REVIEW OF THE STATISTICAL DATA AND FISHERY TRENDS FOR BILLFISH

PREPARED BY: IOTC SECRETARIAT[1], 26 AUGUST 2020

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 **May 2020**, 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 1950–2018.

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: Swordfish and Indo-Pacific sailfish 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 individual species – as a proportion of the total catches of billfish – has changed over time, mostly as a result of changes to the number of longline vessels active in the Indian Ocean (**Fig. 1c**). Catches of swordfish in particular increased during the '90s 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 '90s to around 50% by the early '00s. By the late '00s catches of swordfish declined to around a third of total billfish catches, largely as a result of the decline in the number of longline vessels operated by Taiwan,China. However since 2012 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, possibly from a combination of improvements in reporting as well as increased activities by longliners in waters off the western-central and north-western Indian Ocean as a consequence of improvements in security in the area off Somalia.

- Main fisheries: Up to the mid '90s longline vessels accounted for over 90% of the total billfish (largely as non-targeted catch); in the last 20 years the proportion has fallen from about 70% in the early 2000s to less than 30% in 2018, 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**).

- Main fleets (i.e., highest catches in recent years):
  In recent years four fleets (I.R. Iran, India, Sri Lanka, and Taiwan,China) have reported more than 65% 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 MT in the early '90s to nearly 75,000 MT in the late '90s. Since then, average catches per year have remained relatively stable at between 70,000 MT and 75,000 MT. However, since 2015 catches over 90,000 MT have been reported, with the largest increases reported by Sri Lanka and India (**Fig. 2a**).

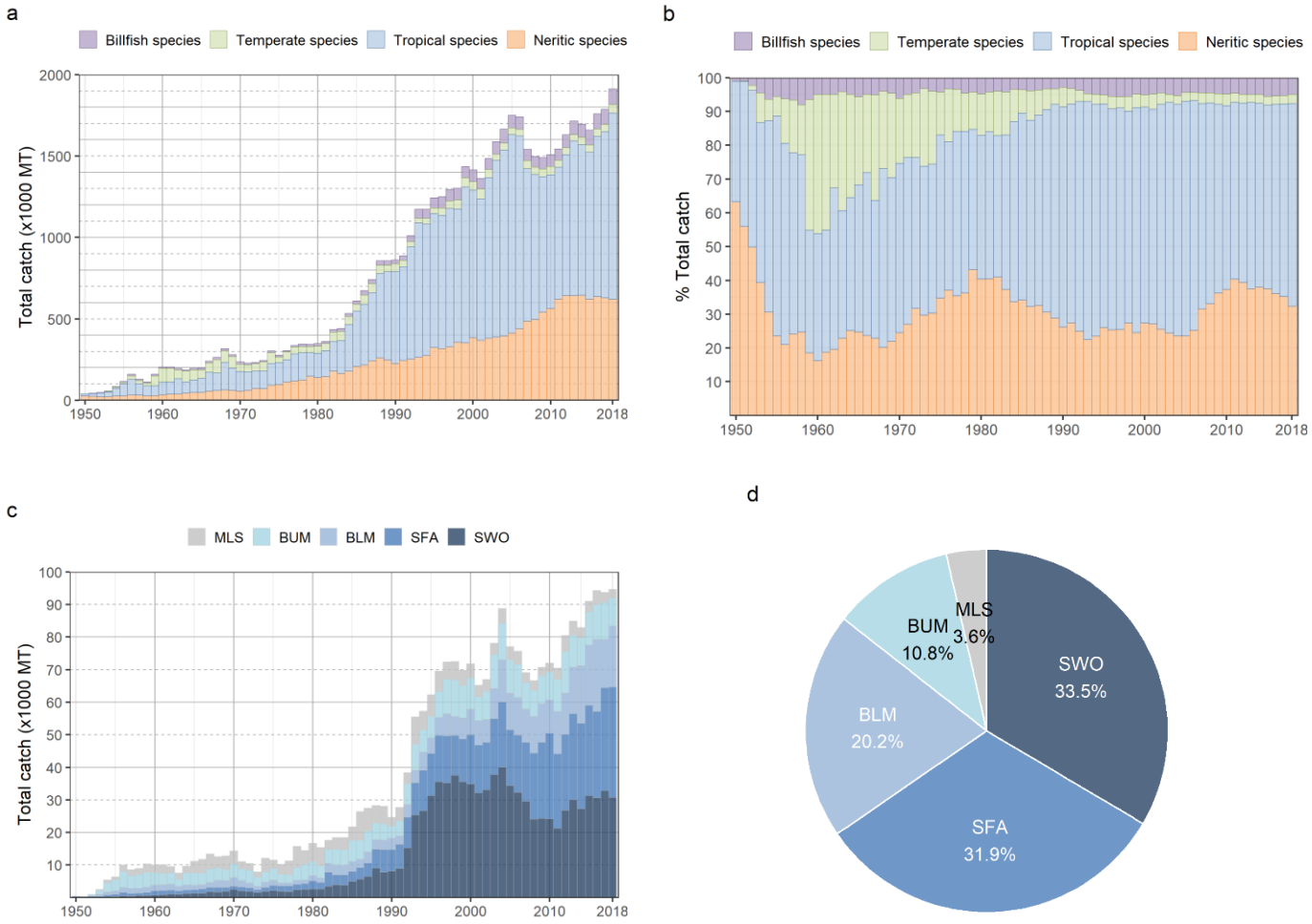

Fig. 1. Top: Contribution of billfish to the total catches of IOTC species in the Indian Ocean over the period 1950-2018. (a) Annual nominal catches (MT) by group of species; (b) Percentage of the annual nominal catches by group of species. Bottom: Contribution of each billfish species to the total combined catches of billfish; (c) Annual nominal catches (MT) by species, 1950-2018; (d) Percentage of the average annual catch by species, 2014-2018

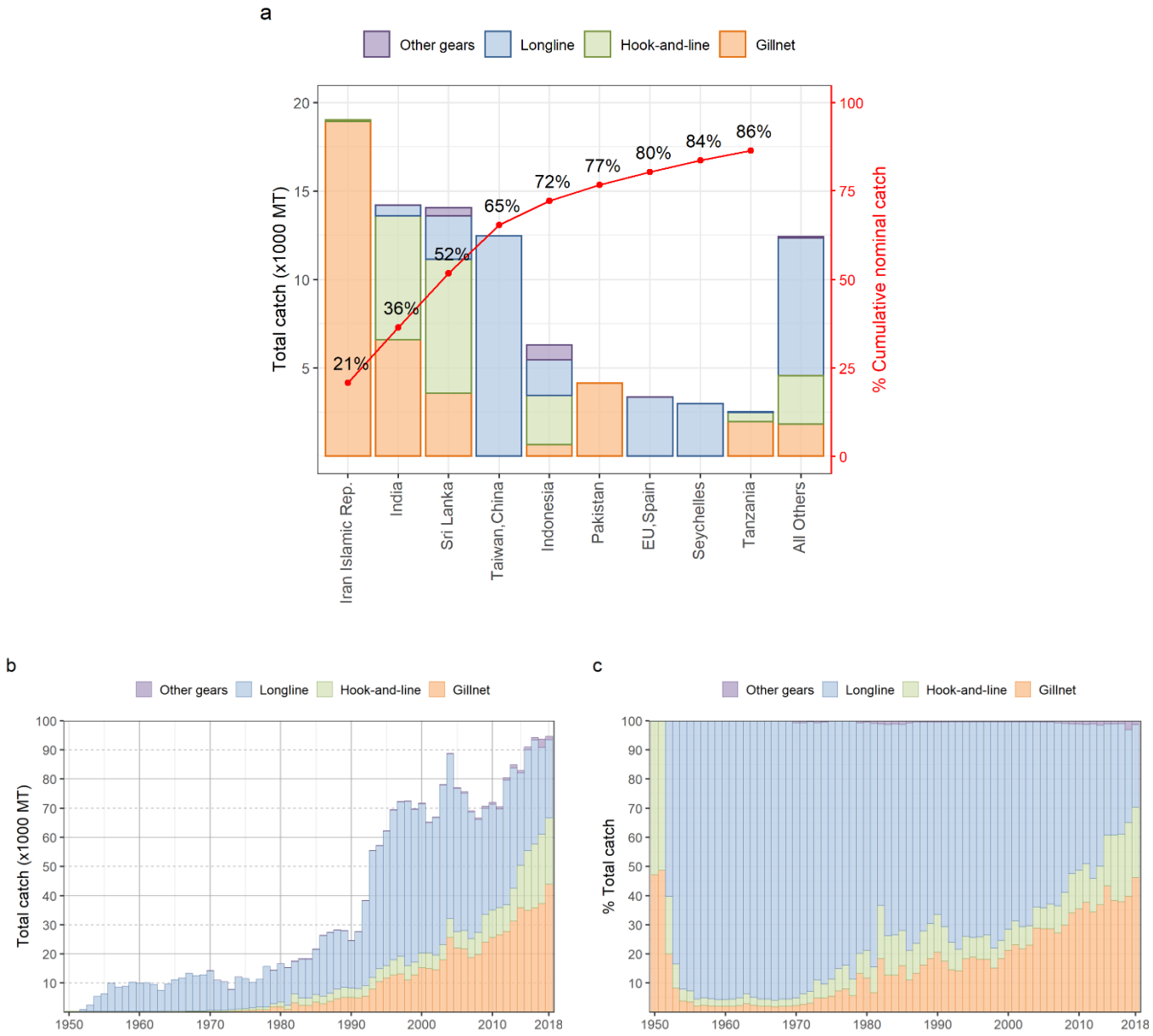

Fig. 2. (a) Average nominal catches (MT) of billfish species over the period 2014–2018, by gear group and CPC ordered according to the importance of catches. The red solid line indicates the cumulative percentage of the total combined catches of the species for the CPCs concerned; (b) Annual time series of nominal catches (MT) of billfish species by gear group recorded in the IOTC database, 1950–2018; (c) Percentage share of all billfish species catches, by gear, 1950-2018

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 Sport 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 their 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 data, 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. While Indonesia is implementing a number of improvements to the collection and validation of data for artisanal fisheries – including electronic logbooks and complete enumeration of catches at key landing sites – catches are considered to be uncertain for the small-scale fisheries.
- Sport fisheries of Australia, France(La Réunion), India, Indonesia, Madagascar, Mauritius, Oman, Seychelles, Sri Lanka, Tanzania, Thailand and United Arab Emirates: Data have either never been submitted, or are available for only a limited number of years for sport 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.

  In 2017 the IOTC Secretariat commissioned a pilot project to develop tools and training materials for CPCs to improve the collection and reporting of catch-and-effort and size frequency from sport fisheries in the Western Indian Ocean[3]. The Project focused on trialling specifically-developed data collection tools on a small number of CPCs, including La Réunion, Kenya, Mauritius and Seychelles – however data reporting continues to be an on-going issue for sports and recreational fisheries.
- Drifting gillnet fisheries of I.R. Iran and Pakistan:

  The gillnet fisheries of I.R. Iran and Pakistan are estimated to account for around 23,000 MT of catches of billfish (equivalent to about 25% of the total billfish catches in the Indian Ocean). However, catches for this component remain uncertain:

  - I.R. Iran**:** In recent years I.R. Iran has reported catches of marlins and swordfish for their gillnet fishery (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 for its offshore gillnet fishery (pre-2012), the resulting estimates are thought to be highly uncertain.
  - Pakistan: In 2019, the IOTC working party on Data Collection and Statistics and the IOTC Scientific Committee endorsed the revised catch series (from 1987 onwards) provided by the Pakistan government for its gillnet fleet and based on the WWF-Pakistan funded data collection programme. This revised catch series introduces large differences in the reported catches of billfish species, in particular for what concerns swordfish, striped marlin and Indo-Pacific sailfish that are now far lower than what originally reported. Current catch estimates for Pakistan account for around 6% of the total catches of billfish in the Indian Ocean, and still suffer from the lack of per-species data until 2017 (catches are reported as “generic” billfish species until that year, with some explicit records of Indo-Pacific sailfish appearing throughout the revised time series).

[3] https://www.iotc.org/documents/facilitating-acquisition-catch-and-effort-and-size-data-sports-fisheries-western-indian

Industrial (longline) fisheries

- Indonesia (fresh longline): Following issues with the reliability of catch estimates of Indonesia's fresh longline fleet in recent years, in 2018 the IOTC Secretariat 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 as 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[4].

- Taiwan,China (fresh longline): Recent issues with IOTC Secretariat'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 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 MT per vessel in 2013 to around 175 MT per vessel in 2016. Over the same period, the proportion of swordfish reported by the Taiwanese fresh 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 changes to the species composition) require further clarification to ensure that the recent increase in average catches is valid.

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 are reported for the longline fishery of EU-Spain, which reports nominal catches for all billfish, while time-area catches are only available 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 (all fisheries)

Size data for all billfish species are generally considered to be unreliable and insufficient to be of use for stock assessment purposes, as the numbers of samples for all species are very often below the minimum sampling coverage of 1 fish per MT 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. 1 cm, 2 cm, 10 cm, etc.) that are reported under identical class bins (e.g. 2 cm, with all fish between 10-20 cm reported as 10-12 cm). For this reason, the average weights estimated for this fishery are considered unreliable. In early 2019 an IOTC consultant was hired to review IOTC's longline size frequency data which, among other tasks, included visits to the national fisheries institutions of the key fleets collecting longline size data. The work has now

[4] https://www.iotc.org/documents/revision-iotc-scientific-estimates-indonesias-fresh-longline-catches-0

been finalized and its final report will be presented at the IOTC Working Party on Tropical Tuna as well as at the Scientific Committee in 2020.

- I.R. Iran and Pakistan (gillnet): No size data reported for billfish species for gillnet fisheries since the '80s. I.R. Iran has started to provide (since 2020) properly georeferenced size-frequency data which are in the process of being incorporated in the IOTC databases: inclusion of historical data from the fleet is also planned.
- 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 have 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 samples in the IOTC database are considered to be of limited value.
- Taiwan,China (fresh-tuna longline): In 2012 Taiwan,China started submitting size frequency data for marlins and swordfish for their fresh tuna longline fleet. 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, 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 '00s.

   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 are 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 2019 Pakistan submitted a revised catch series, dating back to the '80s, and which significantly reduces estimates for billfish for Pakistan in the IOTC database – particularly for Indo-Pacific sailfish. As discussed earlier, billfish catches are reported as aggregated until 2017 included, with the exception of sporadic records of Indo-Pacific catches appearing throughout the time series. The IOTC Secretariat estimates the proportion of specific billfish species using a variety of different techniques (combining proxy years, fleets and areas) but a breakdown of aggregated catches provided straight from the source could contribute to increase the accuracy of the data.

While the new catch series is considered to be an improvement compared to the previous estimates, the composition of billfish species catches for Pakistan gillnet fleet remain uncertain and should be revisited as new information becomes available.

iii. Indonesia (fresh longline): Due to issues with the reliability of catch estimates of Indonesia's fresh longline fleet in recent years, the IOTC Secretariat provided the WPB-16 meeting with an alternative catch series, based on a new estimation methodology developed in collaboration with Indonesia. The revised catch series mostly affected Indonesia's catches of swordfish, striped marlin, and blue marlin estimated by the IOTC Secretariat.

While the new catch series is considered to be an improvement compared to the previous estimates, catches for Indonesia's fresh longline fleet remain uncertain and should be revisited as new information becomes available.

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 MT per vessel in 2013 to around 175 MT 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 changes to the species composition) require further clarification to ensure that the recent increase in average catches is valid.

Section 3: status of fisheries statistics for billfish species

Swordfish (SWO: *Xiphias gladius*)

Fisheries and main catch trends

- Main fishing gear (2014–18): Longline catches[5] currently comprise around 46% of total swordfish catches in the Indian Ocean (**Table 2; Fig. 4**).

- Main fleets (and primary gear associated with catches): percentage of total catches (2014–18): Over 50% of swordfish catches are accounted for by three fleets: Taiwan,China (longline): 22%; Sri Lanka (longline-gillnet): 21%; EU,Spain (swordfish targeted longline): 10% (**Fig. 5**).

- Main fishing areas: Primary: Western Indian Ocean, in waters off Somalia, and the southwest Indian Ocean. During 2009 – 2011, the fishery 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 '90s, 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 9,000 MT in 1991 to 38,000 MT 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, EU,UK and other fleets operating under various flags[6]).

  Since the mid '00s 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, possibly as a consequence of the improvements in security in the area off Somalia.

- Discard levels: Low, although estimates of discards are unknown for most industrial fisheries, mainly longliners. Discards 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 provided the WPB-16 meeting with an alternative catch series based on a new estimation methodology developed in collaboration with Indonesia[7] (**Fig. 3**). 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 billfish 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 MT to less than 35,000 MT directly as a result of the revision to Indonesia's catches.

The government of Pakistan provided the IOTC Secretariat with revised catch series for their gillnet fleet from 1987 onwards, that were endorsed at the 22nd session of the IOTC Scientific Committee in 2019. These revisions, and the species composition estimates performed by the IOTC Secretariat for the reported aggregated billfish species, introduce marked changes in swordfish catches compared to what available at the previous WPB. In particular, swordfish captures appear now to be basically non-existent for the fleet, as opposed to the average 450 MT /year reported by Pakistan prior to the revision.

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

[6] E.g., Senegal, Guinea, etc.

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

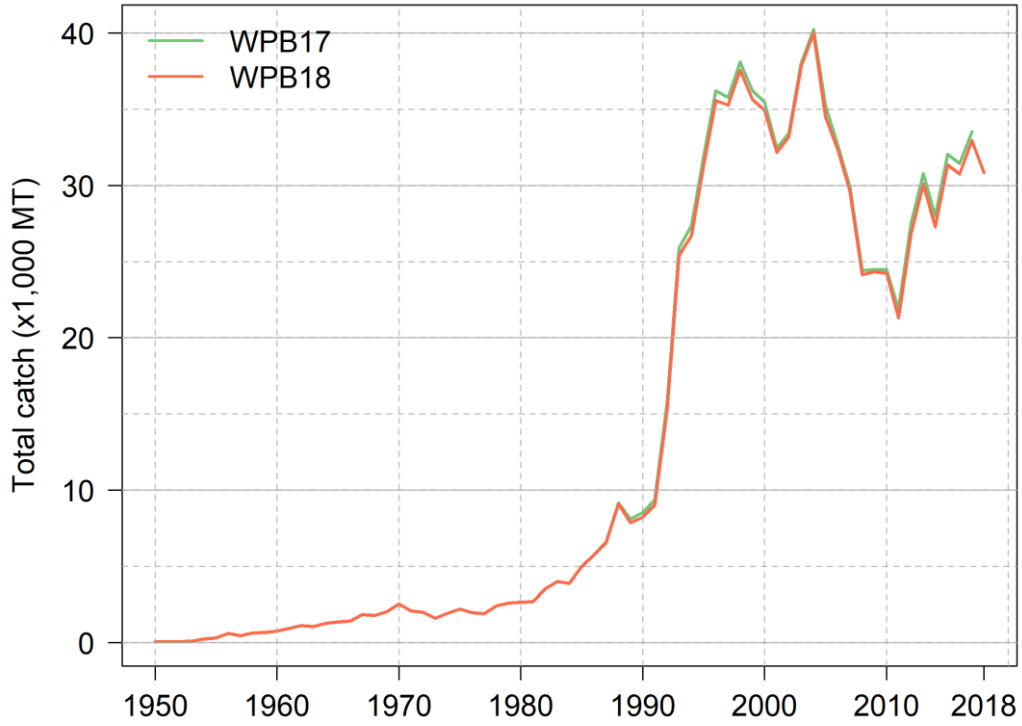

Fig. 3. Comparison of annual time series of total catches (MT) of Indian Ocean swordfish available at the 17th (WPB17, 2019) and 18th (WPB18, 2020) sessions of the IOTC Working Party on Billfish

TABLE 2. Best scientific estimates of the annual nominal catches (MT) of swordfish by fishery for the period 1950–2018. Colour codes (yellow = lower, green = higher) describe the intensity of captures by fishery across decades (left) and years (right). ELL = swordfish targeted longline; LL = Longline; OT = Other gears, i.e. longline-gillnet, handline, gillnet, gillnet-longline, coastal longline, troll line, sport fishing, and all other gears. Data as of May 2020

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
ELL	0	0	0	9	1,841	9,736	7,637	9,031	6,835	7,643	7,876	7,420	6,618	6,257	6,153	4,643
LL	260	1,301	1,905	4,128	19,682	14,940	8,459	6,633	4,875	9,123	8,095	6,677	8,457	9,007	8,039	7,980
OT	37	39	201	956	4,485	7,629	8,241	8,568	9,610	10,019	14,120	13,173	16,287	15,478	18,747	18,223
Total	**297**	**1,340**	**2,106**	**5,093**	**26,008**	**32,305**	**24,338**	**24,232**	**21,320**	**26,785**	**30,091**	**27,270**	**31,362**	**30,743**	**32,939**	**30,847**

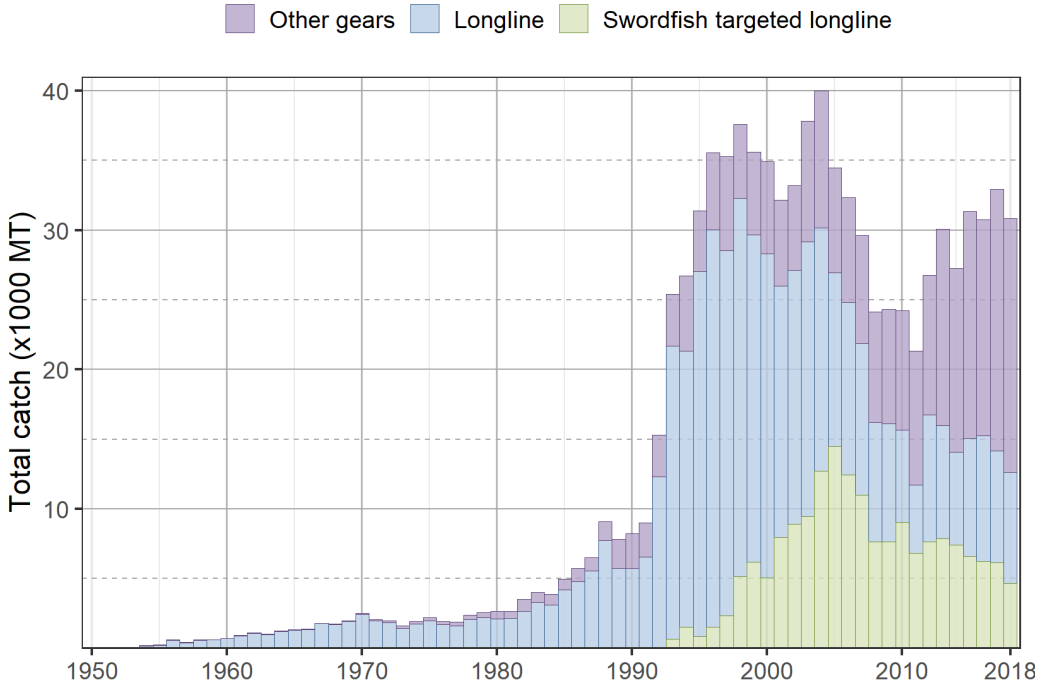

Fig. 4. Annual time series of nominal catches (MT) of swordfish by gear group recorded in the IOTC database, 1950–2018. Other gears include longline-gillnet, handline, gillnet, coastal longline, troll line, sport fishing, and all other gears.

