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REVISION TO THE IOTC SCIENTIFIC ESTIMATES OF INDONESIA'S FRESH LONGLINE CATCHES

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PURPOSE

To provide participants at the Working Party on Billfish (WPB-16) with an overview of the IOTC Secretariat's estimation of Indonesia's longline catches, current issues related to the reliability of estimated catches, and proposed changes to the methodology in response to the following request from the Scientific Committee:

> *SC20 (para.45) Due to on-going uncertainties with the reliability of catches reported by Indonesia, particularly in the case of swordfish, the SC **REQUESTED** that the IOTC Secretariat, in collaboration with Indonesia, review the current methods for estimating catches of billfish for Indonesia in the IOTC database and provide an update at the next meeting of the WPB.*

Accompanying this paper, the IOTC Secretariat has published an alternative nominal catch series (IOTC-2018-WPB16-DATA03b) that incorporates revisions to the Indonesia's fresh longline catches based on changes to the IOTC Secretariat's estimation methodology. Further details can be found in Section 5.

The alternative catch series mostly affects Indonesia's fresh longline catches of swordfish, blue marlin, and striped marlin to a lesser extent, which are estimated to be significantly lower in recent years than previous IOTC estimates. As a consequence of the revisions to Indonesia, total catches across all fleets and gears have been revised downwards by as much as 30% for some billfish species.

The paper also outlines the case for the IOTC Secretariat continue to estimate catches for Indonesia's longline fleet, due to on-going issues with official catches and also uncertainties in Indonesia's longline vessel numbers.

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1. BACKGROUND

According to current IOTC estimates, Indonesia accounts for the highest catches of billfish[2] in the Indian Ocean with over 10% of catches since the early-2000s, of which the majority are caught by fresh-longline vessels[3]. In recent years Indonesia's share of billfish catches has increased even further, with up to 23% of total catches in 2014 and 27% in 2016 (**Fig.1**). Most of this increase has been concentrated in selected billfish species – notably swordfish which increased over 400% (from 4000 t in 2013 to over 20,000 t in 2016), and blue marlin which increased 115% (from 2700 t in 2011 to 5800 t in 2016) (**Fig.2a-b**).

This sharp increase in billfish catches since 2014, estimated by the IOTC Secretariat, appears contrary to the official catches reported by Indonesia, which not only show a *decrease* in catches over the same period but also report billfish catches significantly below the levels estimated by the IOTC.

The reasons for this divergence between the IOTC and Indonesia's official catches are discussed below, as well as proposals to amend the IOTC Secretariat's current estimation procedure that takes into account recent information on changes within Indonesia's fresh longline fishery, and is considered an improvement over current estimates of Indonesia's fresh longline catches.

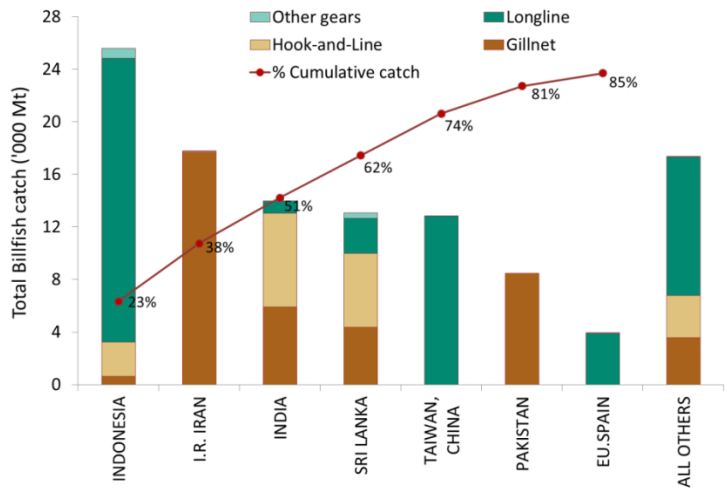
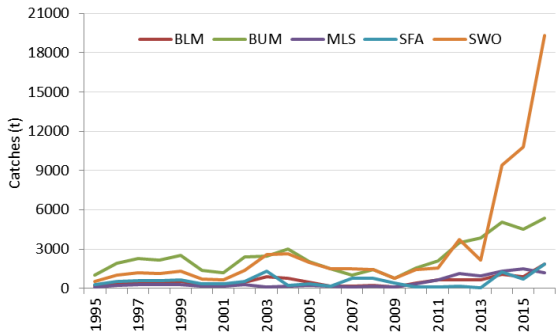


Fig.1: Billfish (all species): average catches in the Indian Ocean over the period 2013–17, by fleet and gear.

