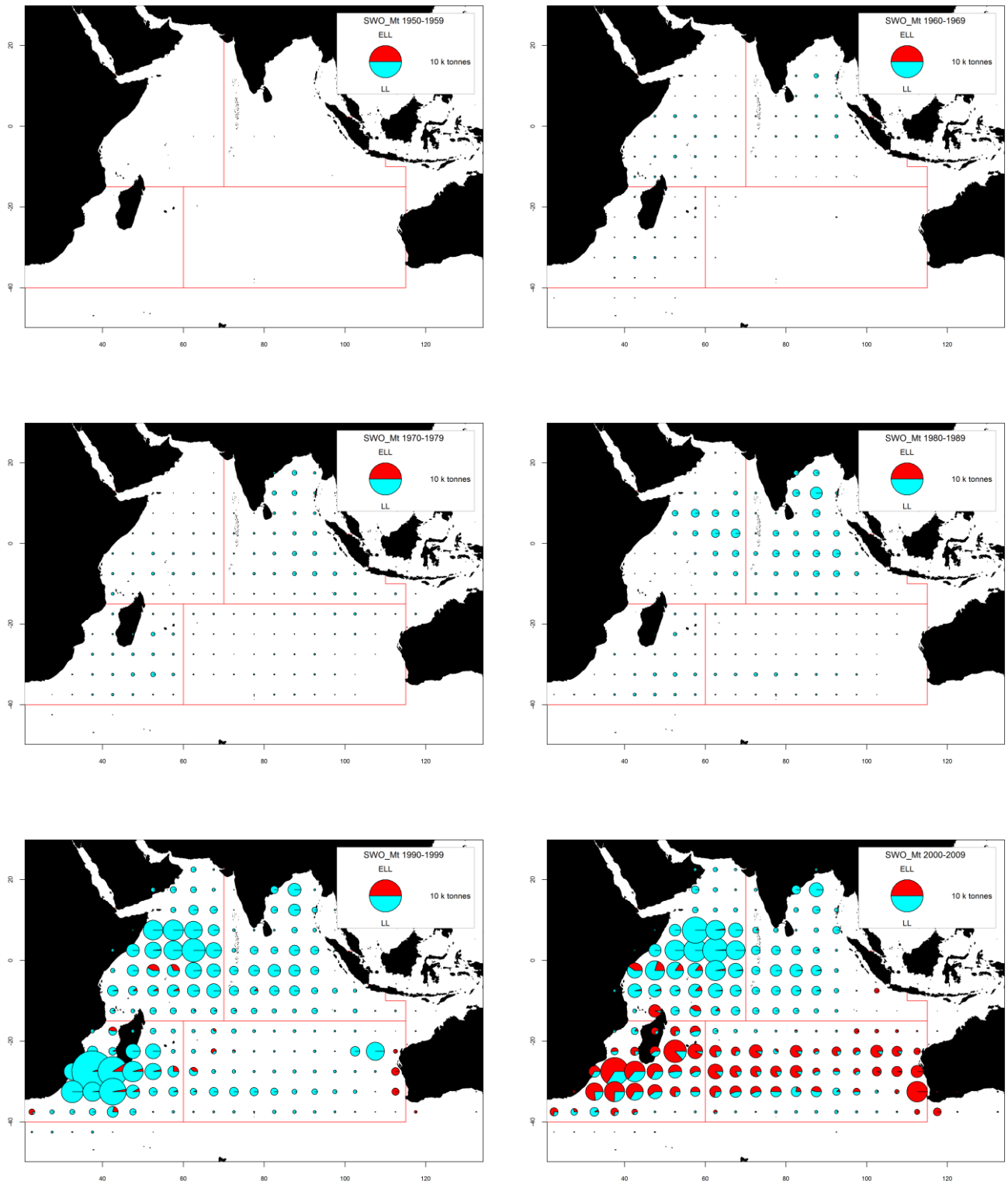


Fig. 5a-f: Swordfish: Time-area catches (total combined in tonnes) as reported for longline fisheries targeting swordfish (**ELL**), other longline fisheries (**LL**), for the period 1950-2009, by decade and type of gear. Red lines represent the areas used for the assessments of swordfish.

Source: IOTC catch-and-effort data. Does not include fleets non-reporting catch-and-effort data.

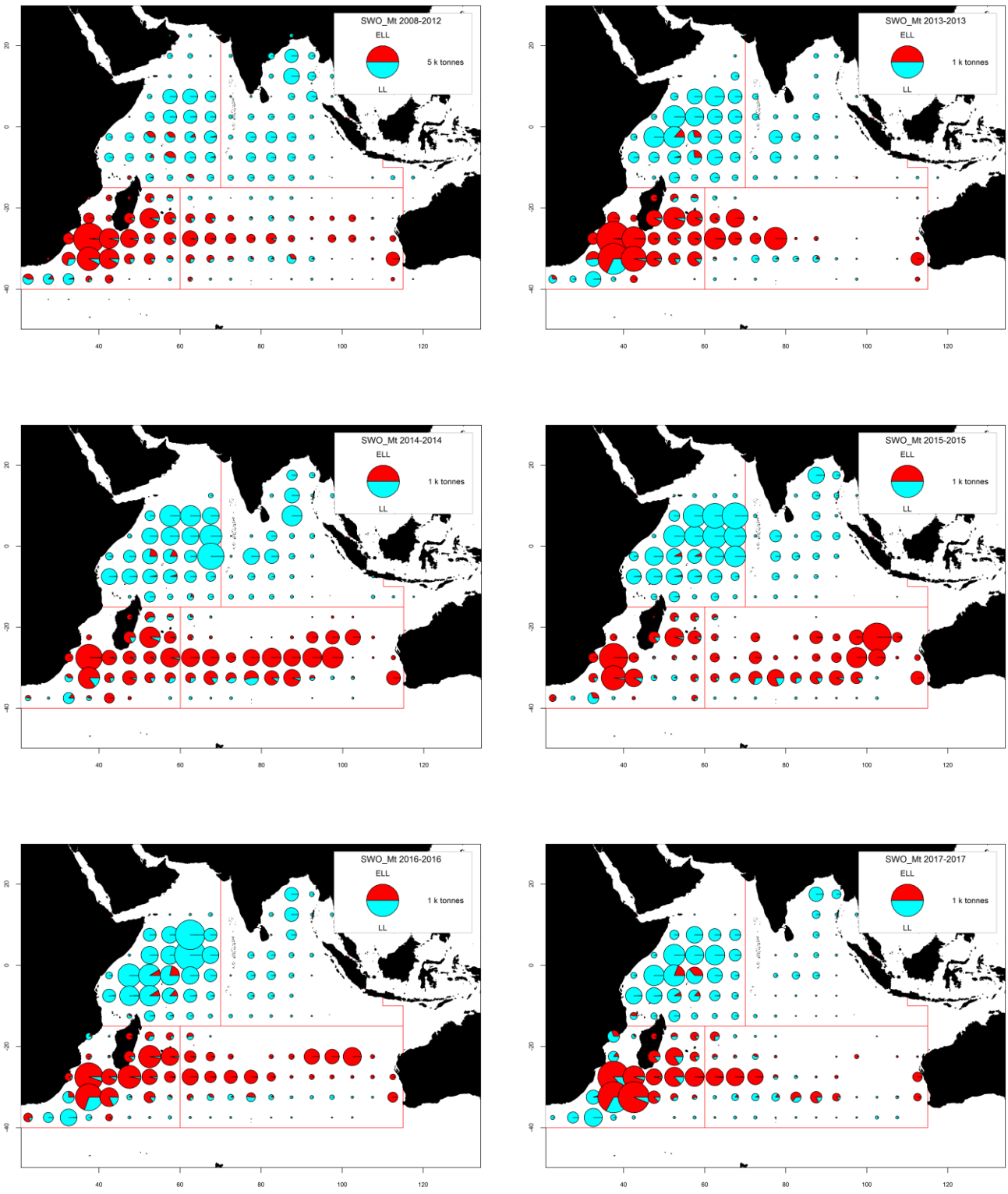


Fig. 6a-f: Swordfish: Time-area catches (total combined in tonnes) for longline fisheries targeting swordfish (**ELL**), other longline fisheries (**LL**), gillnet fisheries (**GI**), and for all other fleets combined (**OT**), for the period 2008-2012 by type of gear and for 20013-17, by year and type of gear. Red lines represent the areas used for the assessments of swordfish.

Source: IOTC catch-and-effort data (unraised). Does not include fleets non-reporting catch-and-effort data.

Swordfish: estimation of catches – data related issues

Retained catches – while the proportion of catches estimated, or adjusted, by the IOTC Secretariat are relatively low (**Fig.7a**), there are uncertainties for the following fisheries/fleets:

- I.R. Iran and Pakistan (Gillnet): the IOTC Secretariat used the catches of swordfish and marlins reported by I.R. Iran for the years 2012 and 2013 to rebuild historical catch series of billfish for this fishery. However, catch rates and species composition for the Iranian and Pakistani gillnet fisheries differ significantly from each other in terms of the species composition, and in the case of Pakistan, the catches by species and are also in contradiction with other estimates derived from WWF funded sampling conducted Pakistan in recent years.

  In 2017 Pakistan also submitted a revised catch series, dating back to the 1980s, and which are significantly lower than current estimates for billfish for Pakistan in the IOTC database, including swordfish. The data are currently pending upload to the IOTC database until further clarifications have been received regarding the catch revision estimation methodology, and particularly the scale of revisions for some billfish species.

- India (Longline): Incomplete catches and catch-and-effort data, especially for its commercial longline fishery. Catches in recent years represent less than 4% of the total catches of swordfish.

- Non-reporting fleets (NEI) (Longline): Catches estimated by the IOTC Secretariat, however the proportion of total catches associated with this fishery are thought to be low and do not have a significant impact on the overall catch series.

Swordfish – Catch-per-unit-effort (CPUE) trends

- Availability: Catch-and-effort series are available for some industrial longline fisheries (**Fig. 7b**).

For most other fisheries, catch-and-effort are either not available (e.g., longline fisheries of Indonesia, drifting gillnet fisheries of Iran and Pakistan), or they are considered poor quality – especially since the early-1990s (e.g., gillnet and longline fisheries of Sri Lanka, Taiwan,China fresh-tuna longliners, Non-reporting longliners (NEI)).

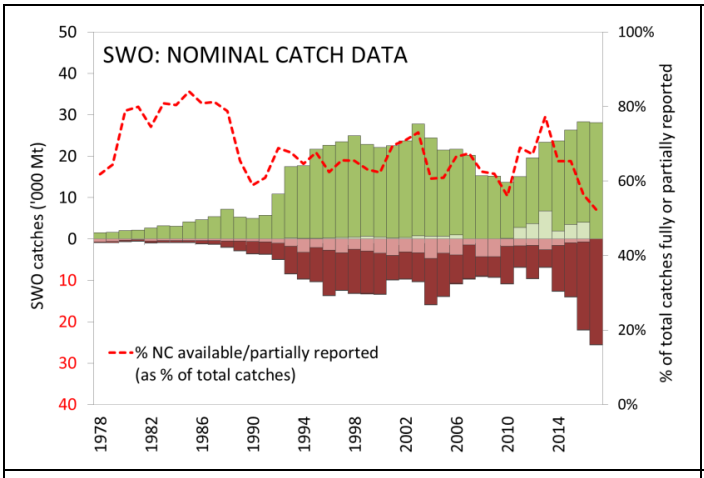
Swordfish – Fish size or age trends (e.g., by length, weight, sex and/or maturity)

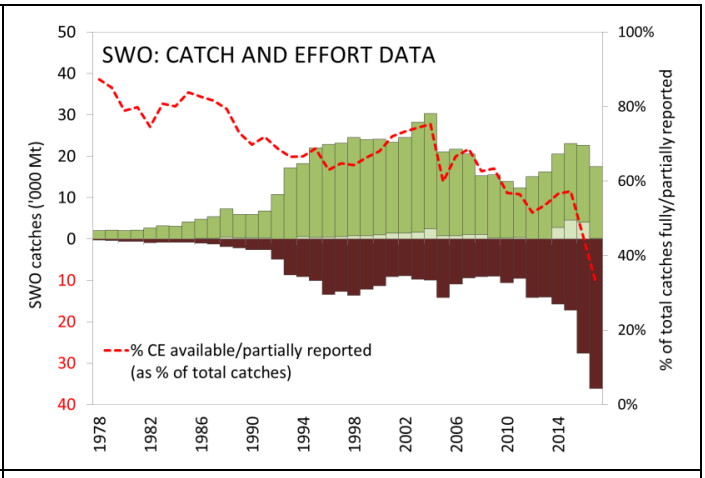
In general, the amount of catch for which size data for the species are available before 2005 is still very low and the number of specimens measured per stratum has been decreasing in recent years (**Fig. 7c**)

- Average fish weight: can be assessed for several industrial fisheries, although they are incomplete or poor quality for most fisheries before the early-80s and also in recent years (due low sampling coverage and time-area coverage of longliners from Japan). The average weights of swordfish are variable but show no clear trend. (**Appendix I**).

- Catch-at-Size (Age) table: data are available but the estimates are thought to have been compromised for some years and fisheries due to:
  i. Uncertainty in the length frequency data recorded for longliners of Japan and Taiwan,China, in which average weights of swordfish derived from length frequency and catch-and-effort data are very different.
  ii. Uncertainties in the catches of swordfish for the drifting gillnet fisheries of I.R. Iran and the longline fishery of Indonesia.
  iii. The lack of size data before the early-70s and poor coverage before the early-80s and for most artisanal fisheries (e.g., Pakistan, India, Indonesia).
  iv. The paucity of size data available from industrial longliners since the early-1990s (e.g. Japan, Philippines, India and China).
  v. The lack of time-area catches for some industrial fleets (e.g. Indonesia, India, NEI fleets).
  vi. The paucity of biological data available, notably sex-ratio and sex-length-age keys.

- Sex ratio data: have not been provided to the Secretariat by CPCs.





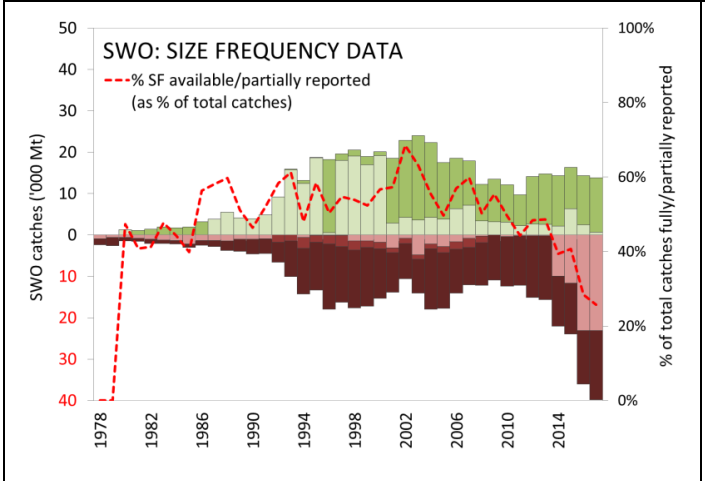


Fig. 7a-c. Swordfish: data reporting coverage (1978–2017).

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.*

Data as of August 2018.

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)

Blue Marlin (BUM: Makaira nigricans)

Fisheries and main catch trends

- Main fishing gear (2013–17): Blue marlin are largely considered to be a non-target species of industrial and artisanal fisheries. Longline catches[6] account for around 70% of total catches in the Indian Ocean, followed by gillnets (24%), with remaining catches recorded under troll and handlines. (**Table 3; Fig. 8**)
- Main fleets (and primary gear associated with catches): percentage of total catches (2012–15): Taiwan,China (longline): 34%; Indonesia (fresh longline): 31%; Pakistan (gillnet): 12%; I.R. Iran (gillnet): 9%, and Sri Lanka (6%) (**Fig. 9**).
- Main fishing areas: Western Indian Ocean, in the main fishing areas operated by longliners.
- Retained catch trends:
  Catch trends are variable, which may reflect the level of reporting and the status of blue marlin as a non-target species.

  Catches reported by drifting longliners were more or less stable until the late-70's, at around 3,000 t to 4,000 t, and have steadily increased since then to reach values between 8,000 t and to over 10,000 t since the early 1990's. The highest catches reported by longliners have been recorded since 2012, and are likely to be the consequence of higher catch rates by some longline fleets which appear to have resumed operations in the western tropical Indian Ocean.
- Discard levels**:** Low, although estimates of discards are unknown for most industrial fisheries, mainly longliners. Negligible levels of discards have also been reported for some purse seine fleets. Discards may also occur in some gillnet fisheries.

Changes to the catch series**:** Catches have been revised in recent years (i.e., 2015) when catches estimates for blue marlin were revised substantially following new reports of catches-by-species for Iran's drifting gillnet fleet[7].

In addition, following issues with the reliability of catch estimates of Indonesia's fresh longline fleet, the IOTC Secretariat has provided the WPB-16 meeting with an alternative catch series based on a new estimation methodology developed in collaboration with Indonesia (IOTC-2018-WPB16-DATA03b available on the WPB meeting webpage). The revised catch series mostly affects catches of swordfish, striped marlin, and blue marlin estimated by the IOTC Secretariat for Indonesia.

Estimates for all three species have been reduced significantly for Indonesia's fresh longline fleet in recent years, while total catches across all fleets have also been revised downwards by as much as 30% for each species (including blue marlin).

TABLE 3: Blue marlin: best scientific estimates of catches by type of fishery for the period 1950–2017 (in metric tons). Data as of August 2018.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
LL	2,567	3,535	3,409	4,545	6,982	7,410	6,369	6,664	6,675	7,281	12,226	10,232	10,789	11,508	13,167	10,976
GN	1	2	124	761	2,357	2,687	2,410	2,049	2,198	3,919	4,828	4,063	3,543	3,673	3,577	4,130
HL	5	9	17	105	168	150	195	277	303	269	265	341	497	684	818	1,533
OT	0	0	0	2	4	7	11	15	15	16	16	17	15	20	52	778
Total	**2,574**	**3,546**	**3,550**	**5,413**	**9,511**	**10,254**	**8,984**	**9,004**	**9,191**	**11,485**	**17,334**	**14,654**	**14,844**	**15,884**	**17,613**	**17,417**

Fisheries: Longline (**LL**); Gillnet (**GN**); Hook-and-Line (includes handline, trolling, baitboat, and sport fisheries) (**HL**); Other gears (includes coastal purse seine, Danish purse seine, beach seine, and purse seine) (**OT**).

[6] Including deep freezing longline (LL), exploratory longline (LLEX), fresh longline (FLL), longlines targeting sharks (SLL), and swordfish targeted longline (LLEX).

[7] Prior to 2013 I.R. Iran reported aggregated catches for all billfish species, which were estimated by species and gear by the IOTC Secretariat. Iran has provided catches by billfish species for the first time, from 2012 onwards, which significantly revised the catch-by-species previously estimated by the Secretariat: the main change being the higher proportions of black marlin, rather than blue marlin reported by I.R. Iran, assigned to the offshore gillnet fishery. As a result of changes in the catch series total catches of black marlin for I.R. Iran were revised upwards by as much as 30% to 50% for a number of years around the mid-2000's.

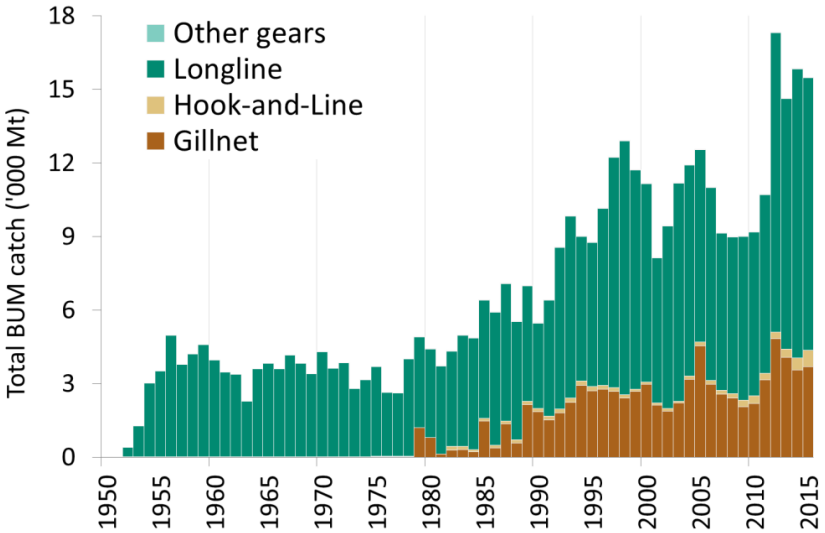


Fig. 8. Blue marlin: catches by gear and year recorded in the IOTC Database (1950–2017). Other gears includes: coastal purse seine, Danish purse seine, beach seine and purse seine.