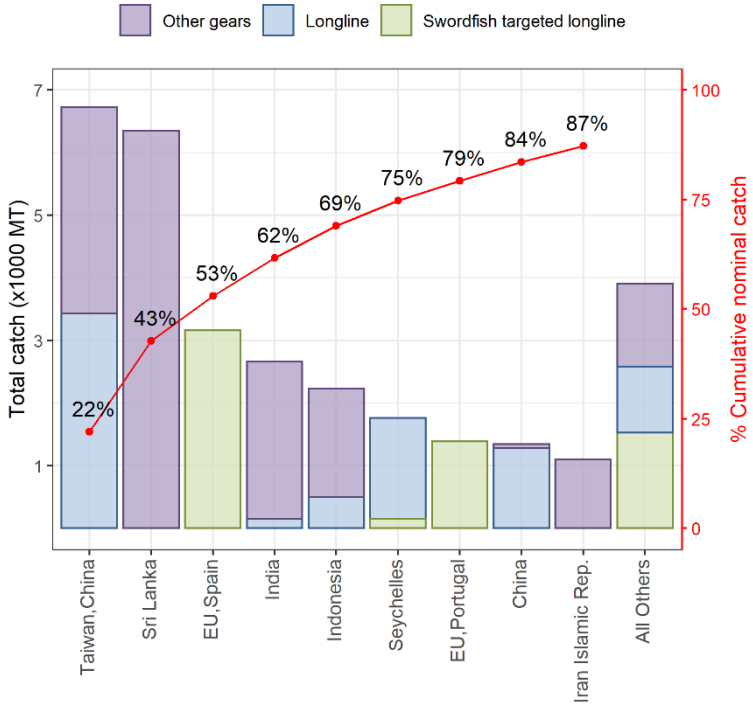

Fig. 5. Average nominal catches (MT) of swordfish over the period 2014–2018, by gear group and CPC ordered according to the importance of catches. The red solid line indicates the cumulative percentage of the total combined catches of the species for the CPCs concerned

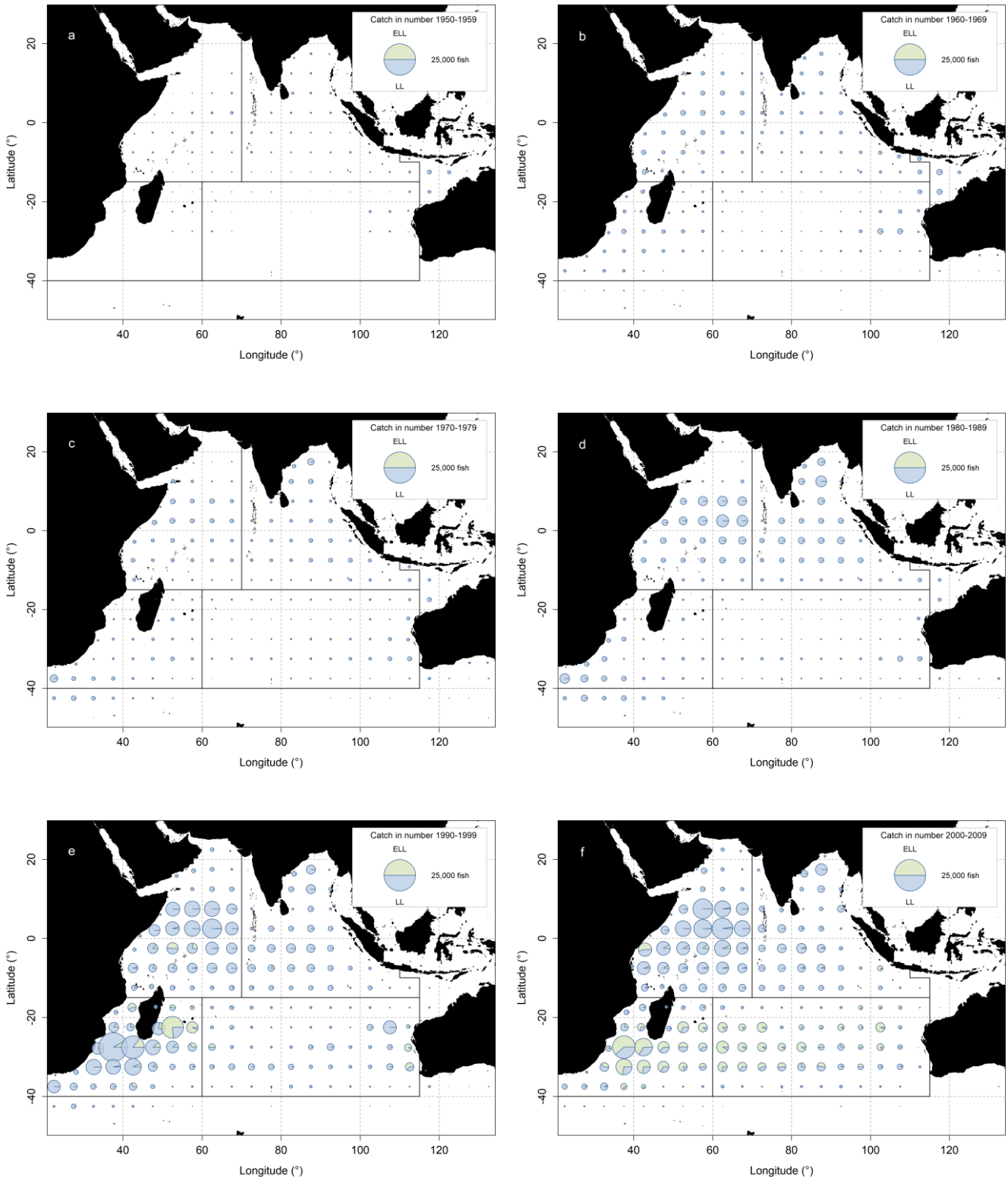

Fig. 6. Mean annual time-area catches of swordfish (in number of fish) as reported by the longline fisheries targeting swordfish (ELL) and other longline fisheries (LL) in the period 1950-2009, by decade and type of gear. Black solid lines represent the areas used for the assessments of swordfish. Does not include catches from fleets not reporting catch-and-effort data

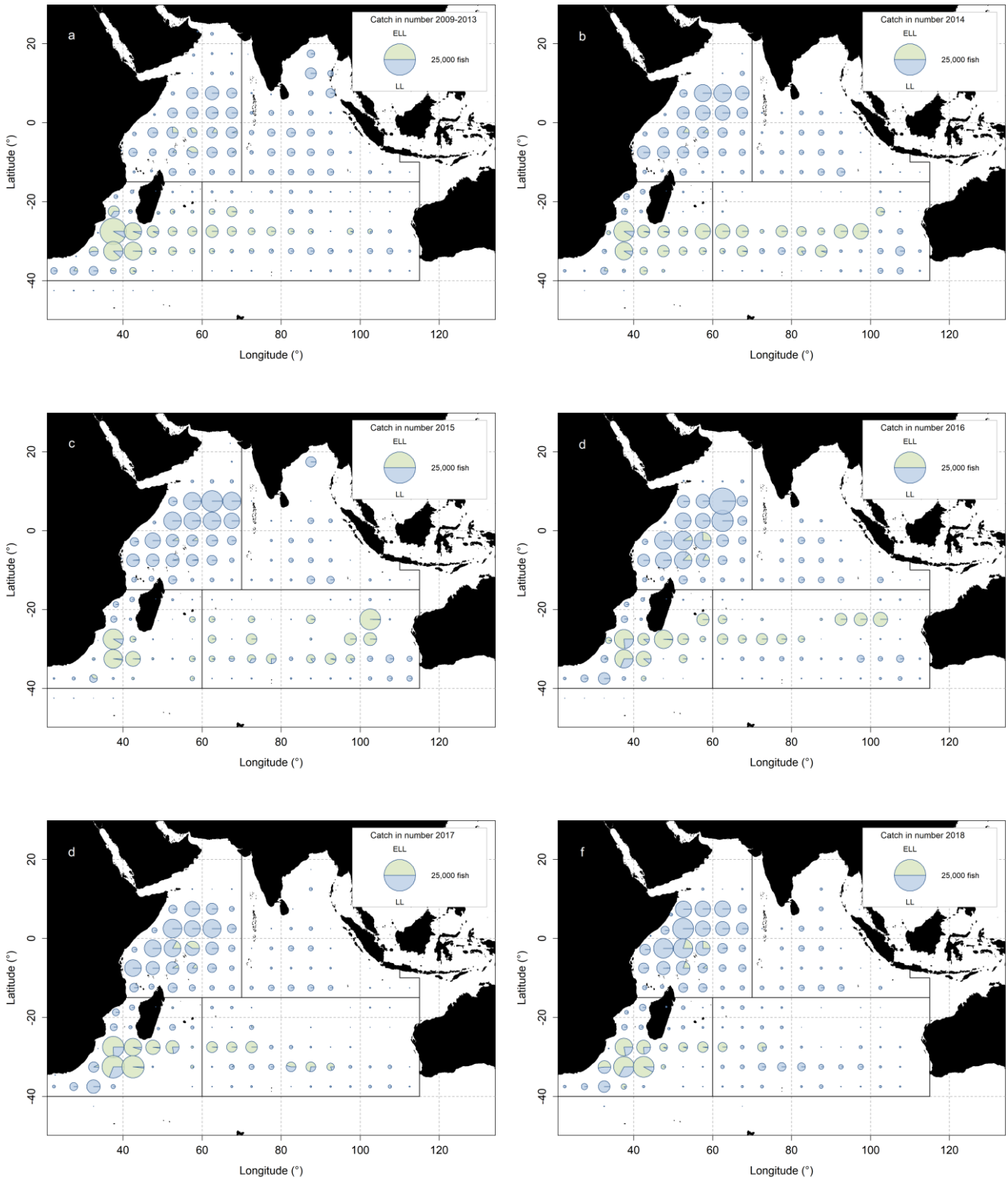

Fig. 7. Mean annual time-area catches of swordfish (in number of fish) as reported by the longline fisheries targeting swordfish (ELL) and other longline fisheries (LL) in the period 2009-2013, by type of gear and for 2014-18, by year and type of gear. Solid black lines represent the areas used for the assessments of swordfish. Does not include catches from fleets not reporting catch-and-effort data

Estimation of catches – data related issues

Retained catches: while the proportion of catches estimated, or adjusted, by the IOTC Secretariat are relatively low (**Fig. 8a**), there are uncertainties for the following fisheries/fleets:

- Pakistan (Gillnet): The IOTC Secretariat uses the catches of swordfish and marlins explicitly reported by Pakistan to estimate the actual species composition for the historical catch series of billfish for this fishery. However, as disaggregated records of billfish species are only available for 2018 and for few selected years in the timeframe subject to the revision, the result of this re-e estimation is that little to no swordfish appears to be caught by the Pakistani gillnet fleet in recent years, which is considered to be inaccurate.
- 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 is thought to be low and does not have a significant impact on the overall catch series.

Catch-per-unit-effort (CPUE) trends

- Availability: Catch-and-effort series are available for some industrial longline fisheries (**Fig. 8b**).

For most other fisheries, catch-and-effort time series for the species are not available at all or not provided up to IOTC standards (e.g., longline fisheries of Indonesia until 2017, drifting gillnet fisheries of Iran and Pakistan), or they considered poor quality, especially since the early ‘90s (e.g., gillnet and longline fisheries of Sri Lanka, Taiwan,China fresh-tuna longliners, and Non-reporting longliners (NEI)).

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 very low and the number of specimens measured per stratum has been decreasing in recent years (**Fig. 8c**).

- **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 ‘90s (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.

Data quality (by dataset)

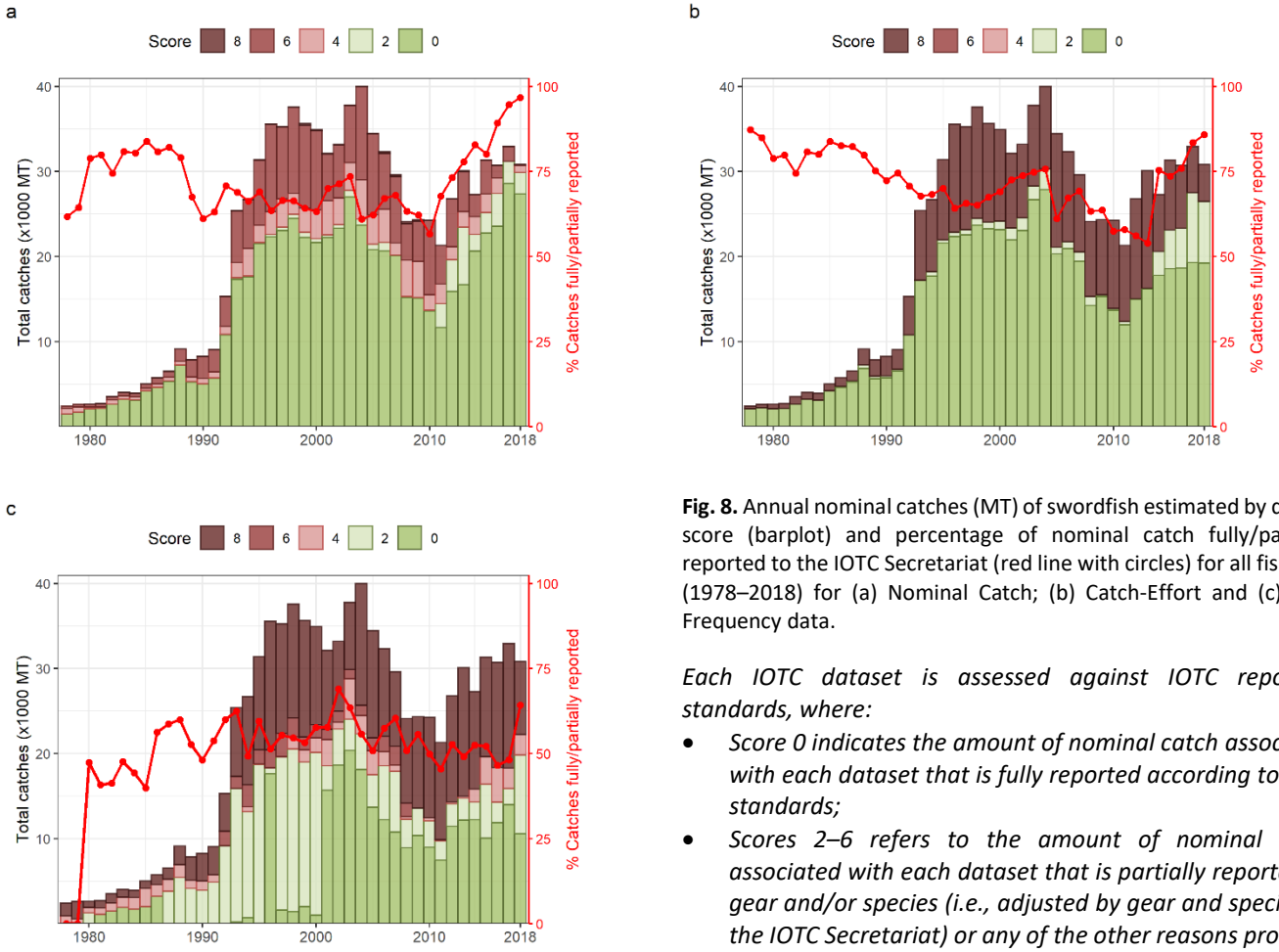

Fig. 8. Annual nominal catches (MT) of swordfish estimated by quality score (barplot) and percentage of nominal catch fully/partially reported to the IOTC Secretariat (red line with circles) for all fisheries (1978–2018) for (a) Nominal Catch; (b) Catch-Effort and (c) Size-Frequency data.

Each IOTC dataset is 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.*

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 (2014–18): Blue marlin are largely considered to be a non-target species of industrial and artisanal fisheries. Longline catches[8] account for around 65% of total catches in the Indian Ocean, followed by gillnets (22%), with remaining catches recorded under troll and handlines (**Table 3; Fig. 10**).
- Main fleets (and primary gear associated with catches): Percentage of total catches (2014–18): Around 80% of the total catches of blue marlin are accounted for by four fleets: Taiwan,China (longline): 43%; Sri Lanka (gillnet, hook and line and longline): 16%; I.R. Iran (gillnet): 13%, and Indonesia (longline and hook-and-line): 6% (**Fig. 10**).
- 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 '70s, at around 3,000 MT to 4,000 MT, and have steadily increased since then to reach values between 8,000 MT and to over 10,000 MT in the late '90s. Some of the highest catches of blue marlin reported by longliners in recent years have been recorded between 2012 and 2016, 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 2015 when catches estimates for blue marlin were revised substantially following new reports of catches-by-species for Iran's drifting gillnet fleet[9] (**Fig. 9**).

In addition, following issues with the reliability of catch estimates of Indonesia's fresh longline fleet, the IOTC Secretariat provided the WPB-16 meeting (2018) with an alternative catch series based on a new estimation methodology developed in collaboration with Indonesia. The revised catch series mostly affected catches of swordfish, striped marlin, and blue marlin estimated by the IOTC Secretariat for Indonesia. In the case of blue marlin, catches have been revised down by around 5,000 MT per year from 2012 onwards.

The revisions provided by the Government of Pakistan for their gillnet fleet, endorsed at the 22nd session of the IOTC Scientific Committee in 2019, introduced marked changes to blue marlin catches compared to what available at the previous WPB. In particular, captures from the species appear now to be significantly lower for the fleet in the entire time range covered by the revision (1987-2018)[10].

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

[9] 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 '00s.

[10] See also the corresponding paragraph under the Swordfish section for further details on the process performed by the Secretariat to re-estimate the species composition from the aggregates of billfish species reported by the revised catches.

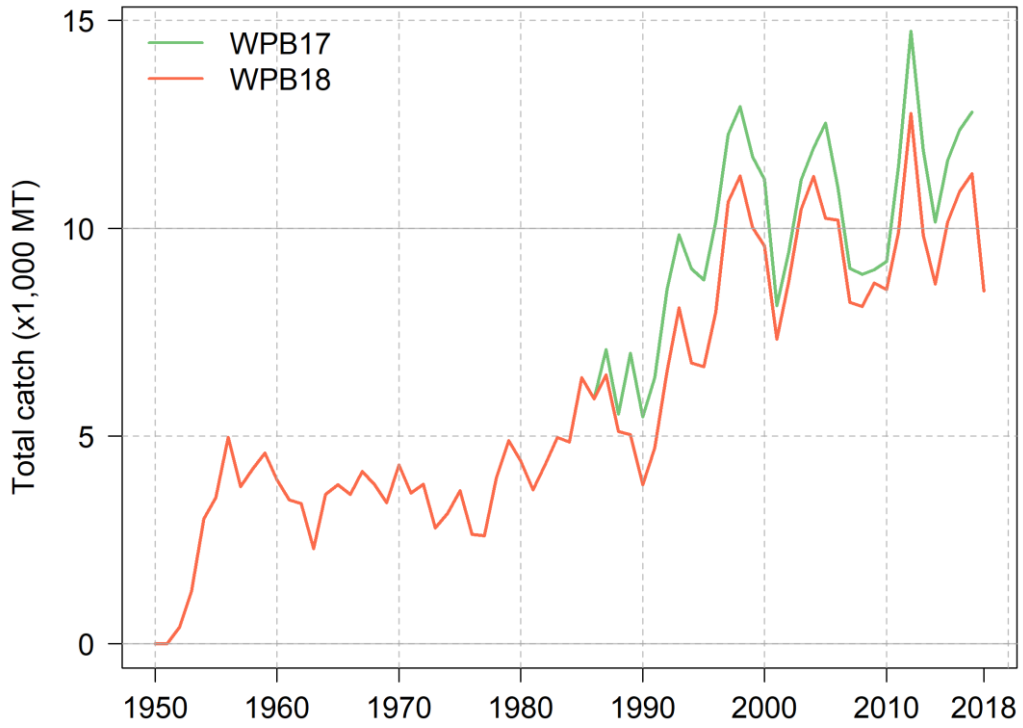

Fig. 9. Comparison of annual time series of total catches (MT) of Indian Ocean blue marlin available at the 17th (WPB17, 2019) and 18th (WPB18, 2020) sessions of the IOTC Working Party on Billfish

TABLE 3. Best scientific estimates of the annual nominal catches (MT) of blue marlin by fishery for the period 1950–2018. Colour codes (yellow = lower, green = higher) describe the intensity of captures by fishery across decades (left) and years (right). LL = Longline; GN = Gillnet; HL = Hook-and-Line (i.e. handline, trolling, baitboat, and sport fisheries); OT = Other gears (i.e. coastal purse seine, Danish purse seine, beach seine, and purse seine. Data as of May 2020

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
LL	2,567	3,535	3,409	4,552	7,071	7,861	7,162	7,185	7,857	10,509	7,746	6,066	7,231	7,858	5,633	5,300
GN	1	2	124	454	409	1,260	1,225	1,018	1,761	1,967	1,726	2,055	2,187	2,101	2,934	1,726
HL	5	9	17	105	168	150	277	303	269	265	341	522	711	867	1,962	1,420
OT	0	0	0	2	4	7	15	15	16	16	18	16	21	55	781	47
Total	**2,574**	**3,546**	**3,550**	**5,113**	**7,652**	**9,278**	**8,679**	**8,521**	**9,902**	**12,757**	**9,831**	**8,659**	**10,150**	**10,881**	**11,310**	**8,492**

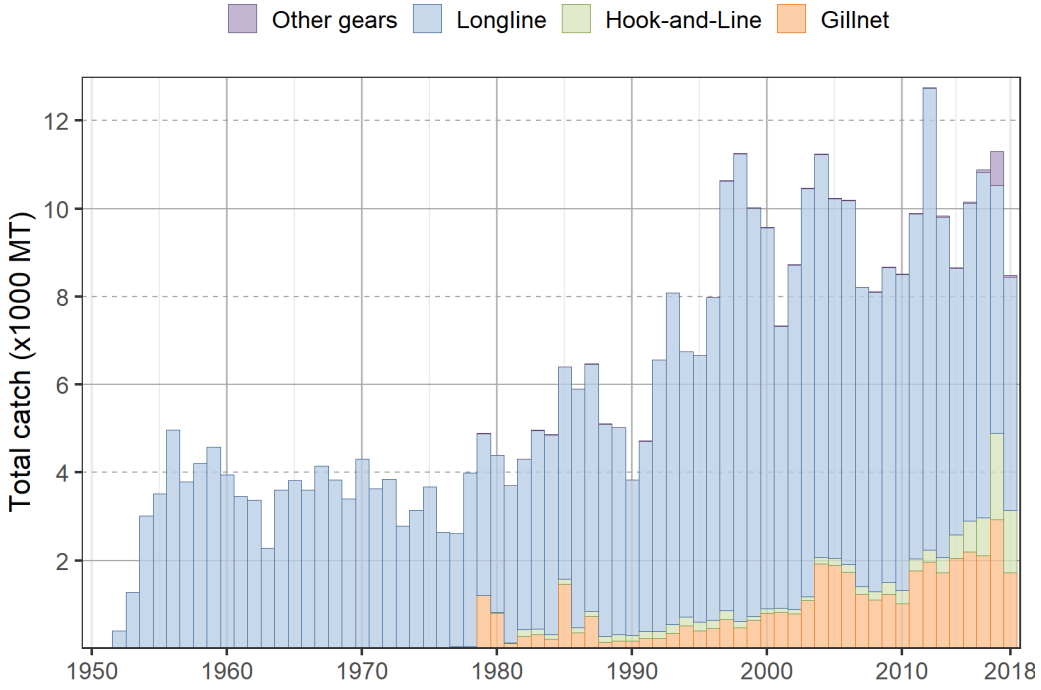

Fig. 10. Annual time series of nominal catches (MT) of blue marlin by gear group recorded in the IOTC database, 1950–2018. Other gears include coastal purse seine, Danish purse seine, beach seine and purse seine