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

[2] Includes black marlin, blue marlin, Indo-Pacific sailfish, striped marlin and swordfish.

[3] Fresh longliners are generally smaller in size than compared to deep-freezing longliners, conduct shorter fishing trips, often within the EEZ area or relatively close to the EEZ boundaries. In the case of Indonesia's fresh longline fleet, catches are almost exclusively within the East Indian Ocean.



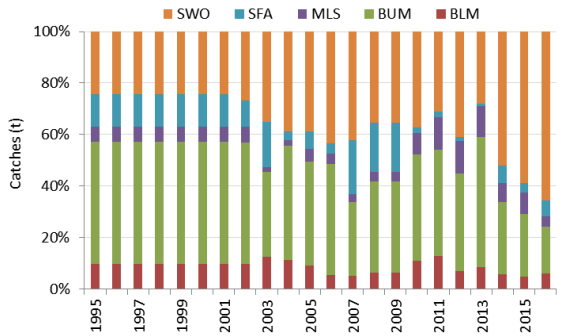


Fig. 2a-b: Billfish (all species): IOTC estimates of Indonesia's billfish catches in the Indian Ocean over the period 1995–2017, by gear. Fig 2b. Left: nominal catches of all billfish species, by species; Fig. 2c. Right: percentage share of billfish catches, by species**.**

2. INDONESIA OFFICIAL CATCHES: ISSUES

For a number of years the IOTC Secretariat has disseminated their own catch estimates for Indonesia to the IOTC Working Parties and Scientific Committee. Indonesia's total catches for IOTC species are reallocated by species and gear, according to the recommendations of a comprehensive review of Indonesia's fisheries conducted in 2012 and endorsed by the Scientific Committee[4].

The rationale for IOTC disseminating their own estimates, rather than Indonesia's official catches, relates to on-going issues with quality Indonesia's catches reported to the IOTC Secretariat, including:

1. Lack of historical catches by species: Indonesia only began reporting IOTC catches by species and gear in 2004. Prior to 2004 catches were reported to the IOTC as species aggregates (e.g., Tongkol (juvenile tunas), tunas, or sharks), which required the IOTC Secretariat to disaggregate by species according to the requirements of the IOTC Scientific Working Parties.
2. Reliability of official catches: In recent years the IOTC Secretariat has noted large, and mostly unexplained, fluctuations in Indonesia's official catches reported to IOTC – both in terms of total catches and catches by species – that suggest on-going issues with Indonesia's capacity for data collection, processing and data validation. This issue is discussed in further detail in relation to Indonesia's longline catches in the section below.

[4] The current IOTC estimation is based on a 2012 review of Indonesia's historical catch series (starting from the 1970s), conducted by an independent IOTC consultant and approved by the IOTC Scientific Committee, and which combines information from a number of data sources including IOTC, IPTP and DGCF.
For further details refer to Moreno (2012) '*Revision of catch statistics for India, Indonesia and Sri Lanka (1950-2011). Assignment of species and gears to the total catch and issues on data quality*', IOTC–2012–SC15–38.

