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Pilot sampling project of artisanal fisheries in North and West Sumatra: Implications on IOTC catch estimates of neritic tunas in Indonesia

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Abstract

For a number of years the IOTC Secretariat, the IOTC-OFCF Project, BOBLME, and other stakeholders in the region have actively engaged with Indonesia to provide technical assistance and build capacity in the fisheries data collection and reporting systems, including the development of logbooks for the industrial fleet, species identification training, and data collection and management workshops.

The following paper presents an overview of a pilot sampling Project in North and West Sumatra, conducted by the IOTC Secretariat and Indonesia's Directorate of General Capture Fisheries (DGCF) since 2014[2]*. The Project aims to pilot a methodology for sampling at landing sites, targeting Indonesia's small scale fisheries to improve the estimates of total catches, and particularly catches by species, for Indonesia's coastal fisheries.*

Preliminary results of the pilot project are presented, and implications for IOTC's current estimates of catches of neritic species for Indonesia – with particular reference to longtail tuna (*Thunnus tonggol*).

1. Introduction

Indonesia reports the highest catches of IOTC species in the Indian Ocean, accounting for over 20% of total catches in recent years, and ranking first or second in importance of catches for each of the main IOTC species groups (i.e., *temperate tunas, tropical tunas, neritic tunas, and billfish*). Indonesia's share of total catches of neritic tunas is even higher – at around a third – although the proportion varies by species (e.g., from 17 per cent for longtail tuna, to nearly 65 per cent for frigate tuna) (**Figs. 2a-b**).

Indonesia also occupies a strategic position located between the IOTC[3] and WCPFC Areas of Competence, and accounts for important catches of Southern bluefin tuna, managed by CCSBT (**Fig.1**)

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[2] Funded by the IOTC Secretariat, BOBLME, and IOTC-OFCF Project.

[3] West Sumatra and North Sumatra faces the Indian Ocean (i.e., IOTC Area of Competence).

Despite the importance of Indonesia's fisheries to catches in the Indian Ocean, substantial gaps exist in the fisheries information available to the IOTC. Indonesia first began publishing catches by species of tuna in 2004[4], while no catch-and-effort or length frequency data has been reported to the IOTC Secretariat for industrial or coastal fisheries since the 1980s. The situation is partly due to the challenges of data collection arising from the geographic complexity of the country, with over 95,000 km of coastline and several thousand landing sites.

More serious are the concerns raised with the quality of the current data collection and reporting systems. Since the early-2000s Indonesia has reported large – and mostly unexplained – fluctuations in total catches between years, as well as abrupt changes in catches by species (refer to **Figs.16-18**), that suggest fundamental problems with the data collection and reporting systems. Indonesia's official catches reported to the IOTC Secretariat remain highly uncertain, while compliance with IOTC's data-related Resolutions remains poor, due to deficiencies in the data collection.

2. Overview of Indonesia's current data collection systems

The Indonesia's data collection system was designed and implemented in the 1970s – and is still the foundation of the current system – based around three components, depending on the size and type of landing site:

1. Obligatory reporting from fishing companies who are required to keep records and make monthly reports of fishing activity and catch of their vessels. This concerns companies based in fishing ports and major landing sites, who submit monthly reports to DGCF in Jakarta.
2. Regular monitoring of major landing places. Major landing places typically have a central fish market or auctioning place (*Tempat Pelelangan Ikan*, TPI) through which most of the landings are channelled and that are required to complete monthly reports of catches of commercial species for each gear, including fishing effort (given as fishing trips).
3. Surveys of fishing village: monthly/quarterly surveys of smaller landing places (mostly fishing villages) not covered elsewhere. This is essentially a census of fishing activity, via interviews of all or some of the fishing households/establishments.

A number of studies[5] have identified issues with the current data collection, particularly for coastal fisheries, that impede the quality and timely reporting of data to the IOTC Secretariat:

[4] Prior to 2004, data has largely been reported as species aggregates (e.g., Tongkol, or TUX).

[5] http://www.iotc.org/news/iotc-ofcf-project-organises-second-data-collection-workshop-indonesia-collaboration-dgcf ; Moreno, (2013), 'Pilot project to improve data collection for tuna sharks and billfish from artisanal fisheries in the Indian Ocean', IOTC Secretariat.

i. Limited validation procedures are in place to verify the data that is reported. While logbook data collection and sampling schemes have recently been implemented on longline vessels – this does not cover the majority of catches of tuna that are caught by Indonesia's coastal (artisanal) fisheries.

ii. Coverage of landing sites is limited when considering coastal fisheries. Official statistics for 2013 indicate around 800 landing sites in Indonesia which are covered by the data collection system[6], including oceanic and archipelagic fishing ports, as well as various types of major and minor landings sites, but the actual number of landing sites is estimated be as much as several thousand – although exact numbers are difficult to estimate due to the range of formal and informal sites that are used to offload catches.

iii. Limited resources by District/Provincial staff to conduct regular monitoring of landing sites and surveys of fishing villages, in addition to a general lack of dedicated staff, financial resources to cover operating costs, and limited training and understanding of data collection.

iv. Under-reporting of catches: Trader records (as reported by fish auction places) are used to reflect production in each of the major ports, but there may be anywhere between 5%-30% of the catch that is not included in the TPI production records, or if collected by the TPI, officials on site may not include it in the final estimates.

v. Aggregation and misidentification of catches by species: Semi-industrial and artisanal fleets in Indonesia commonly offload a mix of species, which are recorded by trader data using commercial fish categories such as '*tuna*', or '*baby tuna*', and which lack the necessary detail on species composition, sizes and fishing effort required by IOTC reporting requirements.

vi. Species misidentification: There are also reports of the commercial species of juvenile tunas '*tongkol*' being incorrectly recorded as longtail tuna (*Thunnus tonggol*) by District authorities, due to the unfortunate similarity in names – an issue that is addressed later in the report.

The situation is complicated further by institutional arrangements for data collection in the county, which are handled by several institutions – including the Directorate General of Capture Fisheries (DGCF), the Ministry of Maritime Affairs and Fisheries, and District and Province offices of Agriculture and Marine Affairs (DINAS) – where poor communication between the institutions compromises the quality of reporting and often leads to conflicting and contradictory data being reported to IOTC.

Despite some improvements in Indonesia's data collection in recent years[7], the quality of catch estimates remains largely uncertain – particularly for coastal fisheries, which account for over 90% of the total catches reported by Indonesia (**Figs.3a-b**), and which are the focus of the remainder of this paper.

[6] Capture Fisheries Statistics, Indonesia, http://statistik.kkp.go.id/

[7] Notably the introduction of logbooks on industrial longline vessels, from 2012 onwards.

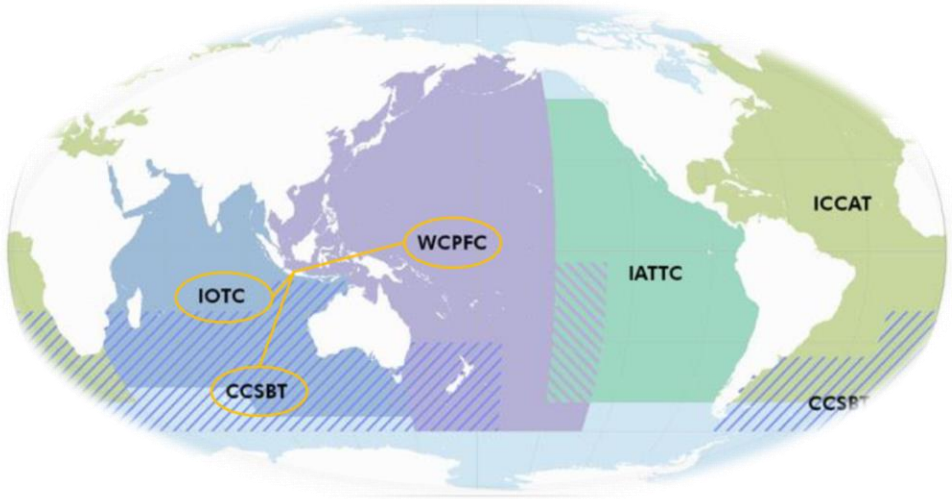


Fig.1. Indonesia: the multilateral tuna cauldron.