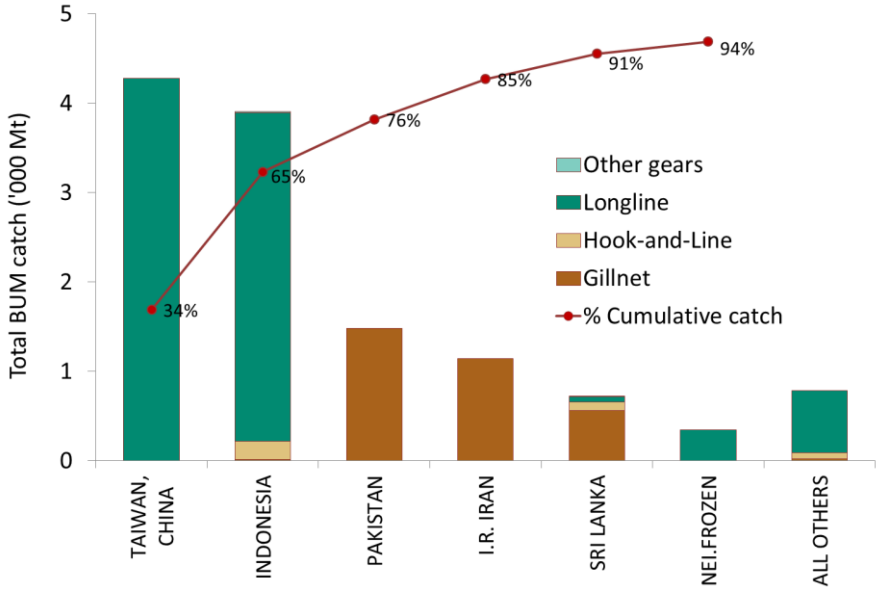


Fig. 9: Blue marlin: average catches in the Indian Ocean over the period 2013–17, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported.

The red line indicates the (cumulative) proportion of catches of blue marlin for the fleets concerned, over the total combined catches reported from all fleets and gears.

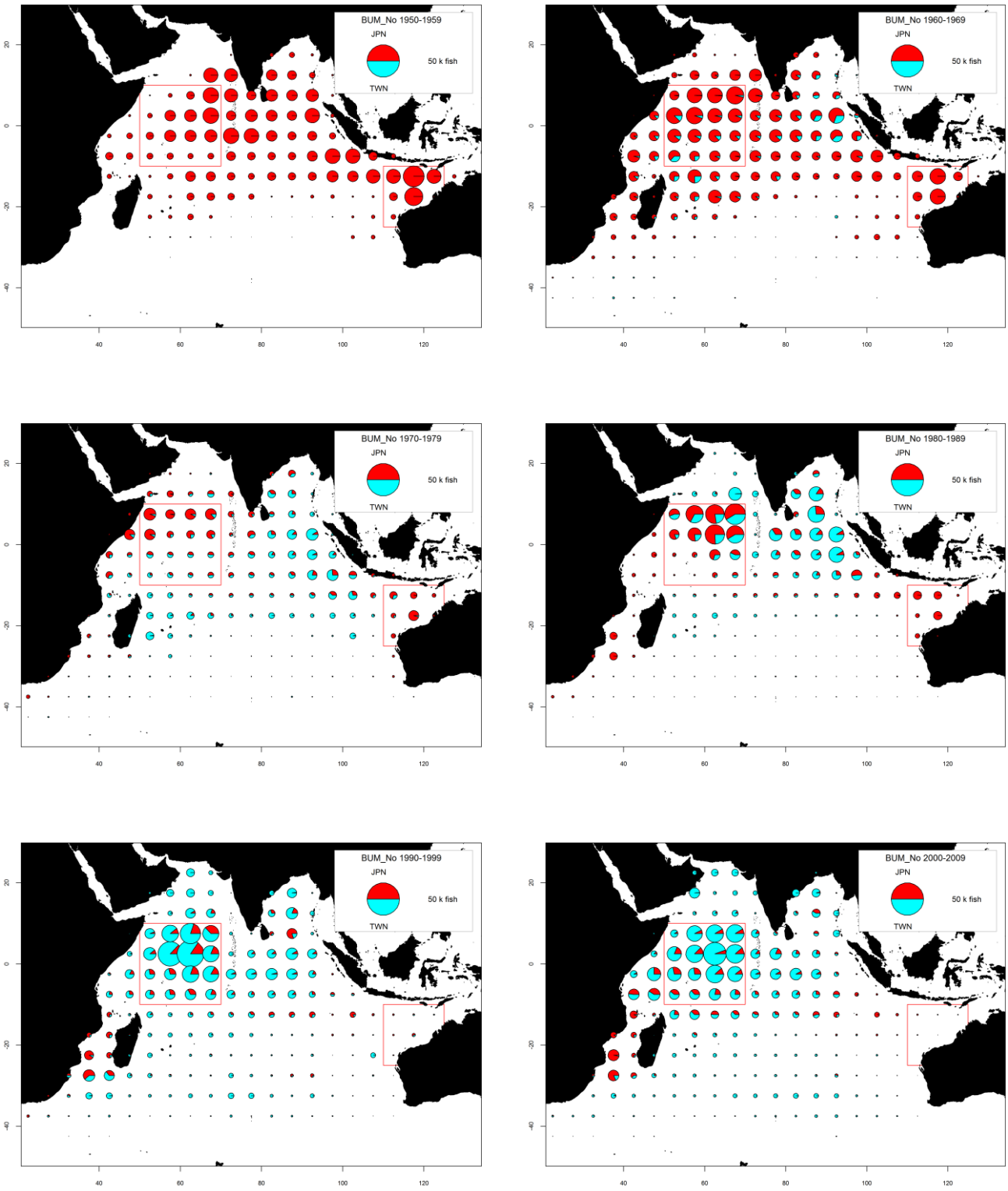


Fig. 10a-f. Time-area catches (in number of fish) of blue marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 1950-2009, by decade and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch-and-effort data (unraised). Does not include fleets non-reporting catch-and-effort data.

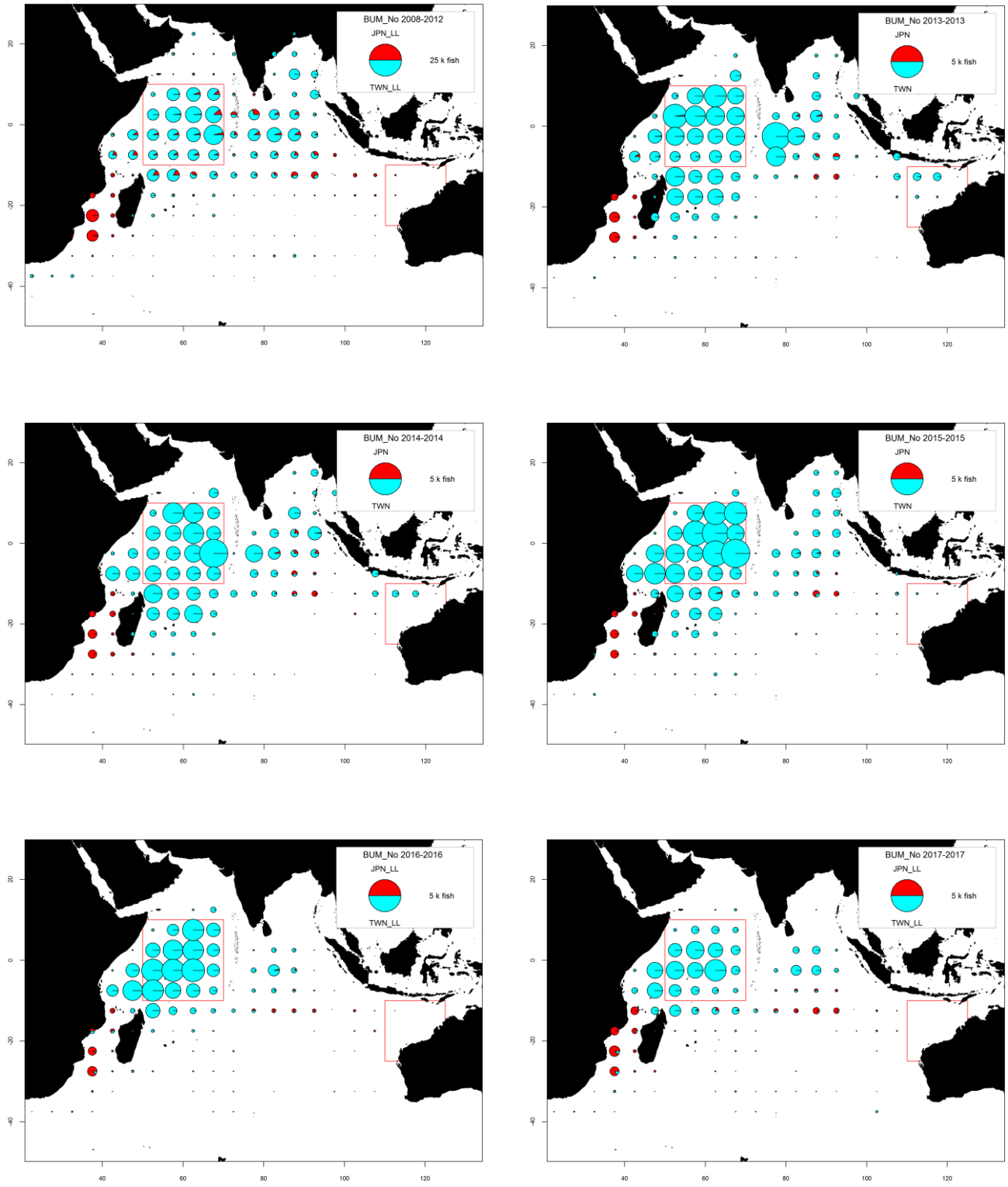


Fig. 11a-f. Time-area catches (in number of fish) of blue marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 2008–12 by fleet and for 2013–17, by year and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch-and-effort data (unraised). Does not include fleets non-reporting catch-and-effort data.

Blue marlin: estimation of catches – data related issues

Retained catches – a high proportion of the catches of blue marlin are estimated, or adjusted, by the IOTC Secretariat are (**Fig.12a**), due to a number of uncertainties in the catches:

- Species aggregates: catch reports often refer to total catches of all three marlin species combined or as an aggregate of all billfish species. Catches-by-species are estimated by the IOTC Secretariat for some years and artisanal fisheries (e.g., gillnet-longline fishery of Sri Lanka, artisanal fisheries of India, Iran and Pakistan) and industrial fisheries (e.g., longliners of Indonesia and Philippines).
- Non-reporting fleets: catches of non-reporting industrial longliners (e.g., India, NEI) and the gillnet fishery of Indonesia are estimated by the Secretariat using alternative information.
- Non-target species: catches are likely to be incomplete for industrial fisheries for which blue marlin is not a target species.
- Conflicting catch reports: longline catches from the Republic of Korea reported as nominal catches, and catch and effort are conflicting, with higher catches recorded in the catch and effort table. For this reason, the Secretariat revised the catches of blue marlin for the Republic of Korea over the time-series using both datasets. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of blue marlin remain uncertain for this fleet.
- Lack of catch data for most sport fisheries.
- Species mis-identification: difficulties in the identification of marlins also contribute to uncertainties in the catch estimates of blue marlin.

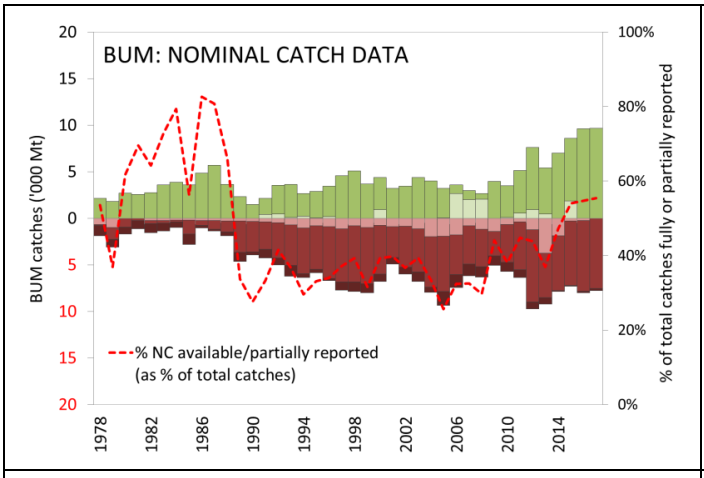
Blue marlin – Nominal catch-per-unit-effort (CPUE) trends

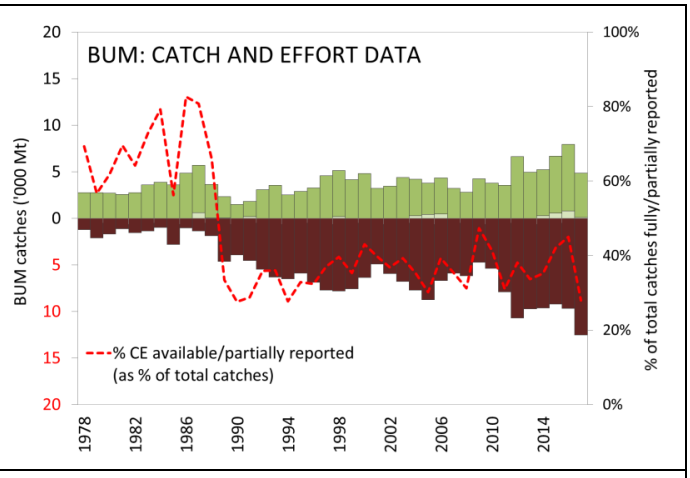
- Availability: Standardized CPUE series have not yet been developed. Nominal CPUE series are available for some industrial longline fisheries, although catches are likely to be incomplete (as catches of non-target species are not always recorded in logbooks).

  No catch-and-effort data are available from sports fisheries, other than for partial data from the sports fisheries of Kenya; likewise no data are available for other artisanal fisheries (gillnet fisheries of Iran and Pakistan, gillnet/longlines of Sri Lanka, gillnets of Indonesia) or other industrial fisheries (NEI longliners and all purse seiners).
- Main CPUE series available: Japanese longline fleet and Taiwanese longline fleet (**Appendix I**).

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

- Average fish weight: can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. However, the number of specimens measured on Japanese longliners in recent years is very low and mis-identification of striped and blue marlin may occur in some longline fisheries. Also the length frequency distributions derived from samples collected by fishermen on Taiwanese longliners may not be representative of the total catches (**Appendix I**).
- Catch-at-Size (Age) table: not available, due to lack of size samples and uncertainty over the reliability of retained catch estimates, or conflicting catch-and-effort data. Fish size is derived from various length and weight information, however the reliability of the size data is reduced for some fleets and when relatively few fish out of the total catch are measured.
- Sex ratio data: have not been provided to the Secretariat by CPCs.





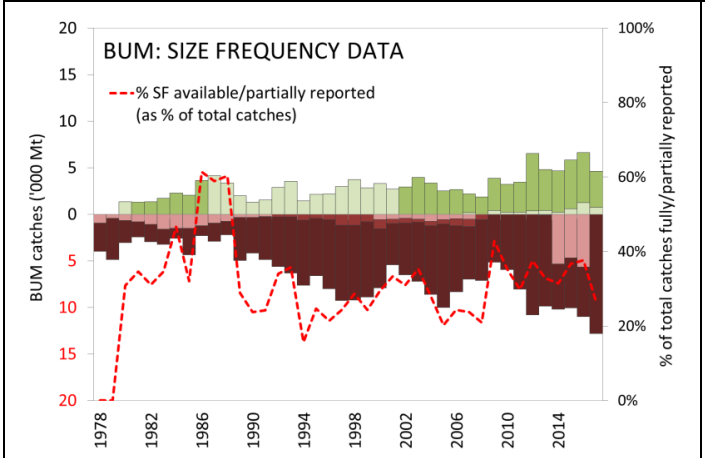


Fig. 12a-c. Blue marlin: data reporting coverage (1978–2017).

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.*

Data as of August 2018.

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)

Black Marlin (BLM)

Fisheries and main catch trends

- Main fishing gear (2013–17): black marlin are largely considered to be a non-target species of industrial and artisanal fisheries. Gillnets account for around 50% of total catches in the Indian Ocean, followed by longlines (17%), with remaining catches recorded under troll and handlines. (**Fig. 13**)
- Main fleets (and primary gear associated with catches): percentage of total catches (2013–17):
  India (gillnet and trolling): 27%; I.R. Iran (gillnet): 26%; Sri Lanka (gillnet and fresh longline): 18%; Indonesia (fresh longline and hand lines): 14% (**Fig. 14**).
- Main fishing areas:

  Primary: between the early-1950s and the late-1980s part of the Japanese fleet was licensed to operate within the EEZ of Australia, and reported very high catches in that area, in particular in waters off northwest Australia.

  Secondary: in recent years, deep-freezing longliners from Japan and Taiwan,China have reported catches of black marlin off the western coast of India and the Mozambique Channel.
- Retained catch trends:
  Since the 1990s catches have increased steadily, from 2,800 t in 1991 to over 10,000 t in 2004. In recent years catches have further increased sharply from around 15,000 t in 2013 to over 22,000 t in 2016 and 2017 – the highest catches recorded in the Indian Ocean for the species (**Table 4**) – largely due to increases reported by the offshore gillnet fisheries of I.R. Iran.

  Catches in Sri Lanka have also risen steadily since the mid-1990's as a result of the development of the fishery using a combination of drifting gillnets and longlines, from around 1,000 t in the early 1990s to over 3,000 t in recent years.
- Discard levels**:** Low, although estimates of discards are unknown for most industrial fisheries, mainly longliners. Negligible levels of discards have also been reported for some purse seine fleets. Discards may also occur in some gillnet fisheries.

Changes to the catch series**:** Following issues with the reliability of catch estimates of Indonesia's fresh longline fleet, the IOTC Secretariat has provided the WPB-16 meeting with an alternative catch series based on a new estimation methodology developed in collaboration with Indonesia (IOTC-2018-WPB16-DATA03b available on the WPB meeting webpage). The revised catch series mostly affects catches of swordfish, striped marlin, and blue marlin estimated by the IOTC Secretariat for Indonesia.

Estimates for all three species have been reduced significantly for Indonesia's fresh longline fleet in recent years, while total catches across all fleets have also been revised downwards by as much as 30% for each species. Changes to the catches for black marlin are less affected, but have also been revised downwards by up to 6% from 2012 onwards.

TABLE 4. Black marlin: best scientific estimates of catches by type of fishery for the period 1950–2017 (in metric tons). Data as of August 2018.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
LL	862	1661	1391	1728	1571	1981	3033	1839	1868	1982	2174	2621	3549	3027	4690	4224
GN	26	31	44	439	2761	6917	6226	6935	6070	8957	8495	8567	9689	8892	10242	10052
HL	24	27	45	486	736	1017	1274	2147	1629	1864	2260	3058	4518	6505	7762	7663
OT	0	0	5	82	112	226	329	460	472	490	483	693	454	455	385	686
Total	**912**	**1,719**	**1,485**	**2,735**	**5,181**	**10,142**	**10,862**	**11,380**	**10,039**	**13,293**	**13,412**	**14,939**	**18,210**	**18,879**	**23,079**	**22,625**

Fisheries: Longline (**LL**); Gillnet (**GN**); Hook-and-Line (includes handline, trolling, baitboat, and sport fisheries) (**HL**); Other gears (includes coastal purse seine, Danish purse seine, beach seine, and purse seine) (**OT**).

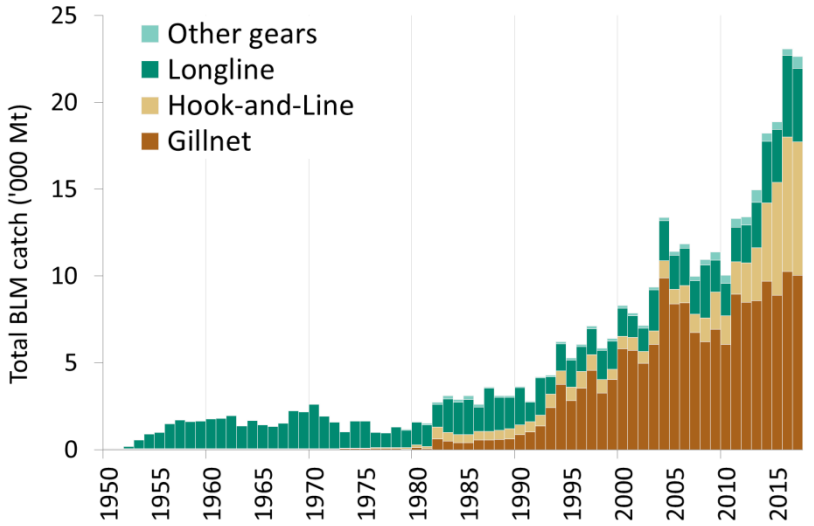


Fig. 13. Black marlin: catches by gear and year recorded in the IOTC Database (1950–2017). Other gears includes: coastal purse seine, Danish purse seine, beach seine and purse seine.