3. Low logbook coverage: Indonesia's logbook coverage is also known to be highly variable. In some years less than 10% of longline logbooks have been submitted by vessels, raising questions over the representative of Indonesia's official catches for longline and purse seiners – although logbook coverage rates do appear to be improving since 2016.
4. Inconsistencies between data sources: major differences in fishing locations between VMS and logbook data have also been noted for Indonesia's longline and purse seine fleet that, to date, remain unresolved and call into question the reliability of time-area catches for Indonesia's offshore fisheries. Inconsistencies have also been noted between Indonesia's longline catches when compared to the number of active vessels and the calculation of average catches per vessel. This issue is of particular importance in the current context and discussed in further detail below, as average catches per vessel are a critical element to the IOTC Secretariat's estimates of Indonesia's longline catches.
5. Low levels of data compliance: aside from the issue of reliability of time-area catches, Indonesia has not reported catch-and-effort to the IOTC Secretariat for the longline and purse seine fleet. Data compliance levels are generally low, with data submissions partially compliant or non-compliant for a number of core IOTC datasets (i.e., size frequency data, catch-and-effort) which limits the information available for Indonesia's fisheries.
6. Conflicting data between national institutions: Several institutions are responsible for collecting fisheries data in Indonesia, including the Directorate General of Capture Fisheries (DGCF), Department of Oceans and Fisheries, Research Institute for Tuna Fisheries, as well as local and provincial authorities (DINAS). In some cases the lack of coordination between institutions in terms of data collection activities, and particularly during the validation, processing, and data review stages, compromises the quality of catch estimates and is likely one of the contributing factors to the inconsistencies observed in data reported to the IOTC.

Longline catches: data quality issues

In the case of Indonesia's fresh longline catches, many of the issues highlighted above apply.

a.) Fluctuations in total longline catches

- Despite the introduction of logbooks on Indonesia's longliners since 2012, fluctuations in total catches and also the species composition continue to be noted in official data reported to the IOTC. Low levels of logbook coverage, and associated issues regarding the representativeness of catches, may partially explain the changes in species composition between years.
- Table 1 summarizes Indonesia's official longline catches reported to the IOTC Secretariat, aggregated by IOTC species group. Sudden changes in catches are reported for a number of species groups,

including sharks (in 2012), and billfish and neritic tunas between 2012-2014; while total catches also change abruptly between years – notably from 13,000 t in 2011 to 36,000 t in 2012.

Table 1. Summary of longline (LLTU) official catches (tonnes), reported by Indonesia to the IOTC Secretariat.

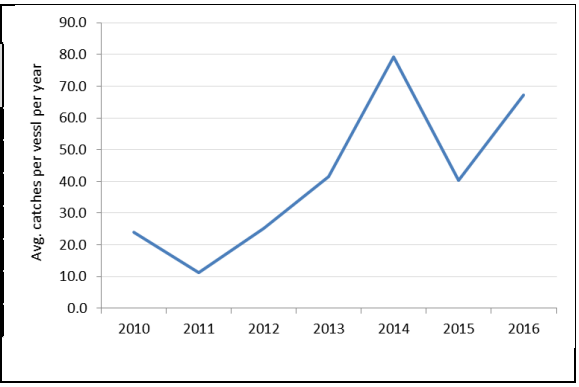
IOTC species group	2010	2011	2012	2013	2014	2015	2016
Billfish	2973	1065	**6456**	**6176**	**6683**	3697	1158
Neritic tunas	64	130	**8629**	**2569**	**2422**	395	295
Others	2104	1679	558	466	536	1292	193
Sharks	598		**4403**	932	510	210	626
Temperate Tunas	2957	2610	3922	1406	3989	4281	2395
Tropical Tunas	14815	7741	11928	14870	11325	12080	11864
Total	23511	**13225**	**35895**	26418	25465	21955	16531

b.) Longline average catches

- Fluctuations in Indonesia's official longline catches can be validated, to some extent, by the number of longline vessels and average catches per vessel, which should generally be expected to vary within feasible ranges – assuming no major changes in fishing effort or fishing behaviour.
- However, as table XX indicates, average catches per vessel vary considerably from year to year: from as low as 11 t in 2013 to around 80 t per vessel in 2014. This in turn leads to a second, related issue below, regarding the reliability of numbers of longline vessels reported by Indonesia.

Table 2. & Fig.3 Average catches per vessel per year in Indonesia. Official data sources.

Year	LL catches (official data)	IOTC IDN-LL active vessel list	Avg. catch per LL vessel
2010	23511	980	24.0
2011	13225	1180	**11.2**
2012	31458	1253	25.1
2013	49741	1200	41.5
2014	36321	458	**79.3**
2015	22108	550	40.2
2016	16531	246	**67.2**



c.) Longline active vessel numbers

- In recent years the number of longline vessels[5] reported by Indonesia to the IOTC active vessel list has decreased by as much as 80% (**Table 3**); from around 1,200 vessels in 2013, to less than 250 vessels by 2016.
- At the same time, the IOTC Secretariat has noted inconsistencies in the number of longline vessels reported by Indonesia between following data sources:
  - IOTC fishing craft statistics[6]: data reported by DGCF, available up to 2013.
  - Indonesia's National Report: submitted by DGCF to the IOTC Scientific Committee, and which includes the number of vessels.
  - Active vessel list: reported by DGCF to the IOTC Secretariat as part of IOTC Resolution 10/08.