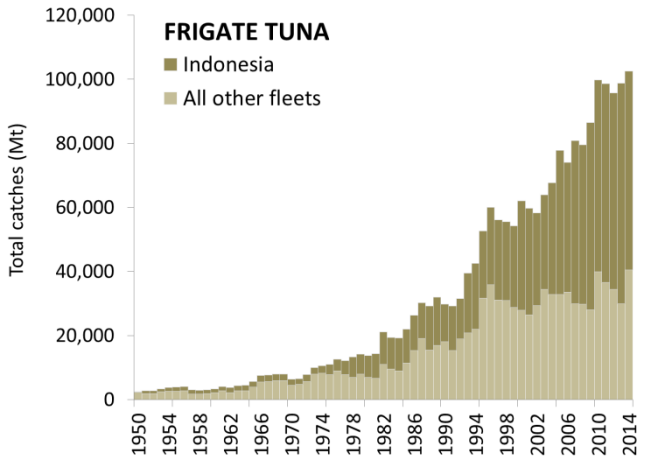


Fig.2a. Total IOTC catches of frigate tuna (1950–2014). Source: IOTC database.

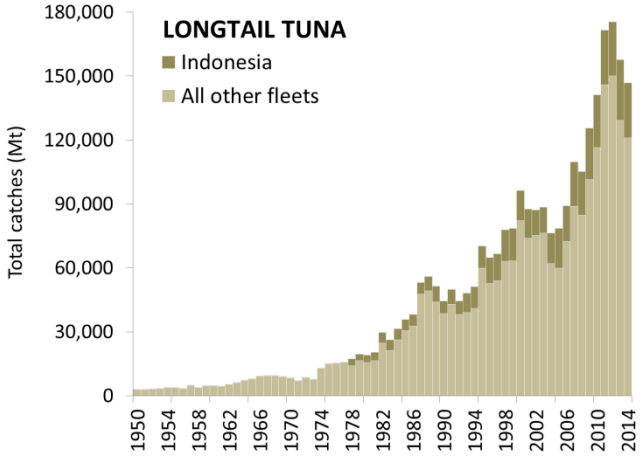


Fig.2b. Total IOTC catches of longtail (1950–2014). Source: IOTC database.

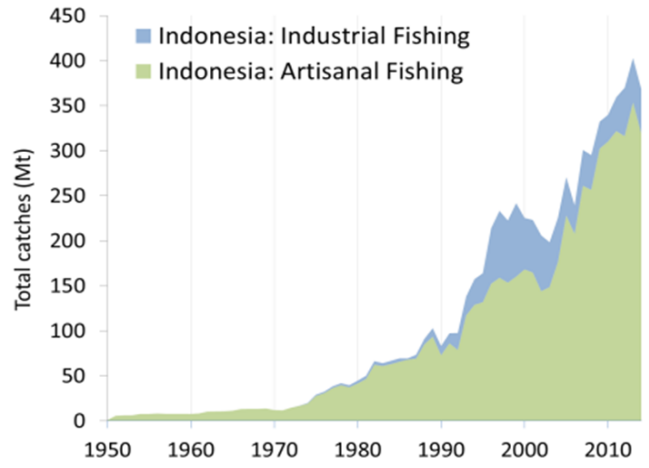


Fig.3a. Indonesia total catches of IOTC species (1950–2014): artisanal and industrial fisheries. Source: IOTC database.

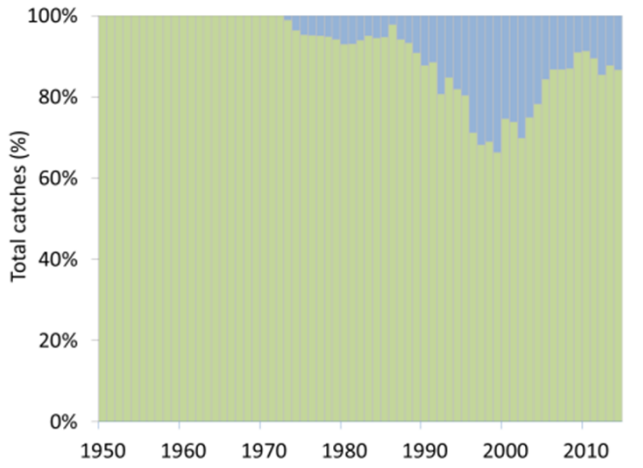


Fig.3b. Indonesia total catches of IOTC species (1950–2014): artisanal and industrial fisheries (percentage total).

3.1 Pilot sampling project of artisanal fisheries: objectives

Following a request for assistance from DGCF in 2014, the Bay of Bengal Large Marine Ecosystems Project (BOBLME) and the IOTC-OFCF Project agreed to assist the DGCF to strengthen the data collection and processing systems for Indonesia's coastal fisheries.

The objectives of the pilot Project were as follows:

1. To devise a collection and management strategy for the coastal fisheries of Indonesia in line with national and international data requirements; in particular provisions of the IOTC Regional Observer Scheme, IOTC minimum data requirements, and FAD Management Plans. The Project sampling protocols address the need for reliable data on species composition of catches and size data (i.e., IOTC species), as the composition of commercial categories varies greatly among fleets using different gears.
2. To build capacity in Indonesia to ensure that the government of Indonesia has the ability to maintain the sampling activities for coastal fisheries once external financial and technical support is discontinued.
3. Use the data collected during the Pilot Project to revise the time-series of catches for West Sumatra and North Sumatra – particularly for neritic tuna and tuna-like species – and facilitate reporting of project data to national and international institutions, including the IOTC Secretariat, as required.
4. Improve overall compliance with IOTC data related resolutions – specifically Res.15/02 '*Mandatory statistical requirements*' for coastal fisheries (i.e., reporting of nominal catches, catch-and-effort, and size frequency data).

Landing sites in the provinces of North Sumatra (Sumatera Utara) and West Sumatra (Sumatera Barat) were selected, for several reasons:

i.) Both provinces are strategically positioned in facing the Indian Ocean, while North Sumatra that has coastlines facing the Indian Ocean and the Malacca Strait – both of which are within the IOTC area of competence, but report some differences in terms of fisheries and species associated with each coastline.

ii.) The importance of catches in North and West Sumatra, which are estimated to account for around 20% of the total catches reported by Indonesia.

iii.) The importance of coastal fisheries North and West Sumatra for skipjack tuna, small specimens of yellowfin tuna and bigeye tuna, and neritic tunas; in particular fisheries associated to anchored-Fish Aggregating Devices (aFAD), which the IOTC has adopted specific data collection and reporting requirements in 2013 that Indonesia will need to begin implementing.

iv.) In recent years West Sumatra has also reported large catches of longtail tuna (*Thunnus tonggol)*, according to Indonesia's official catch statistics. However this appears to be in contradiction with recent findings that suggest widespread misreporting of the commercial category *tongkol* as longtail

tuna in West Sumatra, and which are believed to be composed of juvenile yellowfin tuna, bigeye tuna, skipjack, kawakawa, frigate and bullet tuna.

3.2 Sampling protocols

A total of eight landings sites were initially selected for the pilot, covering major fishing ports, landing sites with an existing fish market/auction infrastructure in place, beach landing sites, as well as small and larger private landing sites (**Table 1**). Sites were also selected to accommodate the range in vessel types, and gears, common throughout Indonesia's coastal fisheries (e.g., liftnet, Danish seine, trolling, and purse seine).

Table 1. Selected sites for sampling and their main characteristics and location.[8]

No.	Selected Site	Sampling start	Target gear	Characteristics	Province	District
1	Belawan	15 Oct 2014	Purse seine	Large port, PPS	North Sumatra	Kota Medan
2	Sibolga	23 Oct 2014	Purse seine	Large port, PPN	North Sumatra	Tapauli Tengah
3	Bungus	13 Oct 2014	Purse seine / Liftnet	Large port, PPS	West Sumatra	Kota Padang
4	Air Bangis	30 Aug 2014	Gillnet	TPI	West Sumatra	Kota Padang
5	Pasie nan Tigo	23 Sep 2014	Liftnet	Beach	West Sumatra	Kota Padang
6	Gaung	9 Sep 2014	Liftnet	Private site	West Sumatra	Kota Padang
7	Muara Padang	3 Oct 2014	Danish seine / Troll-Handline	Private site	West Sumatra	Kota Padang
8	Kambang	15 Aug 2014	Troll - Handline	TPI	West Sumatra	Pesisir Selatan

Sampling protocols were designed and tested in situ for each site to accommodate for their characteristics, such as vessel type, gear, commercialisation or manner of offloading. All enumerators in each of the landing sites were trained on species identification, size measurements, sampling strategies, and code of conduct[9].