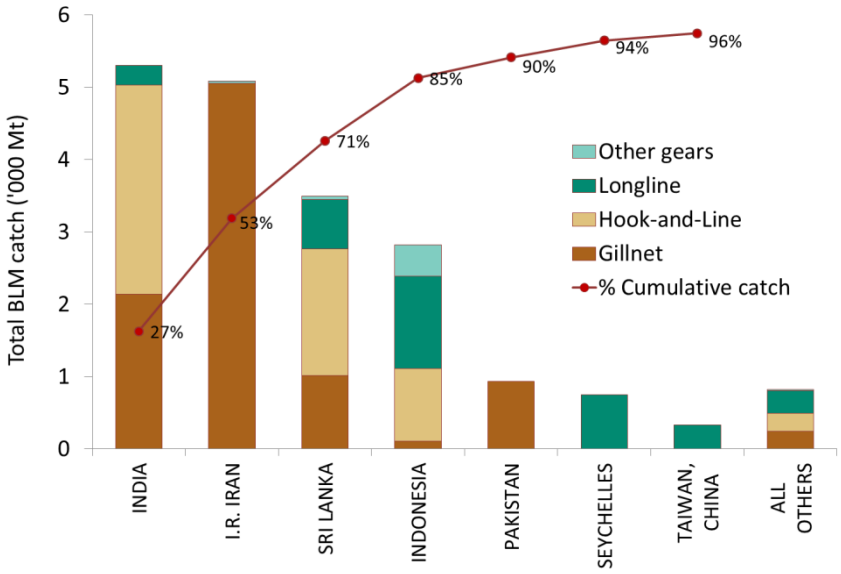


Fig. 14: Black marlin: average catches in the Indian Ocean over the period 2013–17, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported.

The red line indicates the (cumulative) proportion of catches of black marlin for the fleets concerned, over the total combined catches reported from all fleets and gears.

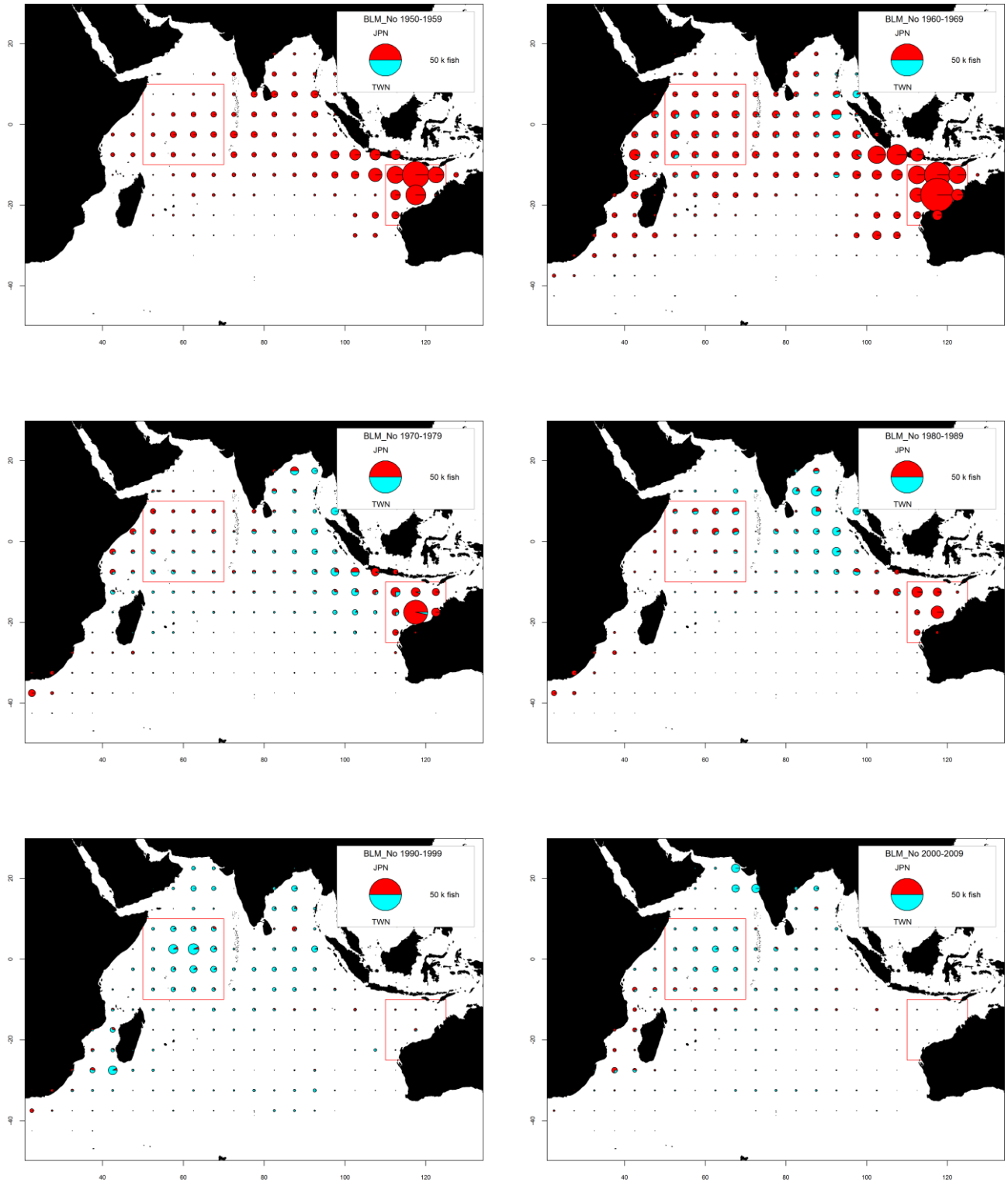


Fig. 15a-f. Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 1950–2009, by decade and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch-and-effort data. Does not include fleets non-reporting catch-and-effort data.

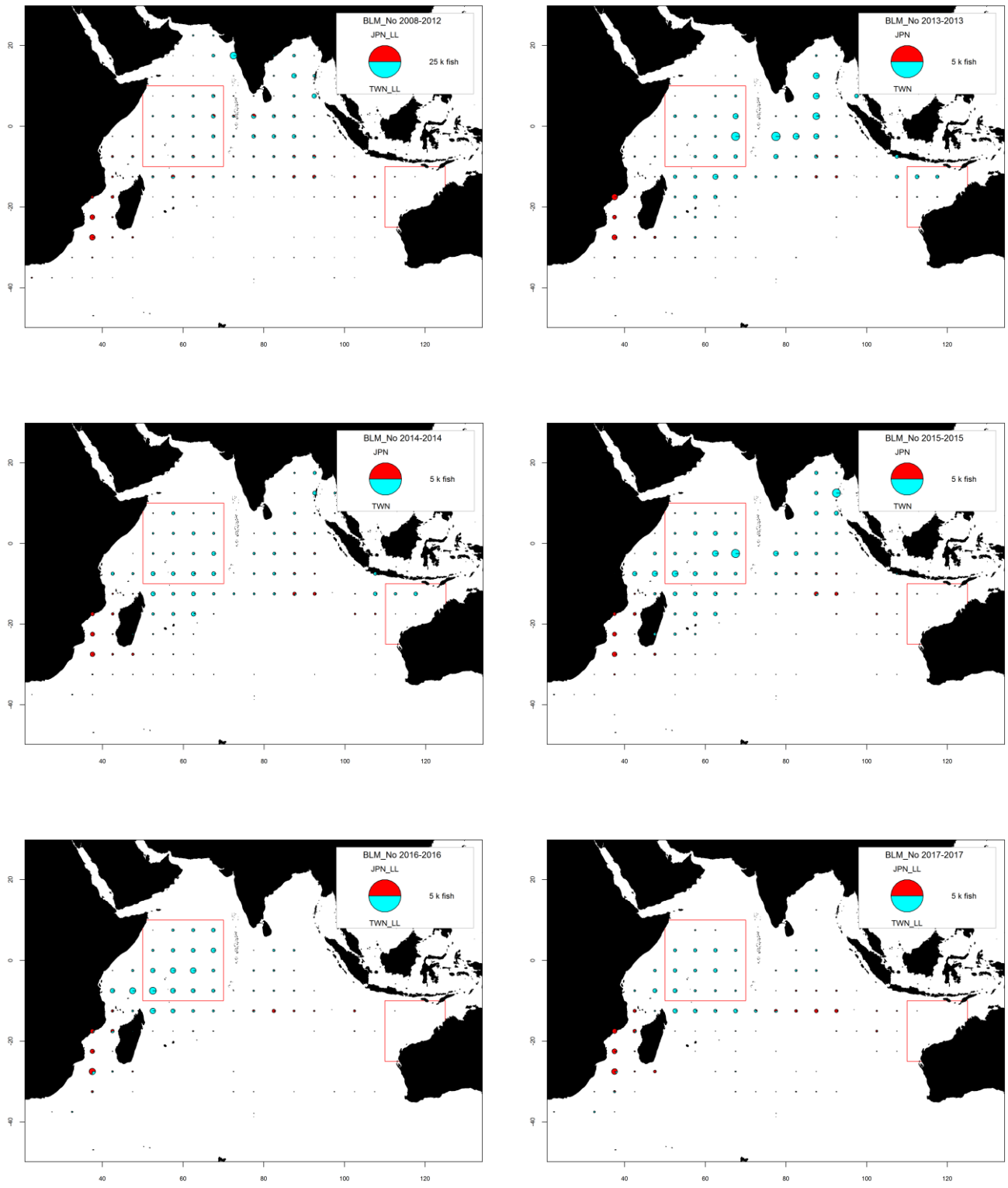


Fig. 16a-f. Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 2008–12 by fleet and for 2013–17, by year and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch-and-effort data (unraised). Does not include fleets non-reporting catch-and-effort data.

Black marlin: estimation of catches – data related issues

Retained catches – a very high proportion of the catches of black marlin are estimated, or adjusted, by the IOTC Secretariat are (**Fig.17a**), due to a number of uncertainties in the catches:

- Species aggregates: catch reports often refer to total catches of all three marlin species combined or as an aggregate of all billfish species; catches by species are estimated by the Secretariat for some years and artisanal fisheries (e.g., gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, I.R. Iran and Pakistan) and industrial fisheries (e.g., longliners of Indonesia and Philippines).
- Non-reporting fleets: catches of non-reporting industrial longliners (e.g., India, NEI fleets) and the gillnet fishery of Indonesia are estimated by the Secretariat using alternative information.
- Non-target species: catches are likely to be incomplete for industrial fisheries for which black marlin is not a target species.
- Conflicting catch reports: longline catches from the Republic of Korea reported as nominal catches, and catch and effort reports are conflicting, with higher catches recorded in the catch and effort table. For this reason, the Secretariat revised the catches of black marlin for the Republic of Korea over the time-series using both datasets. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of blue marlin remain uncertain for this fleet.
- General lack of catch data for most sport fisheries, particularly in the Western Indian Ocean.
- Species mis-identification: difficulties in the identification of marlins also contribute to uncertainties in the catch estimates of black marlin available to the Secretariat.

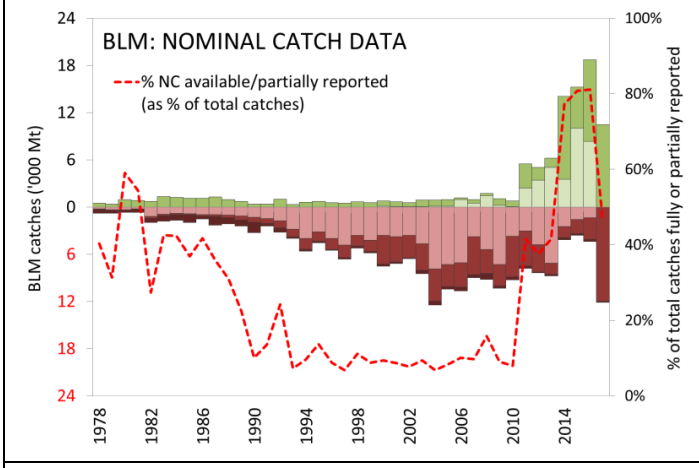
Black marlin – Nominal catch-per-unit-effort (CPUE) trends

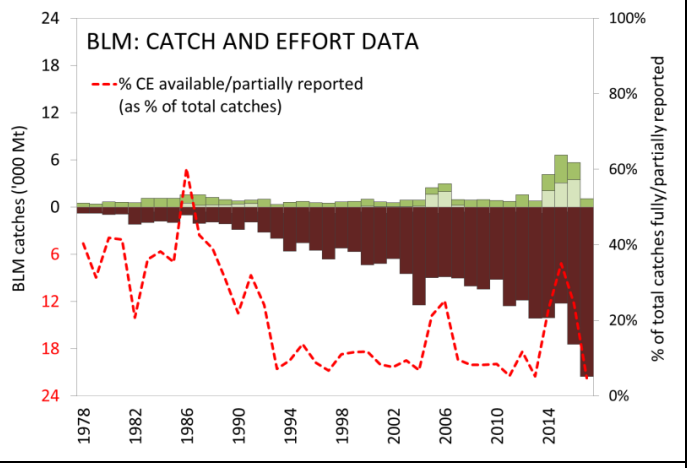
- Availability: Standardized CPUE series have been developed for Japanese and Taiwanese fleets. Nominal CPUE series are available for some industrial longline fisheries, although catches are likely to be incomplete (as catches of non-target species are not always recorded in logbooks).

  No catch-and-effort data are available from sports fisheries, other than partial data from the sports fisheries of Kenya; likewise no data are available for other artisanal fisheries (e.g., gillnet fisheries of Iran, Indonesia and Pakistan).
- Main CPUE series available: Japanese and Taiwan,China longline fleet (**Appendix I**).

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

- Average fish weight: can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. However, the number of specimens measured on Japanese longliners in recent years is very low. Also the length frequency distributions derived from samples collected by fishermen on Taiwanese longliners are also likely to be biased (**Appendix I**).
- Catch-at-Size (Age) table: not available, due to lack of size samples and uncertainty over the reliability of retained catch estimates, or conflicting catch-and-effort data. Fish sizes are derived from various length and weight information, however the reliability of the size data is uncertain for some fleets, particularly when relatively few fish out of the total catch are measured.
- Sex ratio data: have not been provided to the Secretariat by CPCs.





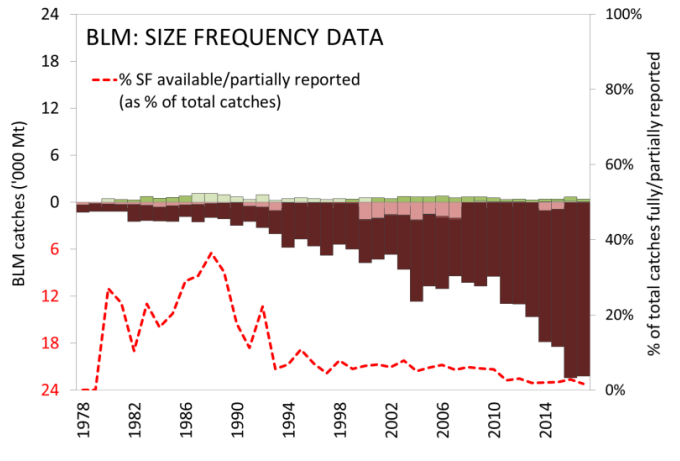


Fig. 17a-c. Black marlin: data reporting coverage (1978–2017).

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.*

Data as of August 2018.

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)

Striped Marlin (MLS)

Fisheries and main catch trends

- Main fishing gear (2013–17): striped marlin are largely considered to be a non-target species of industrial fisheries. Longlines account for around 66% of total catches in the Indian Ocean, followed by gillnets (27%), with remaining catches recorded under troll and handlines. (**Table 5, Fig. 18**)
- Main fleets (and primary gear associated with catches): percentage of total catches (2012–15):
  Indonesia (drifting longline and coastal longline): 37%; Taiwan,China (drifting longline): 19%; I.R. Iran (gillnet): 16%; and Pakistan (gillnet): 8% (**Fig. 19**).
- Main fishing areas: The distribution of striped marlin catches has changed since the 1980's with most of the catch now taken in the north-west Indian Ocean (**Table 6**), although between 2007 – 2011 catches in this area have dropped markedly, in tandem with a reduction of longline effort due to piracy.

  Changes in fishing grounds and catches are thought to be related to changes in access agreements to the EEZs of coastal countries in the Indian Ocean, rather than necessarily changes in the distribution of the species over time. Between the early-50s and the late-80s part of the Japanese fleet was licensed to operate within the EEZ of Australia, and reported relatively high catches of striped marlin in the area, in particular in waters off northwest Australia, as well in the Bay of Bengal. Catches by Japan has since declined dramatically.
- Retained catch trends:
  Catch trends are variable, ranging from 2000 t to 8000 t per year, which may reflect the level of reporting and the status of striped marlin as a non-target species.

  Similarly, catches reported under drifting longlines are highly variable, with lower catch levels between 2009 and 2011 largely due to declining catches reported by Taiwan,China, deep-freezing and fresh-tuna longliners. Catches of striped marlin have since increased in 2012 and 2013, as longline vessels have resumed operations in the north-west Indian Ocean.
- Discard levels**:** Low, although estimates of discards are unknown for most industrial fisheries, mainly longliners. Discards may also occur in the driftnet fishery of the I.R of Iran, as this species has no commercial value in this country.

Changes to the catch series**:** Following issues with the reliability of catch estimates of Indonesia's fresh longline fleet, the IOTC Secretariat has provided the WPB-16 meeting with an alternative catch series based on a new estimation methodology developed in collaboration with Indonesia (IOTC-2018-WPB16-DATA03b available on the WPB meeting webpage). The revised catch series mostly affects catches of swordfish, striped marlin, and blue marlin estimated by the IOTC Secretariat for Indonesia.

Estimates for all three species have been reduced significantly for Indonesia's fresh longline fleet in recent years, while total catches across all fleets have also been revised downwards by as much as 30% for each species. Further details on the estimation methodology can be found in paper IOTC-2018-WPB16-22, but generally speaking estimates of striped marlin are revised downwards in the alternative catch series (Scenario 2), to between 5000 and 3000 t from 2012 onwards.

TABLE 5: Striped marlin: best scientific estimates of catches by type of fishery for the period 1950–2017 (in metric tons). Data as of August 2018.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
LL	1,028	3,104	3,458	5,144	5,120	2,922	2,117	1,679	2,093	2,240	4,534	3,246	2,454	2,843	3,740	2,473
GN	5	8	16	22	161	541	389	407	331	900	978	1,182	1,238	1,263	1,098	1,209
HL	3	5	10	32	72	137	198	273	282	292	287	331	290	270	273	328
OT	0	0	0	6	10	20	29	41	42	44	43	48	40	39	35	77
Total	**1,036**	**3,117**	**3,485**	**5,204**	**5,362**	**3,620**	**2,733**	**2,400**	**2,748**	**3,475**	**5,843**	**4,807**	**4,022**	**4,415**	**5,146**	**4,087**

Fisheries: Longline (**LL**); Gillnet (**GN**); Hook-and-Line (includes handline, trolling, baitboat, and sport fisheries) (**HL**); Other gears (includes coastal purse seine, Danish purse seine, beach seine, and purse seine) (**OT**).

TABLE 6: Striped marlin: best scientific estimates of catches by fishing area for the period 1950–2017 (in metric tons). Data as of August 2018.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NW	335	1,859	1,516	2,073	2,713	1,807	1,177	840	748	1,330	3,619	2,775	1,787	1,684	3,060	2,058
SW	9	124	159	162	661	247	134	219	309	500	346	258	173	178	380	239
NE	551	810	1,542	2,752	1,609	1,331	1,336	1,266	1,505	1,540	1,837	1,725	2,014	2,386	1,659	1,738
SE	141	324	159	218	380	235	85	75	186	106	41	50	47	167	47	52
Total	**1,036**	**3,117**	**3,375**	**5,204**	**5,362**	**3,620**	**2,733**	**2,400**	**2,748**	**3,475**	**5,843**	**4,807**	**4,022**	**4,415**	**5,146**	**4,087**

Areas: Northwest Indian Ocean (**NW**); Southwest Indian Ocean (**SW**); Northeast Indian Ocean (**NE**); Southeast Indian Ocean (**SE**); Southern Indian Ocean (**OT**).