  Up to 2013 longline vessel numbers are generally comparable between all three data sources. However from 2014 onwards the number of vessels decreases sharply, according to the IOTC active vessel list, while Indonesia's National Report continues to report numbers of around 1,300 vessels.

Table 3. Comparison of active vessels reported by Indonesia to the IOTC Secretariat.

	Indonesia Fishing Craft Statistics			National Report	Active vessel list
Year	Longliner fresh (FLL)	Longliner (deep-freezing) (LL)	Total	Longliners (including LL + FLL)	Longliners (including LL + FLL)
2004	1242	-	-	-	-
2005	1373	-	-	-	-
2006	1185	-	-	-	-
2007	1052	-	-	-	-
2008	1052	23	1075	-	-
2009	1015	28	1043	-	-
2010	965	30	995	-	980
2011	1141	33	1174	1188	1180
2012	1242	36	1278	1256	1253
2013	1209	28	1237	1227	1200
2014	-	-	-	1282	**458**
2015	-	-	-	1282	**550**
2016	-	-	-	1311	**246**
2017	-	-	-	-	**214**

- *Not available.*

- DGCF officials in Indonesia have confirmed that the Active Vessel list numbers shown in Table 3 (far-right column) are correct, and the reason for the decline in vessel numbers since 2014 are a combination of factors, including:

[5] Including fresh longliners and a small number (i.e., around 30) of deep-freezing longliners.

[6] Available at: http://iotc.org/oqs

i. Following a ban on transshipment-at-sea, some longline vessels changed gears, species targeting (i.e., to squid jigging), and relocated to archipelagic waters.
ii. Denial or postponement of fishing licenses, particularly in the case of 'ex-foreign' longline vessels previously registered as Indonesian flagged vessels[7].
iii. Around 39 longline vessels damaged in a fire in 2018, while a number of other ex-foreign vessels are known to be sitting idle in port after ceasing fishing activity entirely[8].

Nevertheless, questions still remain over rate of decrease in longline vessels (i.e., from 1,200 in 2013 to less than 250 by 2016), which appears to be unprecedented in such a short period of time. Secondly, is the suggestion of an overall decline in fishing vessels (and fishing capacity) of small-scale longline vessels in the Indian Ocean as a consequence of the decrease in the Indonesian fleet. According to the IOTC active vessel list, the decrease in Indonesia's longline vessel numbers has not been offset by any notable increase in longline vessels reported by other CPCs – which implies that Indonesia's de-registered vessels have either ceased fishing entirely, or changed targeting to non-IOTC species, both of which would appear to be highly unlikely.

An alternative, arguably more plausible, explanation is that the number of active vessels reported since 2014 are more reliable than earlier years, when vessel numbers may have been overestimated. In recent years Indonesia may reported to IOTC the number of *authorized vessels* as active vessels due to misunderstandings between the definition or IOTC reporting requirements, thereby inflating the actual estimates of the number of vessels actually fishing in a given year.

Comparison between the number of authorized and active vessels in the IOTC database appears to confirm this theory, with a higher number of active vessels than authorized vessels between 2010-2013 (**Table 4**). According to DGCF sources, Indonesia has made concerted efforts to improve the accuracy of active vessels reported to IOTC since 2014, and which correspond to a lower numbers than compared authorized vessels, as would normally be expected.

The actual explanation is likely a combination, to some degree, of all of the factors described above. The key point, in relation to the discussions presented in this paper, are that uncertainties still remain over the

[7] Ministerial regulations 56/2014 and 10/2015 introduced a moratorium of fishing permits for ex-foreign vessels. Since then 102 vessels were identified and classified as "ex-foreign vessel". All licenses for these vessels expired by the end of 2015.