The sampling methodology aims to address gaps in Indonesia's current data collection systems for coastal fisheries. Specifically:

i. Total enumeration of vessel landings and total catches of tuna and tuna-like species at selected landing sites.
ii. Sampling of landings by species of IOTC tuna and tuna-like species.
iii. Sampling of daily fishing effort data by boat type and gear.
iv. Collection of length frequency (size) data by species.

[8] The three larger ports (Belawan, Sibolga, and Bungus) are under direct management of DGCF and fall into two categories; oceanic ports (PPS) and archipelagic ports (PPN). The other landing sites consist of a mixture of fish market or auctioning places (TPI), beach or private landing sites.

[9] Further details on the sources used are given in Moreno G. 2015, Implementation Report for the Project Collection of Data from Tuna Fisheries in the Provinces of West Sumatra and North Sumatra, Indonesia. IOTC-BOBLME, 55 pp.

The introduction of a sample based approach to monitor catches FROM coastal fisheries enables potential efficiencies in resources compared to the current data collection system, based on information from Traders records (TPI), and more importantly may improve the quality of catch estimates for coastal fisheries, including:

- catches by species and gear
- measurement of fishing effort
- fleet parameters such as the characteristics of fleets, number of active vessels, and use of FAD

4. Preliminary results of sampling

The following section provides a summary of the results of sampling, up to the end of formal Project activities (i.e., between August 2014 until end-October 2015):

- 7,734 landings were monitored by enumerators across the selected landing sites, collecting information on vessel and gear type, and total catches of tuna and non-tuna catches;
- of which, 1,106 unloadings (landings) were sampled for tuna species, including detailed information on species composition, fishing effort, and sampling of length and weight measurements.
- A total of 23,037 length measurements were taken, including 6,560 measurements of length and weight for the same specimens.

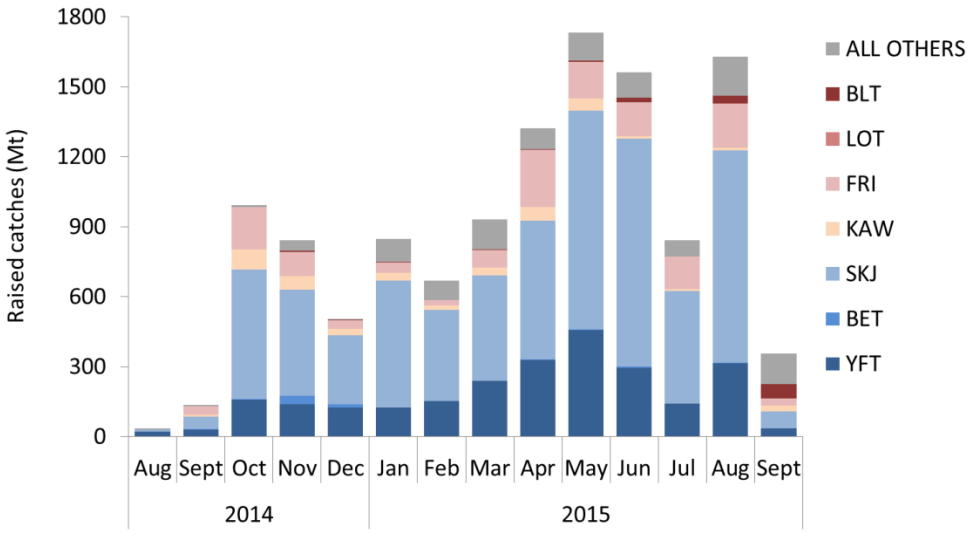
4.1 Species composition of sampled catches

Obtaining more reliable estimates of catches by species from coastal fisheries was one of the main objectives of the Project. As noted earlier, West Sumatra was identified as a priority due to issues in current data collection – specifically the misreporting of the commercial category '*tongkol*' as longtail tuna.

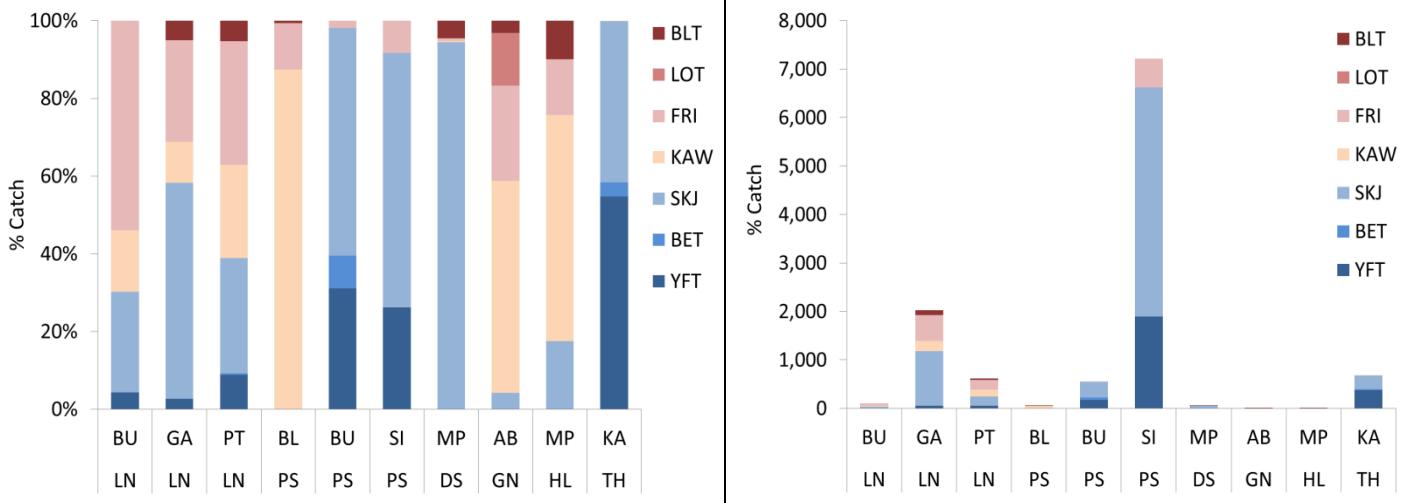
Figures 4a-c shows the species compositions of tuna catches, which vary according to gear type and landing site. Differences in species composition are also reported by the same gears, at different landing sites; for example:

1. Liftnets: frigate tuna and kawakawa are relatively more important in catches landed in Pasie nan Tigo than compared to Gaung. On the other hand, the differences in species between liftnets landed at Bungus and Gaung are most likely an artefact of sampling, as only three liftnet vessels were monitored in Bungus compared to 56 vessels in Gaung.

2. Purse seine: kawakawa accounts for the majority of catches of purse seiners landed in Belawan (albeit based on 2 months of sampling only), in contrast to purse seine catches landed in Bungus and Sibolga which are dominated more by skipjack tuna and yellowfin tuna.



Figs.4a. Species composition of total raised catches from all pilot Project landings.



Figs.4b-c. Species composition of IOTC catches in percentage according to sites and gears sampled.

Gear codes: DS – Danish seine; GN – drift gillnet; TH – troll/handlines; LN - liftnet, PS – purse seine.
Landing site codes: AB – Air Bangis; BL – Belawan; BU – Bungus; GA – Gaung; MP – Murua Padang; KA – Kampang; PT – Pasie nan Tigo; SI – Sibolga;

Figure 5 examines the extent of changes in the species composition by month, for the same gear and landing site, due to possible effects of seasonality, changes in fishing areas, or targeting strategies, etc. In the case of liftnets landing at Guang, and to a lesser extent purse seiners at Sibolga, there are notable changes to the

composition of catches landed throughout 2015 – notably the proportion of frigate tuna (e.g., Guang, March; Sibolga, July), skipjack tuna (e.g., Guang, August and September) and yellowfin tuna (Guang, May). However – based on the preliminary results of the Project alone – it is difficult to perceive an obvious trend in changes to the species composition without complete data for at least 12 months, and preferably over a longer time period.