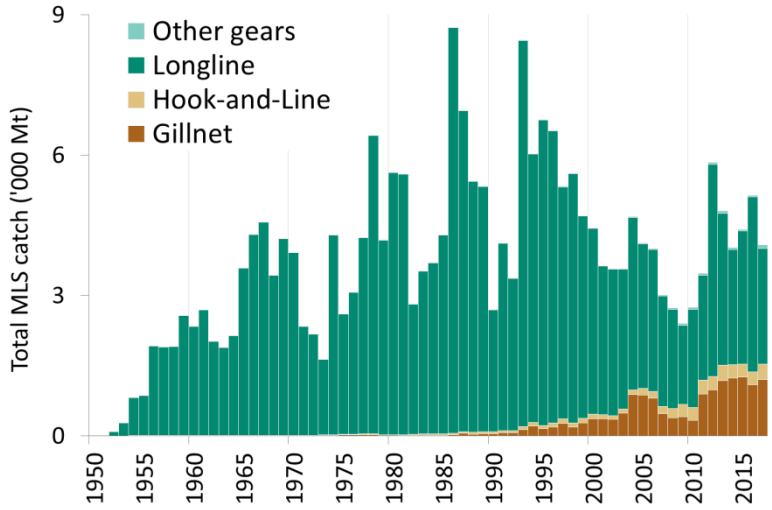


Fig. 18. Striped marlin: catches by gear and year recorded in the IOTC Database (1950–2017). Other gears includes: coastal purse seine, Danish purse seine, beach seine and purse seine.

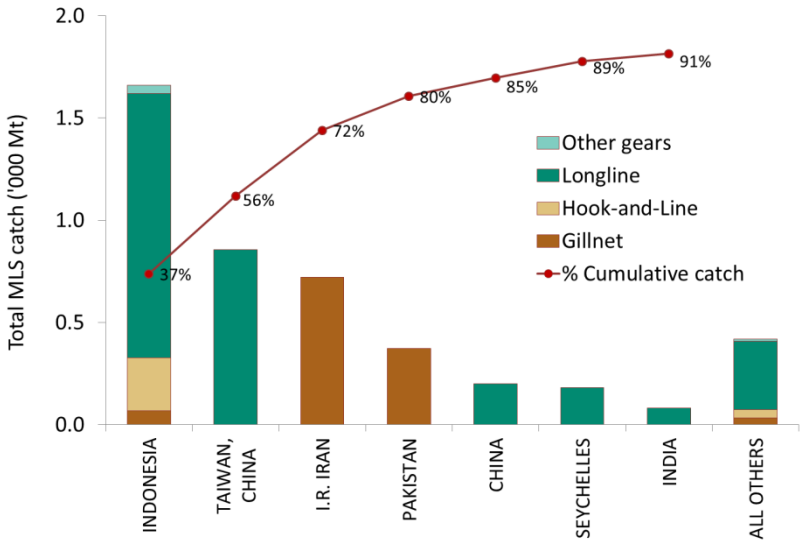


Fig. 19: Striped marlin: average catches in the Indian Ocean over the period 2013–17, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported.

The red line indicates the (cumulative) proportion of catches of striped marlin for the fleets concerned, over the total combined catches reported from all fleets and gears.

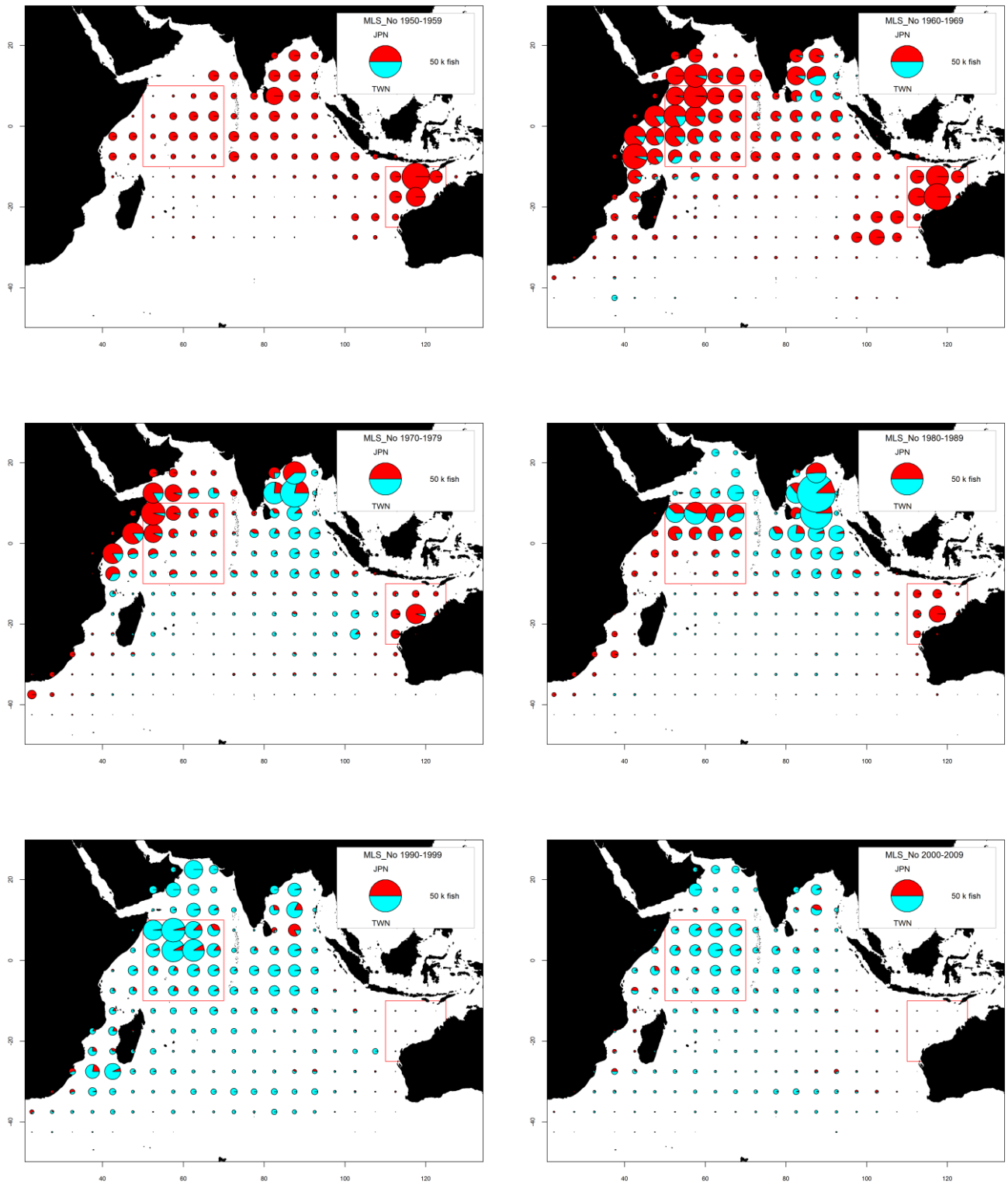


Fig. 20a-f. Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 1950–2009, by decade and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch-and-effort data (unraised). Does not include fleets non-reporting catch-and-effort data.

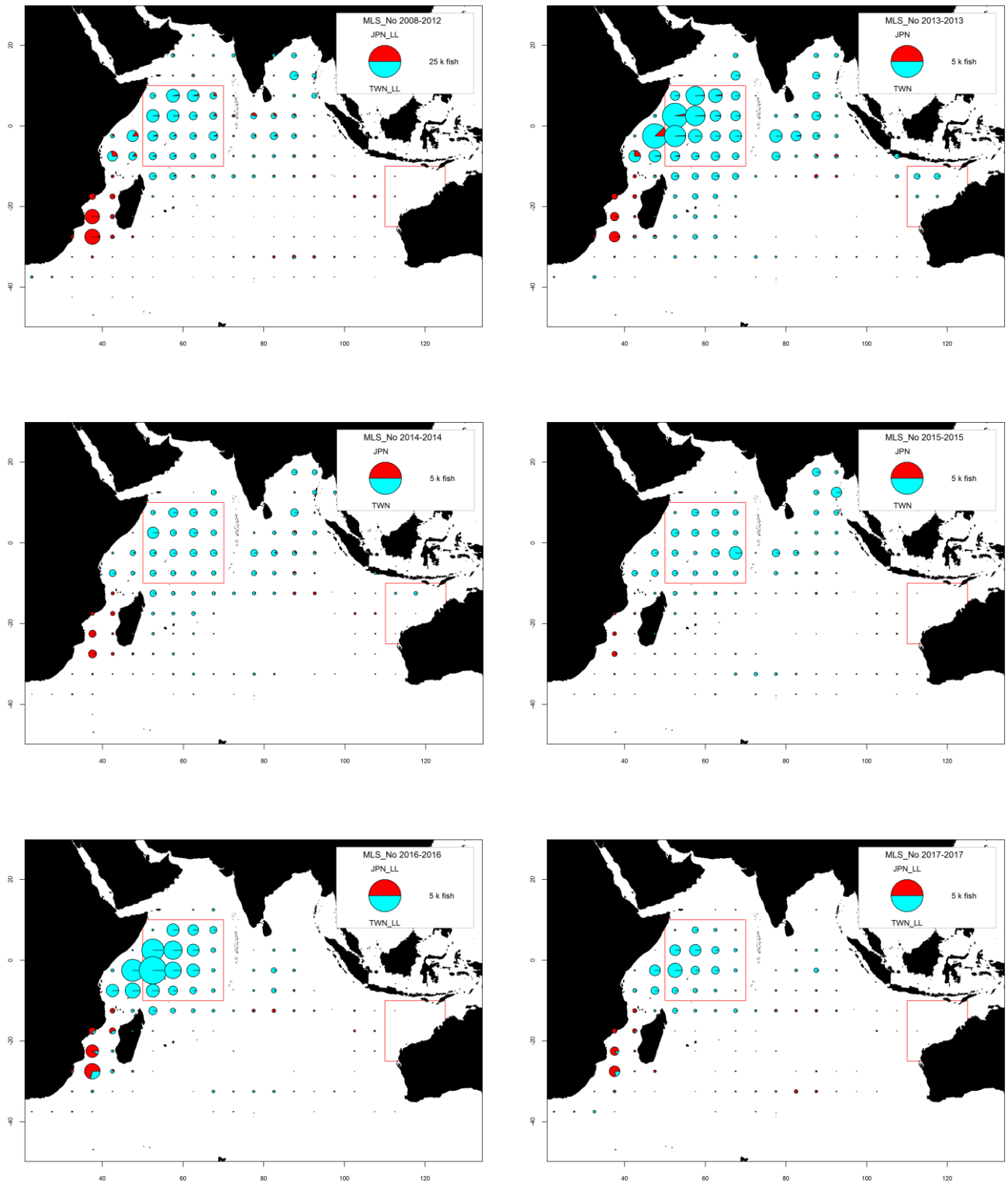


Fig. 21a-f. Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 2006–10 by fleet and for 2011–15, by year and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch-and-effort data (unraised). Does not include fleets non-reporting catch-and-effort data.

Striped marlin: estimation of catches – data related issues

Retained catches – while the proportion of catches estimated, or adjusted, by the IOTC Secretariat are relatively low compared to other species of marlins (**Fig.22a**), there are a number of uncertainties in the catches:

- Species aggregates: catch reports refer to total catches of all three marlin species; catches by species have to be estimated by the IOTC Secretariat for some industrial fisheries (e.g., longliners of Indonesia and Philippines).
- Non-reporting fleets: catches of non-reporting industrial longliners (e.g., India, NEI) and the gillnet fishery of Indonesia are estimated by the Secretariat using alternative information.
- Non-target species: catches are likely to be incomplete for industrial fisheries for which striped marlin is not a target species.
- Conflicting catch reports: longline catches from the Republic of Korea reported as nominal catches, and catch and effort reports are conflicting, with higher catches recorded in the catch and effort table. For this reason, the Secretariat revised the catches of striped marlin for the Republic of Korea over the time-series using both datasets. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of striped marlin remain uncertain for this fleet.

  There are also conflicting catch reports for the drifting gillnet fishery of Pakistan, with very high catches of striped marlins reported by alternative sources (i.e., WWF funded sampling) derived from sampling in different locations in Pakistan. These relatively high catch levels are in contradiction to a revised catch series submitted by the Government of Pakistan to the IOTC in 2017, which estimates much lower catches of billfish based on the results of a separate WWF-funded crew based observer scheme. The IOTC Secretariat is currently in the process of evaluating the revised catch series pending clarification on a number of issues regarding the scale of revisions to catches for some species, including striped marlin.
- Species mis-identification: difficulties in the identification of marlins also contribute to uncertainties in the catch estimates of striped marlin available to the Secretariat.

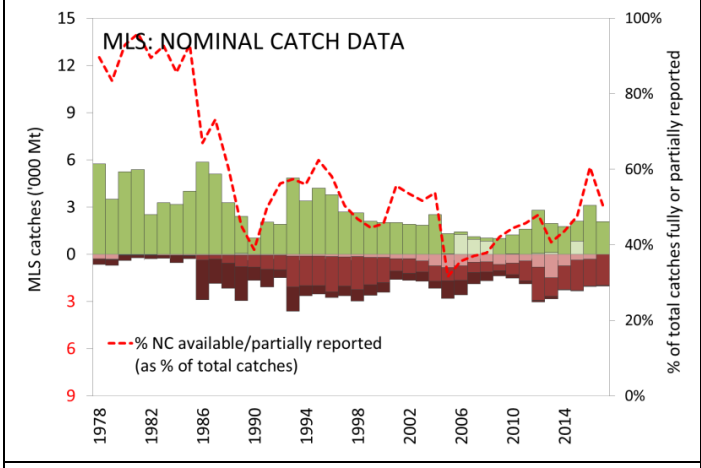
Striped marlin – Nominal catch-per-unit-effort (CPUE) trends

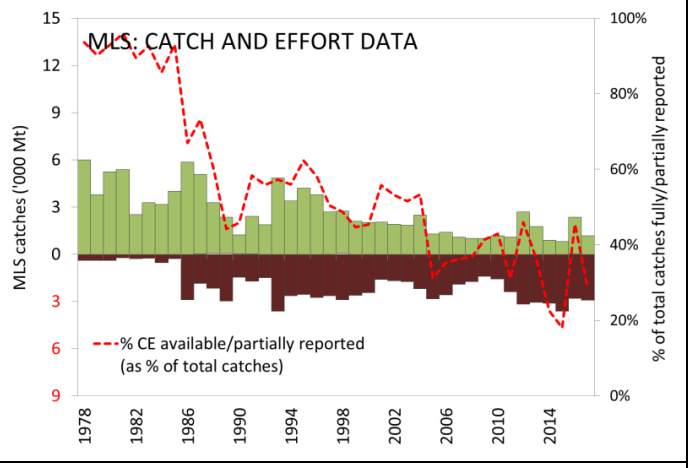
- Availability: Standardized CPUE series have been developed for the Japanese and Taiwanese longline fleets. Nominal CPUE series are available for some industrial longline fisheries, although catches are likely to be incomplete (as catches of non-target species are not always recorded in logbooks).

  No catch-and-effort data are available from sports fisheries, other than for partial data from the sports fisheries of Kenya; likewise no data are available for other artisanal fisheries (e.g., gillnet fisheries of Iran, Pakistan and Indonesia) or other industrial fisheries (NEI longliners and all purse seiners). Unreliable data from gillnet/longlines of Sri Lanka.
- Main CPUE series available: Japanese and Taiwanese longline fleet (**Appendix I**).

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

- Average fish weight: can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. However, the number of specimens measured on Japanese longliners in recent years is very low. Also mis-identification of striped and blue marlin may be occurring in the Taiwanese longline fishery. Thirdly, the length frequency distributions derived from samples collected on Taiwanese longliners differ greatly from those collected on longliners flagged in Japan (**Appendix I**).
- Catch-at-Size (Age) table: not available, due to lack of size samples and uncertainty over the reliability of retained catch estimates, or conflicting catch-and-effort data. Fish size is derived from various length and weight information, however the reliability of the size data is reduced for some fleets and when relatively few fish out of the total catch are measured.
- Sex ratio data: have not been provided to the Secretariat by CPCs.





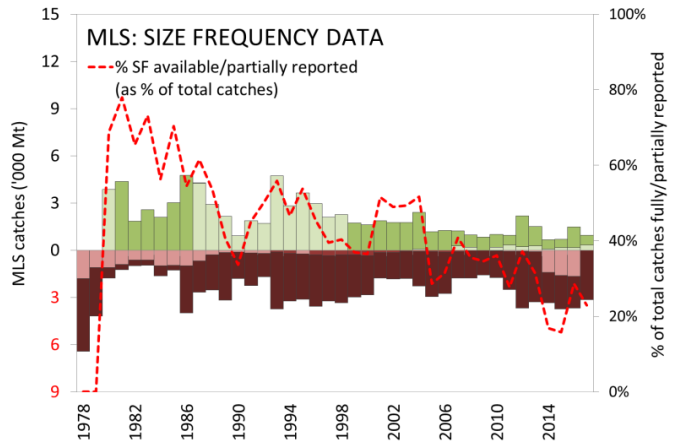


Fig. 22a-c. Striped marlin: data reporting coverage (1978–2017).

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.*

Data as of August 2018.

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)

Indo-Pacific Sailfish (SFA)

Fisheries and main catch trends

- Main fishing gear (2013–2017): gillnets account for around 70% of total catches in the Indian Ocean, followed by troll and hand lines (21%), with remaining catches recorded under longlines and other gears (**Fig. 23**).
- Main fleets (and primary gear associated with catches): percentage of total catches (2013–17):
  Three quarters of the total catches of Indo-Pacific sailfish are accounted for by four countries situated in the Arabian Sea: I.R. Iran (gillnets): 31%; India (gillnets and trolling): 19%; Pakistan (gillnets): 16%; and Sri Lanka (gillnets and fresh longline): 9% (**Fig. 24**).

  This species is also a popular catch for sport fisheries (e.g. Kenya, Mauritius, and Seychelles).
- Main fishing areas: Primary: north-west Indian Ocean (Arabian Sea).
- Retained catch trends:
  Catches have increased sharply since the mid-1990's (from around 5,000 t in the early 1990s to nearly 30,000 t from 2011 onwards) (**Table 7**) – largely due to the development of a gillnet/longline fishery in Sri Lanka and, especially, the extension of Iranian gillnet vessels operating in areas beyond the EEZ of I.R. Iran. In the case of I.R. Iran, gillnet catches have increased from less than 1,000 t in the early 1990's to between 7,000 t and over 11,000 t since 2013.

  Catches from drifting longline fleets have also likely increased, but have been under reported as the species has little commercial value. In recent years, deep-freezing longliners from Japan have reported catches of Indo-Pacific sailfish in the central western Indian Ocean, between Sri Lanka and the Maldives and the Mozambique Channel.
- Discard levels**:** Moderate to high, however discard levels are largely unknown for most industrial fisheries (i.e., mostly longliners).

Changes to the catch series**:** Following issues with the reliability of catch estimates of Indonesia's fresh longline fleet, the IOTC Secretariat has provided the WPB-16 meeting with an alternative catch series based on a new estimation methodology developed in collaboration with Indonesia (IOTC-2018-WPB16-DATA03b[8] available on the WPB meeting webpage). The revised catch series mostly affects catches of swordfish, striped marlin, and blue marlin estimated by the IOTC Secretariat for Indonesia.

Estimates for all three species have been reduced significantly for Indonesia's fresh longline fleet in recent years, while total catches across all fleets have also been revised downwards by as much as 30% for each species. Changes to the catches for sailfish are less affected, but have also been revised downwards by up to 5% from 2012 onwards.

TABLE 7: Indo-Pacific sailfish: best scientific estimates of catches by type of fishery for the period 1950–2017 (in metric tons). Data as of August 2018.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
LL	297	804	385	256	1,400	1,416	2,534	1,257	656	455	700	903	2,674	1,709	3,593	3,748
GN	165	181	504	1,774	6,055	12,503	13,863	18,303	21,037	19,920	21,229	22,956	21,832	21,445	19,163	22,890
HL	171	213	456	1,427	2,470	3,927	4,445	5,412	5,999	5,477	5,048	5,581	4,638	6,708	6,916	7,892
OT	-	-	2	24	41	85	134	171	175	184	180	275	173	167	142	361
Total	**633**	**1,197**	**1,347**	**3,480**	**9,966**	**17,931**	**20,976**	**25,143**	**27,867**	**26,035**	**27,157**	**29,714**	**29,318**	**30,030**	**29,813**	**34,891**

Fisheries: Longline (**LL**); Gillnet (**GN**); Hook-and-Line (includes handline, trolling, baitboat, and sport fisheries) (**HL**); Other gears (includes coastal purse seine, Danish purse seine, beach seine, and purse seine) (**OT**).