[8] Presidential regulation 44/2016 was issued to strengthen previous regulations related to negative foreign investment in Indonesia's fisheries. All ex-foreign vessels ceases fishing activity entirely activity, as the regulation forbid the vessel to change gear, or sell the vessel domestically or abroad, leading many vessels to be left rotting in the port, some of them was caught in fire in several weeks ago (39 vessel).

reliability of Indonesia's active longline list (particularly prior to 2014), and the extent to which vessel numbers can be used by the IOTC's estimation procedure.

Table 4. Comparison of IOTC authorized and active vessels, as reported by Indonesia to IOTC.

Year	Authorised vessel list	Active vessel list
2006	953	-
2007	610	-
2008	573	-
2009	672	-
2010	729	980
2011	929	1180
2012	1146	1253
2013	898	1200
2014	918	458
2015	754	550
2016	425	246
2017	225	214

In summary, while uncertainties remain regarding quality of Indonesia's official data, the IOTC Secretariat continues to provide an alternative catch series that aims to at least partially resolve some of the issues highlighted above, given the importance of Indonesia as the largest fishery for IOTC species in the Indian Ocean.

The remainder of the paper focuses on the IOTC Secretariat's estimates for Indonesia, in the context of the fresh longline fleet, in the context of the estimate of billfish catches.

4. INDONESIA LONGLINE CATCHES: CURRENT IOTC ESTIMATION PROCEDURES

The IOTC Secretariat's current catch estimates for Indonesia's longline fleet are derived from information from a comparable 'proxy' longline fleet (Taiwan,China) considered to be a more reliable indicator of the overall catch trends and species composition, i.e., compared to Indonesia's official catches.

Taiwan,China has the second largest fleet of fresh (small) longliners in the Indian Ocean, collects detailed information on catches, including time-area catches and fishing effort, and also licenses a large number of vessels in the Eastern Indian Ocean operating in similar fishing grounds to Indonesia's longline fleet. The estimation methodology essentially involves extracting selected information from the Taiwanese fleet and catches which are then applied to Indonesia, as follows:

i. Average catches are extracted from the Taiwanese fresh vessels, and down weighted using a fixed ratio as the average catch rates of Taiwanese vessels are generally considered to be higher than the Indonesian fleet.

ii. Average catches taken from Taiwan,China are then multiplied by the number of Indonesia's active longline vessels to estimate Indonesia's total fresh longline catches.

iii. Catches by species are then estimated by applying the species composition from Taiwan,China (i.e., small-scale longliners) to the Indonesian fresh longline fleet.

Current IOTC methodology: assumptions

The IOTC Secretariat's estimates are dependent on a number of assumptions; notably:

1. That fishing patterns, including fishing effort, target species, catch composition, as well as trends in average catch rates, are comparable between Indonesia fresh longline and the Taiwanese fresh (small) longline fleet operating in the Eastern Indian Ocean.
2. That Taiwanese catches, including the species composition of catches, and number of active fresh longline vessels reported to the IOTC Secretariat are accurate *for all years*.
3. That the number of Indonesian active longline vessels reported to IOTC are also accurate.

However recent information related to changes in both the Indonesian and Taiwanese fresh longline fleets have called into question the validity of these assumptions, and the quality of the IOTC Secretariat's catch estimates in recent years:

- The current estimation procedure is particularly sensitive to the number of active vessels reported by Indonesia. However, as the previous section discussed, inconsistencies in the number of active longline vessels have been noted by the IOTC Secretariat since 2014, with some reports of a decrease of up to 80% of vessels.
- In the case of Taiwan,China, the number of fresh (small-scale) longline vessel has also decreased by around 30%, from 307 vessels in 2013, to 2012 vessels in 2016. However longline catches remained at similar levels (or even increased), raising average longline catches per vessel from 100 t in 2013 to around 175 t in 2016. Over the same period, the proportion of swordfish reported by Taiwanese flesh longline vessels increased from around 8% to over 30%, due to improvements in the estimation of catches by species, according to official sources.