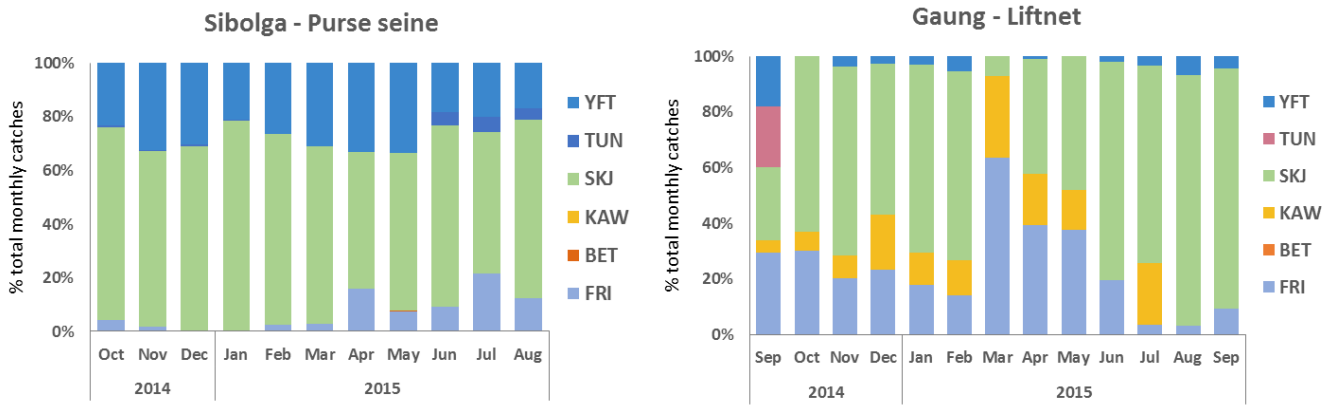


Fig.5. Species composition of purse seine catches in Sibolga (left), and liftnet catches in Gaung (right).

4.2 Misreporting of tongkol

Around 15% of catches reported at the pilot landing sites were categorized as the commercial category of juvenile tunas (*tongkol*). Returning to the issue of possible misclassification of *tongkol* as longtail tuna (*Thunnus tonggol*), almost no catches of longtail tuna were recorded at the landing sites covered by the pilot project in West Sumatra, besides relatively small quantities at Air Bangis that originate possibly as far away as Mentawai. However the report acknowledges there are important gaps in the sampling coverage, given the limited number of landing sites and gears covered by the pilot project, that need to be covered in the future.

Figure 6 below shows the species composition of catches of tongkol, based on the results of sampling for each landing site. A number of different species are recorded, and in different proportions, according to the landing site. Enumerators reported frigate tuna, skipjack tuna, and kawakawa as the species more commonly associated with catches of tongkol; however the extent of mixing of species under the tongkol commercial category, and differences in species composition between landings site, emphasizes the importance of sampling of the commercial species categories.

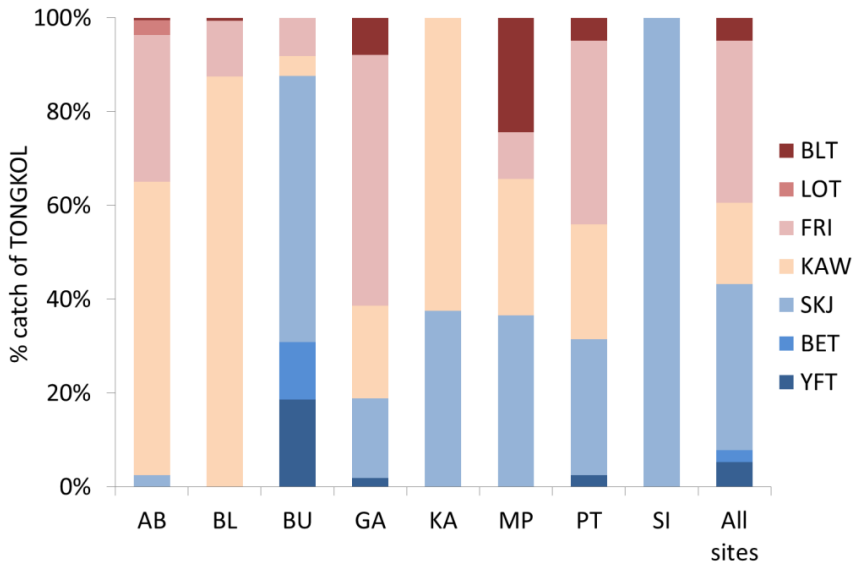


Fig.6. Species composition of catches of commercial species tongkol, by landing site.

Landing site codes: AB – Air Bangis; BL – Belawan; BU – Bungus; GA – Gaung; MP – Murua Padang; KA – Kampang; PT – Pasie nan Tigo; SI – Sibolga;

4.3 Length frequency data

A total of 23,037 length measurements, including 6,560 measurements of both length and weight for the same specimens, were collected by the pilot project by the end of October 2015. **Table 2** shows the number of length measurements taken by gear. Samples tend to be dominated by the most common tuna species caught by each gear, and there are few size observations from small-scale gears (e.g., handline, Danish seine, and drifting gillnet) that do not necessarily target tuna species.

Table 2. Total number of length measurements sampled by gear in West Sumatra and North Sumatra.

Species	DS	GN	HL	LN	PS	TH	Grand Total
Frigate tuna	20	53	96	2,980	156		3,305
Bigeye tuna					55	110	165
Bullet tuna	122		62	412	15		611
Dolphinfish					10		10
Kawakawa	1	35	365	2,147	365	40	2,953
Rainbow runner					5		5
Skipjack tuna	1,402	8	151	2,561	4,331	1,813	10,266
Yellowfin tuna				916	2,956	1,850	5,722
Grand Total	**1,545**	**96**	**674**	**9,016**	**7,893**	**3,813**	**23,037**

Figure 7 shows the length frequency distributions for skipjack tuna and yellowfin tuna (YFT), two of the most common species observed by enumerators and which were also relatively well-sampled. There are clear differences in sizes caught according to gear, as one would expect, with larger sized specimens associated with purse seiners compared to liftnet.

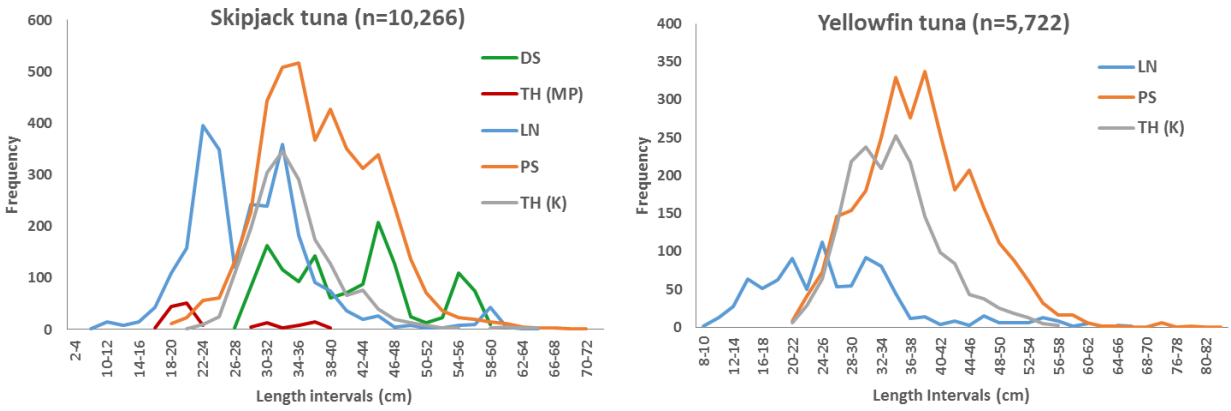


Fig.7. Frequency distribution of skipjack tuna (left) and yellowfin tuna (right) lengths (cm) according to gear. Total number of samples are shown in brackets.
Gear codes: DS – Danish seine; GN – drift gillnet; TH – troll/handlines in Muara Padang (MP) and Kambang (K) landing sites; LN - liftnet, PS – purse seine. Distributions not shown for gears with small number of samples (e.g., <50 samples).