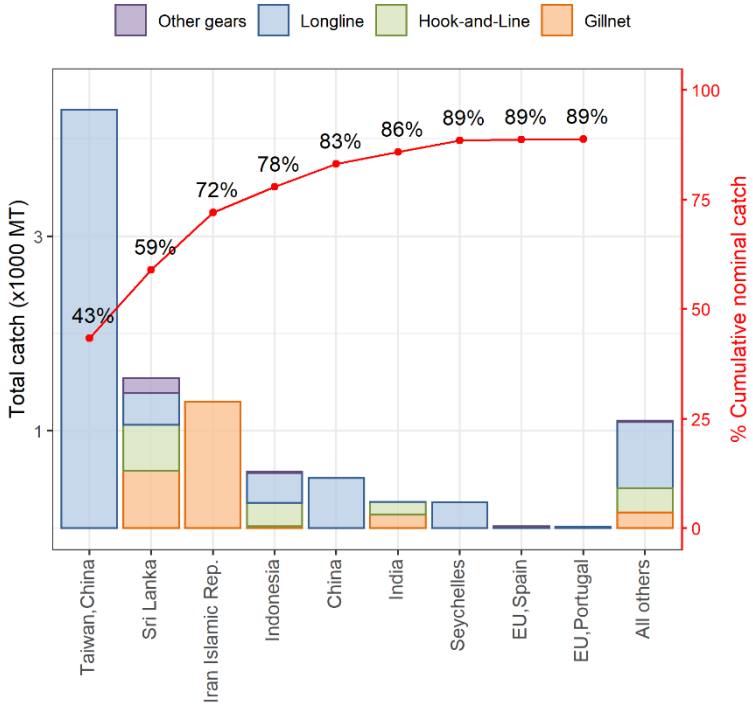

Fig. 11. Average nominal catches (MT) of blue marlin over the period 2014–2018, by gear group and CPC ordered according to the importance of catches. The red solid line indicates the cumulative percentage of the total combined catches of the species for the CPCs concerned

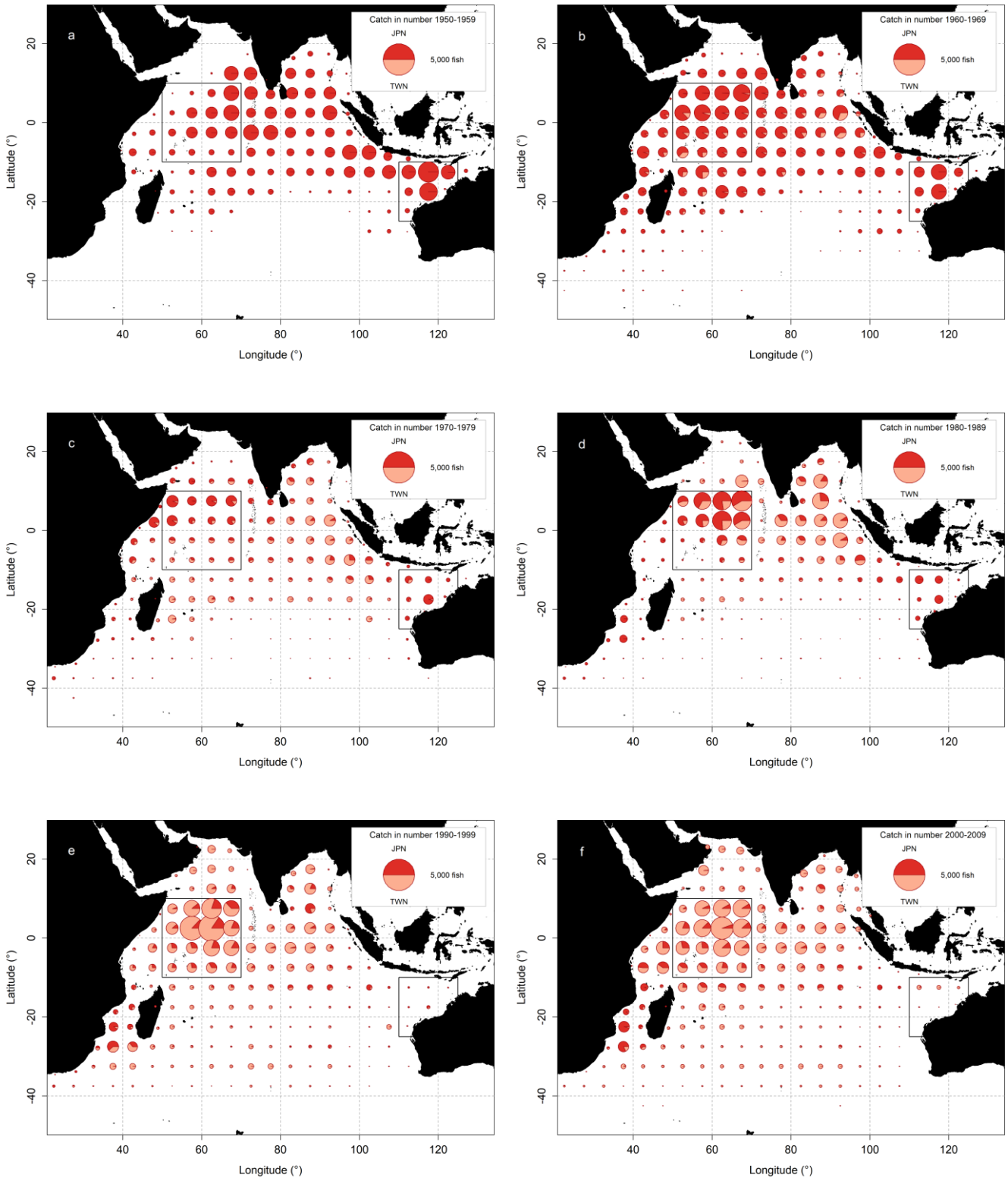

Fig. 12. Mean annual time-area catches (in number of fish) of blue marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 1950-2009, by decade and fleet. Black solid lines represent the marlin main longline fishing grounds identified by the IOTC WPB. Does not include catches from fleets not reporting catch-and-effort data

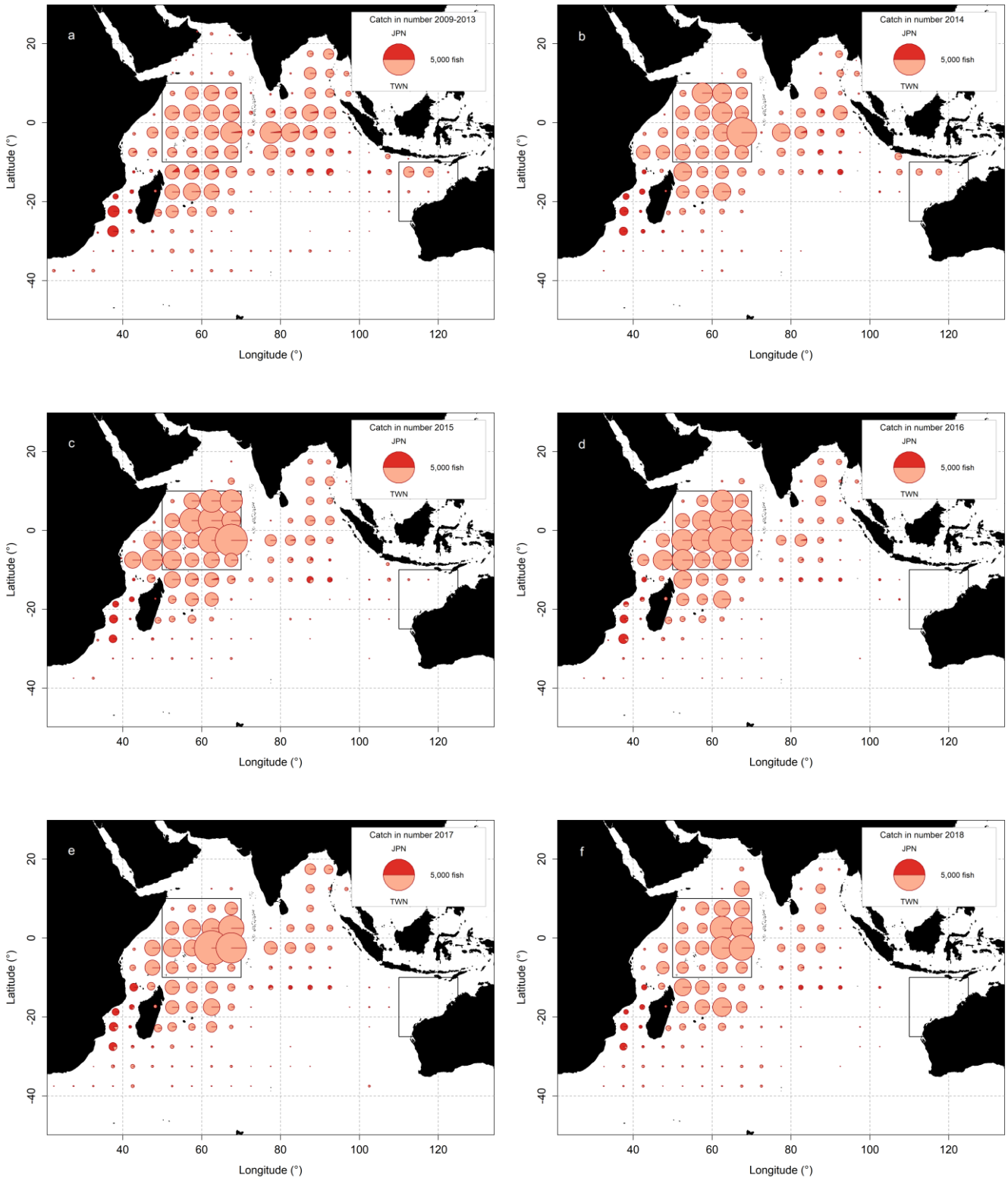

Fig. 13. Mean annual time-area catches (in number of fish) of blue marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 2009–13 by fleet and for 2014–18, by year and fleet. Solid black lines represent the marlin main longline fishing grounds identified by the IOTC WPB. Does not include catches from fleets from not reporting catch-and-effort data

Estimation of catches – data related issues

Retained catches – a relatively high proportion of blue marlin catches have been estimated, or adjusted, by the IOTC Secretariat across the entire time series and until recent years (**Fig. 14a**), 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.

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) (**Fig. 14b**).

  No catch-and-effort data are available from sport fisheries, other than for partial data from the sport 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**).

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 (**Fig. 14c**). 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.

Data quality (by dataset)

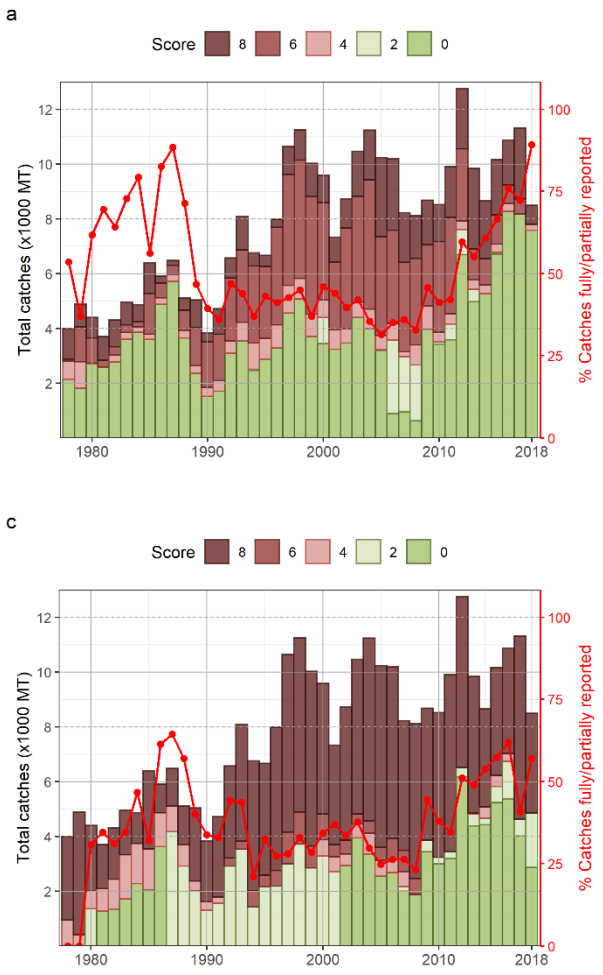

Fig. 14. Annual nominal catches (MT) of blue marlin estimated by quality score (barplot) and percentage of nominal catch fully/partially reported to the IOTC Secretariat (red line with circles) for all fisheries (1978–2018) for (a) Nominal Catch; (b) Catch-Effort and (c) Size-Frequency data.

Each IOTC dataset is 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.*

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: *Makaira indica*)

Fisheries and main catch trends

- Main fishing gear (2014–18): Black marlin is largely considered to be a non-target species of industrial and artisanal fisheries. Gillnets account for more than 50% of total catches in the Indian Ocean, followed by troll and handlines (32%), with remaining catches recorded under longlines (12%) (**Fig. 16**).
- Main fleets (and primary gear associated with catches): percentage of total catches (2014–18):
  More than 70% of the total catches of black marlin are accounted for by three fleets: I.R. Iran (gillnet): 30%; India (gillnet and trolling): 23%; Sri Lanka (gillnet and fresh longline): 21%.
- Main fishing areas:
  Primary: Between the early '50s and the late '80s 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 (**Fig. 18**).

  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 (**Fig. 19**).
- Retained catch trends: Since the '90s catches have increased steadily, from 2,500 MT in 1991 to around 13,000 MT in 2004. In recent years catches have further increased sharply from around 13,000 MT in 2012 to over 22,000 MT in 2016 – the highest catches recorded in the Indian Ocean for the species – largely due to increases reported by the offshore gillnet fisheries of I.R. Iran. Catches decreased to 15,000 MT in 2017 and re-increased to about 18,500 MT in 2018 (**Table 4**). Catches in Sri Lanka have also risen steadily since the beginning of the '90s as a result of the development of the fishery using a combination of drifting gillnets and longlines, from around 1,000 MT in 1991 to an average of around 3,900 MT 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

Catch estimates for black marlin have been largely unaffected by the recent revisions to Indonesia's fresh longline fleet (as opposed to other species such as swordfish and blue marlins), mostly as black marlins are generally more associated with gillnets operating in more coastal waters.

Also, the revisions provided by the Government of Pakistan for their gillnet fleet, endorsed at the 22nd session of the IOTC Scientific Committee in 2019, did not introduce relevant changes to blue marlin catches compared to what available at the previous WPB[11].

[11] See also the corresponding paragraph under the Swordfish section for further details on the process performed by the Secretariat to re-estimate the species composition from the aggregates of billfish species reported by the revised catches.

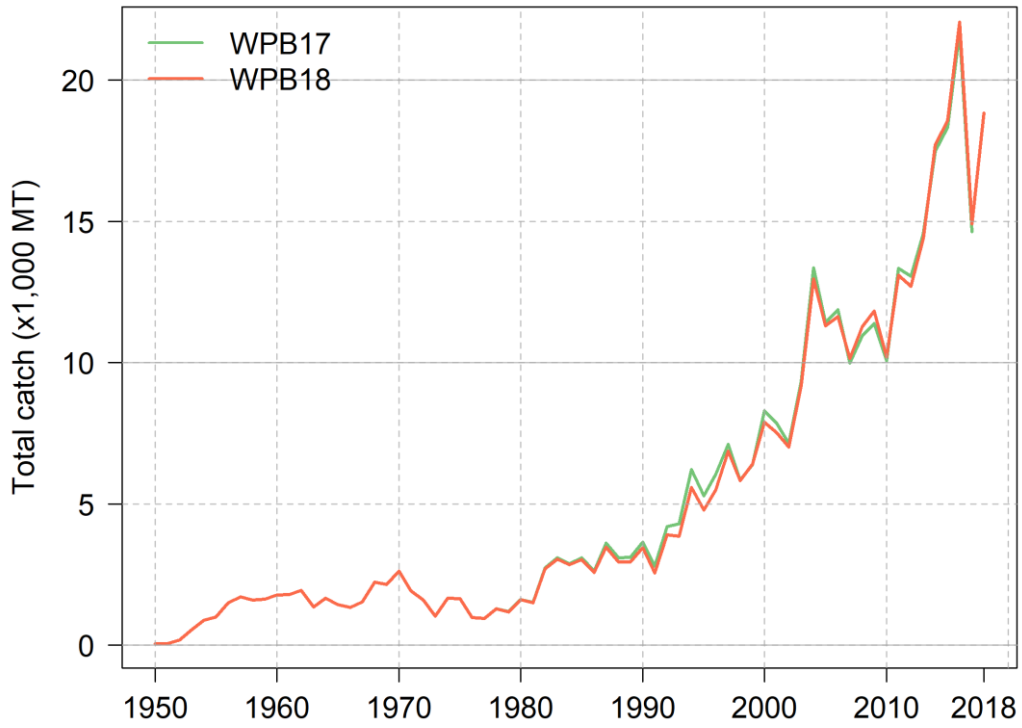

Fig. 15. Comparison of annual time series of total catches (MT) of Indian Ocean black marlin available at the 17th (WPB17, 2019) and 18th (WPB18, 2020) sessions of the IOTC Working Party on Billfish

TABLE 4. Best scientific estimates of the annual nominal catches (MT) of black marlin by fishery for the period 1950–2018. Colour codes (yellow = lower, green = higher) describe the intensity of captures by fishery across decades (left) and years (right). LL = Longline; GN = Gillnet; HL = Hook-and-Line (i.e. handline, trolling, baitboat, and sport fisheries); OT = Other gears (i.e. coastal purse seine, Danish purse seine, beach seine, and purse seine. Data as of May 2020

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
LL	862	1,661	1,391	1,755	2,425	3,770	3,719	3,765	4,209	3,304	2,825	2,648	2,293	3,006	1,869	1,218
GN	26	31	44	368	1,597	5,053	5,507	4,340	6,537	6,652	7,777	9,931	9,156	10,596	7,614	11,083
HL	24	27	42	447	737	1,029	2,146	1,629	1,864	2,261	3,089	4,630	6,625	7,981	4,653	6,092
OT	0	0	7	97	113	226	460	472	490	484	702	503	508	480	784	449
Total	**912**	**1,719**	**1,483**	**2,668**	**4,872**	**10,078**	**11,832**	**10,207**	**13,100**	**12,701**	**14,394**	**17,712**	**18,582**	**22,063**	**14,920**	**18,841**

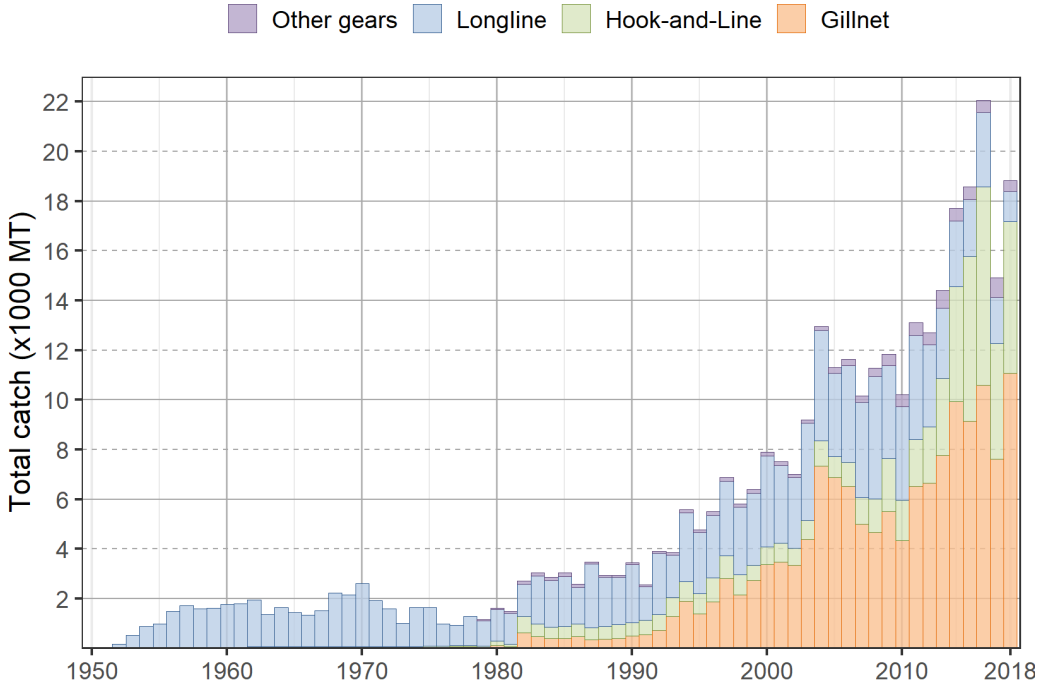

Fig. 16. Annual time series of nominal catches (MT) of black marlin by gear group recorded in the IOTC database, 1950–2018. Other gears include coastal purse seine, Danish purse seine, beach seine and purse seine

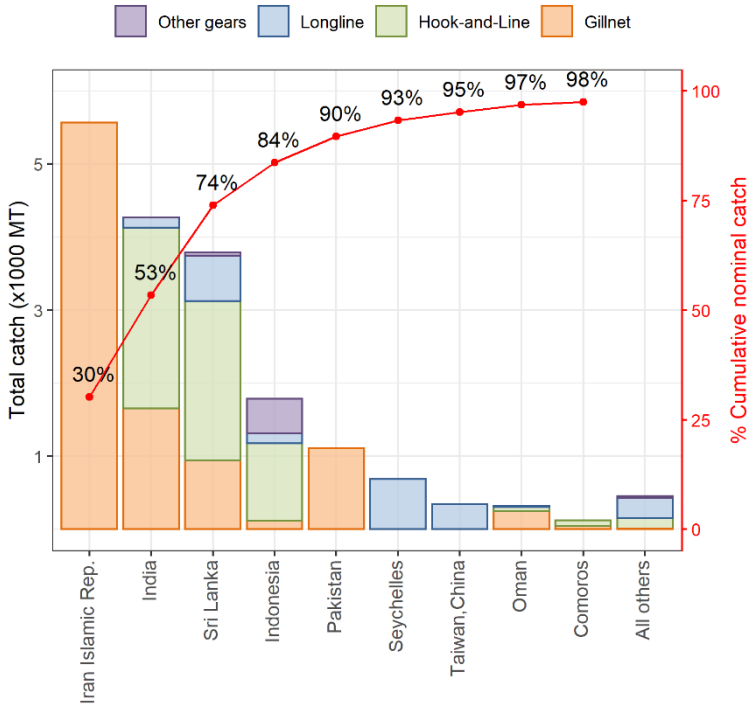

Fig. 17. Average nominal catches (MT) of black marlin over the period 2014–2018, by gear group and CPC ordered according to the importance of catches. The red solid line indicates the cumulative percentage of the total combined catches of the species for the CPCs concerned

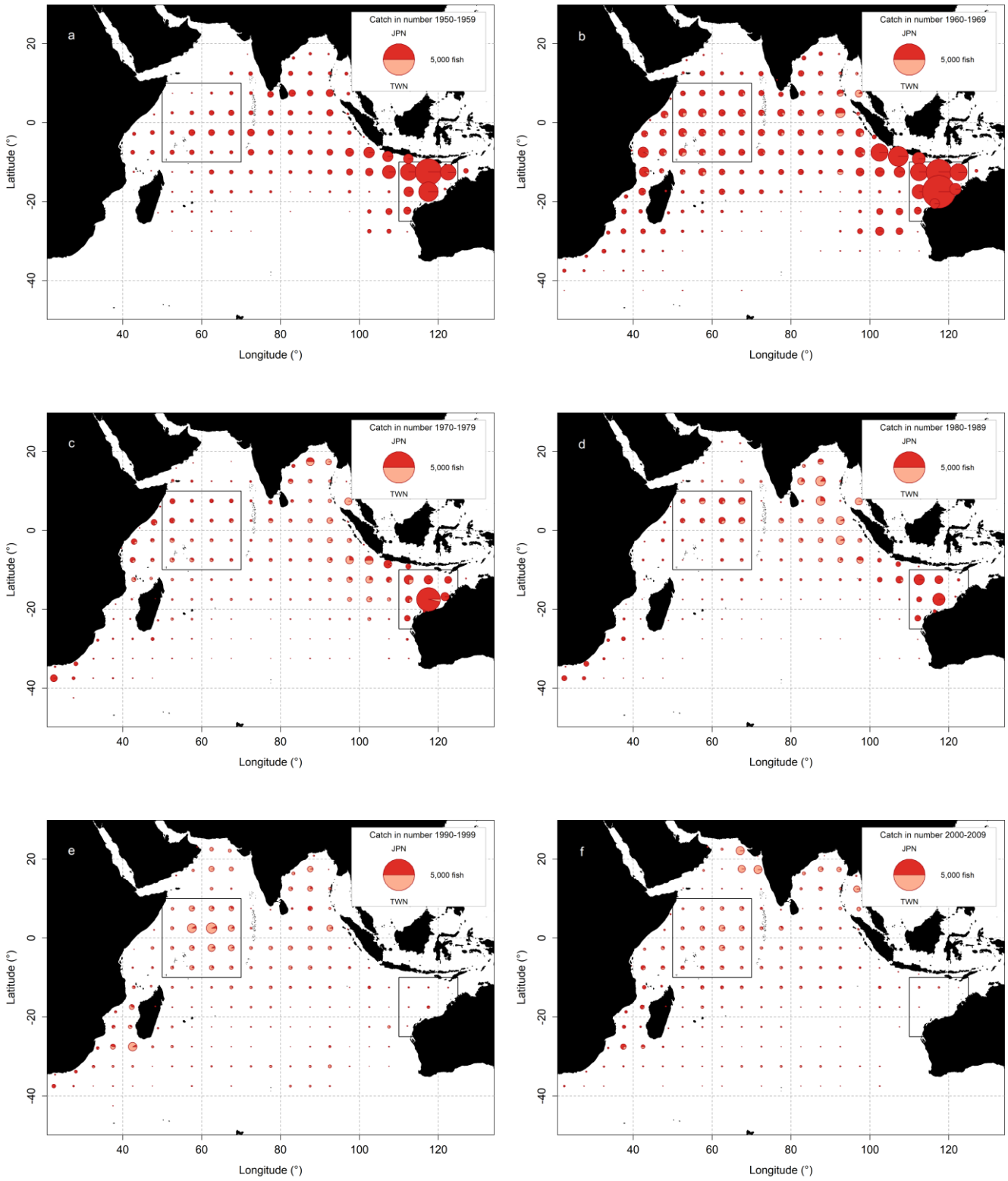

Fig. 18. Mean annual time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 1950–2009, by decade and fleet. Black solid lines represent the marlin main longline fishing grounds identified by the IOTC WPB. Does not include catches from fleets not reporting catch-and-effort data