Due to uncertainties in the number of Indonesia's longline vessels since 2014, the IOTC Secretariat has, until this point, repeated the number of active vessels (of around 1200 vessels) until the changes to fleet have been fully understood, i.e., rather than apply the <250 vessels as reported by Indonesia. Combined with the increase in Taiwanese average catches per vessel, explains why the IOTC Secretariat's estimates of Indonesia's fresh longline catches increased by nearly 150% between 2013 and 2016. Likewise, the changes to Taiwan,China's species composition of longline catches also explain why the majority of this increase of Indonesia's longline catches was allocated as swordfish.

The dependency on a number of core pieces of information (i.e., longline vessel numbers, average catches per vessel, and species composition) that appear to have simultaneously changed have created a compounding effect with unexpected, and unrealistic changes, in the IOTC Secretariat's estimates for Indonesia's fresh longline catches.

Recent discussions between the IOTC Secretariat and fisheries scientists in Taiwan,China and Indonesia have also concluded that the fishing patterns, targeting and catch composition are sufficiently different between the two longline fleets that the Taiwanese fleet is not appropriate proxy and should not be used to estimate or adjust Indonesia's catches.

Changes to the IOTC Secretariat's current estimation procedure – at least in recent years – are clearly needed, given the changes in fleet capacity and catches of the Taiwanese fleet and the impact on catches estimated for Indonesia.

5. UPDATES TO THE IOTC ESTIMATION PROCEDURE

While the estimation methodology essentially remains unchanged – in the sense that the calculation still depends on:

i.) the number of longline numbers;
ii.) estimates of the average catches per vessel;
iii.) the species composition of catches;

changes have been made to the data sources used to take account of recent information available for Indonesia's fishery, as follows:

1. Numbers of Indonesian active longline vessels: taken from the IOTC active vessel list, which includes the recent decline in longline vessel numbers, following official confirmation of the active vessel numbers by DGCF officials.
2. Multiply the number of active longline vessels in each year by an average catch of ≈30 t per vessel, per year to estimate the total catches. Average catches per vessel were approximated based on a comparison with a number of sources, including:
    - Comparison of average catches during an IOTC-OFCF sampling project between 2003-2008. Catches, including average catches per vessel, are generally considered relatively reliable during this period.

- Estimates of average catches per vessel provided in a 2013 IOTC Fishing Capacity report[9].
- Cross-checking average catches per vessel a random sample of fresh longline vessels based in Benoa[10].

3. Total catches disaggregated by species according to the species composition reported by DGCF to the IOTC Secretariat, for 2012-2017. Cross-checks were also carried out by comparing the results with the species composition of sampling at Benoa, one of the main landing sites for fresh longliners in Indonesia.

Discussion of results

Nominal catches generated using the new updated catch estimation methodology have been provided to the WPB, and are available for download on the WPB-16 meeting webpage (see dataset IOTC-2018-WPB16-DATA03b[11]).

Applying the new estimation procedure revises the IOTC Secretariat's estimates for Indonesia's fresh longline catches as follows:

1. A decline in total catches of Indonesia's fresh longliners, reflecting the decrease in the longline vessel numbers reported in the IOTC active vessel list since 2014.
2. Changes to Indonesia's fresh longline species composition (from 2012 onwards) based on the proportions of catch by species reported by DGCF's official data.

Changes to Indonesia's fresh longline species composition mostly affects the proportion of swordfish, blue marlin, and to striped marlin to a lesser extent (**Fig.4**) – all of which have declined relative to increases in proportion of catches of tropical tunas (yellowfin tuna and bigeye tuna) which are the main target species of the fishery, rather than billfish.

In terms of total billfish catches (i.e., across all fleets and gears), catches have also been reduced by as much as 30% for selected billfish species as a consequence of the revisions to Indonesia's fresh longline fleet. Catches of swordfish no longer show the sharp increase previously estimated by the IOTC Secretariat (**Fig.5**), as catches in recent years have been revised from over 50,000 t to less than 35,000 t directly as a result of changes to Indonesia's catches.

[9] Estimation of fishing capacity by tuna fishing fleets in the Indian Ocean, IOTC-2013-SC16-INF04, http://www.iotc.org/documents/estimation-fishing-capacity-tuna-fishing-fleets-indian-ocean

[10] A random sample of 12 fresh longline vessels, ranging in size from 40 GT to 155 GT, licensed to fish both within the EEZ and high seas. Total annual catches ranged from between 16 t to 50 t, while average catches across all sampled vessels were estimated at ≈26 t per year.