[8] http://www.iotc.org/documents/WPB/16/data/03b-NC_Scenario2

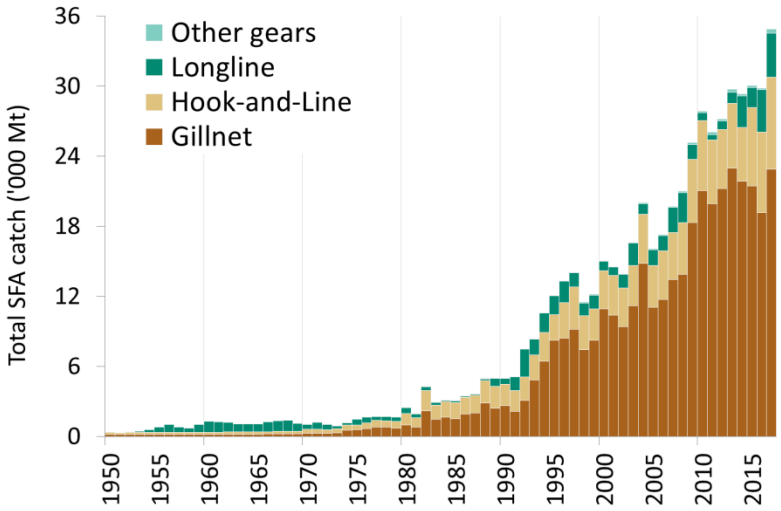


Fig. 23. Indo-Pacific sailfish: catches by gear and year recorded in the IOTC Database (1950–2017). Other gears includes: coastal purse seine, Danish purse seine, beach seine and purse seine.

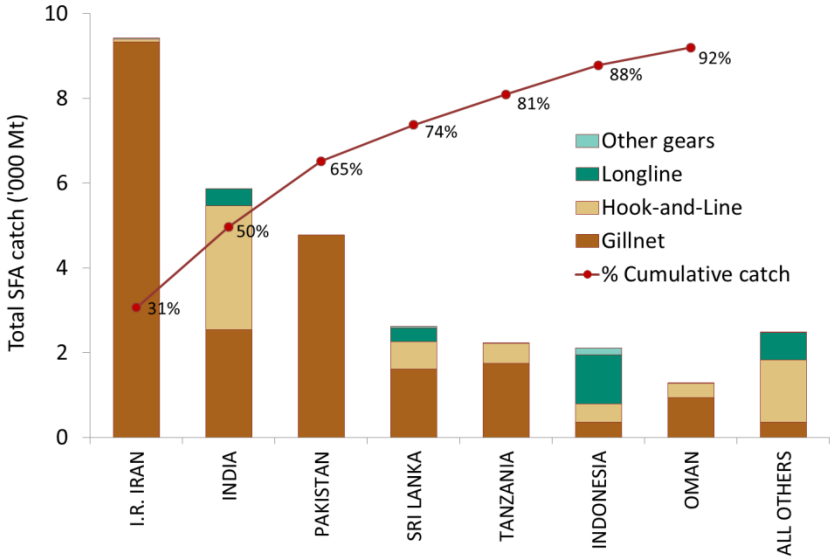


Fig. 24: Indo-Pacific sailfish: average catches in the Indian Ocean over the period 2013–17, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported.

The red line indicates the (cumulative) proportion of catches of Indo-Pacific sailfish for the fleets concerned, over the total combined catches reported from all fleets and gears.

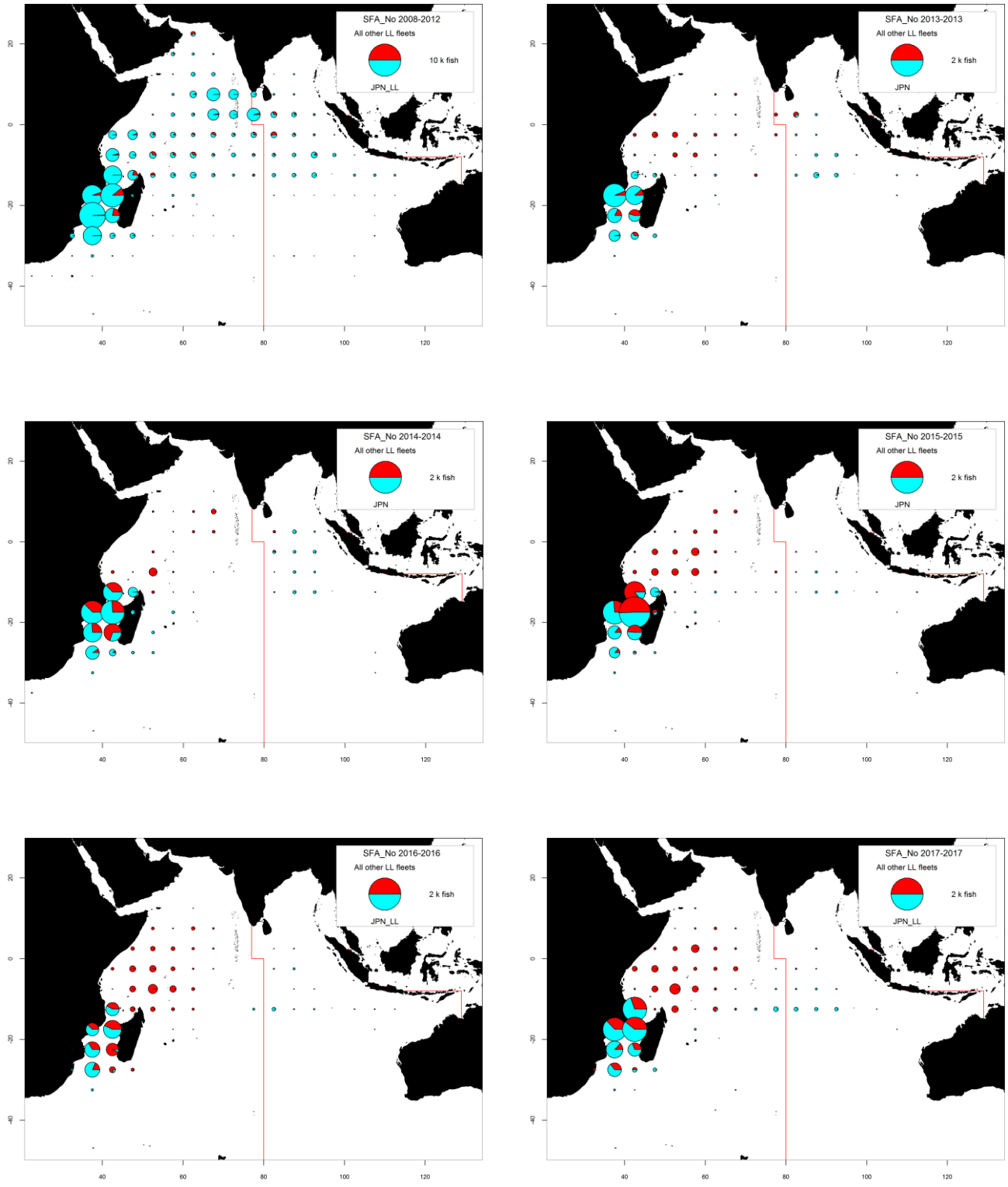


Fig. 25a-f. Time-area catches (in number of fish) of Indo-Pacific sailfish as reported for the longline fisheries of Japan (JPN) and all other longline fleets for the period 2008–12, by fleet and for 2012–17, by year and fleet. Red lines represent the IOTC Areas.

Source: IOTC catch-and-effort data (unraised). Does not include fleets non-reporting catch-and-effort data.

Indo-pacific sailfish: estimation of catches – data related issues

Retained catches – a very high proportion of the catches of Indo-Pacific sailfish are estimated, or adjusted, by the IOTC Secretariat are (**Fig.26a**), due to a number of uncertainties in the catches listed below. However, unlike the other billfish species, Indo-Pacific sailfish are more reliably identified because of the large and distinctive first dorsal fin that runs most of the length of the body:

- Species aggregates: catch reports often refer to total catches of all billfish species combined; catches by species are estimated by the Secretariat for some artisanal fisheries (e.g., gillnet/longline fishery of Sri Lanka and artisanal fisheries of India and Pakistan) and industrial fisheries (e.g., longliners of Indonesia and Philippines).

  Catches of Indo-Pacific sailfish reported for some fisheries may also refer to the combined catches of more than one species of billfish, in particular marlins and shortbill spearfish (i.e., in the case of coastal fisheries).

- Conflicting reports: In 2017 Pakistan also submitted a revised catch series, dating back to the 1980s, and which are significantly lower than current estimates for billfish for Pakistan in the IOTC database, and particularly catches of Indo-Pacific sailfish. The data are currently pending upload to the IOTC database until further clarifications have been received regarding the catch revision estimation methodology, and particularly the scale of revisions for some billfish species.

- Non-reporting fleets: catches of non-reporting industrial longliners (e.g., India, NEI fleets) and the gillnet fishery of Indonesia are estimated by the Secretariat using alternative information.

- Non-target species: catches are likely to be incomplete for industrial fisheries for which Indo-Pacific sailfish is not a target species.

- Missing or incomplete catches: catches are likely to be incomplete for some artisanal fisheries (e.g., Pakistan gillnets, Maldives pole-and-line) due to under-reporting.

  There is also a lack of catch data for most sport fisheries.

Indo-Pacific sailfish – Nominal catch-per-unit-effort (CPUE) trends

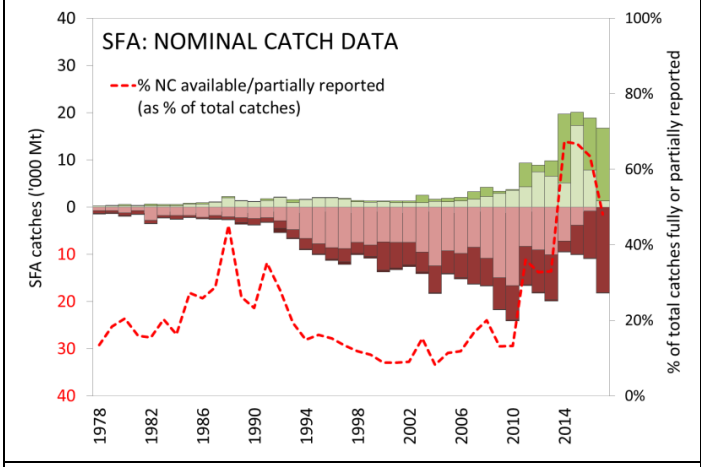
- Availability: Standardized and nominal CPUE series have not yet been developed. No catch and effort data are available from sports fisheries, other than partial data from the sports fisheries of Kenya; or other artisanal fisheries (e.g., I.R. Iran and Pakistan (gillnet), Sri Lanka (gillnet-longline), Indonesia (gillnet)) or industrial fisheries (NEI longliners and all purse seiners).

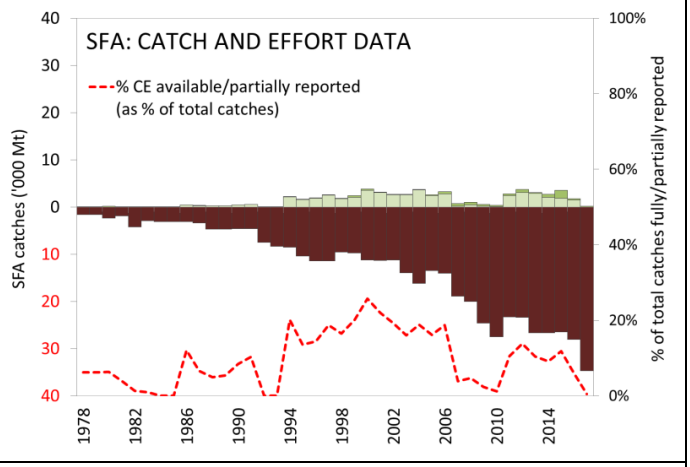
Indo-Pacific sailfish – Fish size or age trends (e.g., by length, weight, sex and/or maturity)

- Average fish weight: can only be assessed for the longline fishery of Japan since 1970 and the gillnet/longline fishery of Sri Lanka since the late 1980s (**Appendix I**). The number of specimens measured on Japanese longliners in recent years is, however, very low. Furthermore, specimens discarded might be not accounted for in industrial fisheries, where they are presumed to be of lower size (leading to possible bias of existing samples).

- Catch-at-Size (Age) table: not available, due to lack of size samples and uncertainty over the reliability of retained catch estimates, or conflicting catch-and-effort data. Fish size is derived from various length and weight information, however the reliability of the size data is reduced for some fleets and when relatively few fish out of the total catch are measured.

- Sex ratio data: have not been provided to the Secretariat by CPCs.





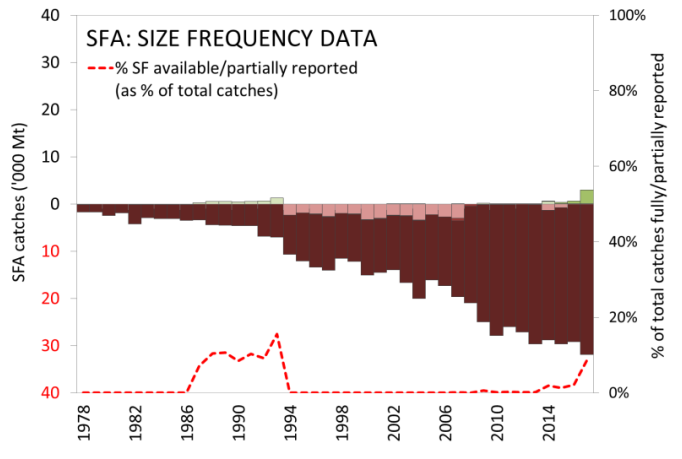


Fig. 26a-c. Indo-Pacific sailfish: data reporting coverage (1978–2017).

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.*

Data as of August 2018.

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)

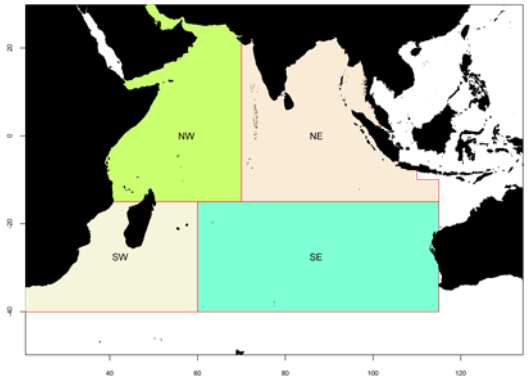
APPENDIX I

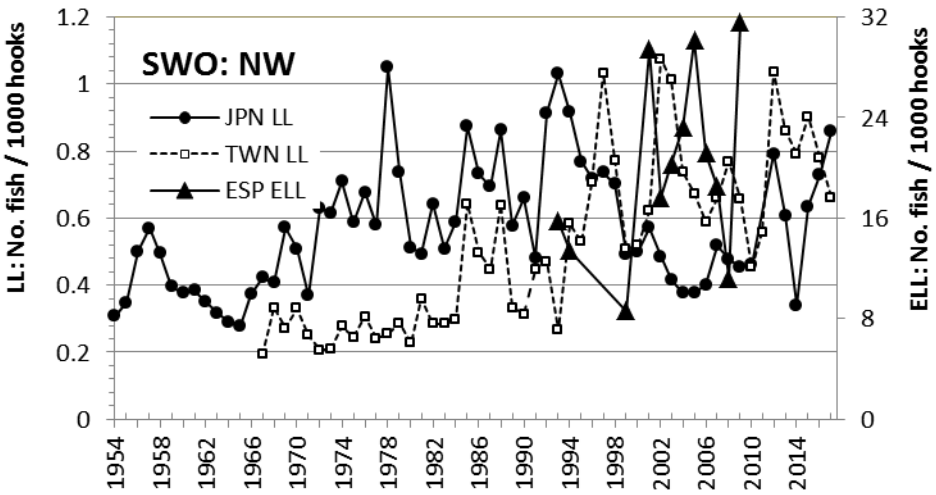
REVIEW OF FISHERIES TRENDS FOR BILLFISH

1. SWORDFISH

a. Catch rates and area fished

Areas used for the assessment of the Indian Ocean swordfish stock





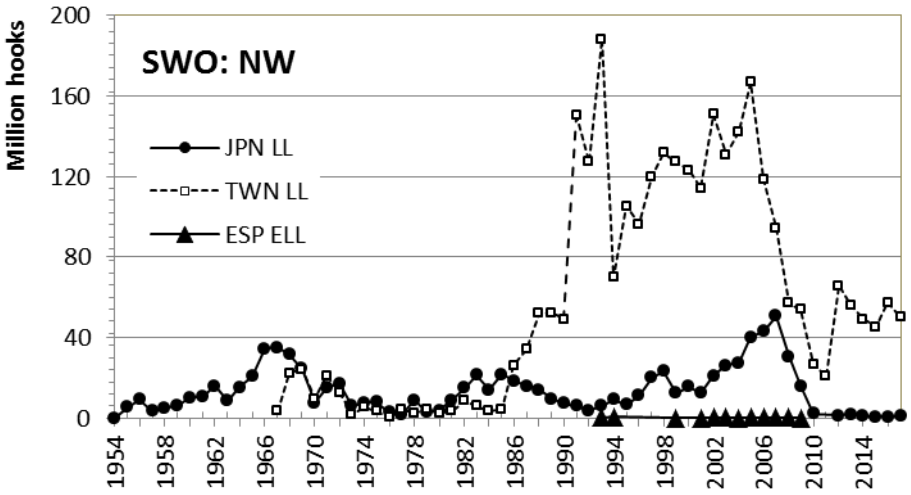
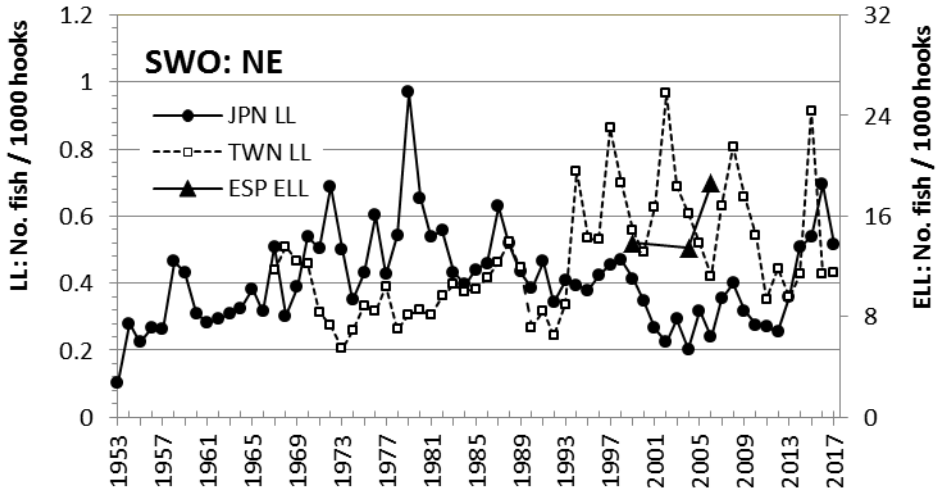


Fig. 1.1 Swordfish: Top: Nominal CPUE (number of fish/1000 hooks), Bottom: Total fishing effort (million of hooks set) for the longline fleets of EU-Spain, Japan, and Taiwan,China fishing in the Indian Ocean, by area (NW) and year (1952 to 2017). The assessment areas referred to are shown in the map above. Source: IOTC catch and effort data (unraised).



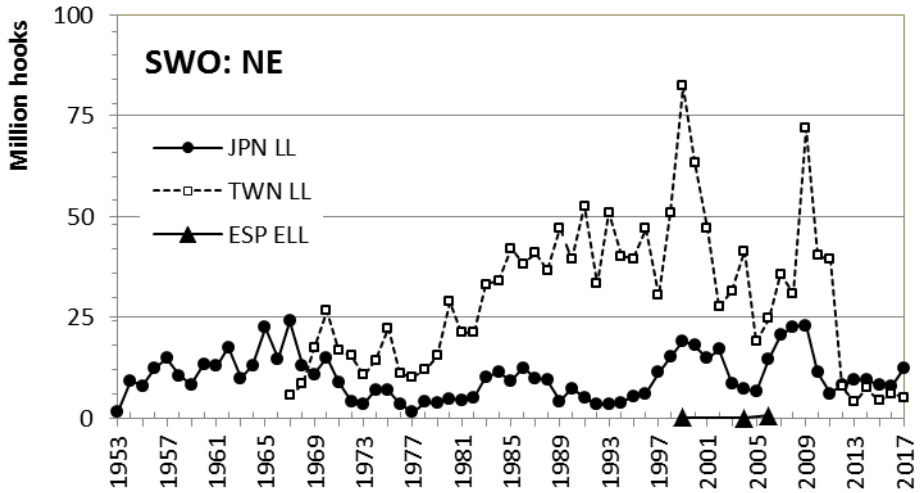


Fig. 1.2 Swordfish: Top: Nominal CPUE (number of fish/1000 hooks), Bottom: Total fishing effort (million of hooks set) for the longline fleets of EU-Spain, Japan, and Taiwan,China fishing in the Indian Ocean, by area (NE) and year (1952 to 2017). The assessment areas referred to are shown in the map above. Source: IOTC catch and effort data (unraised).