Figure 8 shows the length frequency distributions for bigeye tuna and frigate tuna. In the case of bigeye tuna (BET), the low number of samples (n=165) means that the length distribution is highly variable without showing any clearly defined peak. For frigate tuna (FRI), data from the liftnet fisheries shows a more clearly defined peak (and which account for the majority of samples), but this does not appear to be the case for other gears – again due to the small number of samples available.

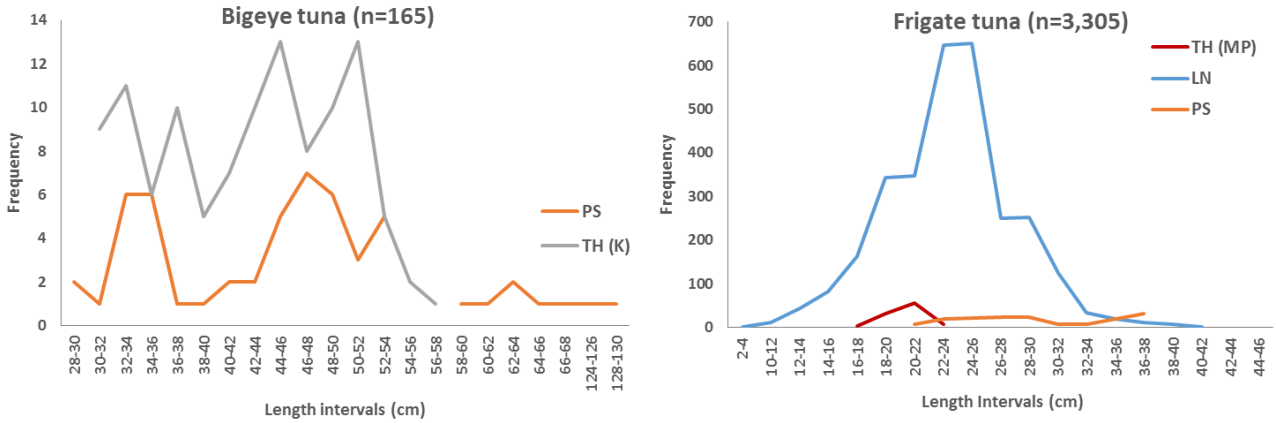
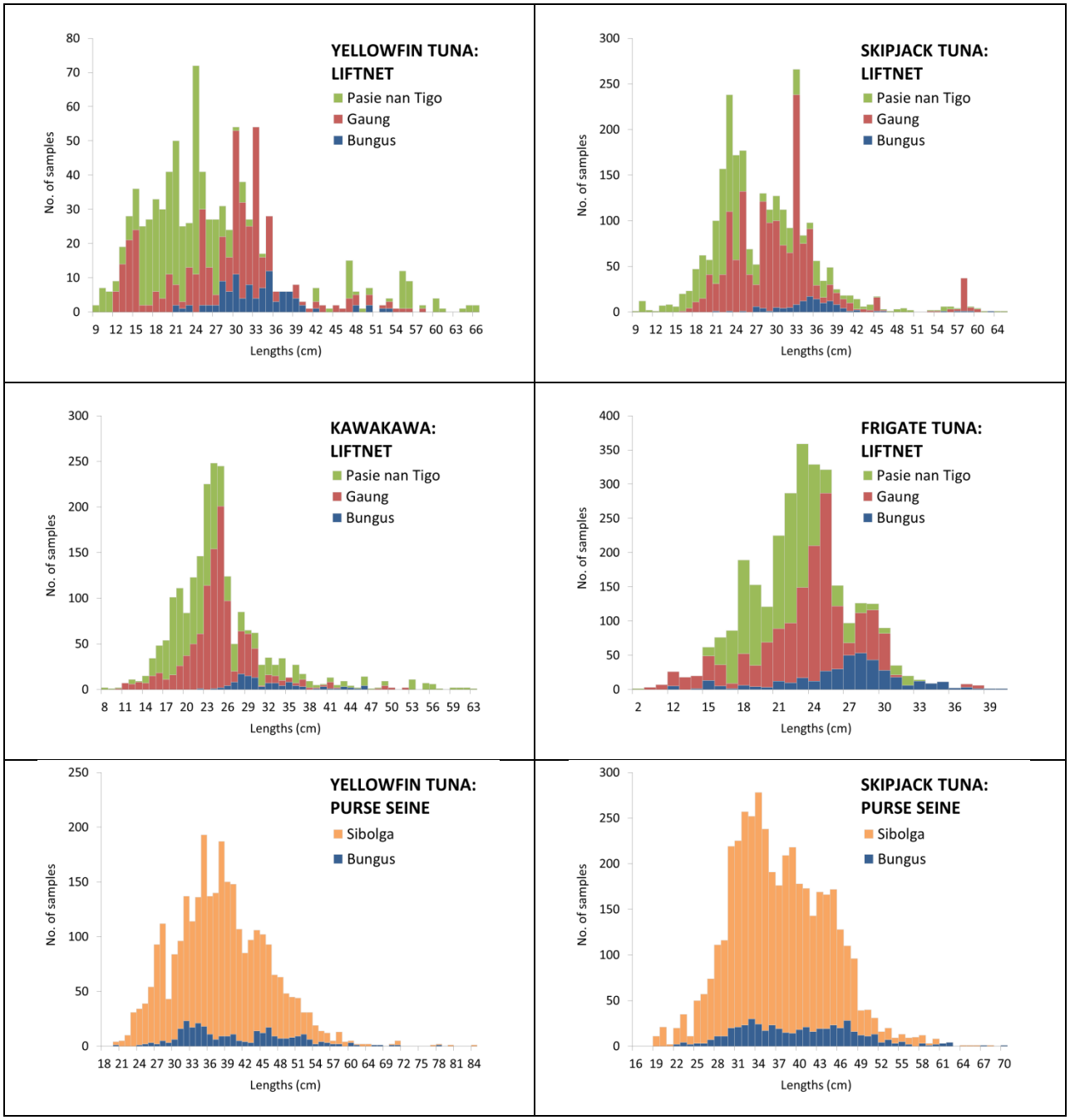


Fig.8. Frequency distribution of bigeye tuna (left) and frigate tuna (right) lengths (cm) according to gear. Total number of samples are shown in brackets.
Gear codes: TH – troll/handlines in Muara Padang (MP) and Kambang (K) landing sites; LN - liftnet, PS – purse seine. Distributions not shown for gears with small number of samples (e.g., <50 samples).

Differences in the length frequency distributions can also be observed within the same gear, according to different landing sites (e.g., liftnet catches of yellowfin tuna) (**Fig.9a-f**) – however it is unclear to what extent these differences are a function of different cohorts, differences in selectivity of the gear, or potential bias in the sampling. Additional samples collected over a longer time period are ultimately needed in order to determine this.



Figs.9a-f. Length frequency distribution for selected species and gears, by landing site.

One important observation highlighted by length data collected by the Project is the relatively small size of specimens caught by the main gears monitored by the Project. The majority of samples (i.e., below the upper quartile limit) for each of the main species are smaller than the size at first maturity (**Table 3**).

Small specimens appear to be particularly an issue for the larger sized tunas – bigeye and yellowfin tuna – where the scale of differences are greatest between the average size of samples and size at maturity. For example, most bigeye and yellowfin tuna samples recorded by the Project were between 40-49 cm or less; considerably smaller than the 100 cm identified as size at maturity. In the case of yellowfin tuna, of the 5,722 samples, the largest specimen was 84 cm – which while not considered juvenile is still well below the length at first maturity.

The implication is that if Indonesia's fisheries account for substantial catches of species of juvenile and immature specimens, either through direct or indirect targeting, serious questions are raised over the long-term sustainability and management of the stocks (see inset pictures on the next page).

Table 3. Comparison of size of samples measured for lengths and size at maturity. Inset pictures below show examples of the size of specimens recorded at the Project landing sites.