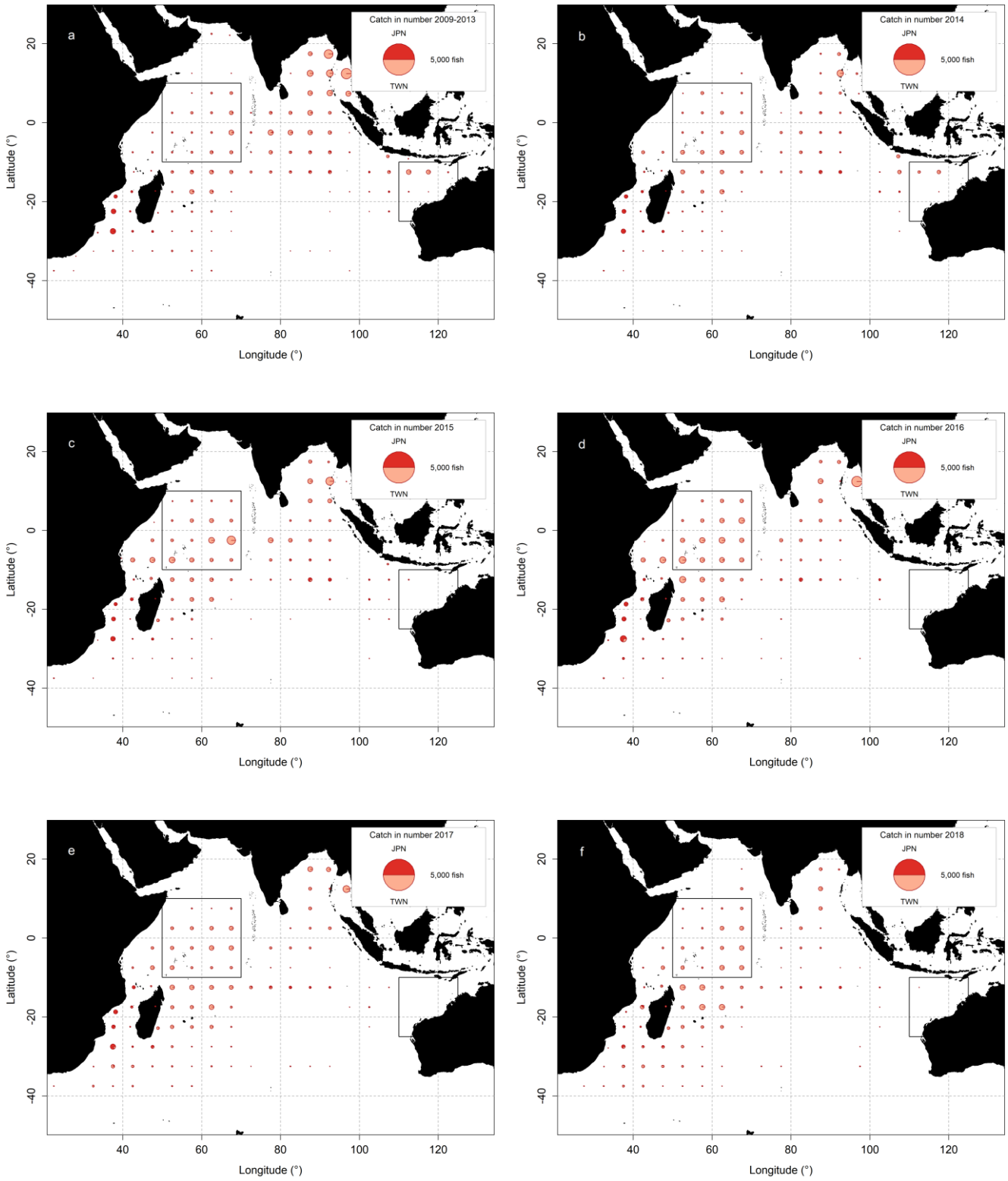

Fig. 19. Mean annual time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 2009–13 by fleet and for 2014–18, by year and fleet. Black solid lines represent the marlin main longline fishing grounds identified by the IOTC WPB. Does not include catches from fleets not reporting catch-and-effort data

Estimation of catches – data related issues

Retained catches – while in recent years the proportion of black marlin catches estimated by the Secretariat was relatively high, a very high proportion of the catches of black marlin were estimated, or adjusted, by the IOTC Secretariat (**Fig. 20a**) until 2010 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 black 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.

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) (**Fig. 20b**).

  No catch-and-effort data are available from sport fisheries, other than partial data from the sport fisheries of Kenya; likewise no data are available for other artisanal fisheries (e.g., gillnet fisheries of Indonesia and Pakistan). Detailed catch-and-effort data are available for the gillnet fishery of I.R. Iran since 2007, including details for the offshore component of the fleet.
- Main CPUE series available: Japanese and Taiwan,China longline fleet (**Appendix I**).

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 (**Fig. 20c**). 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.

Data quality (by dataset)

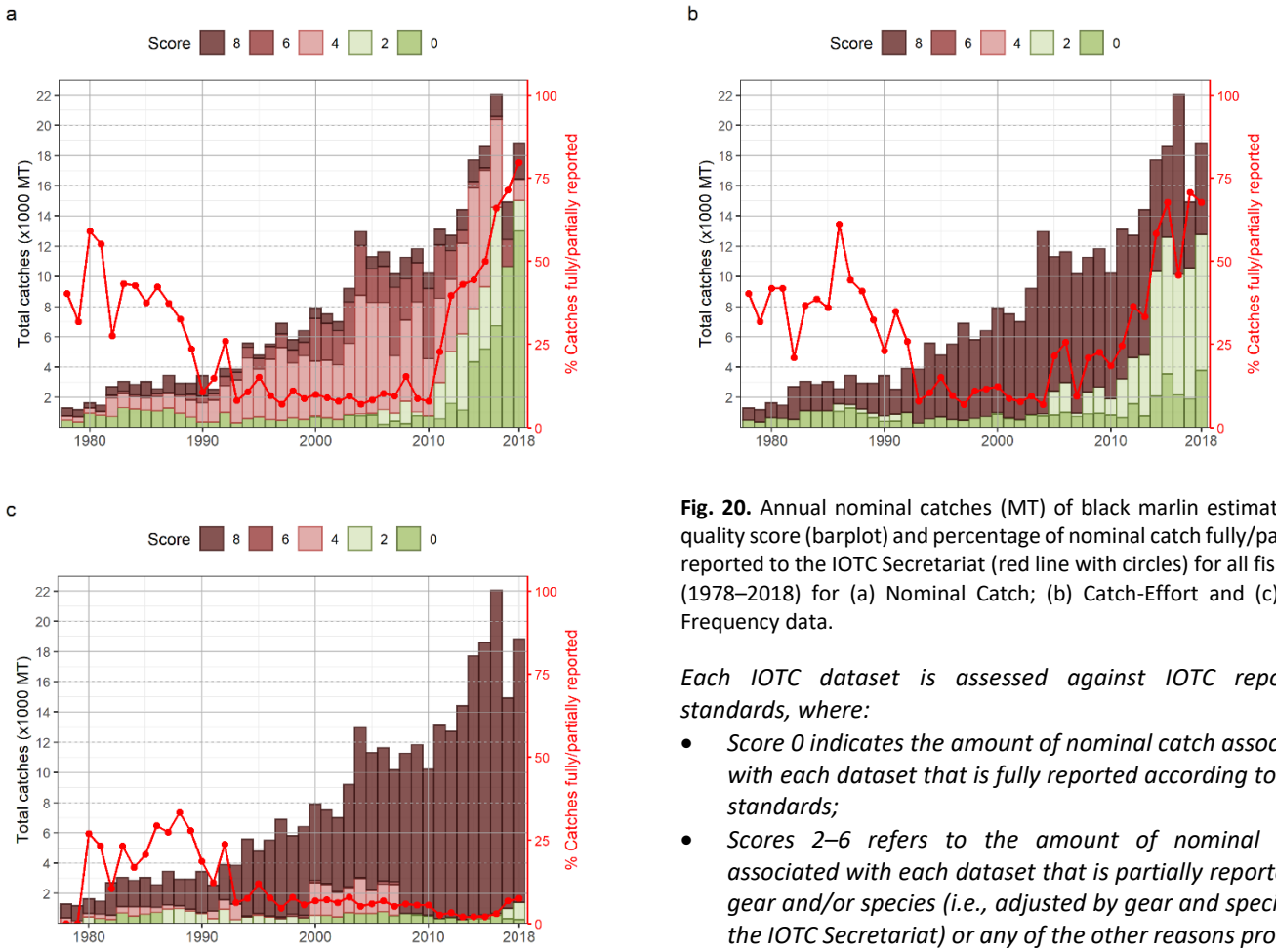

Fig. 20. Annual nominal catches (MT) of black marlin estimated by quality score (barplot) and percentage of nominal catch fully/partially reported to the IOTC Secretariat (red line with circles) for all fisheries (1978–2018) for (a) Nominal Catch; (b) Catch-Effort and (c) Size-Frequency data.

Each IOTC dataset is 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.*

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: *Tetrapturus audax*)

Fisheries and main catch trends

- Main fishing gear (2014–18): Striped marlin is largely considered to be a non-target species of industrial fisheries. Gillnets account for about 50% of total catches in the Indian Ocean, followed by longlines (40%). The remaining catches are mostly recorded under troll and handlines (**Table 5, Fig. 22**).
- Main fleets (and primary gear associated with catches): percentage of total catches (2014–18): Around 75% of the total catches of striped marlin are accounted for by four fleets: I.R. Iran (gillnet): 25%; Taiwan,China (longline): 20%; Indonesia (longline): 18%; and Pakistan (gillnet): 12% (**Fig. 23**).
- Main fishing areas: The distribution of striped marlin catches has changed since the '80s with most of the catch now taken in the north-west Indian Ocean, although between 2007–2011 catches in this area have dropped markedly, in tandem with a reduction of longline effort due to piracy (**Figs. 24-25**).
  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 (**Fig. 24**).
- Retained catch trends: Catch trends are variable, ranging from 2,000 MT to 8,000 MT per year, which may reflect the level of reporting and the status of striped marlin as a non-target species, rather than actual catches. In particular, catches reported under drifting longlines are highly variable, with lower catch levels between and 2011 largely due to declining catches reported by Taiwan,China, deep-freezing and fresh-tuna longliners. Since 2012, catches of striped marlin have fluctuated between 3,000 MT – 5,000 MT per year.
- 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. 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 provided the WPB-16 meeting with an alternative catch series based on a new estimation methodology developed in collaboration with Indonesia. The revised catch series mostly affects catches of swordfish, striped marlin, and blue marlin estimated by the IOTC Secretariat for Indonesia.

In the case of striped marlin, catches have been revised downwards to between 3,000 MT and 5,000 MT from 2012 onwards.

Also, the revisions provided by the Government of Pakistan for their gillnet fleet, endorsed at the 22nd session of the IOTC Scientific Committee in 2019, did not introduce relevant changes to striped marlin catches compared to what available at the previous WPB[12].

[12] See also the corresponding paragraph under the Swordfish section for further details on the process performed by the Secretariat to re-estimate the species composition from the aggregates of billfish species reported by the revised catches.

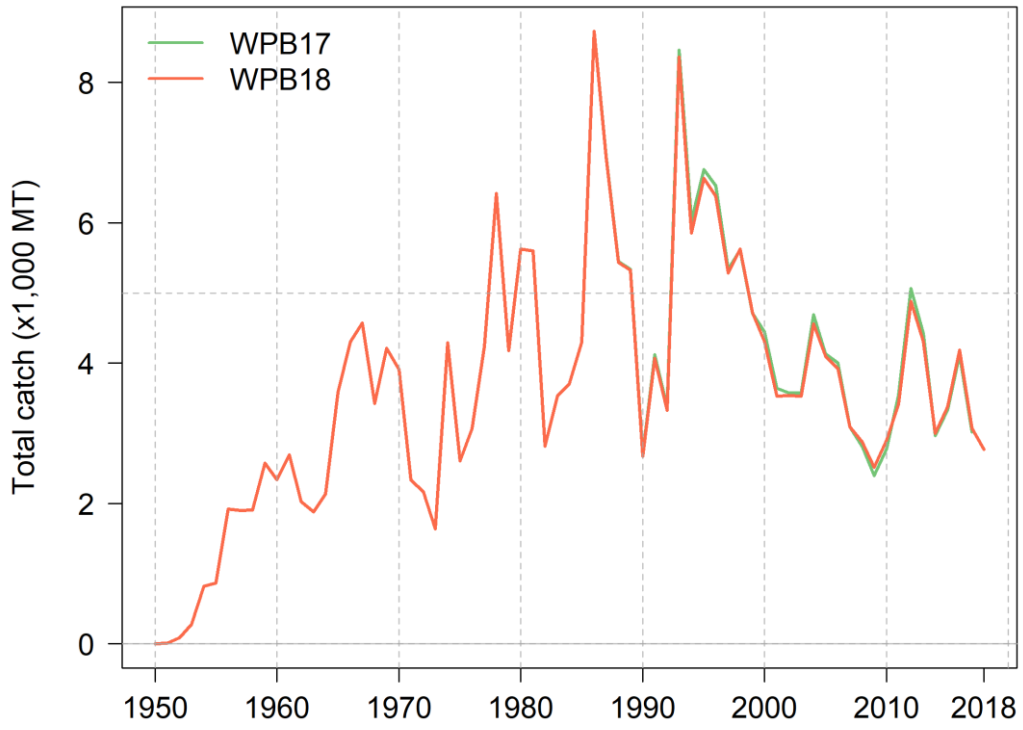

Fig. 21. Comparison of annual time series of total catches (MT) of Indian Ocean striped marlin available at the 17th (WPB17, 2019) and 18th (WPB18, 2020) sessions of the IOTC Working Party on Billfish

TABLE 5. Best scientific estimates of the annual nominal catches (MT) of striped marlin by fishery for the period 1950–2018. Colour codes (yellow = lower, green = higher) describe the intensity of captures by fishery across decades (left) and years (right). LL = Longline; GN = Gillnet; HL = Hook-and-Line (i.e. handline, trolling, baitboat, and sport fisheries); OT = Other gears (i.e. coastal purse seine, Danish purse seine, beach seine, and purse seine. Data as of May 2020

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
LL	1,028	3,104	3,458	5,144	5,115	2,935	1,679	2,123	2,308	3,771	2,890	1,357	1,721	2,633	1,345	1,014
GN	5	8	16	20	96	506	526	453	767	777	1,040	1,280	1,313	1,182	1,297	1,431
HL	3	5	10	32	72	137	273	282	292	288	332	319	301	329	342	288
OT	0	0	0	6	10	20	41	42	44	43	49	45	44	44	86	36
Total	**1,036**	**3,117**	**3,485**	**5,202**	**5,293**	**3,599**	**2,519**	**2,900**	**3,412**	**4,880**	**4,311**	**3,000**	**3,379**	**4,188**	**3,070**	**2,769**

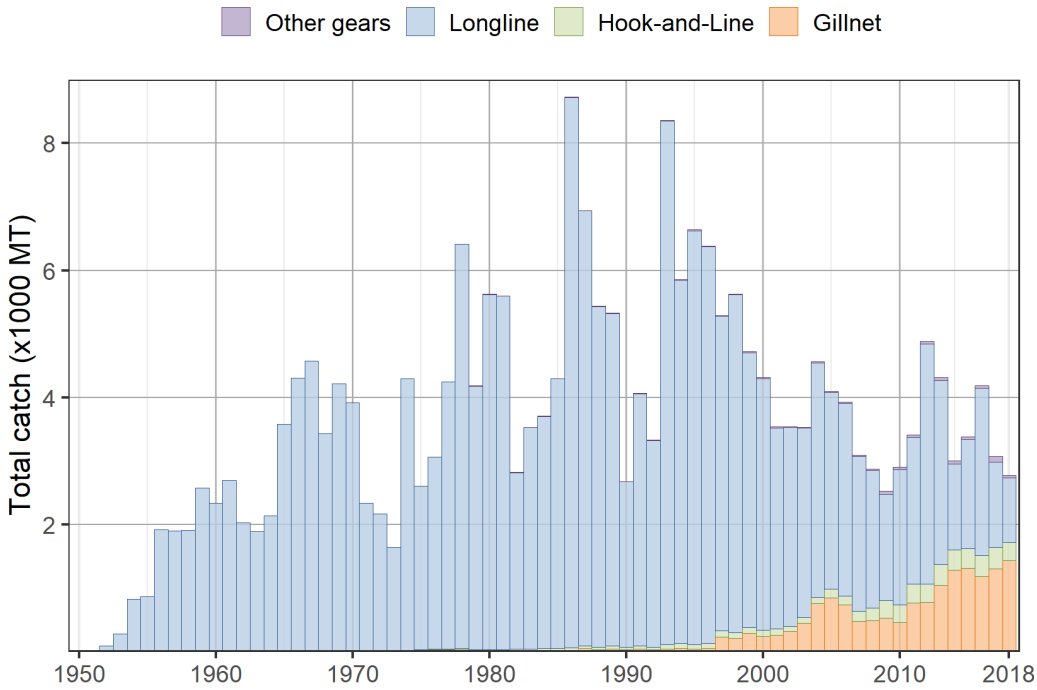

Fig. 22. Annual time series of nominal catches (MT) of striped marlin by gear group recorded in the IOTC database, 1950–2018. Other gears include coastal purse seine, Danish purse seine, beach seine and purse seine

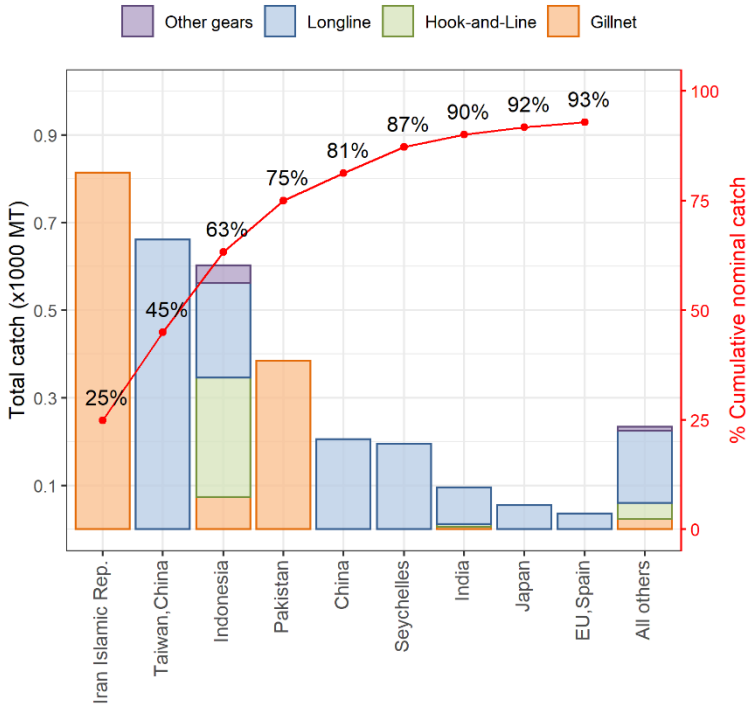

Fig. 23. Average nominal catches (MT) of striped marlin over the period 2014–2018, by gear group and CPC ordered according to the importance of catches. The red solid line indicates the cumulative percentage of the total combined catches of the species for the CPCs concerned

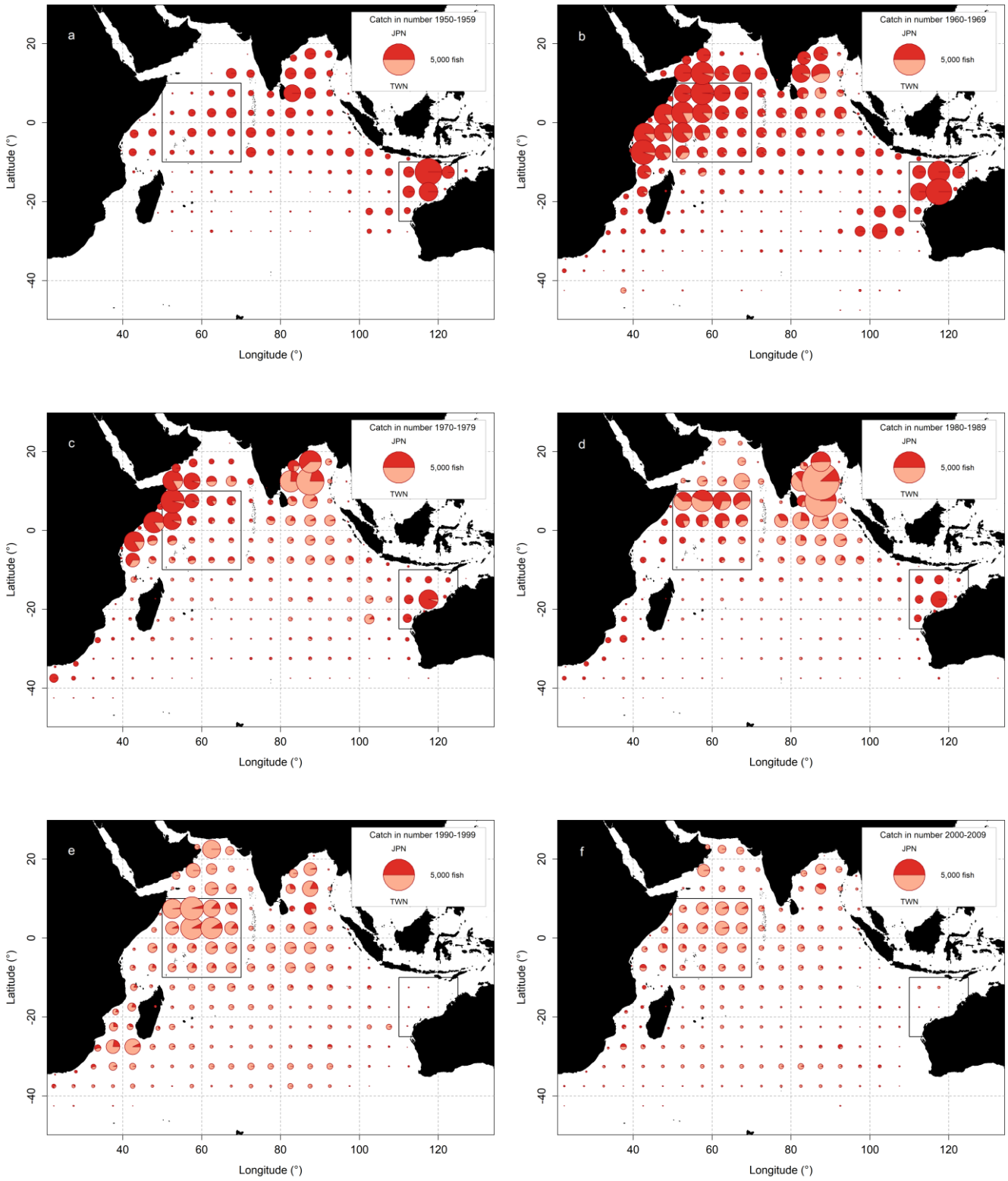

Fig. 24. Mean annual time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 1950–2009, by decade and fleet. Solid black lines represent the marlin main longline fishing grounds identified by the IOTC WPB. Does not include fleets non-reporting catch-and-effort data