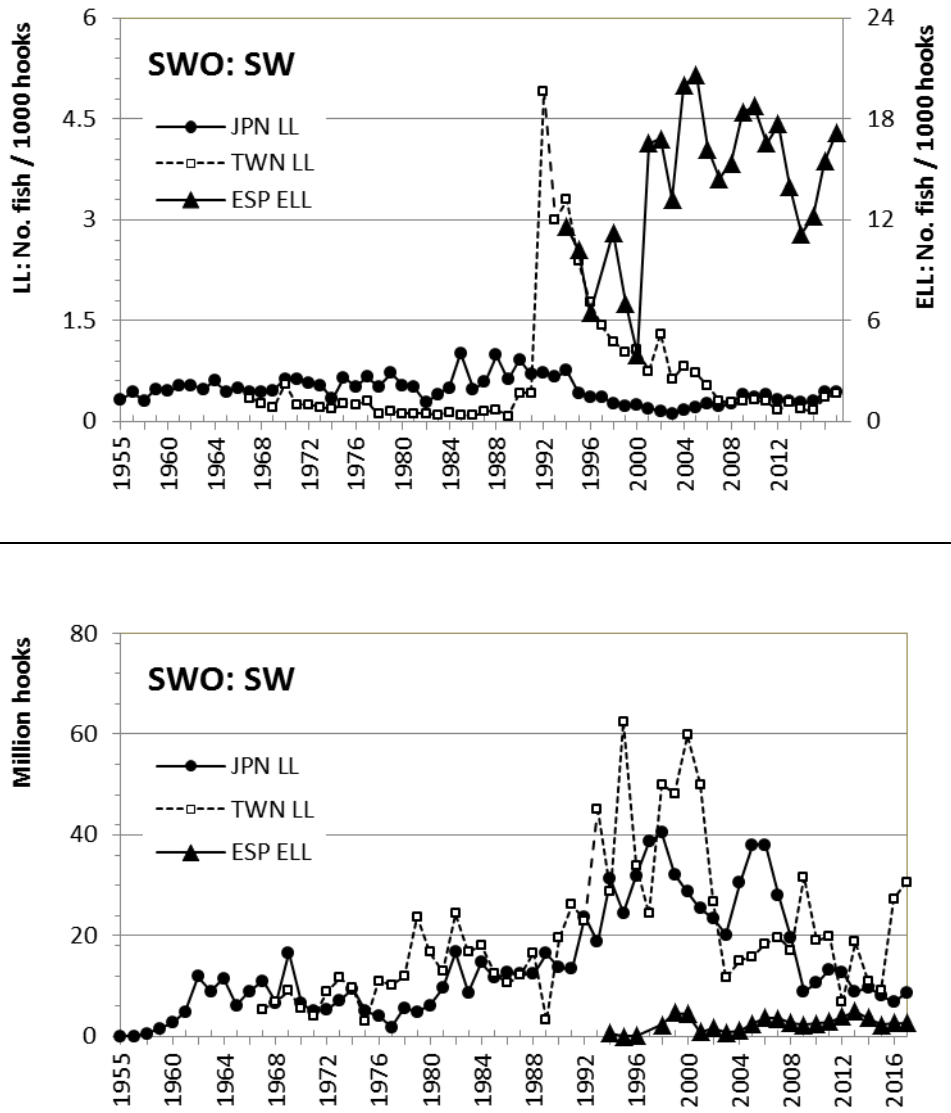


Fig. 1.3 Swordfish: Top: Nominal CPUE (number of fish/1000 hooks), Bottom: Total fishing effort (million of hooks set) for the longline fleets of EU-Spain, Japan, and Taiwan,China fishing in the Indian Ocean, by area (SW) and year (1952 to 2017). The assessment areas referred to are shown in the map above. Source: IOTC catch and effort data (unraised).

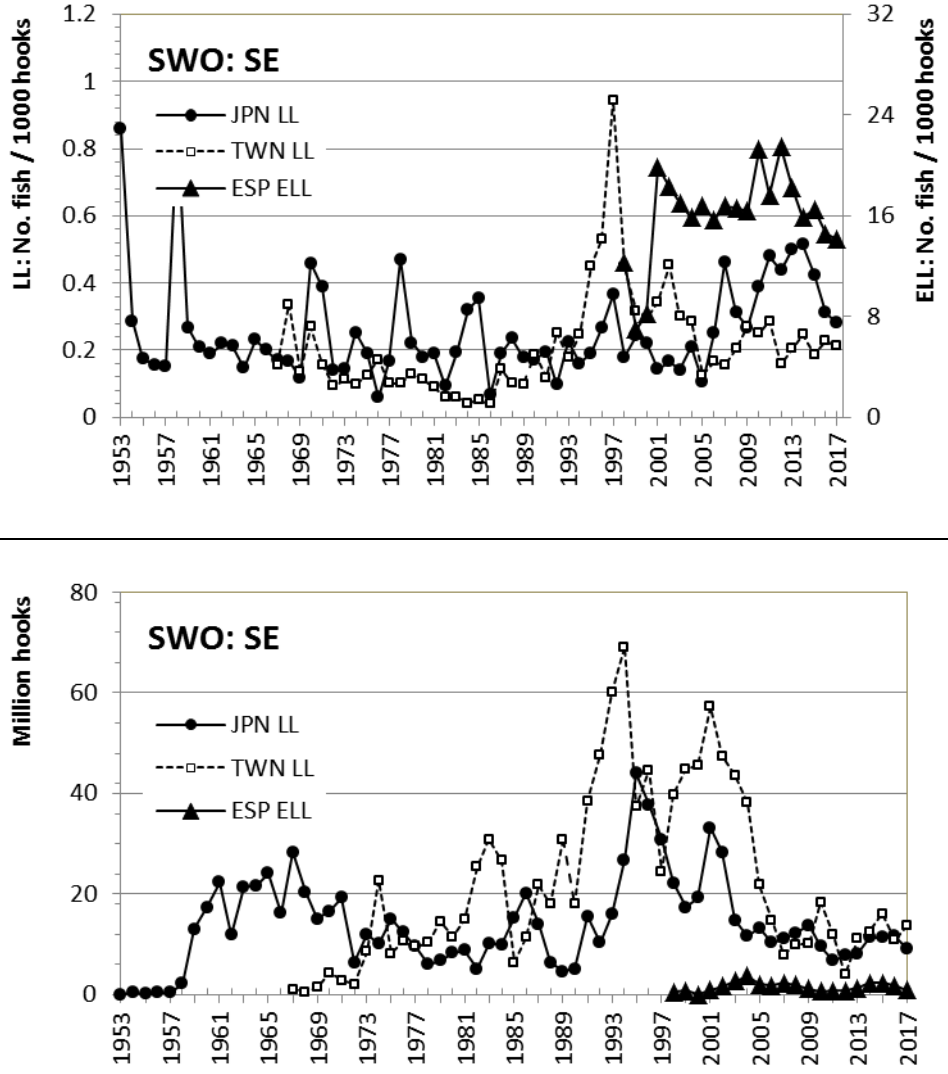


Fig. 1.4 Swordfish: Top: Nominal CPUE (number of fish/1000 hooks), Bottom: Total fishing effort (million of hooks set) for the longline fleets of EU-Spain, Japan, and Taiwan,China fishing in the Indian Ocean, by area (SE) and year (1953 to 2017). The assessment areas referred to are shown in the map above. Source: IOTC catch and effort data (unraised).

b. Swordfish: average weight and length frequency samples

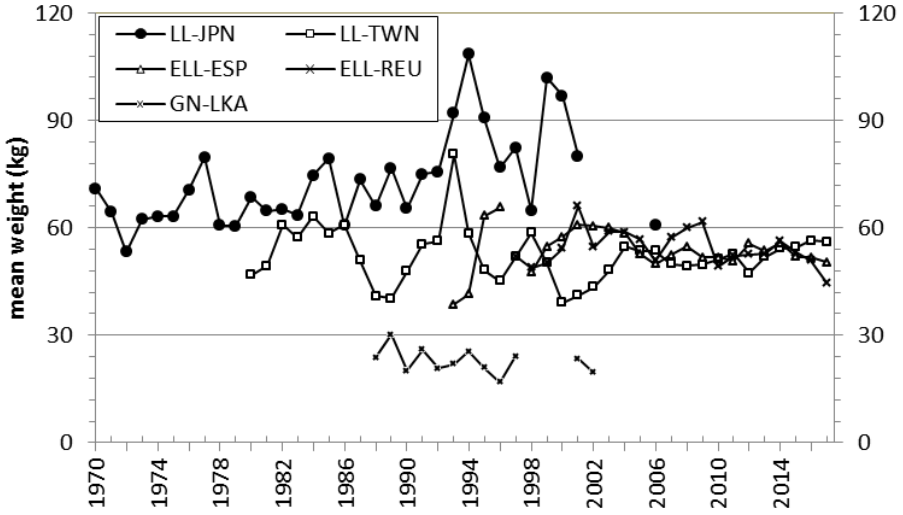


Fig. 1.5 Swordfish: average weight (kg) estimated from the size samples available for longliners of Japan (1970-2017) and Taiwan,China (1970-2017), EU-Spain (1993-2017), EU-La Réunion (1997-2017), and the gillnet fishery of Sri Lanka (1988-2017). NOTE: Average weights are shown for years in which 300 or more specimens were sampled for length. Source: size data (unraised).

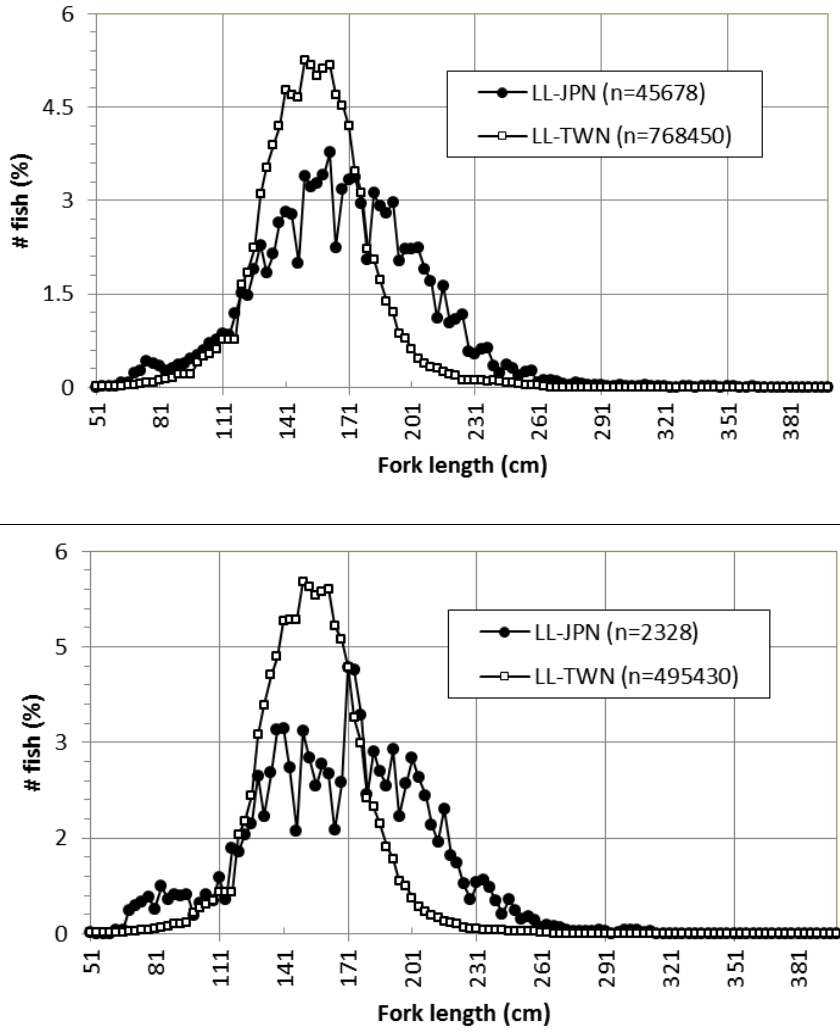
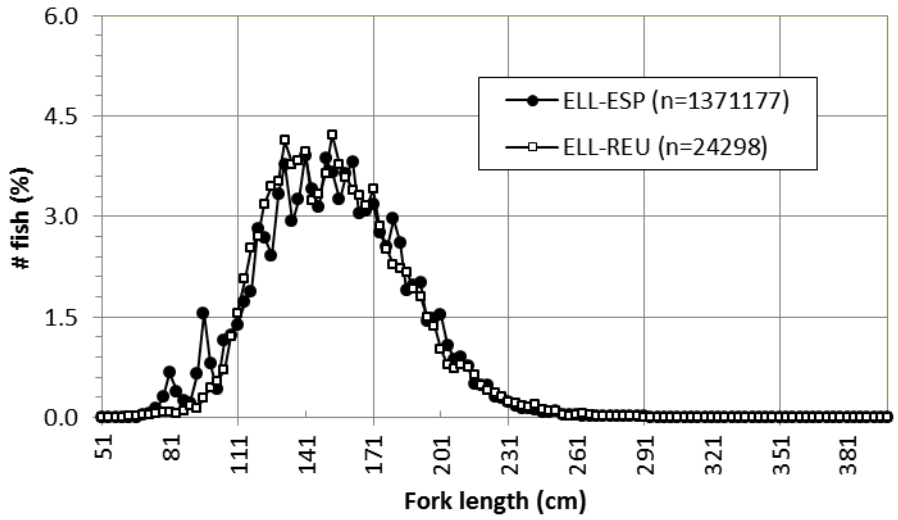


Fig. 1.6 Swordfish: samples by length class (eye to fork length; expressed as %) estimated for the longline fisheries of Japan (JPN) and Taiwan,China in the Indian Ocean, for (Top) 1950-2015 and (Bottom) 2000-09. Source: size data (unraised).



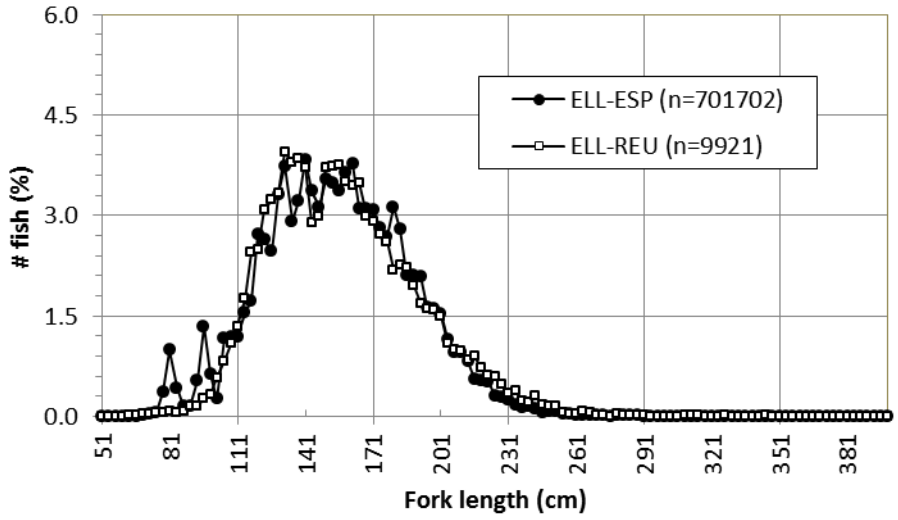
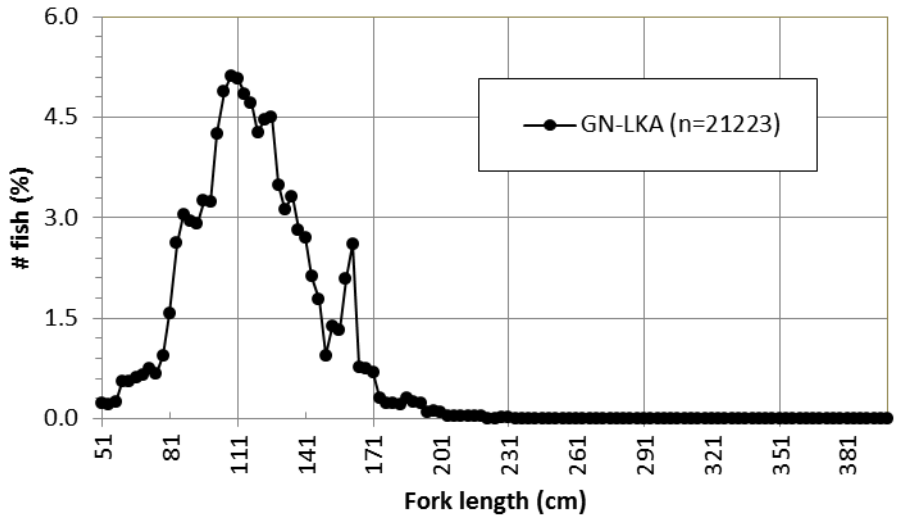


Fig. 1.7 Swordfish: samples by length class (eye to fork length; expressed as %) estimated for the longline fisheries of (Top) EU-Spain (1993-2015), EU-La Réunion (1997-2017), and (Bottom) EU-Spain and EU-La Réunion 2000-2009. Source: size data (unraised).



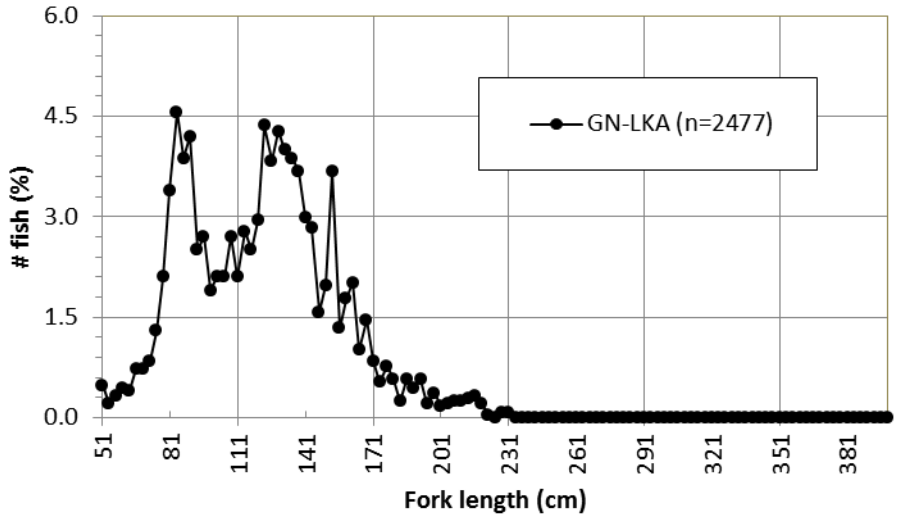
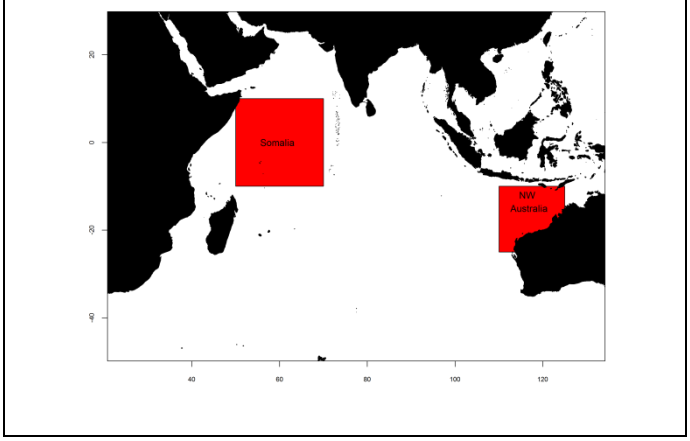


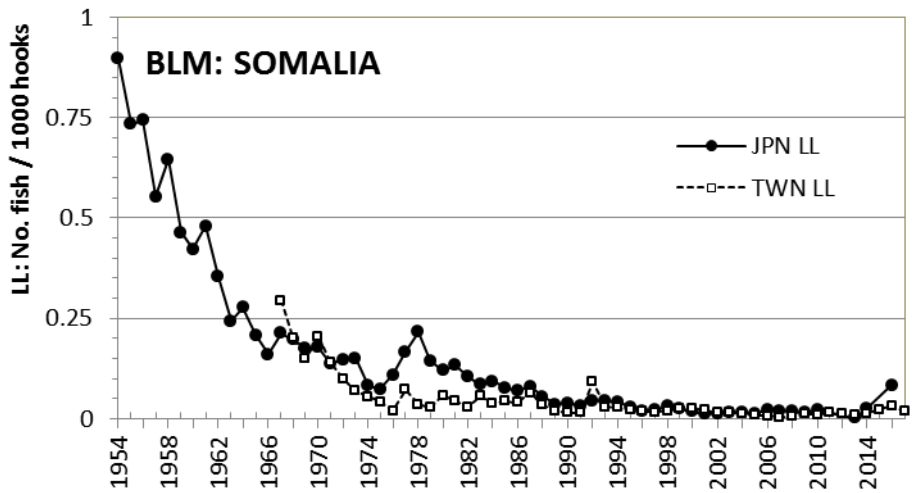
Fig. 1.8 Swordfish: samples by length class (eye to fork length; expressed as %) estimated for the gillnet fisheries of Sri Lanka in the Indian Ocean, for (Top) 1988-2017 and (Bottom) 2000-09. Source: size data (unraised).