Species	Size at maturity (50%) (cm)[10]	Project data: size frequency samples (cm)					No. of samples
		Average	Lower quartile	Upper quartile	Min.	Max	
Bigeye tuna (BET)	100	44	36	49	28	130	165
Bullet tuna (BLT)	35	23	20	26	13	32	611
Frigate tuna (FRI)	29 - 35	23	20	26	2	44	3,305
Kawakawa (KAW)	38 - 50	26	20	30	8	63	2,953
Skipjack tuna (SKJ)	41 - 43	35	30	40	2	76	10,266
Yellowfin tuna (YFT)	100	35	29	40	9	84	5,722

Source: IOTC Fisheries Indicators, and Pilot Project data.

[10] IOTC Fisheries Indicators, http://www.iotc.org/science/status-summary-species-tuna-and-tuna-species-under-iotc-mandate-well-other-species-impacted-iotc

(Inset pictures) Examples of size of specimens measured sampled during the pilot Project.

5. Comparison of sample data with official statistics

As part of the evaluation of the pilot Project, attempts were made to compare the results of sampling with official catch estimates (at the Province, District and landing site level), to assess differences in landings, total catches and particularly the species composition of catches.

- District/Landing site level data: were requested numerous times from District staff, but this proved difficult to obtain due to a number of issues including the confidentiality of the data (e.g., census surveys and regular frame surveys), but also a general lack of willingness to share data by Districts. Detailed comparisons were possible for only for two of the eight Project landing sites – Bungus and Sibolga which are monitored directly by DGCF and operate a data collection system covering all larger sized fishing vessels using these ports (>5 GT) (see **Sections 5.1 and 5.2** below).
- Province level data: are published annually by DGCF, and so comparisons with Project data were much easier to compile.

Based on the limited comparisons that were possible with official / District level data made available to the Project team, the following observations were noted:

5.1 Case study 1: Bungus

Purse seine and tuna longliner[11] vessels account for the majority of catches landed at Bungus, with the remaining catches accounted for mostly by liftnet vessels. Tuna and tuna-like species also account for around 90% of total catches unloaded at Bungus.

[11] Tuna longline is not included in the scope of the pilot Project, as it is covered separately by logbook data collection system.

Comparisons between the Project sampling data and Port Authority data were carried out for liftnet and purse seine vessels, for the period January to September 2015.

Figure 10 presents a summary of the catch-by-species for Project and Port Authority data for liftnet vessels, and which shows very good agreement between the species composition of the two data sources for January to April 2015 – perhaps surprisingly so given the differences after April. From May onwards there is disagreement between the two data sources, both in terms of total catch levels and species composition. Major differences in the species composition are evident in May and June – particularly the proportion of frigate tuna, kawakawa and other (non-tuna) species. It is unclear why differences in the species composition occur only in selected months – particularly given that catches by species are almost identical between January and April – and requires further investigation of the data and Port Authority officials. However, for the months in which catches by species differ, the scale of differences suggests there may be major issues of species misidentification in Port Authority data, where a substantial proportion of the catch was classified as non-tuna species – specifically as scads.

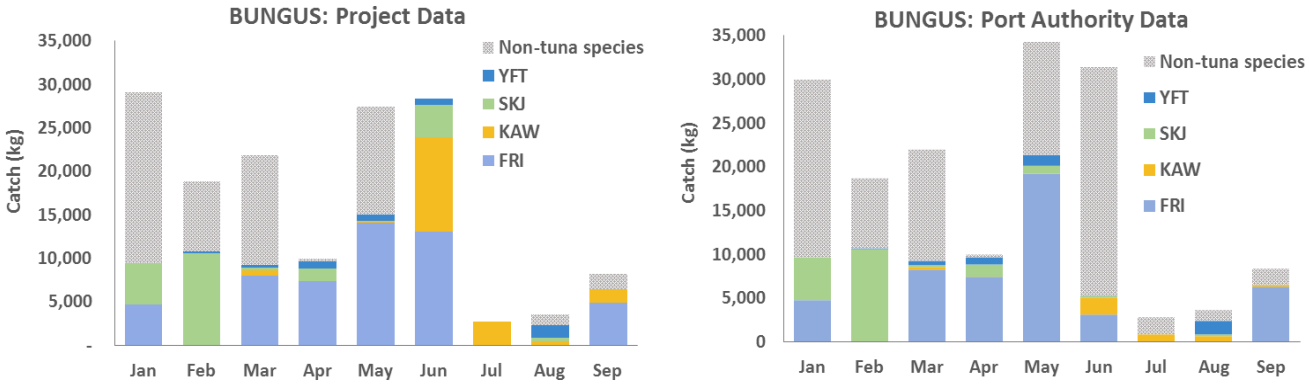


Fig.10. Bungus Project data: comparison of liftnet catch estimates (kg) and their species composition, in 2015.

Total catch levels (i.e., including all tuna and non-tuna species) by liftnet vessels were broadly similar between both data sources (**Fig.11**). Port Authority data indicates two more liftnet landing events in the period May to June, compared to Project data, indicating that the Project has not always been able to monitor all landings as required by the sampling protocols. This does not, however, explain the differences in species composition noted above.

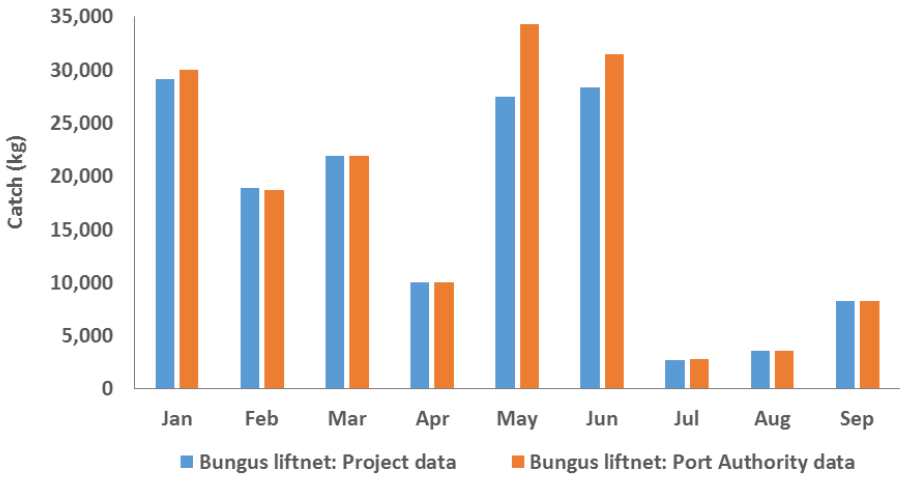


Fig.11. Bungus: comparison of total liftnet catches (kg) monitored by the Project and Port Authority data, January – September 2015. Includes all tuna and non-tuna catches.

Comparisons were also made in terms of landings of purse seine vessels (during the same period, January to September 2015). Very large discrepancies were noted between total catches (including tuna and non-tuna species) reported by the Project and Port Authority data – again, related to the number of landing events monitored (**Fig.12**). However, in this case the Project recorded a higher number of landings when compared to Port Authority data. Between April and August 2015, 9 purse seiner landings were monitored by the Project, including one vessel that landed 73,887 kg on 1 June 2015; while the Port Authority recorded only 5 purse seiner landings during the same period. When questioned on the discrepancy between the total number of landings, DGCF reported that the Port Authority was missing information on a number of the unloadings recorded by the Project, and that the records would be corrected in the near future.

Important differences were also noted between the species composition of catches of purse seiners between the two data sources (**Fig. 13**). This is particularly evident in April, May, and June, where the proportions of skipjack, yellowfin, and frigate tuna are different – however, the discrepancies in species composition may partially be explained by the number of unloadings missing from Port Authority data, particularly if there are seasonal effects on the composition of catches.