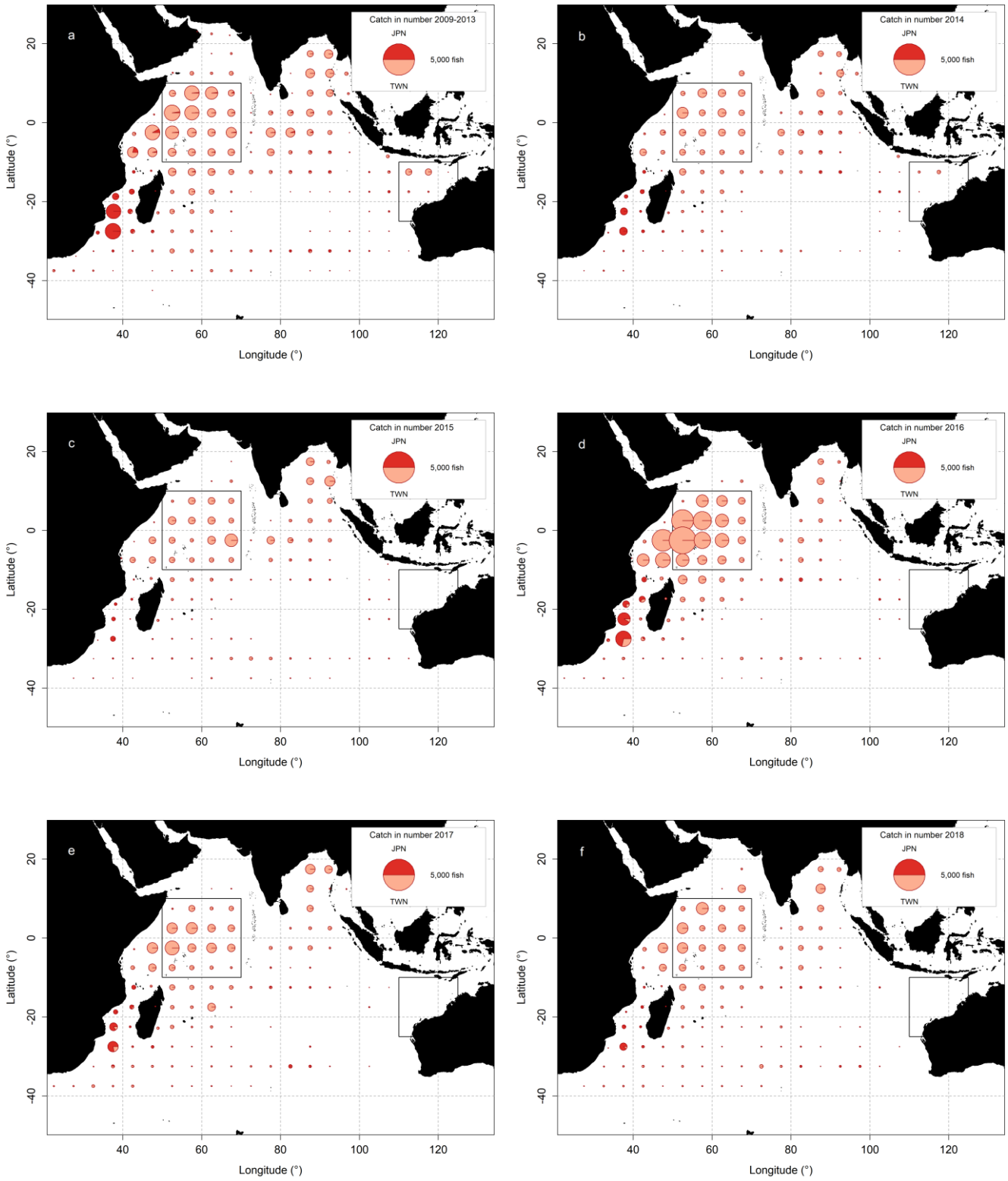

Fig. 25. Mean annual time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 2009–13 by fleet and for 2014–18, by year and fleet. Solid black lines represent the marlin main longline fishing grounds identified by the IOTC WPB. Does not include fleets non-reporting catch-and-effort data

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. 26a**), 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 for some years (2000-2001, and 2010-2011), 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.
- Species mis-identification: Difficulties in the identification of marlins also contribute to uncertainties in the catch estimates of striped marlin available to the Secretariat.

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) (**Fig. 26b**).

  No catch-and-effort data are available from sport fisheries, other than for partial data from the sport 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**).

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 (**Fig. 26c**).
- Sex ratio data: Have not been provided to the Secretariat by CPCs.

Data quality (by dataset)

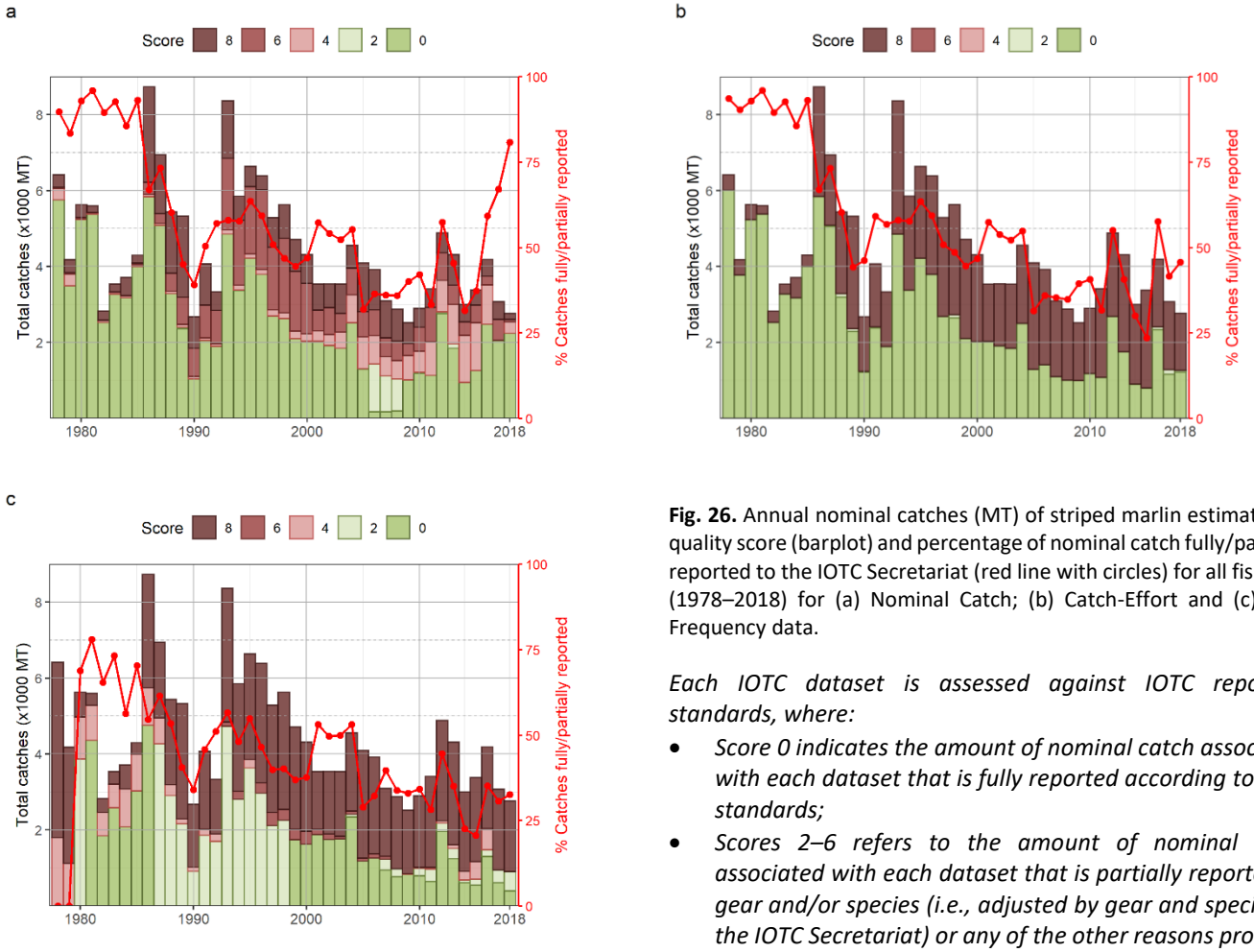

Fig. 26. Annual nominal catches (MT) of striped marlin estimated by quality score (barplot) and percentage of nominal catch fully/partially reported to the IOTC Secretariat (red line with circles) for all fisheries (1978–2018) for (a) Nominal Catch; (b) Catch-Effort and (c) Size-Frequency data.

Each IOTC dataset is 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.*

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: *Istiophorus platypterus*)

Fisheries and main catch trends

- Main fishing gear (2014–2018): Gillnets account for around 70% of total catches in the Indian Ocean, followed by troll and hand lines (23%), with remaining catches recorded under longlines and other gears (**Fig. 28**).
- Main fleets (and primary gear associated with catches): percentage of total catches (2014–18): If we exclude the Republic of Tanzania (whose catch data have been repeated in recent years by the Secretariat, due to the lack of explicit reporting from the country), then 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): 35%; India (gillnets and trolling): 24%; Pakistan (gillnets): 9%; and Sri Lanka (gillnets and fresh longline): 9% (**Fig. 29**). 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 '90s, from around 7,000 MT in the early '90s to over 26,000 MT from 2010 onwards (**Table 6**). This increase is largely due to the development of the gillnet/longline fisheries in India and Sri Lanka as well as the reporting of consistent catches from Iranian gillnet vessels (in particular, for what concerns the offshore component of the fleet). In the case of I.R. Iran, gillnet catches have increased from less than 1,000 MT in the early '90s to between 7,000 MT and 12,000 MT since 2013. Catches of the Sri Lankan gillnet fishery have significantly decreased in recent years, with a recent increase to levels around 1,000 MT detected for years between 2014 and 2018, while the combined reported catch of the gillnet and hook-and-line fisheries of India reached 10,000 MT in 2018.

  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 also reported catches of Indo-Pacific sailfish in the central western Indian Ocean, between Sri Lanka and the Maldives and the Mozambique Channel. In 2018, geo-referenced catches of Indo-Pacific sailfish were reported for the first time in both the small-scale and large-scale longline fisheries of China, showing that both fleets are also operating in the southern-central part of the Indian Ocean, i.e. south of 20° S and between 40-60° E.
- Discard levels**:** Moderate to high, however discard levels are largely unknown for most industrial fisheries (i.e., mostly longliners).

Changes to the catch series

Catch estimates for Indo-Pacific sailfish have been largely unaffected by the recent revisions to Indonesia's fresh longline fleet (as opposed to other species such as swordfish and blue marlins), mostly as sailfish are generally more associated with gillnet fisheries.

The revisions provided by the Government of Pakistan for their gillnet fleet, endorsed at the 22nd session of the IOTC Scientific Committee in 2019, introduced non-negligible changes to Indo-Pacific sailfish catches compared to what available at the previous WPB. In particular, captures from the species appear now to be significantly lower for the fleet in the entire time range covered by the revision (1987-2018)[13]. It is worth mentioning that Indo-Pacific sailfish is the only billfish species explicitly reported in the revised Pakistan gillnet catches (1987-2017) as received by the Secretariat: starting from 2018, Pakistan is reporting distinct billfish species as opposed to the generic 'Billfish' aggregate used in the revised time series until 2017.

[13] See also the corresponding paragraph under the Swordfish section for further details on the process performed by the Secretariat to re-estimate the species composition from the aggregates of billfish species reported by the revised catches.

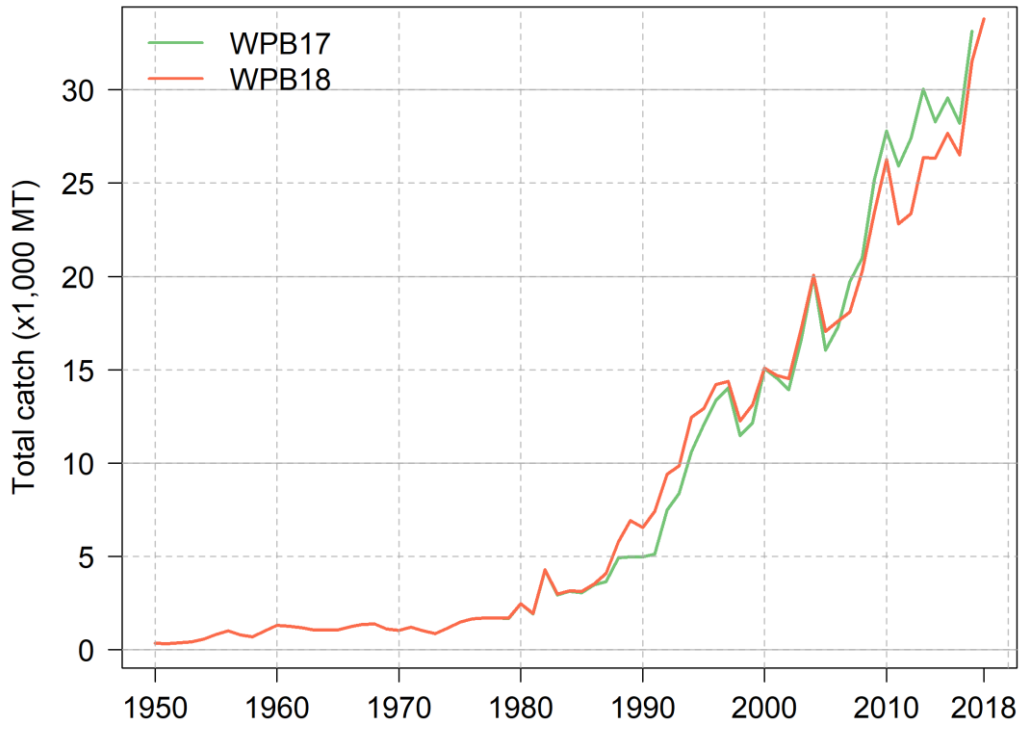

Fig. 27. Comparison of annual time series of total catches (MT) of Indian Ocean Indo-Pacific sailfish available at the 17th (WPB17, 2019) and 18th (WPB18, 2020) sessions of the IOTC Working Party on Billfish

TABLE 6. Best scientific estimates of the annual nominal catches (MT) of Indo-Pacific sailfish by fishery for the period 1950–2018. Colour codes (yellow = lower, green = higher) describe the intensity of captures by fishery across decades (left) and years (right). LL = Longline; GN = Gillnet; HL = Hook-and-Line (i.e. handline, trolling, baitboat, and sport fisheries); OT = Other gears (i.e. coastal purse seine, Danish purse seine, beach seine, and purse seine. Data as of May 2020

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
LL	297	804	385	270	1,815	2,467	2,313	1,638	1,557	1,731	2,130	1,530	1,121	1,790	1,095	1,251
GN	165	181	504	2,082	6,927	11,311	15,425	18,448	15,593	16,409	18,357	19,820	19,588	17,719	21,478	25,208
HL	171	213	427	1,427	2,471	3,934	5,479	5,999	5,477	5,049	5,515	4,791	6,632	6,764	8,530	7,121
OT	0	0	32	45	42	85	171	175	184	180	359	191	314	225	423	227
Total	**633**	**1,197**	**1,348**	**3,825**	**11,255**	**17,797**	**23,388**	**26,260**	**22,811**	**23,369**	**26,361**	**26,332**	**27,656**	**26,498**	**31,524**	**33,807**

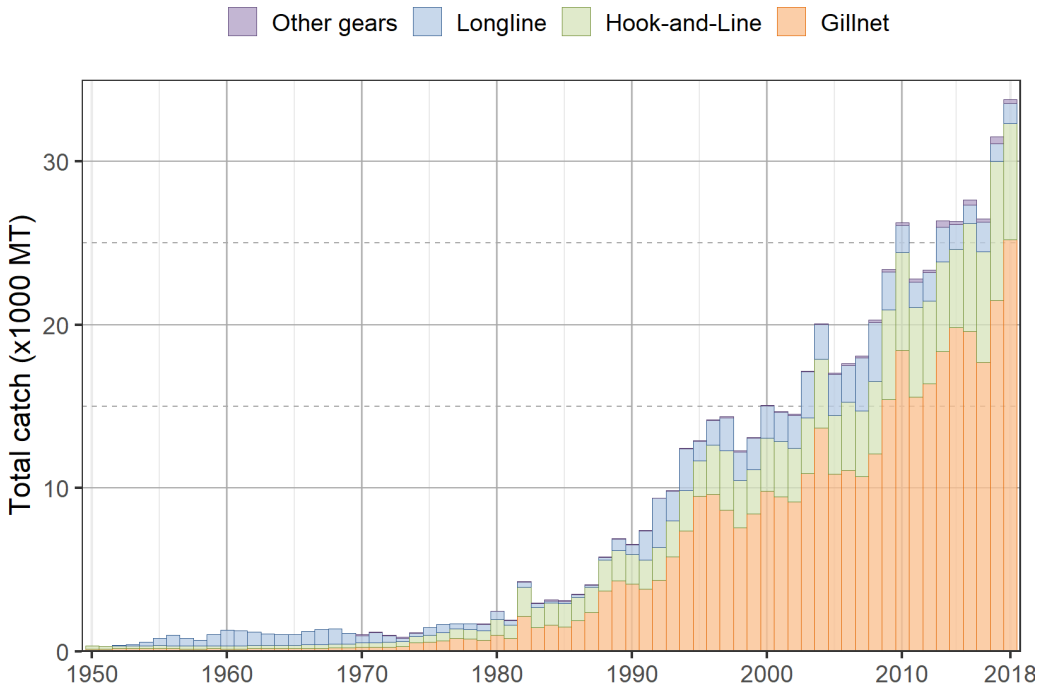

Fig. 28. Annual time series of nominal catches (MT) of Indo-Pacific sailfish by gear group recorded in the IOTC database, 1950–2018. Other gears include coastal purse seine, Danish purse seine, beach seine and purse seine

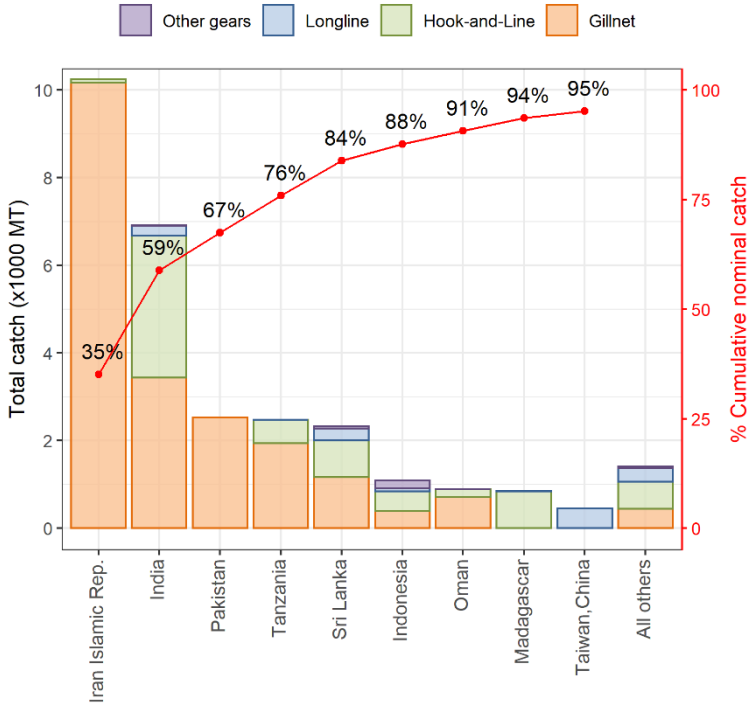

Fig. 29. Average nominal catches (MT) of Indo-Pacific sailfish over the period 2014–2018, by gear group and CPC ordered according to the importance of catches. The red solid line indicates the cumulative percentage of the total combined catches of the species for the CPCs concerned

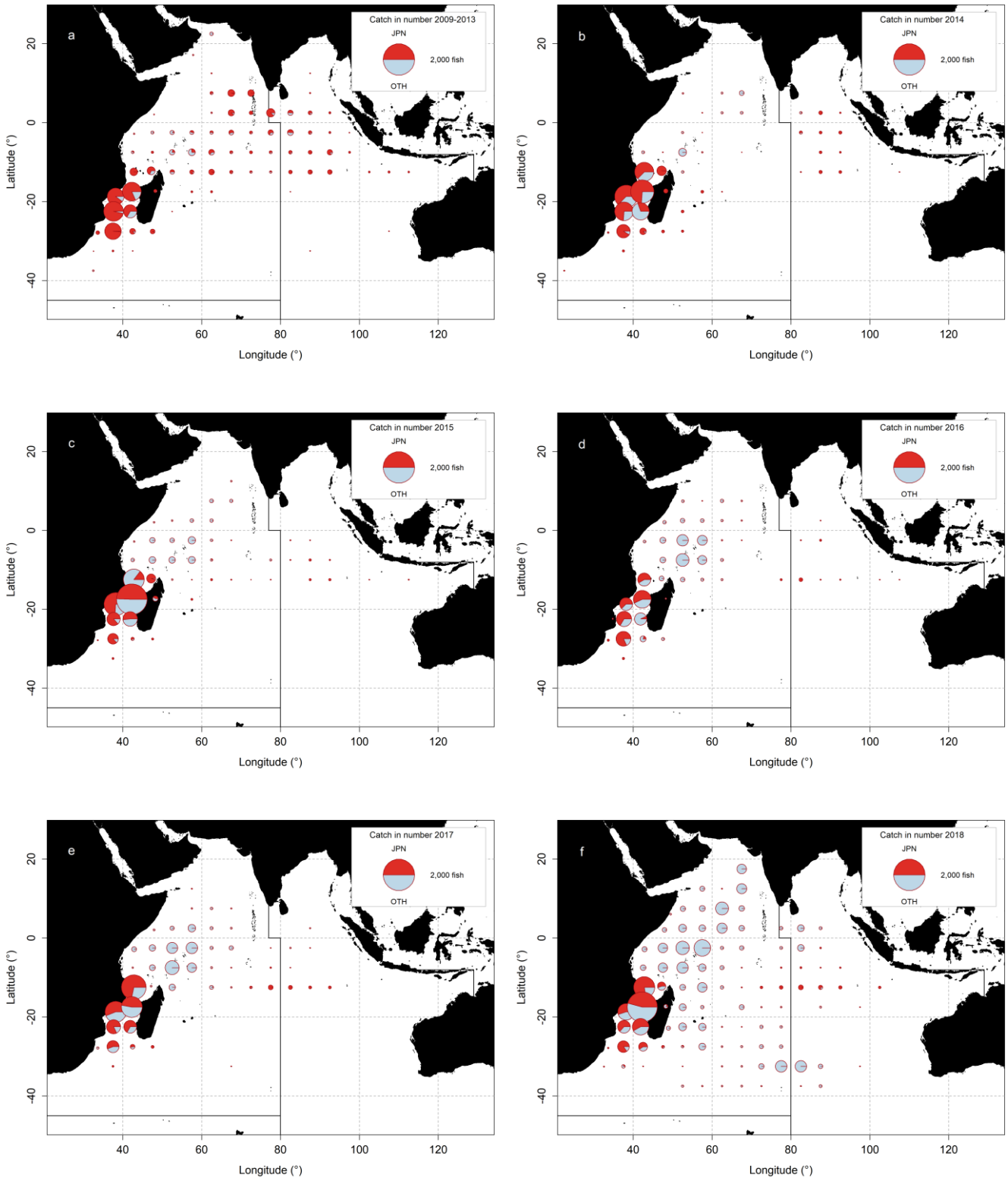

Fig. 30. Mean annual time-area catches (in number of fish) of Indo-Pacific sailfish as reported for the longline fisheries of Japan (JPN) and all other longline fleets for the period 2009–13, by fleet and for 2014–18, by year and fleet. Black solid lines represent the IOTC Areas. Does not include fleets non-reporting catch-and-effort data

Estimation of catches – data related issues

Retained catches – until 2015, a very high proportion of the catches of Indo-Pacific sailfish was estimated, or adjusted, by the IOTC Secretariat (**Fig. 31a**), 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, so species mis-identification is not an issue as with marlin species:

- 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 2019 Pakistan submitted a revised catch series, dating back to the '80s, in which billfish catches were significantly lower than current estimates in the IOTC database, particularly for what concerns catches of Indo-Pacific sailfish. The revised catch series were officially endorsed at the 22nd Session of the IOTC Scientific Committee and have been included in IOTC database. The IOTC Secretariat is liaising with Pakistan to ensure a proper breakdown from the sources of all historical billfish revised catches into their specific components.