2. BLACK MARLIN

a. Catch rates and area fished

Hot spots of marlins identified by the IOTC WPB





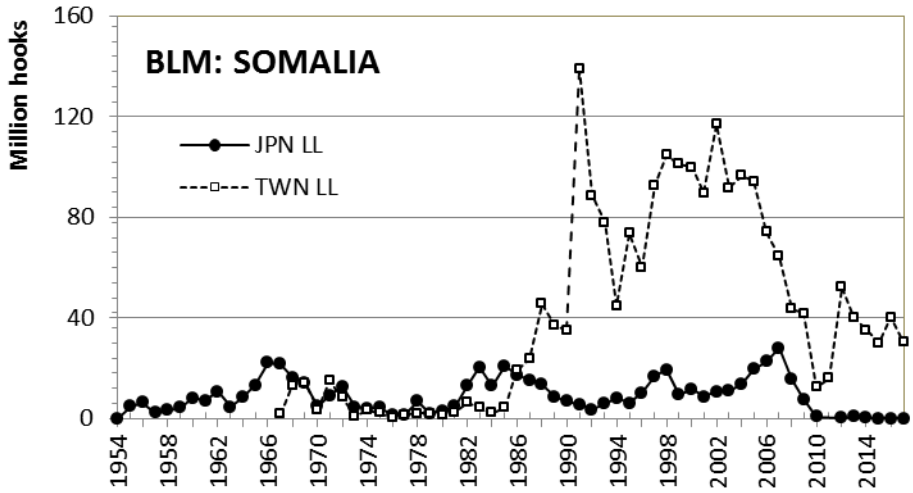
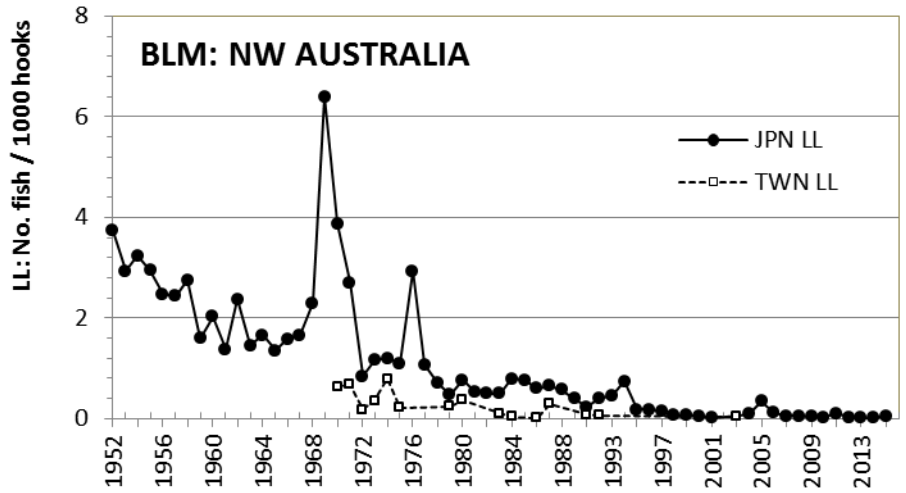


Fig. 2.1 Black marlin: Top: Nominal CPUE (number of fish/1000 hooks), Bottom: Total fishing effort (million of hooks set) for the longline fleets of Japan (JPN), and Taiwan,China (TWN) fishing in the Indian Ocean, by area (Somalia) and year (1954 to 2017). The areas referred to are shown in the map of hotspots of marlins above.



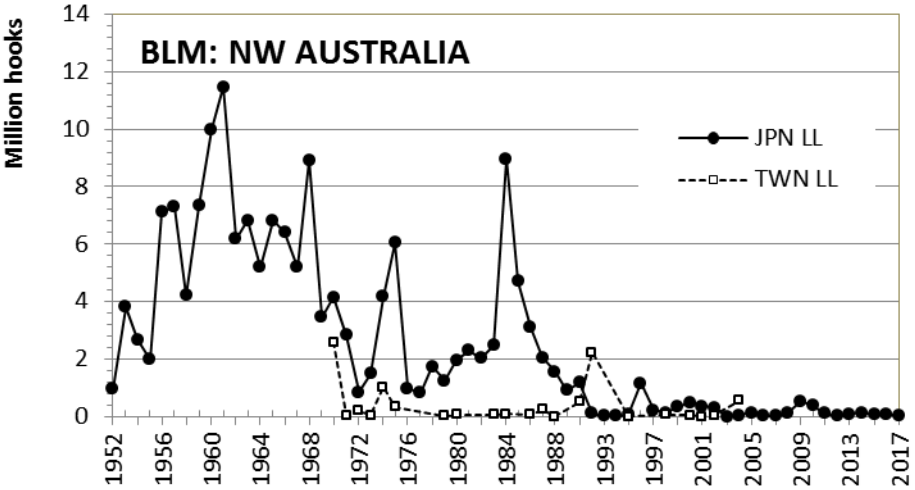


Fig. 2.2 Black marlin: Top: Nominal CPUE (number of fish/1000 hooks), Bottom: Total fishing effort (million of hooks set) for the longline fleets of Japan (JPN), and Taiwan,China (TWN) fishing in the Indian Ocean, by area (NW Australia) and year (1954 to 2017). The areas referred to are shown in the map of hotspots of marlins above.

b. Black marlin: average weight and length frequency samples

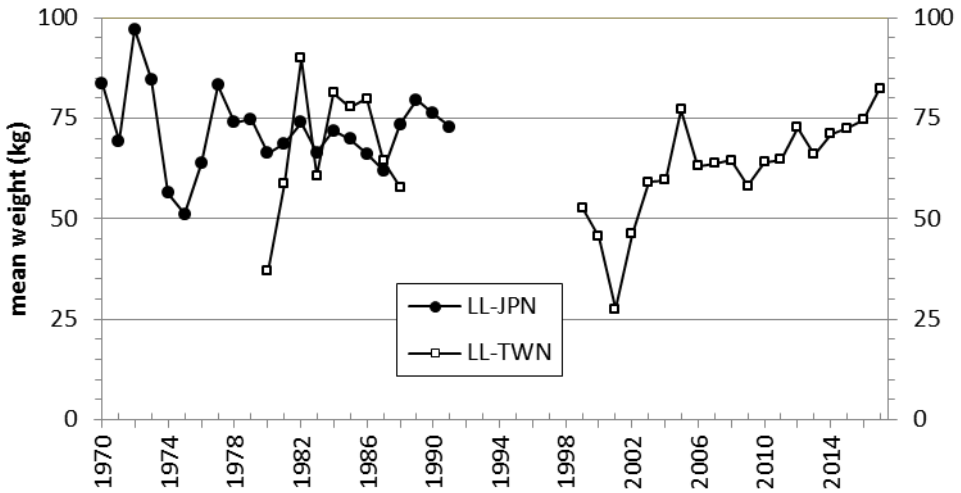
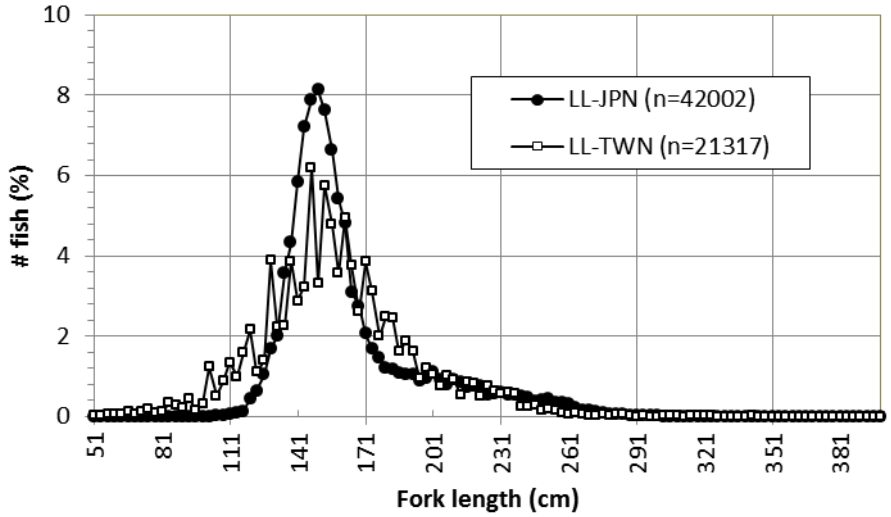


Fig. 2.3 Black marlin: average weight (kg) estimated from the size samples available for longliners of Japan (1970-2017) and Taiwan,China (1980-2017). NOTE: Average weights are shown only for years in which 300 or more specimens were sampled for length. Source: size data (unraised).



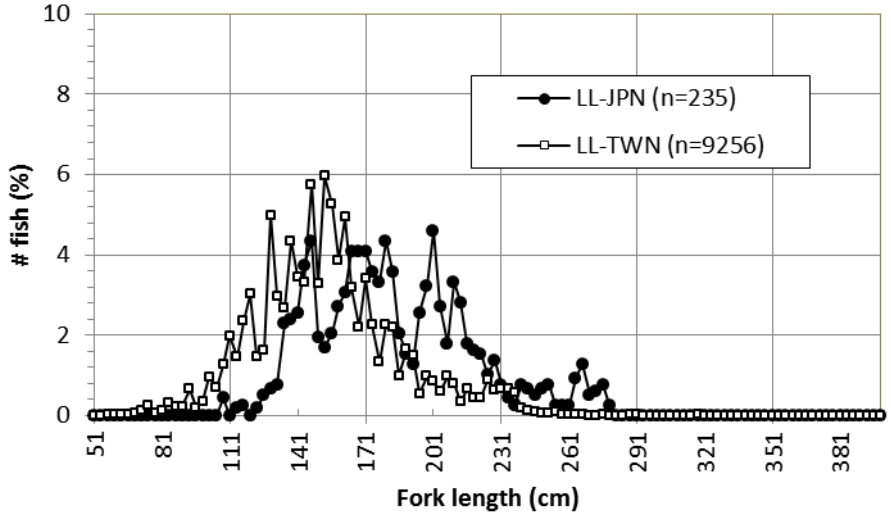
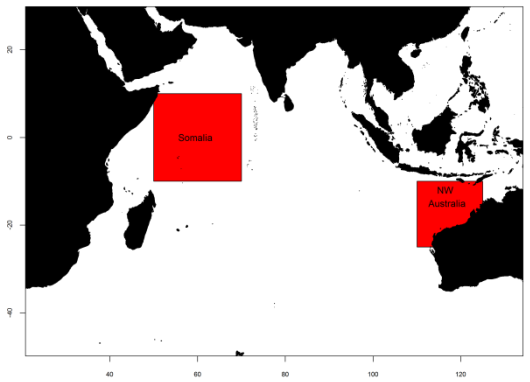


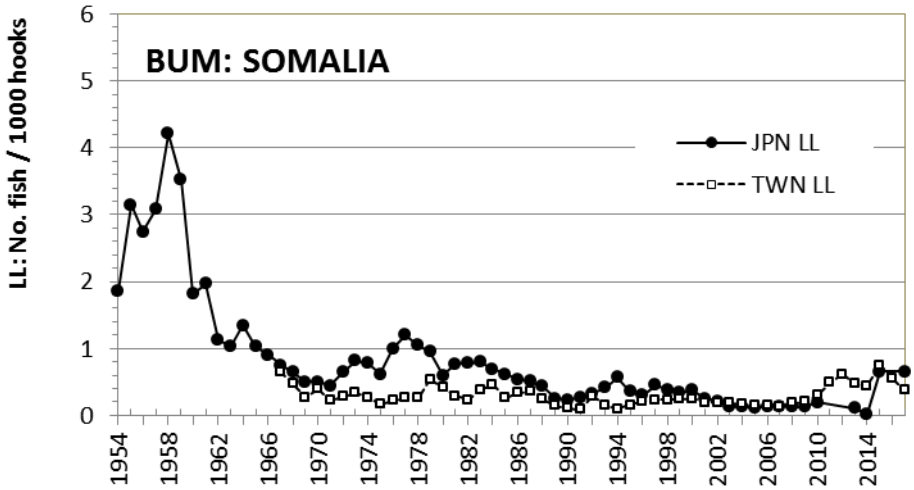
Fig. 2.4 Black marlin: samples by length class (eye to fork length; expressed as %) estimated for the longline fisheries of Japan and Taiwan,China in the Indian Ocean, for (Top) 1950-2017 and (Bottom) 2000-09. Source: size data (unraised).

3. BLUE MARLIN

a. Catch rates and area fished

Hot spots of marlins identified by the IOTC WPB





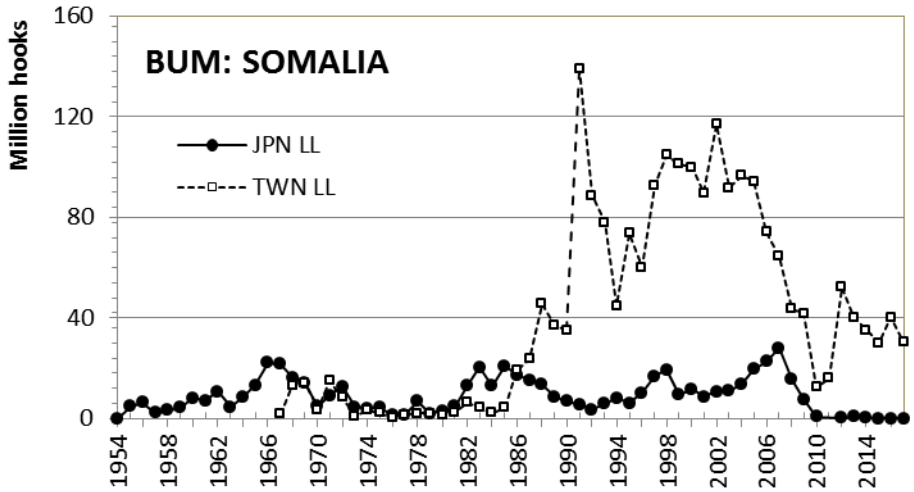
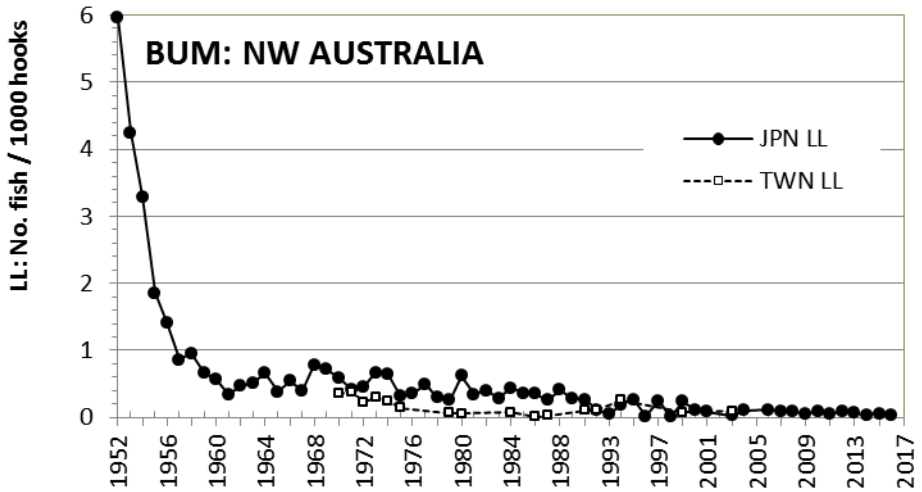


Fig. 3.1 Blue marlin: Top: Nominal CPUE (number of fish/1000 hooks), Bottom: Total fishing effort (million of hooks set) for the longline fleets of Japan (JPN), and Taiwan,China (TWN) fishing in the Indian Ocean, by area (Somalia) and year (1954 to 2017). The areas referred to are shown in the map of hotspots of marlins above.



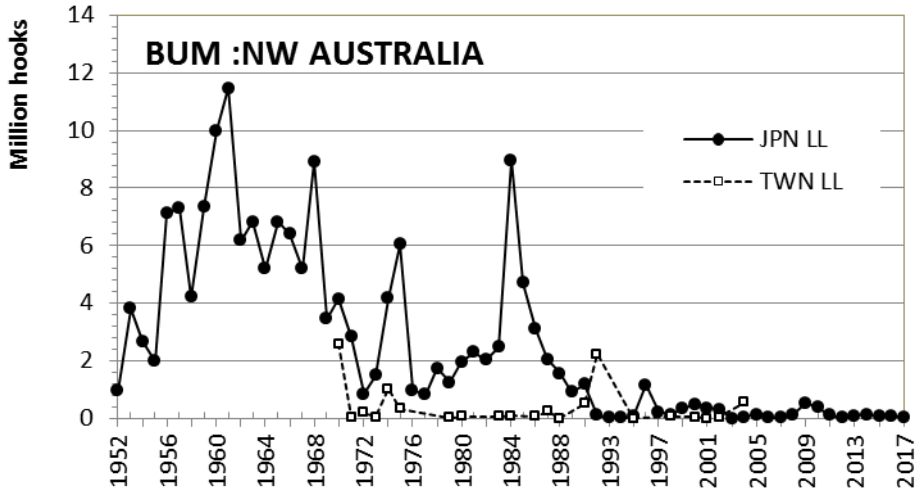


Fig. 3.2 Blue marlin: Top: Nominal CPUE (number of fish/1000 hooks), Bottom: Total fishing effort (million of hooks set) for the longline fleets of Japan (JPN), and Taiwan,China (TWN) fishing in the Indian Ocean, by area (NW Australia) and year (1954 to 2017). The areas referred to are shown in the map of hotspots of marlins above.

b. Blue marlin: average weight and length frequency samples

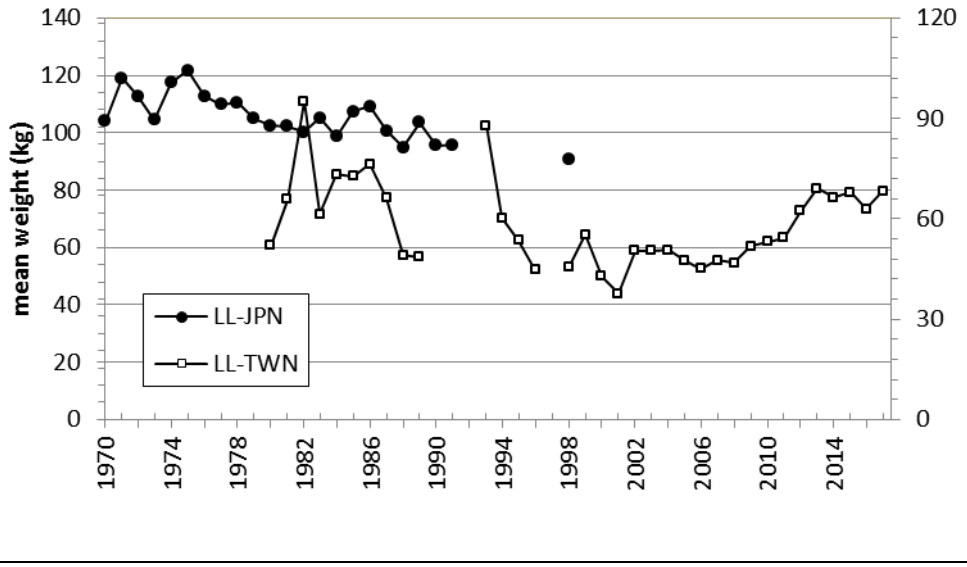
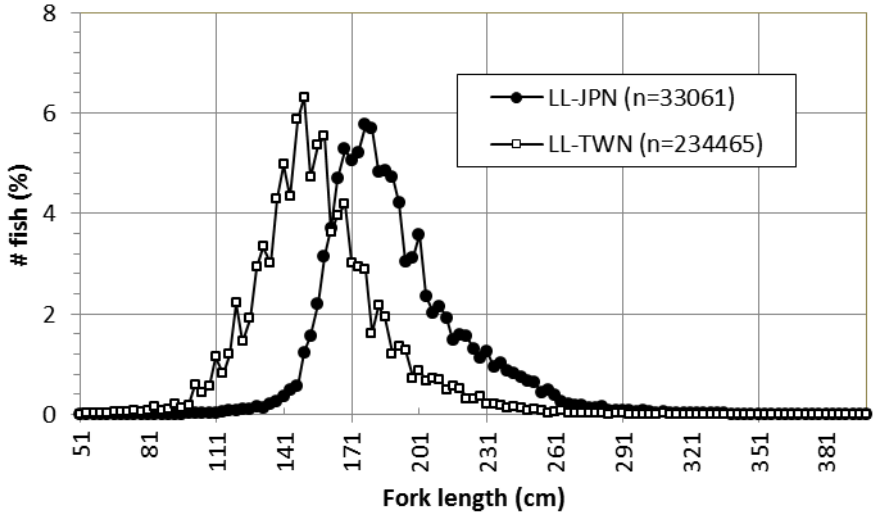


Fig. 3.3 Blue marlin: average weight (kg) estimated from the size samples available for longliners of Japan (1970-2017) and Taiwan,China (1980-2017). NOTE: Average weights are shown only for years in which 300 or more specimens were sampled for length. Source: size data (unraised).