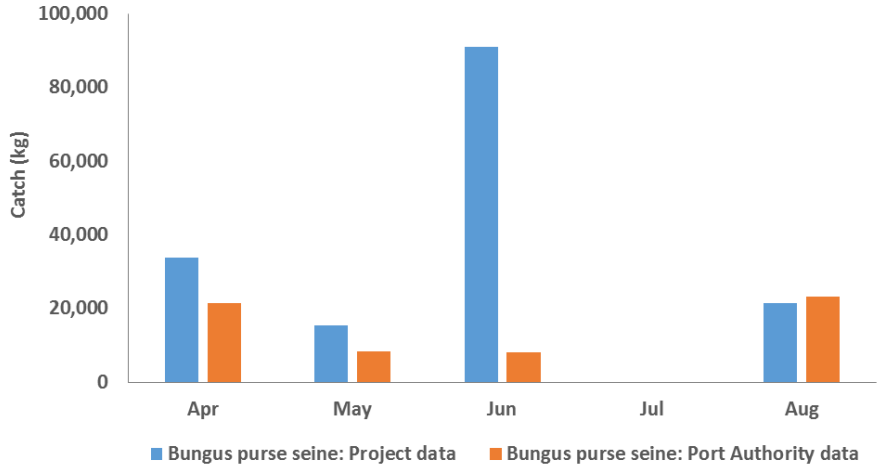


Fig.12. Monthly comparison of total purse seine catches in Bungus Port monitored by the Project and Port Authority data. Note that no landings were recorded for January to March 2015.

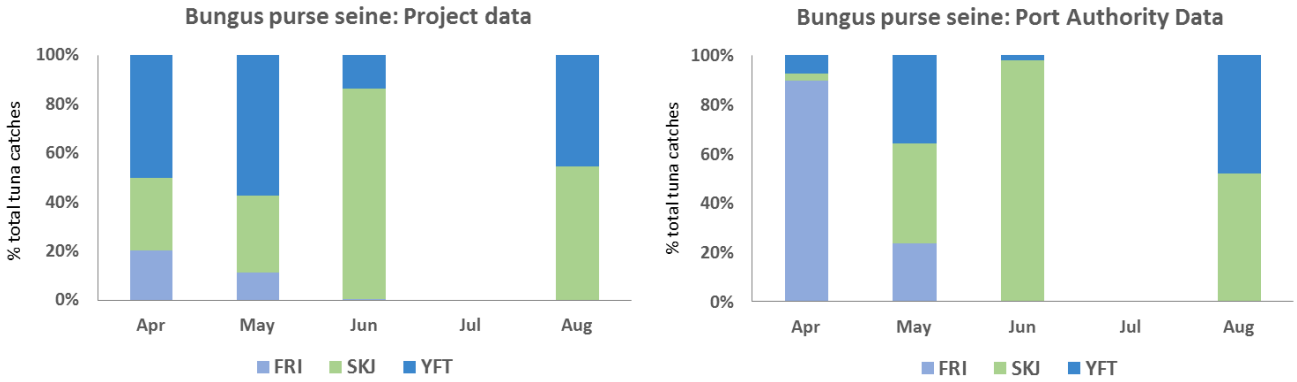


Fig.13. Monthly comparison of the species composition of purse seine catches in Bungus Port monitored by the Project and Port Authority data, during 2015.

In summary:

- The comparison of sampling and DGCF Port Authority data for Bungus indicates important differences in the species composition for purse seiners, and also liftnet vessels.
- In the case of purse seiners this may be partly related to a number of major landings missing from Port Authority data, rather than species misidentification which appears to be more clearly the case for liftnet vessels.
- Nonetheless the Project data are generally considered more reliable for the estimation of species composition, given the methodology is based on sampling of actual catches, and enumerators have received specific training on species identification. Port Authority data on the other hand relies heavily on information from logbooks, and there is the possibility that this may include errors or biased information reported by the fishing master.

- It is also alarming that the Bungus Port Authority appears to have a problem in covering purse seine landing events in particular, which has the effect of underestimating production.

5.2 Case study 2: Sibolga landing site

Sibolga Archipelagic Port is a much busier port than Bungus in terms of landing activity. While the majority of landings are by purse seiners, but there are also substantial offloadings by liftnet, gillnet, and handline vessels. As in the case of Bungus, there is also a data collection system in place to collect data from vessels landing in the port and adjacent private company landing sites. For Sibolga, aggregated data (i.e., total catches for all landings, by species, and month) were provided by DGCF for the purposes of comparison.

Sibolga: Number of landings

Table 4 compares the number of purse seine landing events monitored by sampling and Sibolga Port Authority. Differences in the number of landings up to March 2015 are explained by a gradual increase in sampling coverage during the initial phases of the Project, due to practical issues of establishing suitable working routines by the enumerators and securing the collaboration of private companies to gain access to private landing sites.

From April 2015 onwards, there is a generally better agreement in terms of the number of landings reported by the Project and Port Authority, but there continue to be important differences.

Generally Port Authority data reports a higher number of landings than the Project – which one would generally expect, given the limited resources of enumerators monitoring landings at a busy port – however, like Bungus, there are also months in which the Project reports the higher number of landings. This is probably due to logistical issues at the port, in which several of the landing sites are separated by large distances, making it difficult to cover all activity both for Project and also Port Authority staff.

Also, securing the collaboration of private companies has been difficult, but this situation is reportedly improving. However it highlights the issue that neither the Project enumerators or Port Authority are able to consistently monitor all landings at the port, and the importance of comparison of data from each source to reconcile unloadings from missing vessels.

Table 1. Sibolga: number of purse seine landings monitored by the Project and the Port Authority.

Month	Port data	Project data
Jan	102	49
Feb	119	66
Mar	125	71
Apr	110	111
May	125	98

Jun	115	131
Jul	108	99
Aug	120	132
Sep	127	N/A
Oct	134	N/A

Sibolga: Total catches and species composition

Figure 14 indicates substantial differences in terms of total catches and species composition between the results of sampling and Port Authority data. The Project catch estimates are significantly lower in the period Jan-Mar 2015 – as one would expect, given the lower number of total landings observed by enumerators compared to Port data. It should also be noted that Port Authority data were missing for January 2015, which is presumed to be an error with the dataset provided by DGCF.

From April onwards the pattern is less clear, and there appears to be no obvious relationship between levels of coverage of landings, total catches, or species composition between the Project and Port Authority data. For example:

- In June Port Authority catch estimates of tunas are higher, despite a greater number of landings reported by the Project (i.e., 131 landings, compared to 115 landings by Port data).
- In July and August there is relatively good agreement in catch estimates between the Project and Port Authority, despite there being a difference of at least 10 vessel landing events between the two data sources (Table 13). More detailed information from the Port Authority is needed in order to clarify these differences.

In summary:

- Like Bungus, the comparison between sampling and Port Authority data for Sibolga indicates important differences the species composition of catches – particularly in terms of the proportions of skipjack, yellowfin, and frigate tuna.
- While there is a need to clarify the reasons for differences in catch levels and number of landings using operational level data from the Port Authority (i.e., individual vessel unloadings), the results of the Project suggest there is a need to adjust the species composition of purse seine catches landed in Sibolga reported by official data.

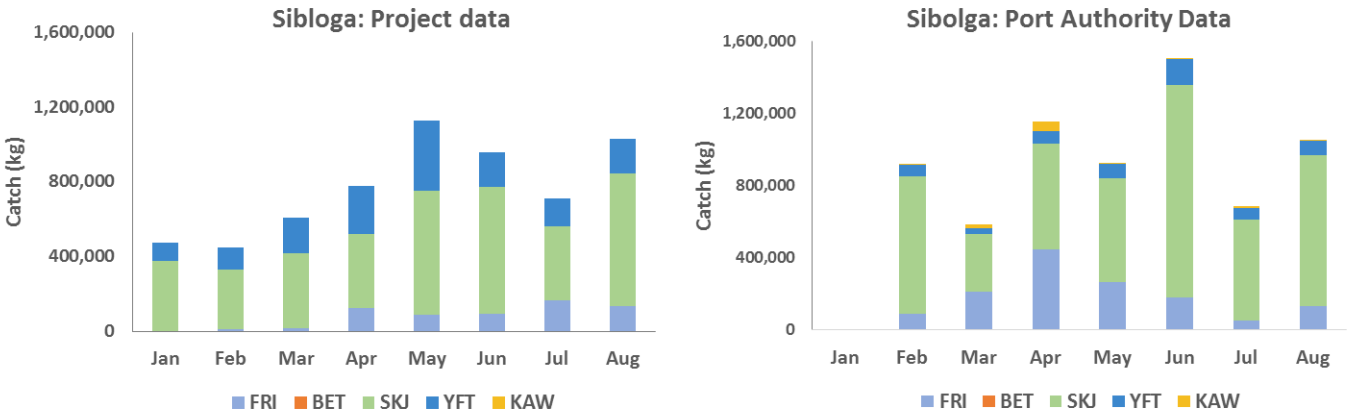


Fig.14. Monthly comparison of the species composition of purse seine catches in Sibolga Port monitored by the Project and Port Authority data.