- 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 generalized lack of catch data for most sport fisheries.

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 sport fisheries, other than partial data from the sport 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) (**Fig. 31b**).

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 '80s (**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 (**Fig. 31c**). 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.

Data quality (by dataset)

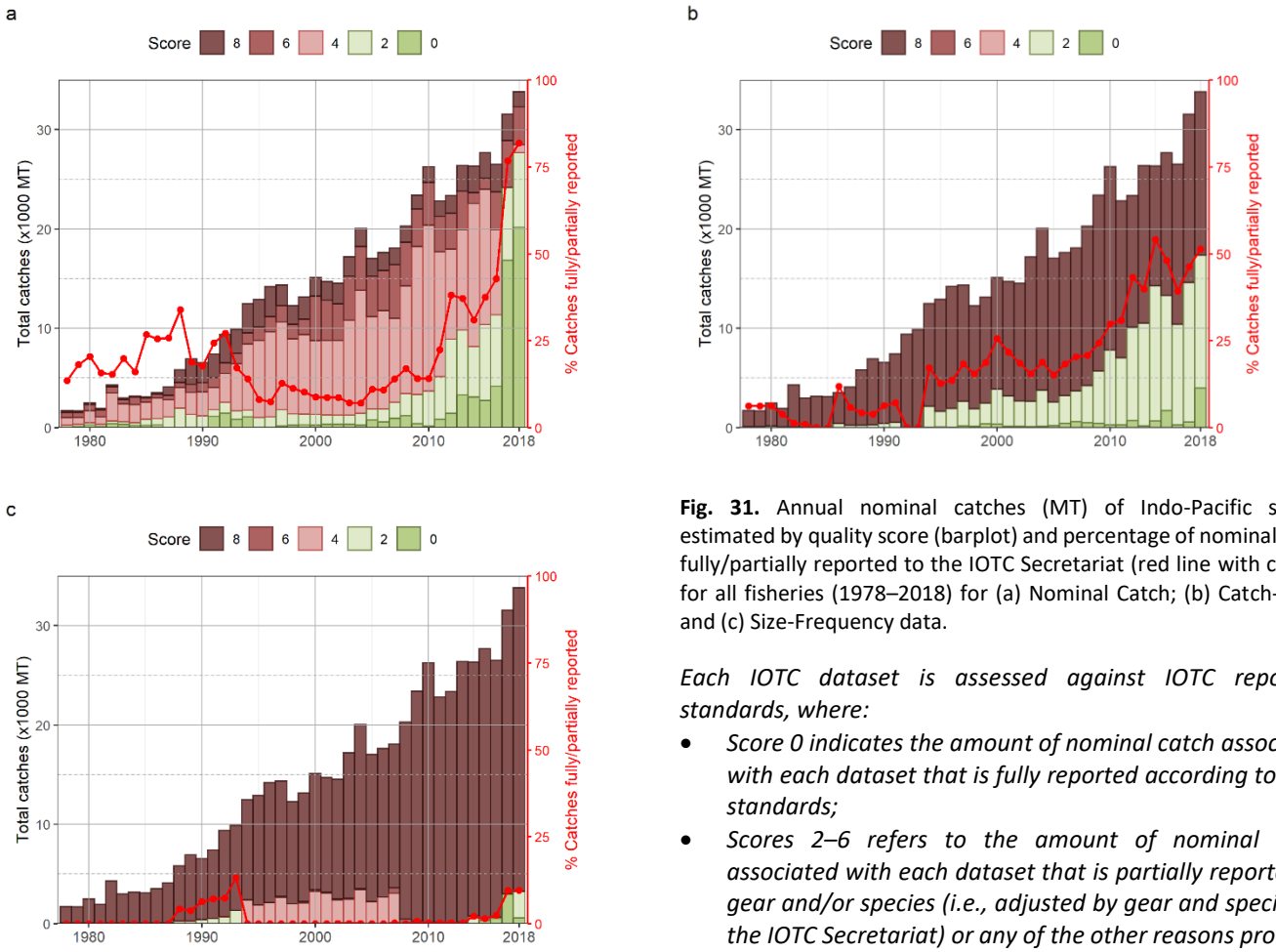

Fig. 31. Annual nominal catches (MT) of Indo-Pacific sailfish estimated by quality score (barplot) and percentage of nominal catch fully/partially reported to the IOTC Secretariat (red line with circles) for all fisheries (1978–2018) for (a) Nominal Catch; (b) Catch-Effort and (c) Size-Frequency data.

Each IOTC dataset is 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.*

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 species

Swordfish (SWO)

Assessment areas

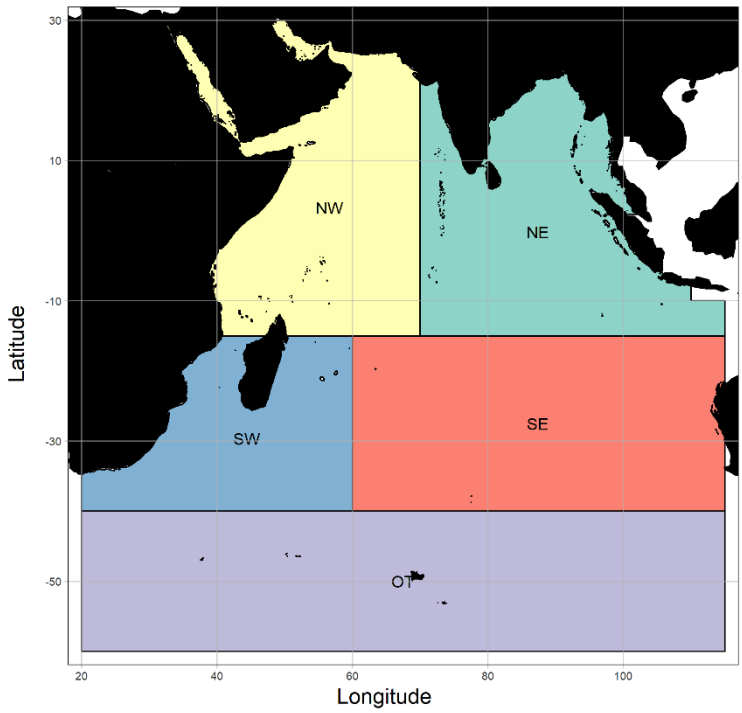

Fig. A1. Areas used for the assessment of the Indian Ocean swordfish stock

Nominal catch per unit of effort

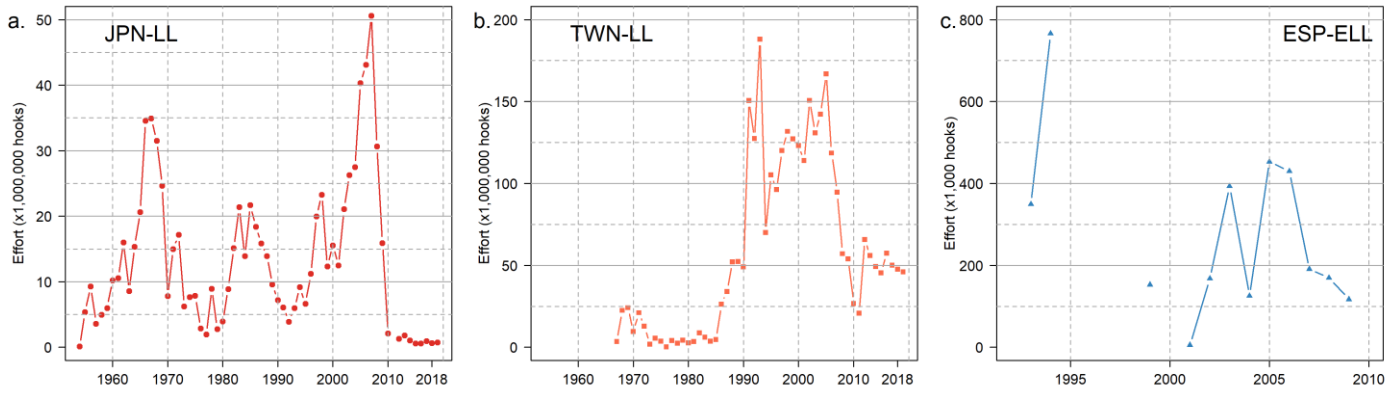

Fig. A2. Total fishing effort (hooks) exerted by the longline fishing fleets of (a) Japan, (b) Taiwan,China and (c) EU,Spain in the North-West area used for assessing the Indian Ocean swordfish stock (see **Fig. A1**). LL = longline; ELL = swordfish targeted longline

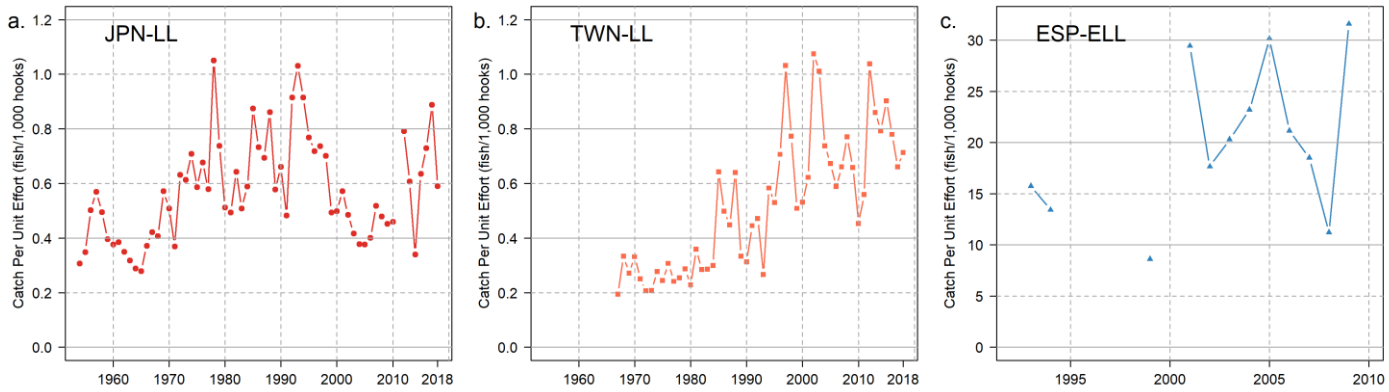

Fig. A3. Nominal Catch Per Unit Effort (number of fish / 1,000 hooks) of swordfish caught by the longline fishing fleets of (a) Japan, (b) Taiwan,China and (c) EU,Spain in the North-West area used for assessing the Indian Ocean swordfish stock (see **Fig. A1**). LL = longline; ELL = swordfish targeted longline

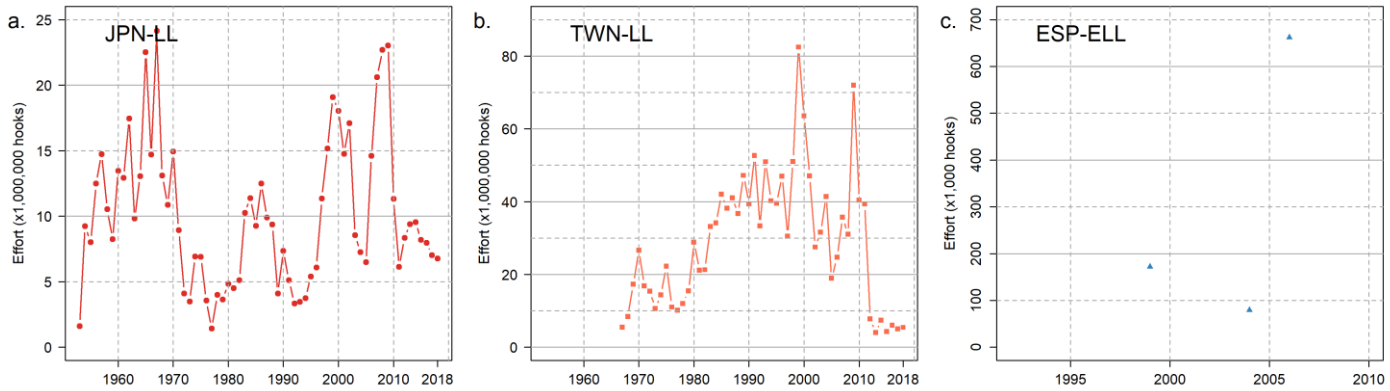

Fig. A4. Total fishing effort (hooks) exerted by the longline fishing fleets of (a) Japan, (b) Taiwan,China and (c) EU,Spain in the North-East area used for assessing the Indian Ocean swordfish stock (see **Fig. A1**). LL = longline; ELL = swordfish targeted longline

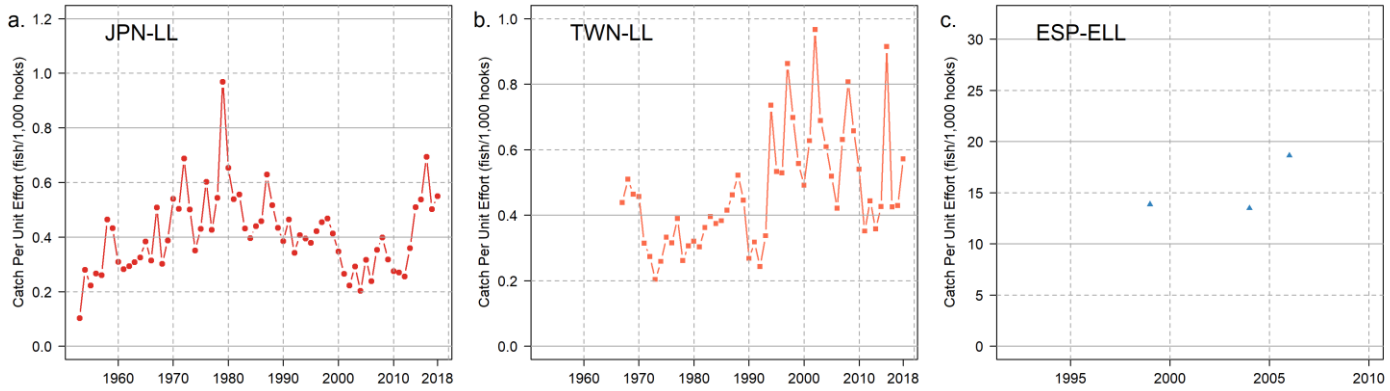

Fig. A5. Nominal Catch Per Unit Effort (number of fish / 1,000 hooks) of swordfish caught by the longline fishing fleets of (a) Japan, (b) Taiwan,China and (c) EU,Spain in the North-East area used for assessing the Indian Ocean swordfish stock (see **Fig. A1**). LL = longline; ELL = swordfish targeted longline

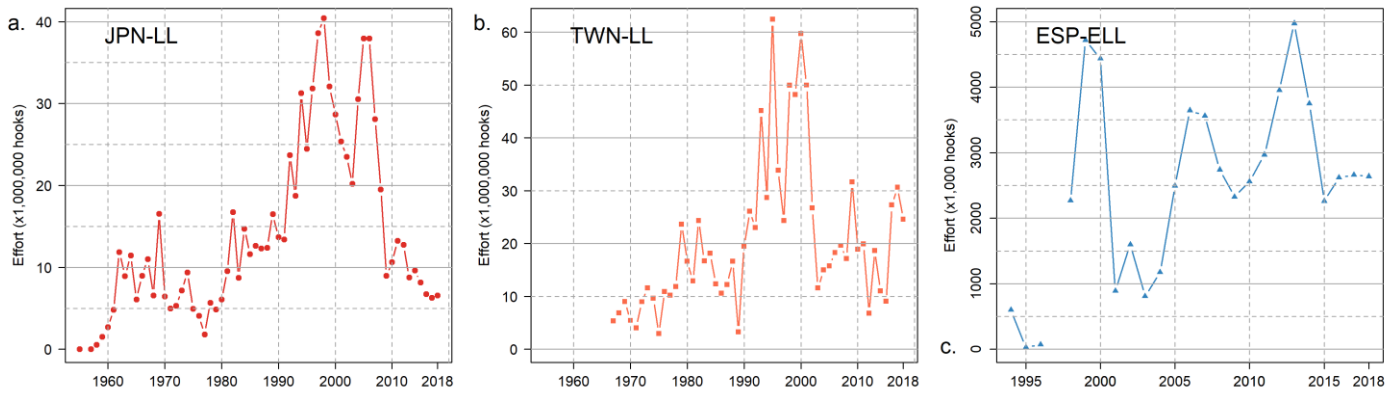

Fig. A6. Total fishing effort (hooks) exerted by the longline fishing fleets of (a) Japan, (b) Taiwan,China and (c) EU,Spain in the South-West area used for assessing the Indian Ocean swordfish stock (see **Fig. A1**). LL = longline; ELL = swordfish targeted longline

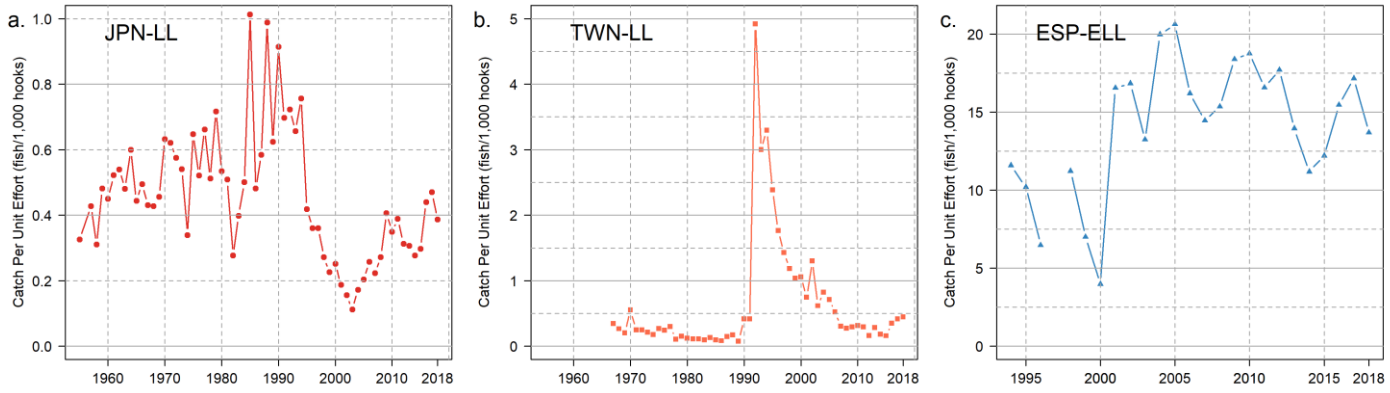

Fig. A7. Nominal Catch Per Unit Effort (number of fish / 1,000 hooks) of swordfish caught by the longline fishing fleets of (a) Japan, (b) Taiwan,China and (c) EU,Spain in the South-West area used for assessing the Indian Ocean swordfish stock (see **Fig. A1**). LL = longline; ELL = swordfish targeted longline

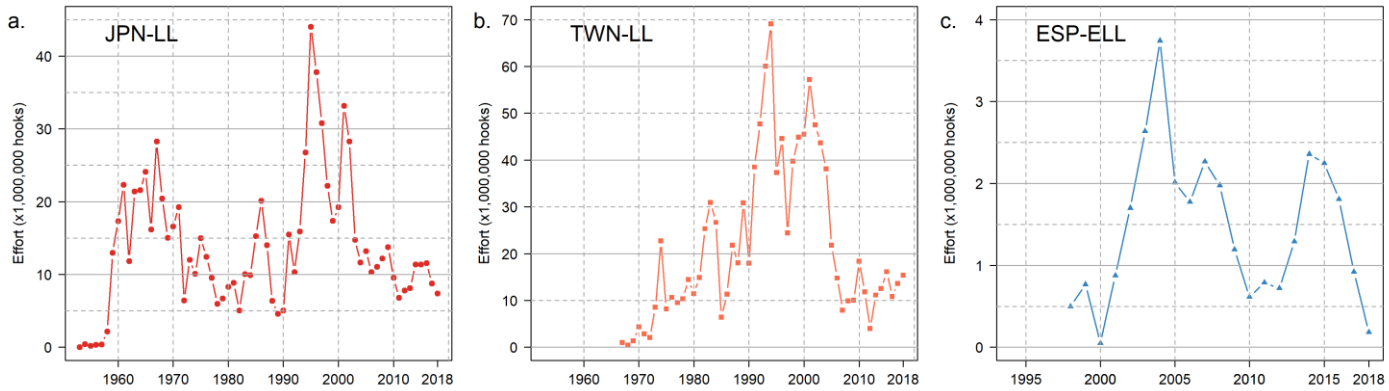

Fig. A8. Total fishing effort (hooks) exerted by the longline fishing fleets of (a) Japan, (b) Taiwan,China and (c) EU,Spain in the South-East area used for assessing the Indian Ocean swordfish stock (see **Fig. A1**). LL = longline; ELL = swordfish targeted longline

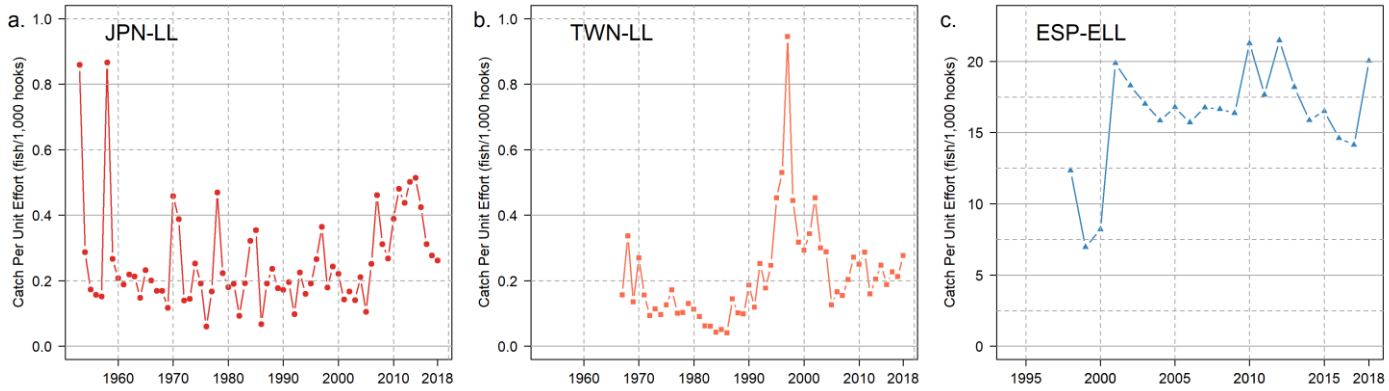

Fig. A9. Nominal Catch Per Unit Effort (number of fish / 1,000 hooks) of swordfish caught by longline fishing fleets of (a) Japan, (b) Taiwan,China and (c) EU,Spain in the South-East area used for assessing the Indian Ocean swordfish stock (see **Fig. A1**). LL = longline; ELL = swordfish targeted longline