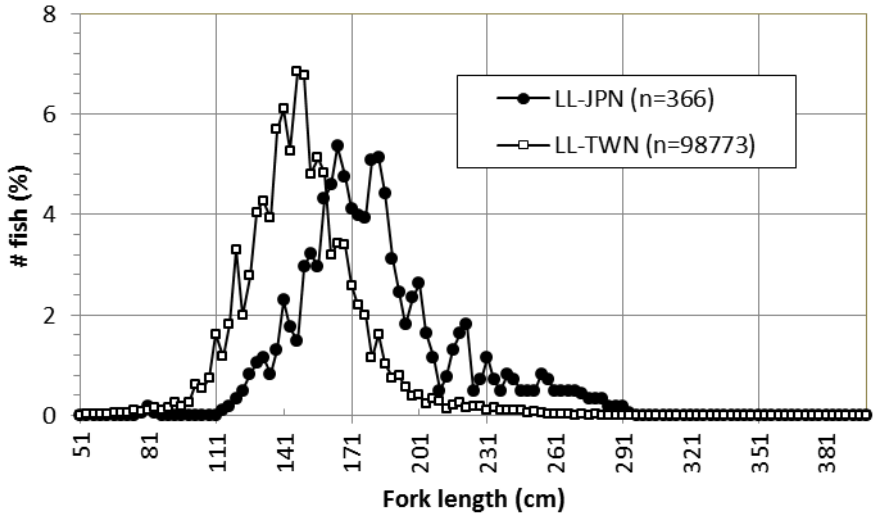
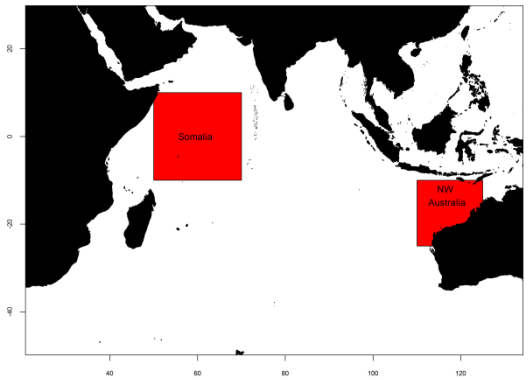


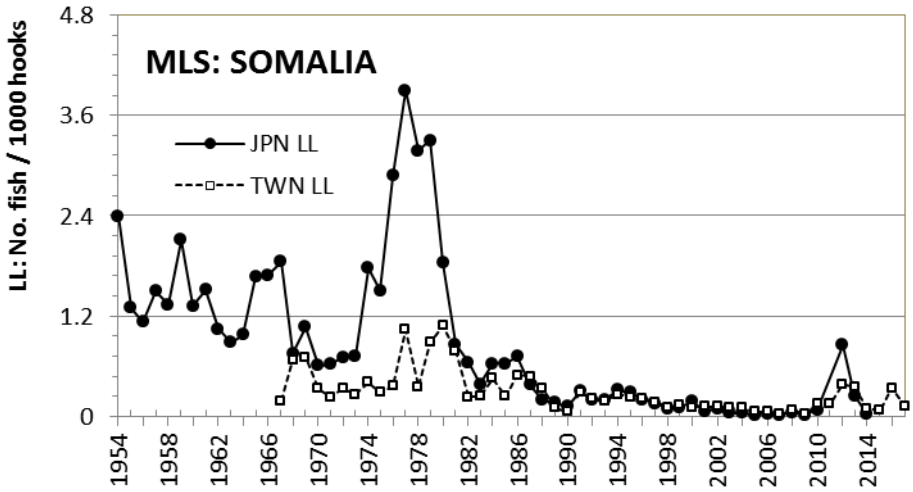
Fig. 3.4 Blue marlin: samples by length class (eye to fork length; expressed as %) estimated for the longline fisheries of Japan and Taiwan,China in the Indian Ocean, for (Top) 1950-2017 and (Bottom) 2000-09. Source: size data (unraised).

4. STRIPED MARLIN

a. Catch rates and area fished

Hot spots of marlins identified by the IOTC WPB





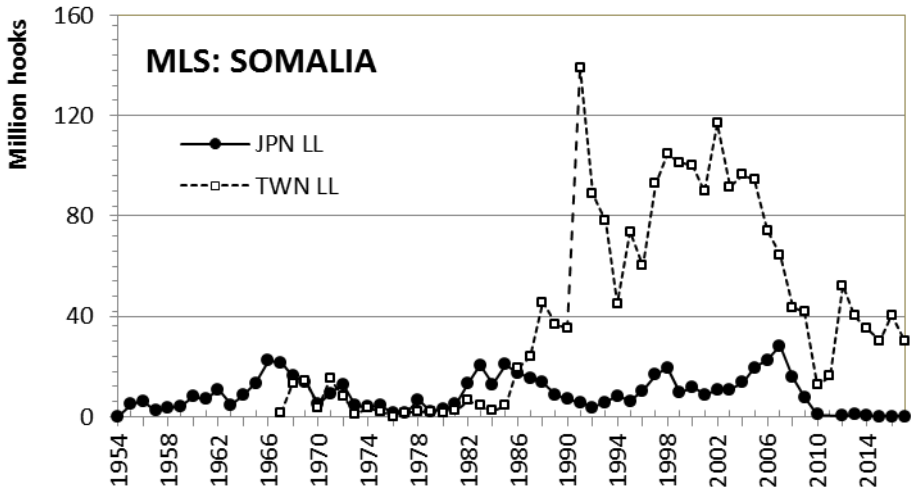
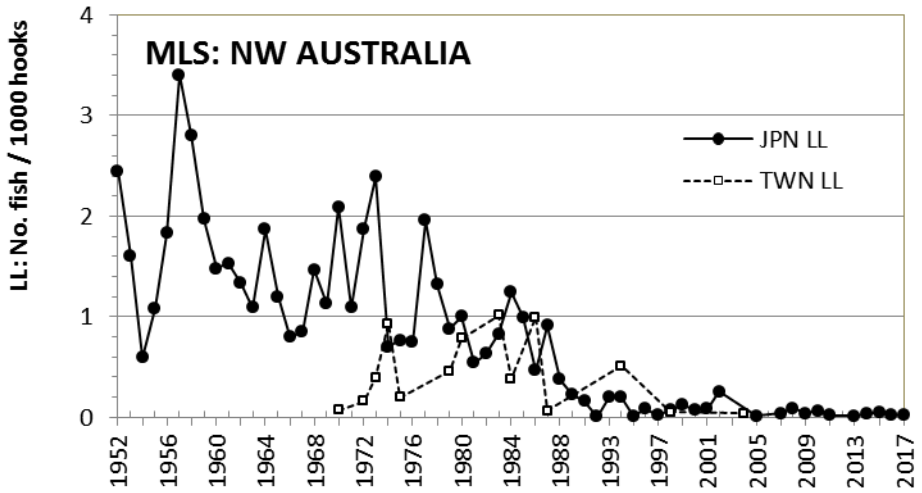


Fig. 4.1 Striped marlin: Top: Nominal CPUE (number of fish/1000 hooks), Bottom: Total fishing effort (million of hooks set) for the longline fleets of Japan (JPN), and Taiwan,China (TWN) fishing in the Indian Ocean, by area (Somalia) and year (1952 to 2017). The areas referred to are shown in the map of hotspots of marlins above.



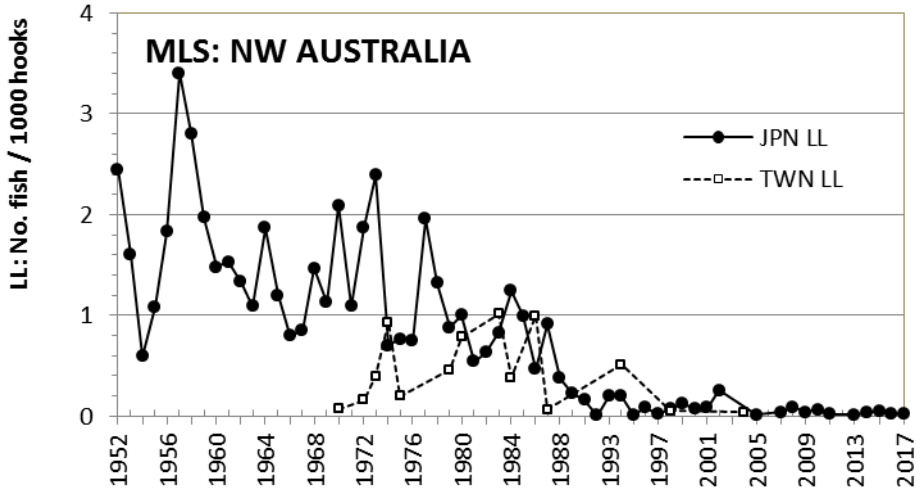


Fig. 4.2 Striped marlin: Top: Nominal CPUE (number of fish/1000 hooks), Bottom: Total fishing effort (million of hooks set) for the longline fleets of Japan (JPN), and Taiwan,China (TWN) fishing in the Indian Ocean, by area (NW Australia) and year (1952 to 2017). The areas referred to are shown in the map of hotspots of marlins above.

c. Striped marlin: average weight and length frequency samples

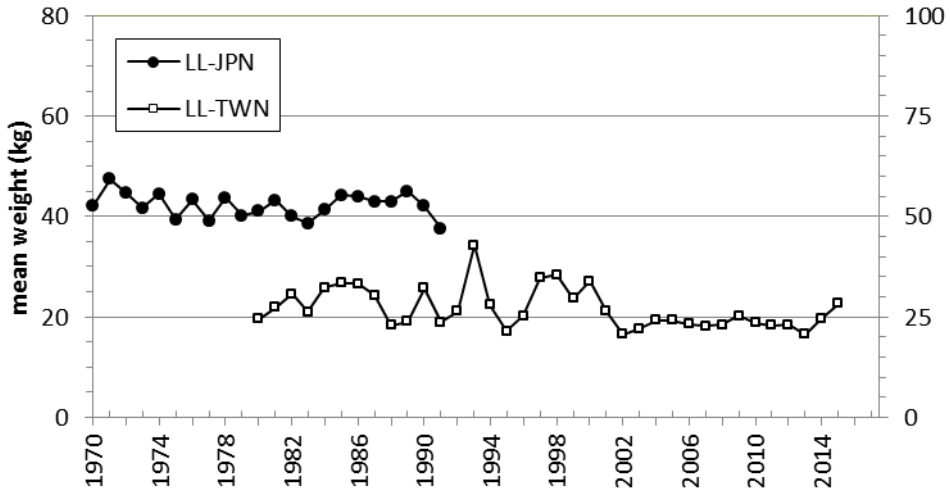


Fig. 4.3 Striped marlin: average weight (kg) estimated from the size samples available for longliners of Japan (1970-2017) and Taiwan,China (1980-2017). NOTE: Average weights shown only for years in which 300 or more specimens were sampled for length. Source: size data (unraised).

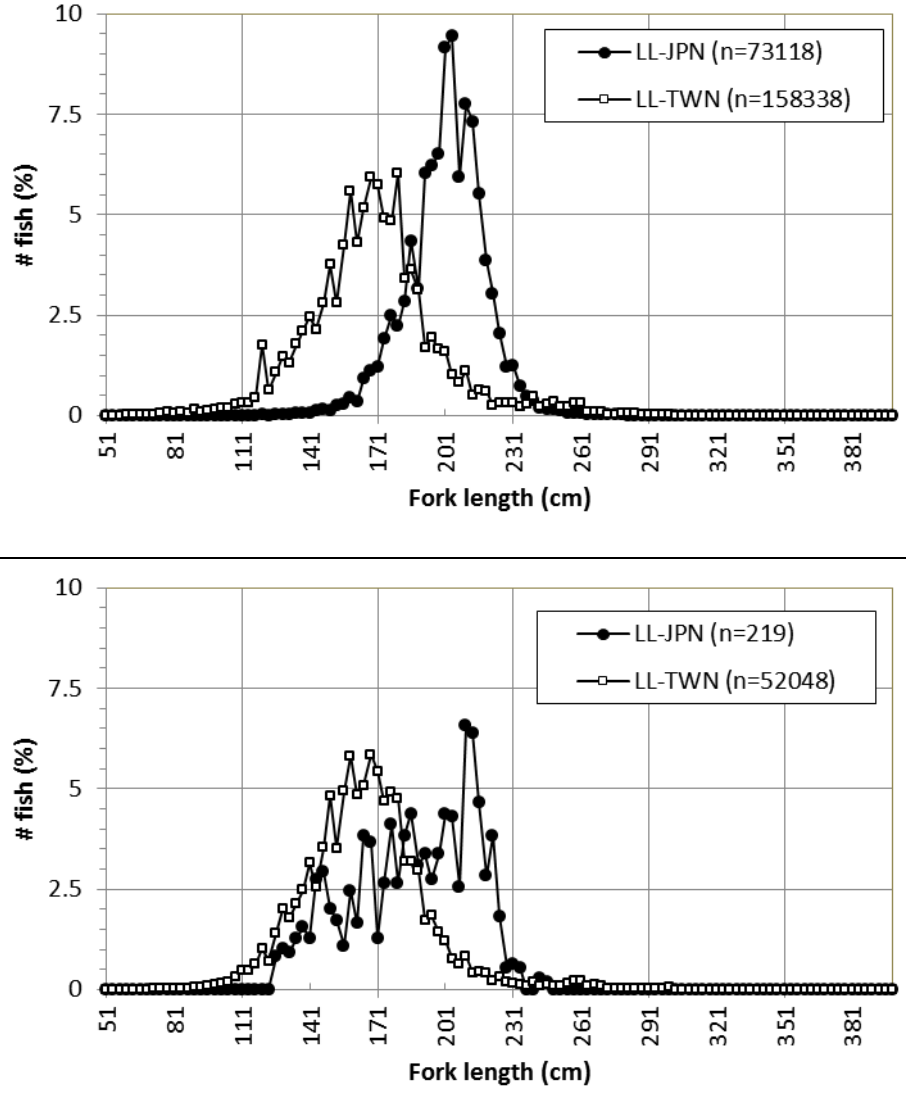


Fig. 4.4 Striped marlin: samples by length class (eye to fork length; expressed as %) estimated for the longline fisheries of Japan and Taiwan,China in the Indian Ocean, for (Top) 1950-2015 and (Bottom) 2000-09. Source: size data (unraised).

5. INDO-PACIFIC SAILFISH

a. Indo-Pacific sailfish: average weight and length frequency samples

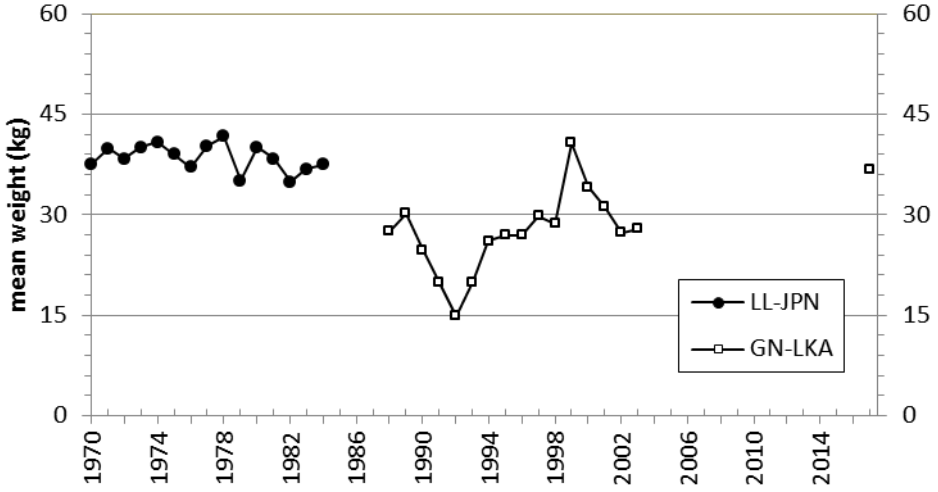
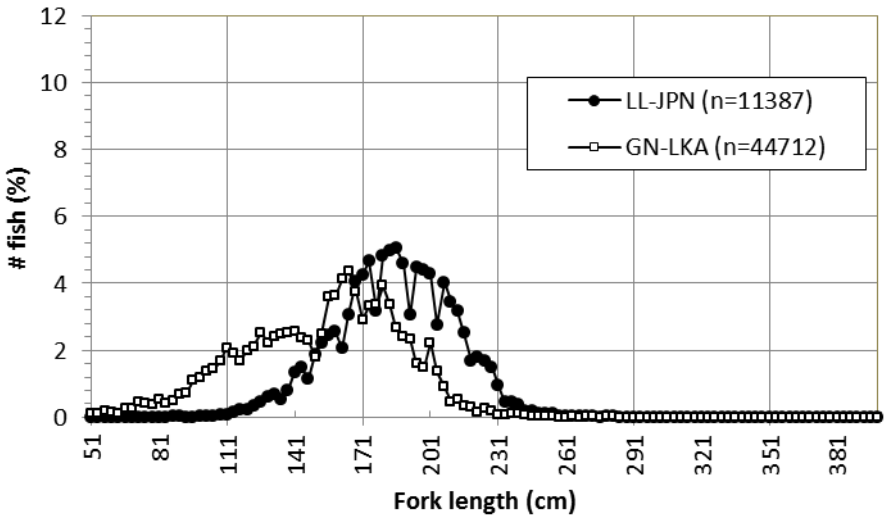


Fig. 5.1 Indo-Pacific sailfish: average weight (kg) estimated from the size samples available for longliners of Japan (1970-2017) and gillnet fishery of Sri Lanka (1980-2017). NOTE: Average weights shown only for years in which 300 or more specimens were sampled for length. Source: size data (unraised).



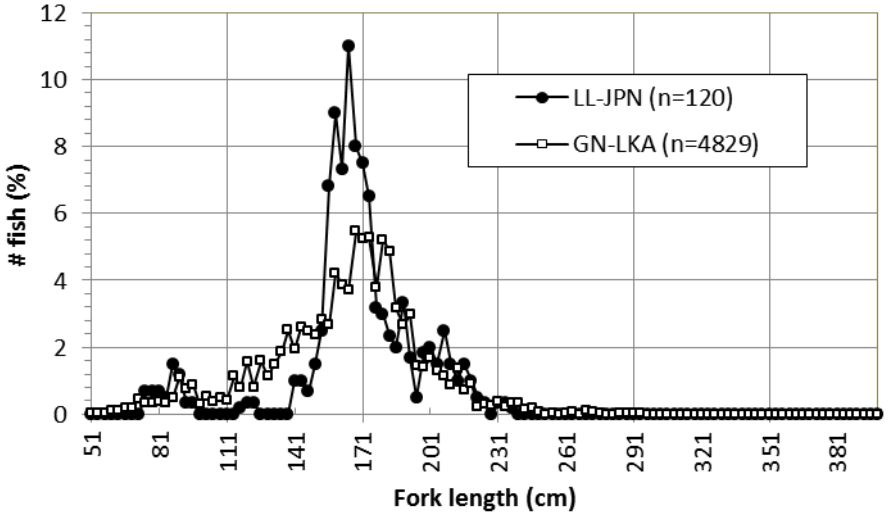


Fig. 5.2 Indo-pacific sailfish: samples by length class (eye to fork length; expressed as %) estimated for the longline fisheries of Japan and the gillnet fishery of Sri Lanka in the Indian Ocean, for (Top) 1950-2017 and (Bottom) 2000-09. Source: size data (unraised).