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

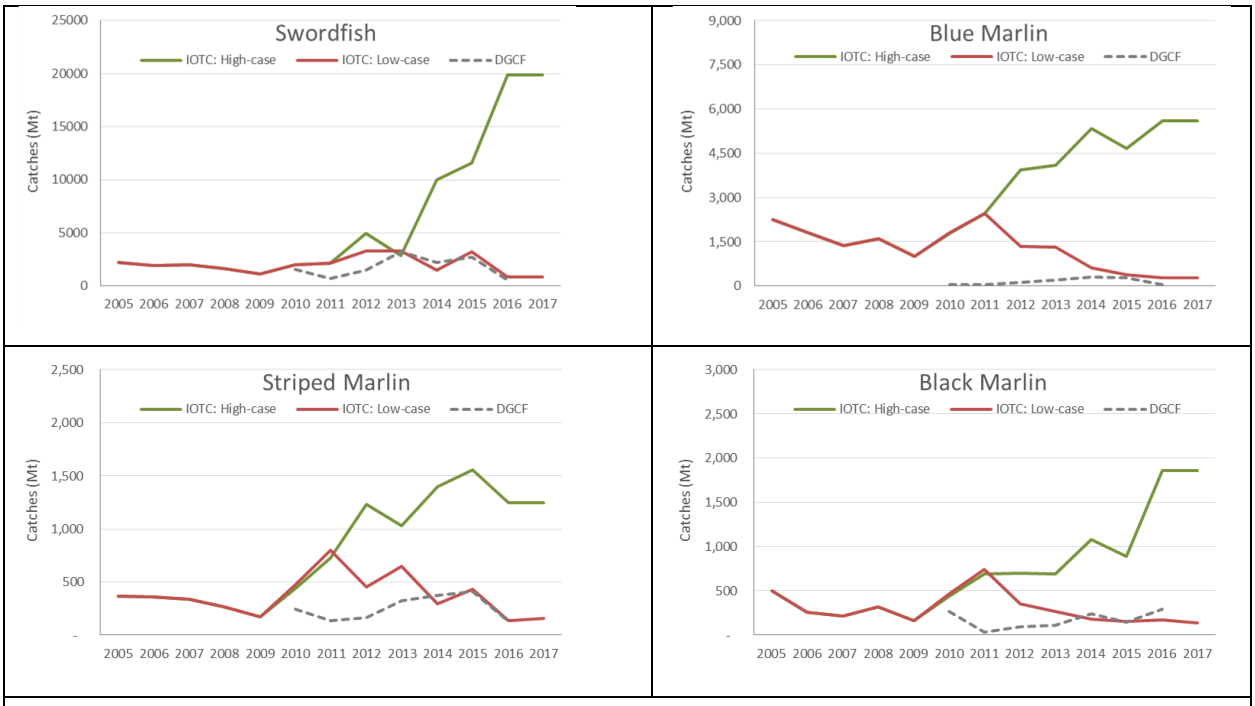


Fig.4 Comparison of IOTC estimates for selected billfish catches in Indonesia (high case and low case), and official catches submitted by DGCF.