Average weights and length frequency samples

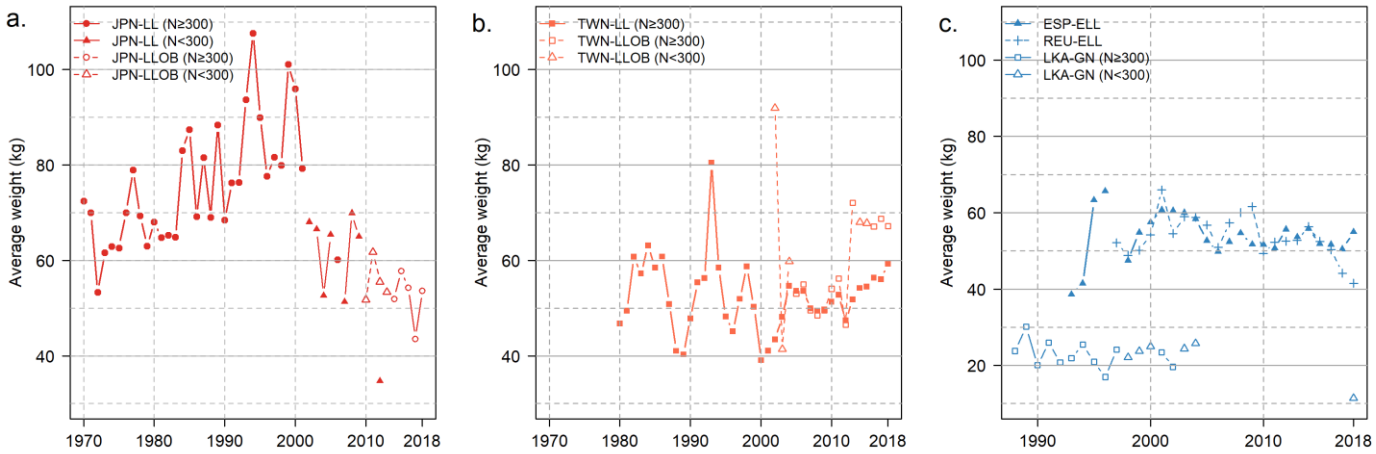

Fig. A10. Annual time series of average weights (kg) of Indian Ocean swordfish estimated from size samples collected by fishing crews and observers (OB) onboard longliners of Japan (1970-2018), Taiwan,China (1980-2018), EU-Spain (1993-2018), EU-La Réunion (1997-2018), and gillnetter of Sri Lanka (1988-2018). N = number of fish sampled; LL = longline; ELL = swordfish targeted longline; GN = gillnet

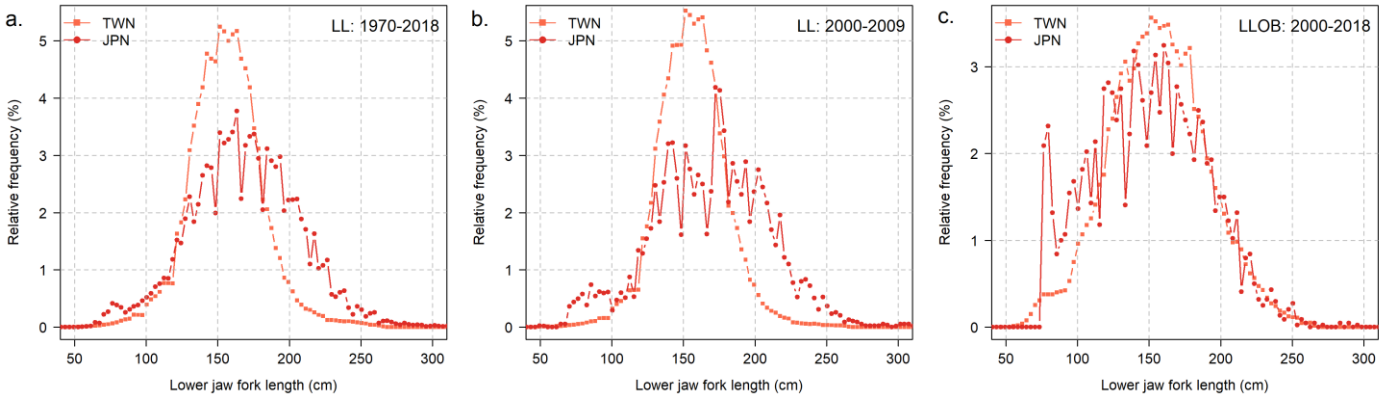

Fig. A11. Relative size frequency distributions (%) of Indian Ocean swordfish estimated for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) from (a) samples collected by fishing crews (LL) during 1970-2018 and (b) 2000-09 and (c) samples collected by onboard observers (LLOB) during 2000-2018

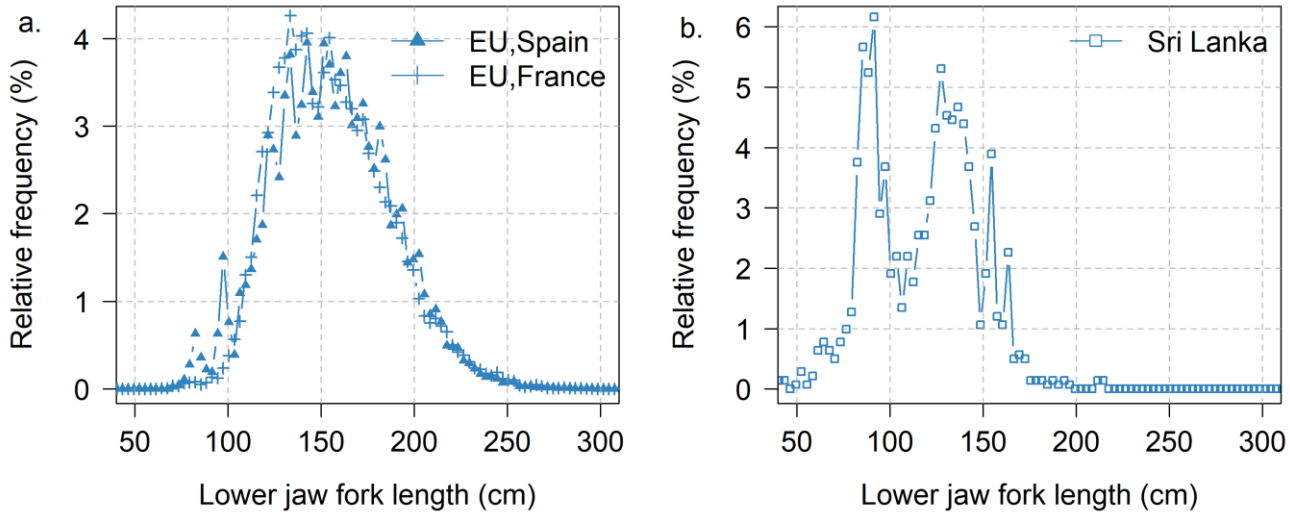

Fig. A12. Relative size frequency distributions (%) of Indian Ocean swordfish estimated for (a) the swordfish targeted longline fisheries of EU,Spain and EU,France (based in La Reunion Island) during 1998-2018 and (b) the gillnet fishery of Sri Lanka during 1988-2018

Marlins (BLM, BUM, MLS)

Fishing grounds

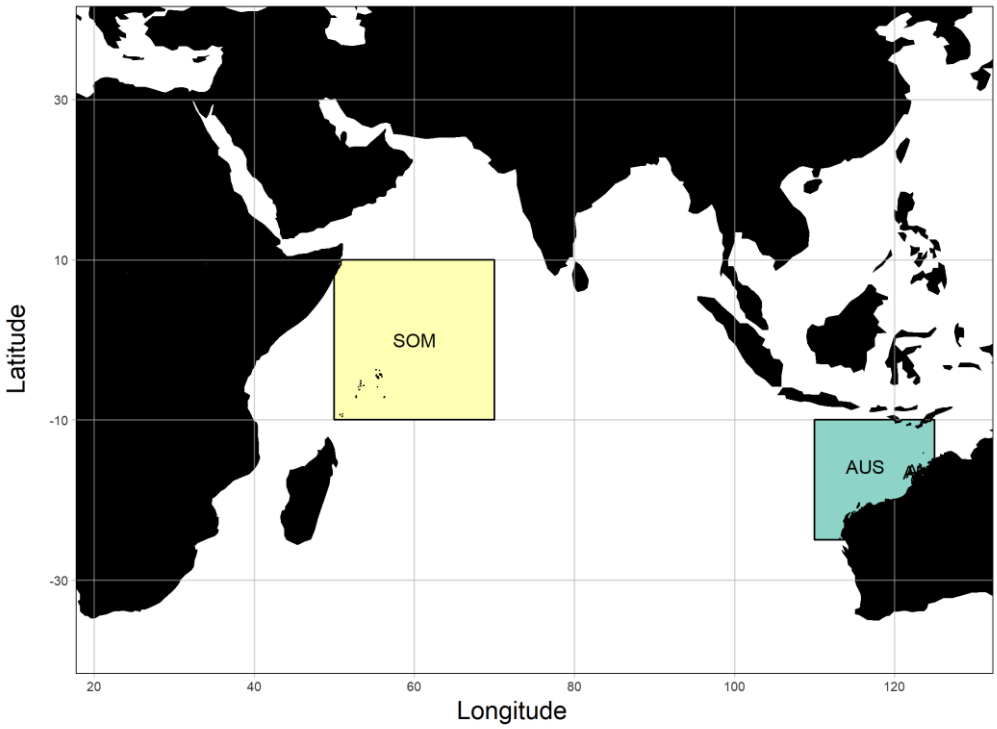

Fig. A13. Main longline fishing grounds of marlins identified by the IOTC Working Party on Billfish. SOM = Somalia; AUS = Australia

Fishing effort

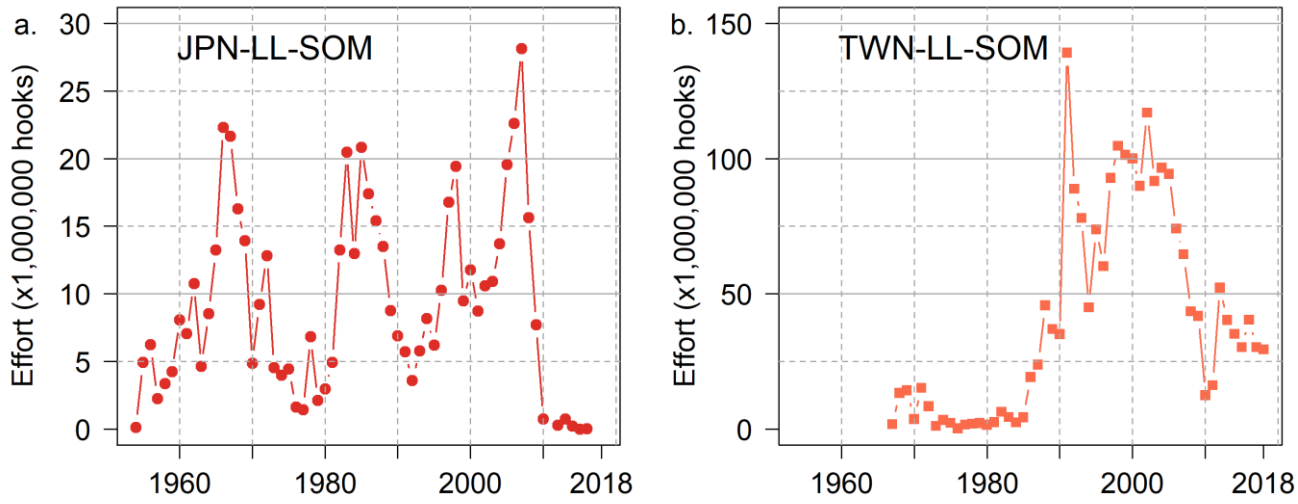

Fig. A14. Total fishing effort (hooks) exerted by the longline fishing fleets of (a) Japan and (b) Taiwan,China in the main longline fishing grounds of marlins identified off the coasts of Somalia (see **Fig. A13**)

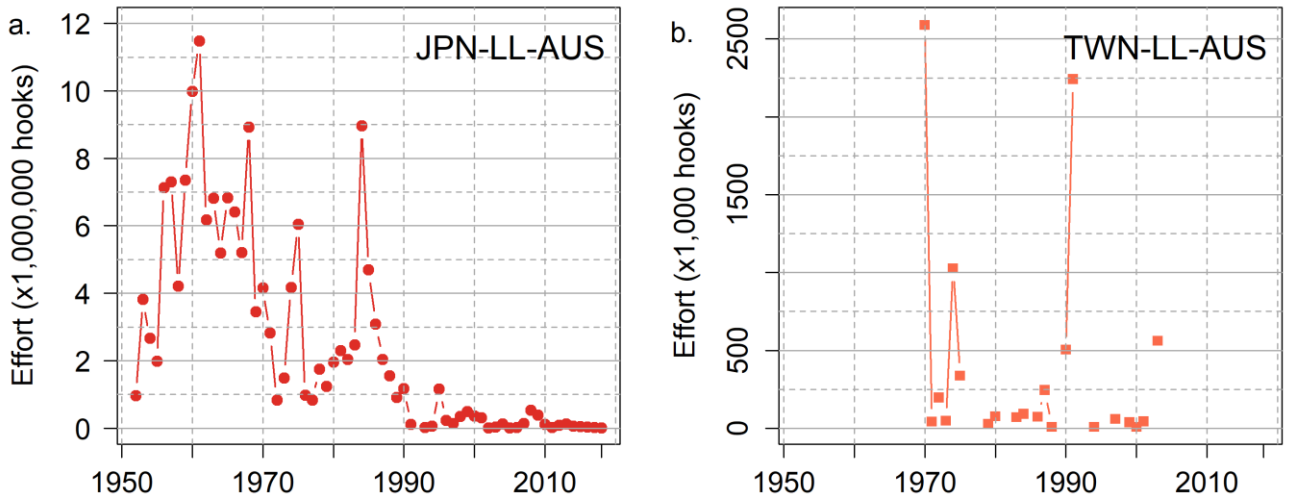

Fig. A15. Total fishing effort (hooks) exerted by the longline fishing fleets of (a) Japan and (b) Taiwan,China in the main longline fishing grounds of marlins identified off the coasts of Australia (see **Fig. A13**)

Nominal catch per unit of effort

Blue marlin (BUM)

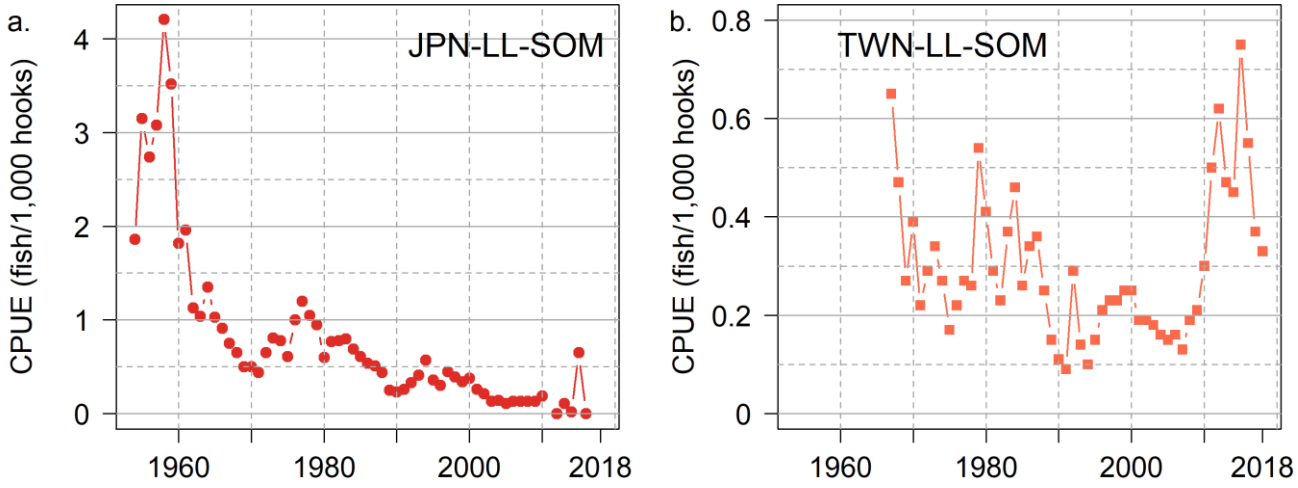

Fig. A16. Nominal Catch Per Unit Effort (number of fish / 1,000 hooks) of blue marlin caught by the longline fishing fleets of (a) Japan and (b) Taiwan,China in the main longline fishing grounds of marlins identified off the coasts of Somalia (see **Fig. A13**)

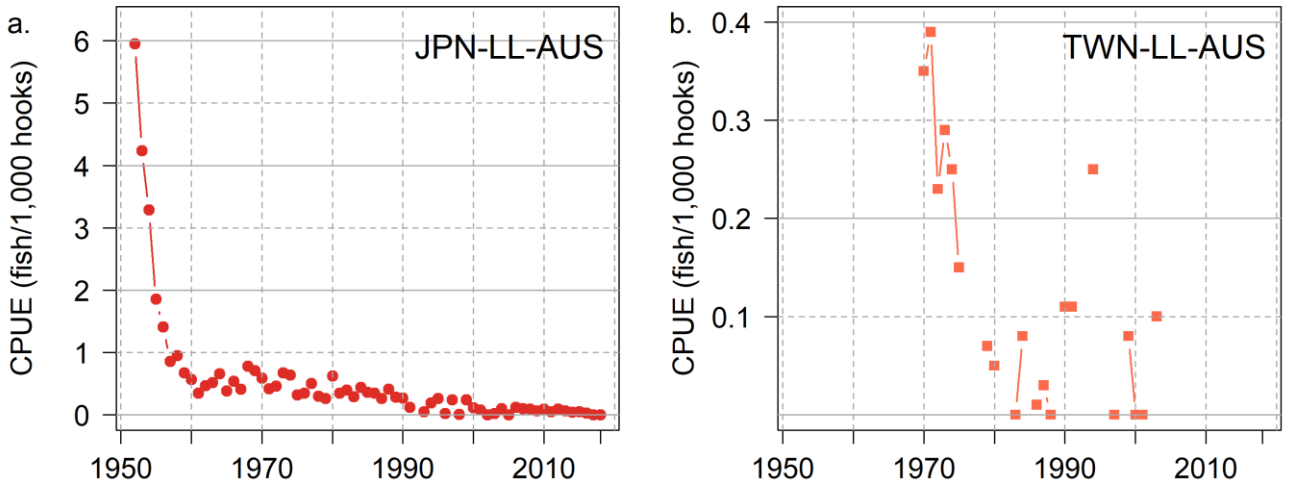

Fig. A 17. Nominal Catch Per Unit Effort (number of fish / 1,000 hooks) of blue marlin caught by the longline fishing fleets of (a) Japan and (b) Taiwan,China in the main longline fishing grounds of marlins identified off the coasts of Australia (see **Fig. A13**)

Black marlin (BLM)

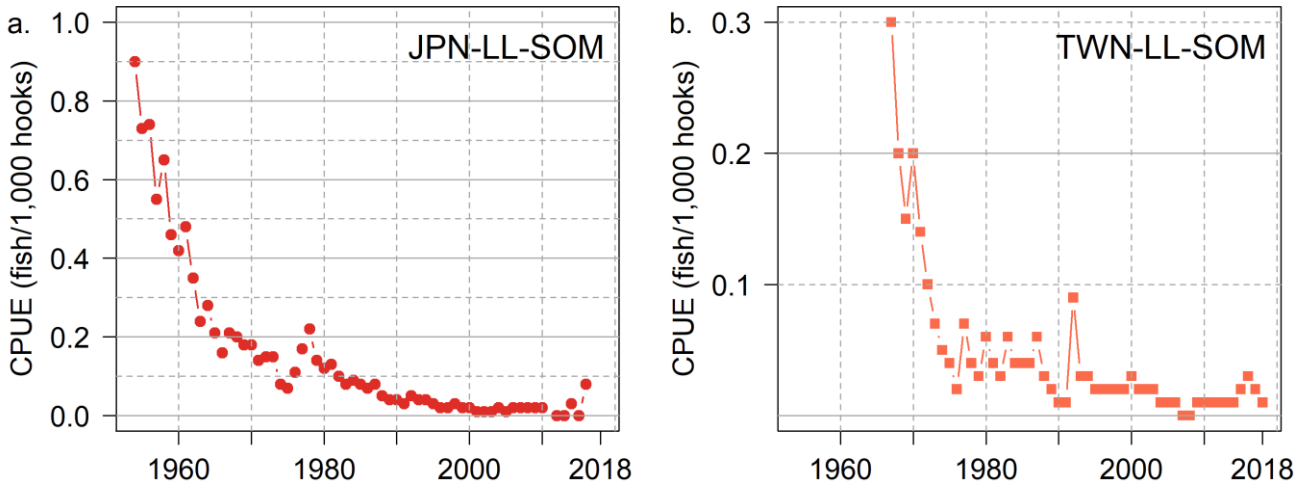

Fig. A18. Nominal Catch Per Unit Effort (number of fish / 1,000 hooks) of black marlin caught by the longline fishing fleets of (a) Japan and (b) Taiwan,China in the main longline fishing grounds of marlins identified off the coasts of Somalia (see **Fig. A13**)

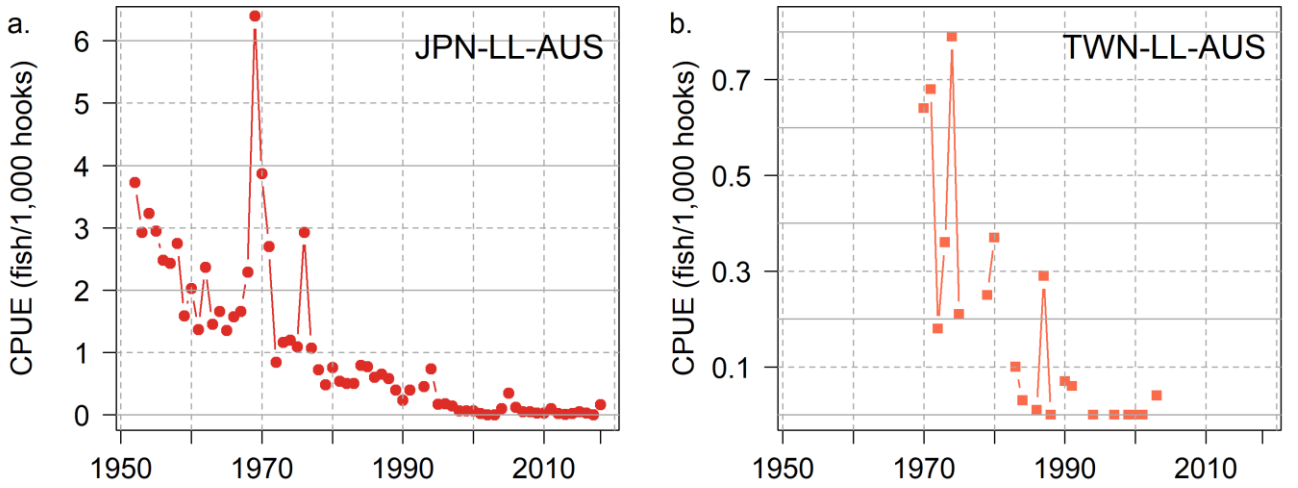

Fig. A19. Nominal Catch Per Unit Effort (number of fish / 1,000 hooks) of black marlin caught by the longline fishing fleets of (a) Japan and (b) Taiwan,China in the main longline fishing grounds of marlins identified off the coasts of Australia (see **Fig. A13**)

Striped marlin (MLS)

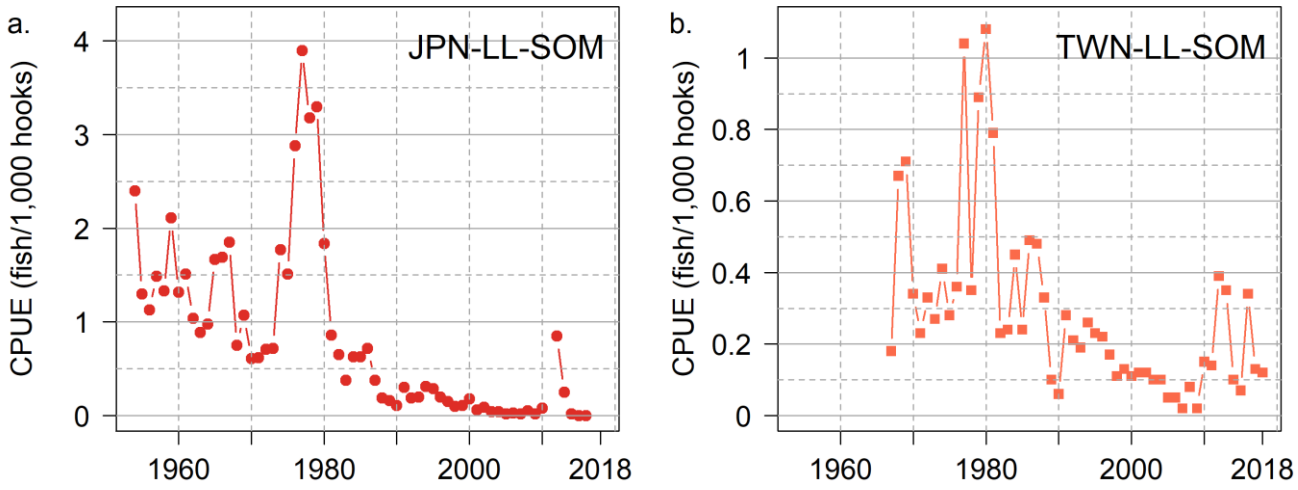

Fig. A20. Nominal Catch Per Unit Effort (number of fish / 1,000 hooks) of striped marlin caught by the longline fishing fleets of (a) Japan and (b) Taiwan,China in the main longline fishing grounds of marlins identified off the coasts of Somalia (see **Fig. A13**)

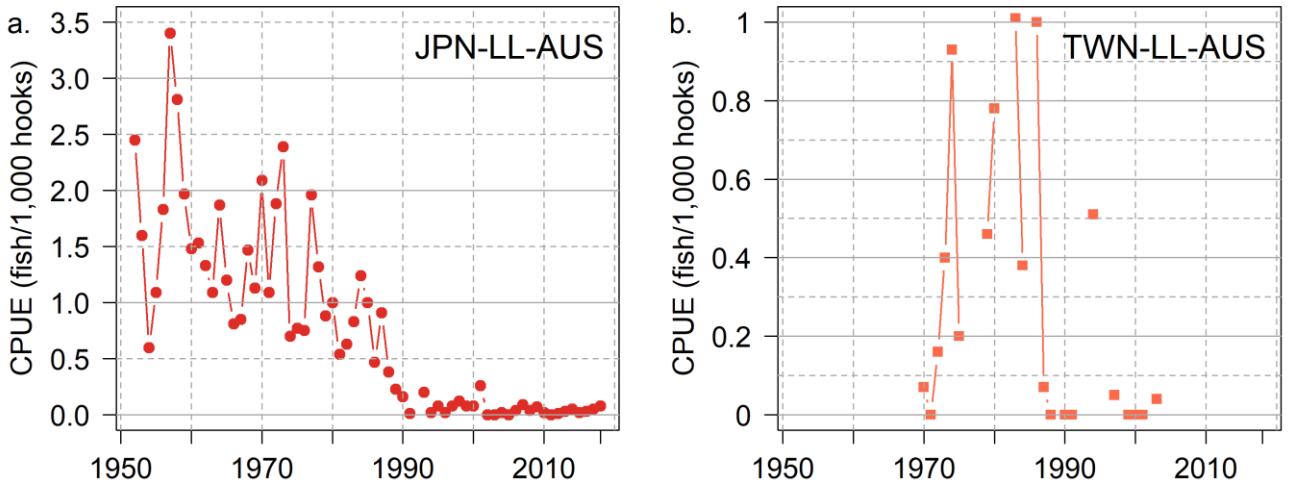

Fig. A21. Nominal Catch Per Unit Effort (number of fish / 1,000 hooks) of striped marlin caught by the longline fishing fleets of (a) Japan and (b) Taiwan,China in the main longline fishing grounds of marlins identified off the coasts of Australia (see **Fig. A13**)

Average weight and length frequency samples

Blue marlin (BUM)

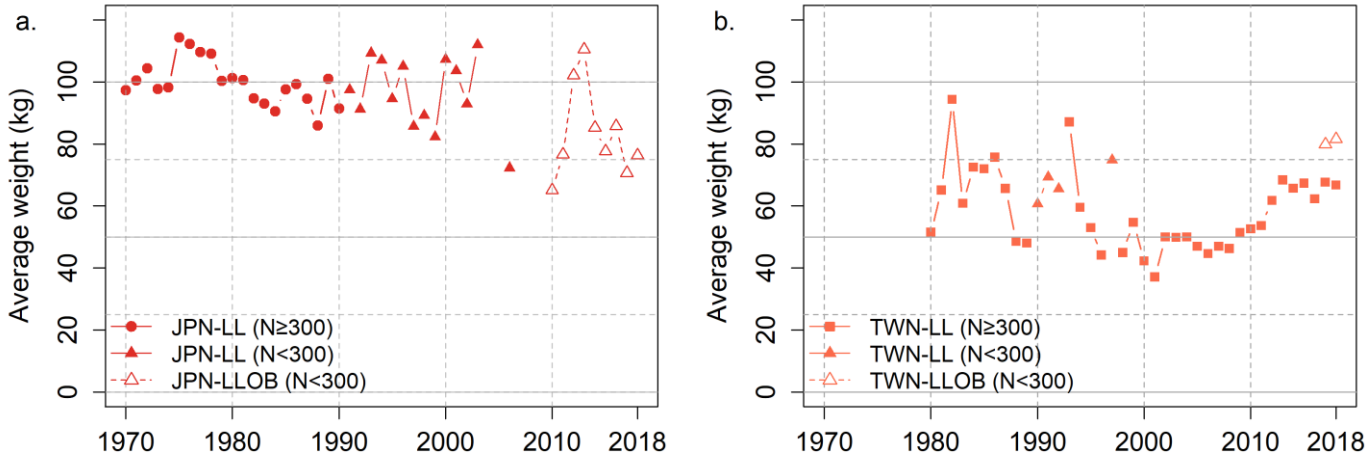

Fig. A22. Annual time series of average weights (kg) of blue marlin estimated from size samples collected by fishing crews and observers (OB) onboard longliners of Japan (1970-2018) and Taiwan,China (1980-2018). N = number of fish sampled

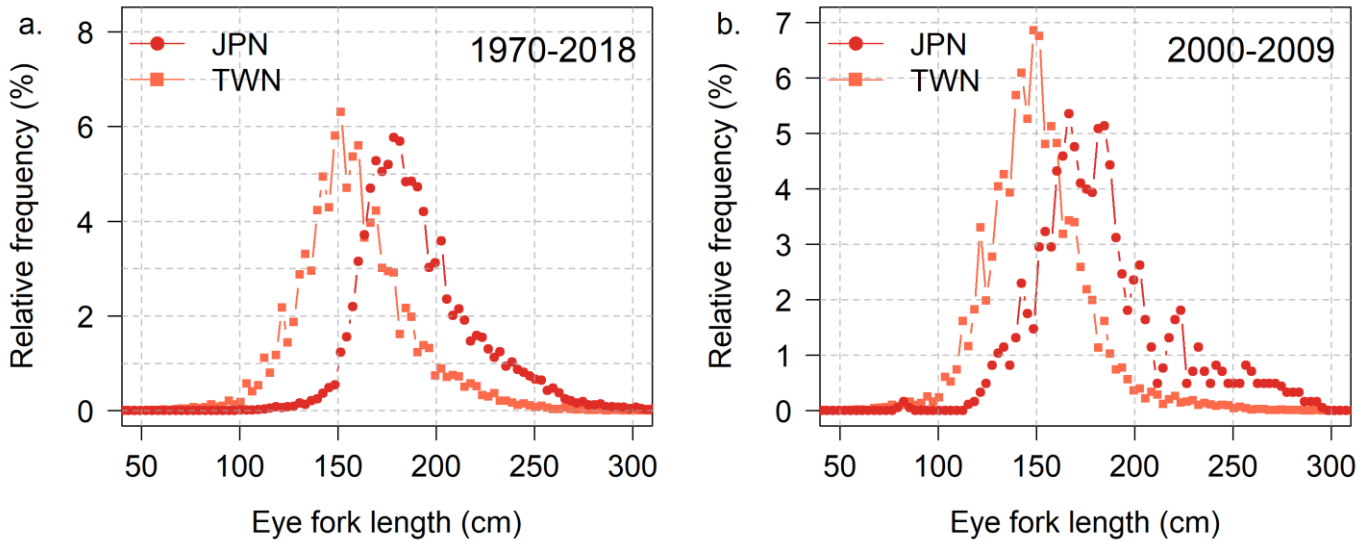

Fig. A23. Relative size frequency distributions (%) of blue marlin estimated for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) from samples collected by fishing crews during (a) 1970-2018 and (b) 2000-09

Black marlin (BLM)

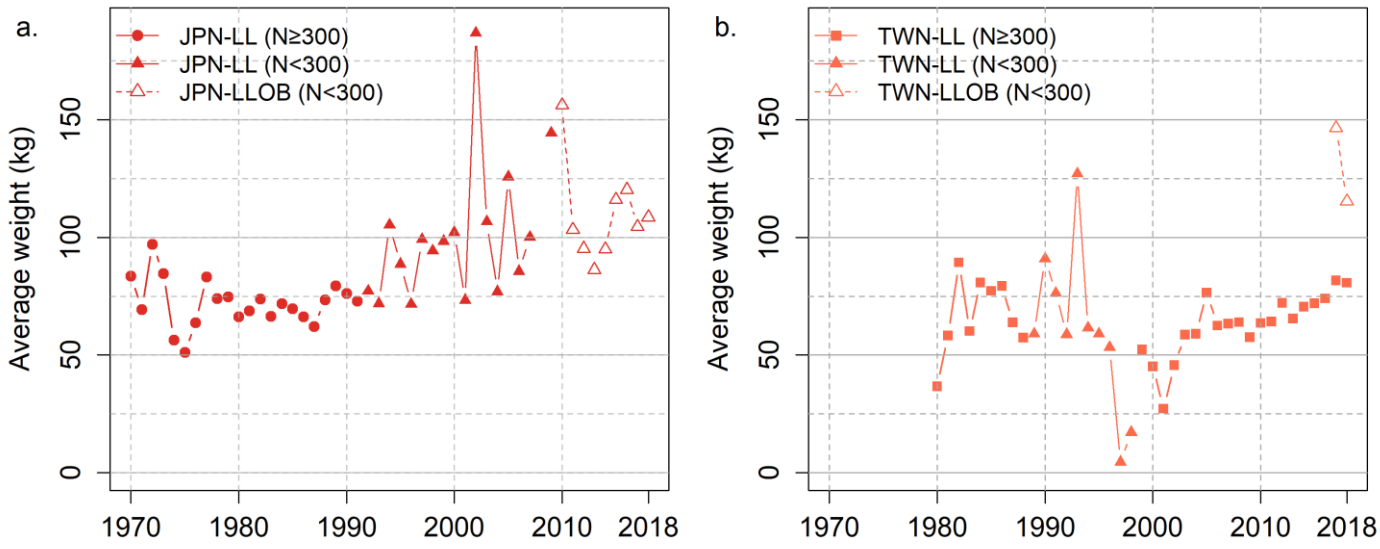

Fig. A24. Annual time series of average weights (kg) of black marlin estimated from size samples collected by fishing crews and observers (OB) onboard longliners of Japan (1970-2018) and Taiwan,China (1980-2018). N = number of fish sampled

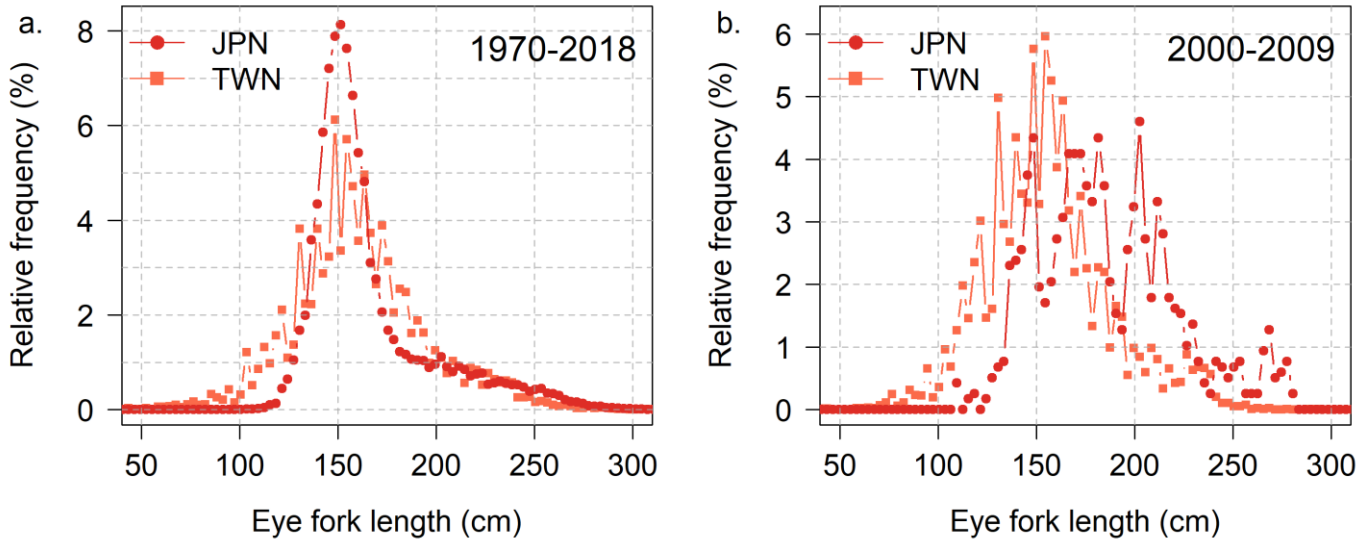

Fig. A25. Relative size frequency distributions (%) of black marlin estimated for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) from samples collected by fishing crews during (a) 1970-2018 and (b) 2000-09

Striped marlin (MLS)

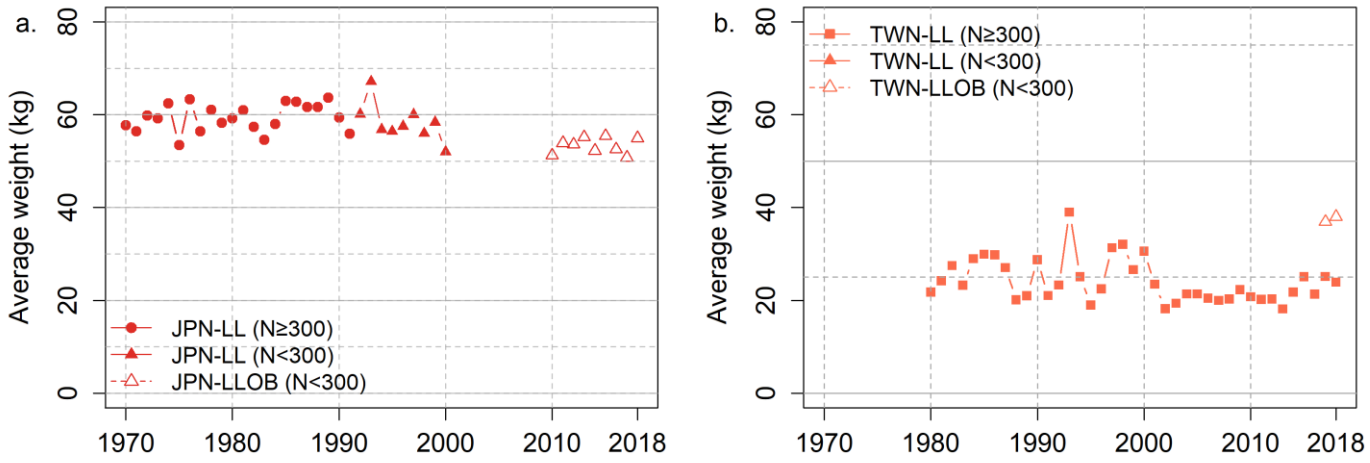

Fig. A26. Annual time series of average weights (kg) of striped marlin estimated from size samples collected by fishing crews and observers (OB) onboard longliners of Japan (1970-2018) and Taiwan,China (1980-2018). N = number of fish sampled

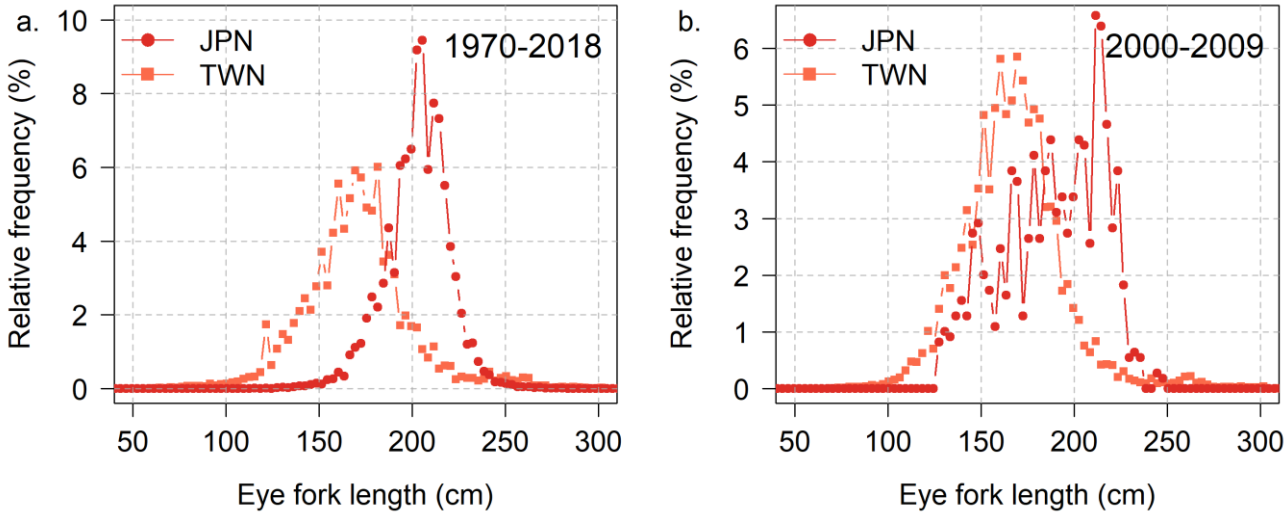

Fig. A27. Relative size frequency distributions (%) of striped marlin estimated for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) from samples collected by fishing crews during (a) 1970-2018 and (b) 2000-09

Indo-Pacific sailfish (SFA)

Average weight and length frequency samples

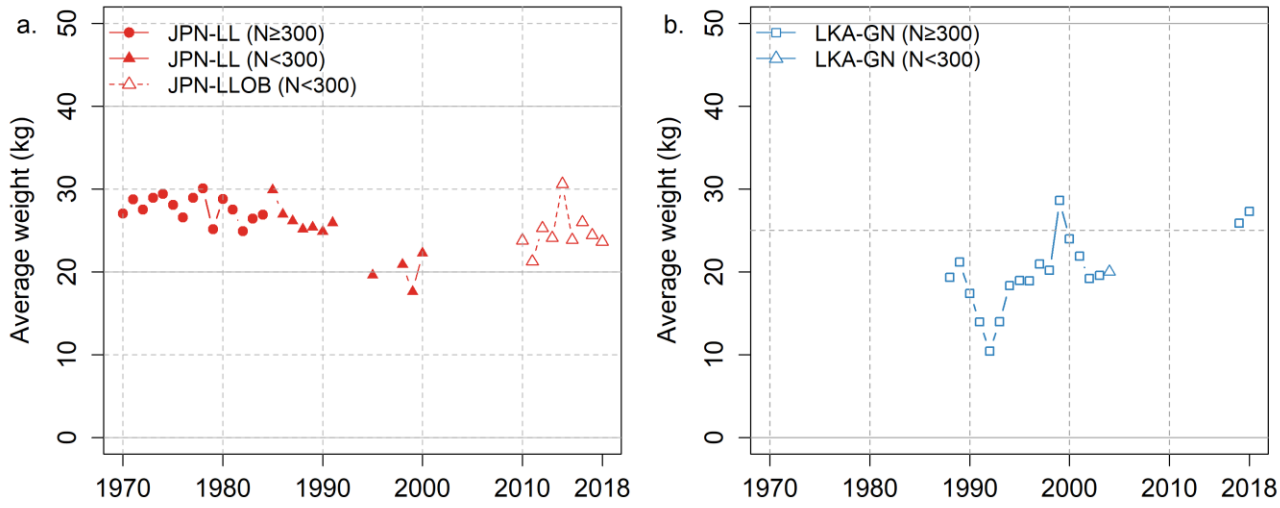

Fig. A28. Annual time series of average weights (kg) of Indo-Pacific sailfish estimated from size samples collected by fishing crews and observers (OB) onboard longliners of Japan (1970-2018) and Taiwan,China (1980-2018). N = number of fish sampled

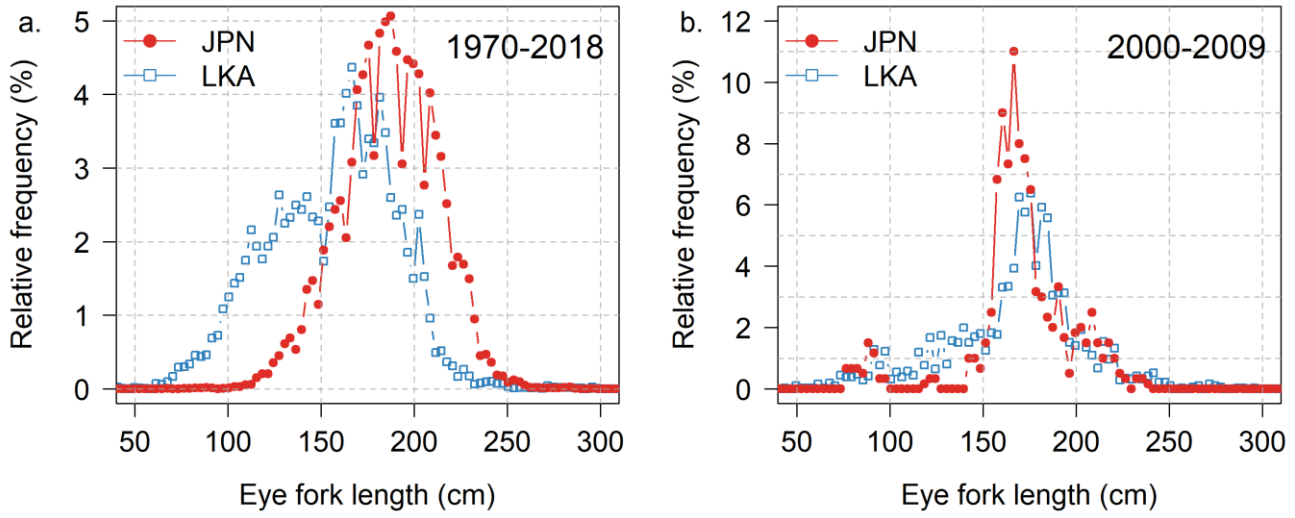

Fig. A29. Relative size frequency distributions (%) of Indo-Pacific sailfish estimated for the longline fishery of Japan (JPN) and gillnet fishery of Sri-Lanka (LKA) from samples collected by fishing crews during (a) 1970-2018 and (b) 2000-09