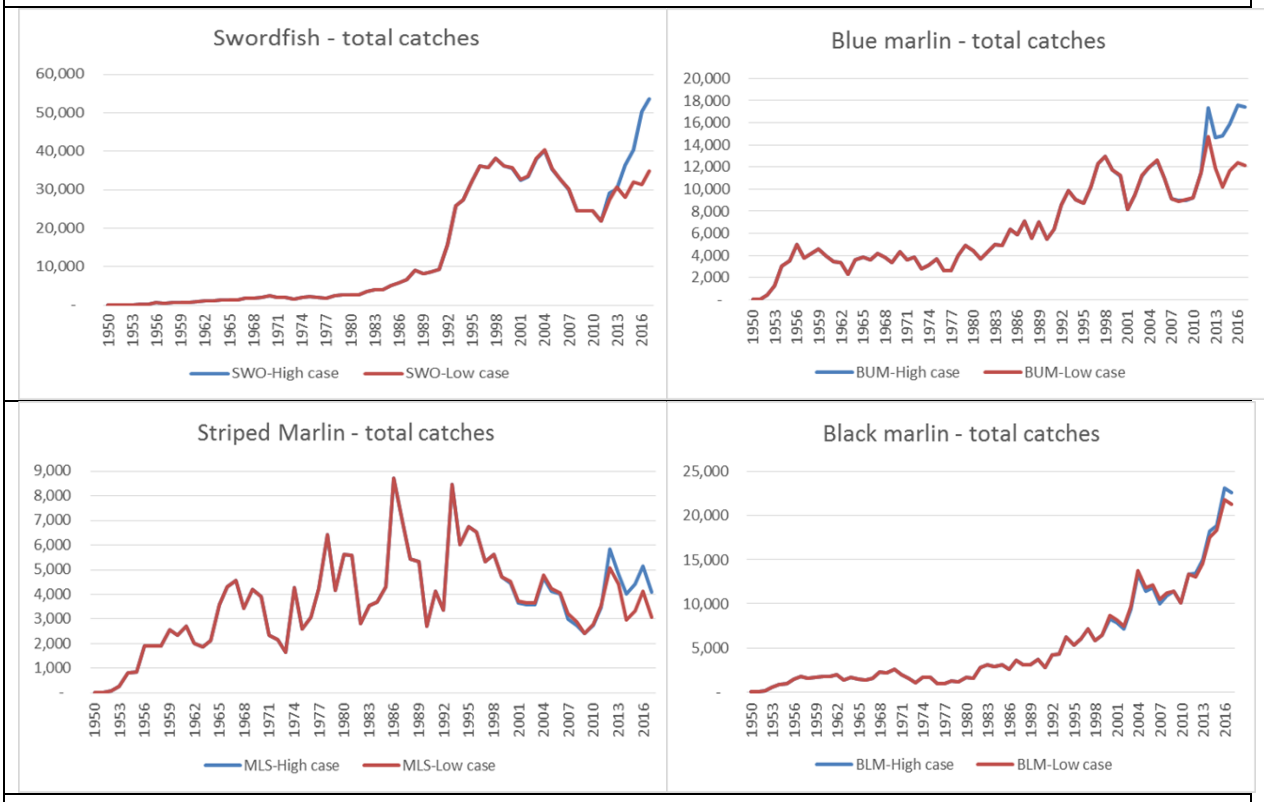


Fig.5 Comparison of IOTC total catch estimates for selected billfish catches (all fleets, all gears).

Evaluation of the new estimation method

1. Indonesia's longline catches are no longer dependent on catch trends within the Taiwanese fleet – in accordance with the recommendations and advice of fisheries scientists of Indonesia and Taiwan,China, and in that sense can be considered an improvement.
2. The revised catches are in also line with catches prior to 2014, while also showing a declining trend that corresponds to the apparent decrease in the number of Indonesia's active fresh longline vessels.
3. Changes to the species composition have also been validated, to some extent, by comparison to port sampling of landings in Benoa 2012-2017 – one of the principal ports for landings of fresh longliners.
4. The revised catch series also more closely aligned with the official catches reported by DGCF, in terms of overall catch levels and also catches by species, although concerns still remain over the robustness of Indonesia's official data and the fluctuations in longline total catches. For the present time, however, Indonesia's estimates of species composition of longline catches appear to be a better indicator than a reliance on alternative proxy fleets.

Issues outstanding

1. Although now unrelated to IOTC Secretariat's estimates of Indonesia's catches, the recent changes in the Taiwanese fleet need to be elaborated further – given the impact on total swordfish catches in particular – and whether historical catches also need to be revised in order to reflect the revisions in the estimates of catches by species reported by Taiwan,China.
2. There continues to be uncertainties regarding the number of active longline vessels prior to 2014, and catches for these years are considered to be uncertain – and possibly overestimated – even when applying the changes to the IOTC Secretariat's estimation procedure presented by this paper. However without further investigation the exact level of overestimation is difficult to assess at this point in time.

The main source of uncertainty concerns the number of active vessels, particularly in earlier years, and which is where the focus should be in terms of improving the quality of the Indonesia's estimates. For this reason the IOTC Secretariat recommends that the new estimation methodology be periodically reviewed as new information becomes available.