5.3 Comparison with West Sumatra Province official data

Comparisons with published catches (at the Province level) and pilot Project were carried out for just West Sumatra, given Sibolga was the only the landing site in North Sumatra were sampling was conducted over a continuous 12 month period.

To estimate the species composition at the Province level from the pilot Project data, (raised) catches by landing site were simply aggregated, irrespective of the size or type of landing site. Aggregated catches are therefore dominated by the species composition from landing sites which record the highest catches in West Sumatra (i.e., Gaung, and Pasie nan Tigo). No adjustments were made to weight the 'average' species composition (e.g., by type of landing site, and vessel-gear combination) by the number of landing sites and vessel activity, as this information was not available. It should therefore be noted that comparisons with the pilot Project data and Province level detailed here are rudimentary and intended for exploratory purposes only.

Figure 15 compares the species composition of West Sumatra, raised catches from the pilot Project, as well as the overall species composition of all coastal fisheries in Indonesia (IOTC estimates). The following observations can be noted:

- Almost no catches of longtail tuna were recorded by the Pilot Project, in contrast to official figures for West Sumatra, and also current IOTC estimates for Indonesia.
- Higher proportions of frigate tuna, rather than bullet tuna, were reported by the pilot Project compared to West Sumatra.
- Around 60% of catches in the pilot Project recorded as tropical tunas (yellowfin tuna, bigeye tuna, and skipjack tuna) at the selected landing sites, which is generally in line with official data for West

Sumatra – however the proportions differ in terms of each of the three species, which may suggest possible issues with species identification, particularly for catches of juvenile tunas.

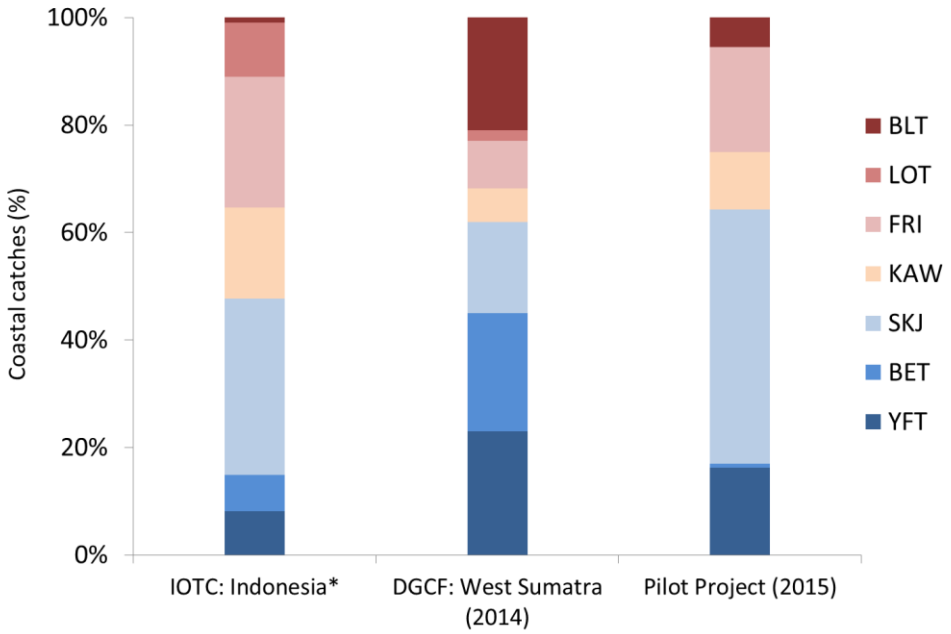


Fig.15 Comparison of IOTC estimates for Indonesia (all coastal fisheries), West Sumatra and the pilot Project data.

6. Revision of official catch statistics / IOTC catch estimates

Despite relatively high levels of sampling coverage at the selected landing sites, the report recommends the *preliminary* results of the pilot Project presented here should not be used to revise official catch estimates – given the relatively small number of sites covered by the pilot Project (i.e., 8 sites in total, of which 6 were sampled over a continuous 12 month period).

Sampling should instead be continued over a longer time period, and data collection extended to additional landing sites and gears to improve the representativeness of sampling coverage:

- For example in North Sumatra, only one site (Sibolga) was covered adequately, and which is dominated by one gear (purse seine). Therefore revising the catches of North Sumatra cannot be recommended based on the information from one site and one gear type alone.
- There is also is a need to extend coverage to other gears with no coverage in the Project (e.g., drift gillnet, set gillnet, and set longline), and which account for substantial catches of IOTC species at the national level[12]. Limited data is available for drift gillnets, due to the termination of sampling in Air Bangis and

[12] Indonesia Capture Fisheries Statistics, 2013, DGCF.

which is an important gap to address in terms of future sampling given the large number of drift gillnets operating in both West and North Sumatra, as well as in Indonesia in general.

- In the case of small-scale gears such as Danish seine and troll-handlines – which are covered to some extent by the Project – while catches of tuna per vessel are generally small, the number of vessels in operation may result in significant catches at the District and Province level, and presents a strong case for sampling of more landing sites important for these gears.
- Even for gears which have been well sampled by the Project (e.g., liftnet and purse seine), there is limited data available for other important landing sites, such as Belawan in North Sumatra, where up to 300 purse seiners carry out landings and where the composition of catches in the Malacca Strait is known to be different from catches facing the Indian Ocean.

Secondly, prior to the revision of official catch estimates (or IOTC estimates), a comprehensive appraisal should also be conducted between the Project data and official catch estimates at the *landing site level*, which was not possible during the Project due to difficulties accessing data collected by Districts. **Section 5** has already highlighted a number of major discrepancies between sampling and Port Authority data, for Bungus and Sibolga landing sites, which need to be fully understood before recommendations can be made to formally correct official data.

Nevertheless, Project results are encouraging so far – identifying a number of major differences in total catches, number of landings, and species composition compared to official catch estimates – that can used to strengthen the case of the need for further improvements to Indonesia's current data collection systems, by incorporating, for example, a sample based approach to complement existing data collection mechanisms for catches from Indonesia's coastal fisheries.

7. Alternative catch series

Given the limits of the pilot Project data, in terms of coverage of landing sites in time and space, the following section briefly considers alternative data series available for the estimation of Indonesia's nominal catches:

1. DGCF Indonesia official published catches

Fluctuations in the Indonesia's official catch statistics, particularly by species, continue to be noted by the IOTC Secretariat, undermine the quality of the reported catches and indicate the need for further improvements in the data collection and reporting systems. **Fig.16** below shows the species composition of tuna catches for West Sumatra, and extent of variability reported in recent years – particularly since 2013.

Related to changes in the species composition, overestimates of longtail tuna noted in recent years – due to the possible misclassification of juvenile tunas (*tongkol*) – appears to have been addressed by DGCF, to some extents, according to the official catch estimates published for 2013 and 2014. **Figs.17a-f** show a sharp

changes in catches of several species for West Sumatra from 2013 onwards, which appears to suggest longtail tuna catches have been reclassified as yellowfin tuna in 2013, and also bullet tuna and bigeye tuna in 2014.

However it remains unclear what changes were implemented by DGCF in terms of estimation of catches by species since 2013; as well as what steps, if any, are being made to correct the data for earlier years. While the reduction in catches of longtail tuna is cautiously welcomed, questions remain over the new method of estimation of catch by species. Also the abrupt change in the species composition of catches between years has implications on stock assessment and indices of abundance, and implies possible changes in targeting that may not actually be realistic – if the data officially reported are to be respected in the IOTC database.

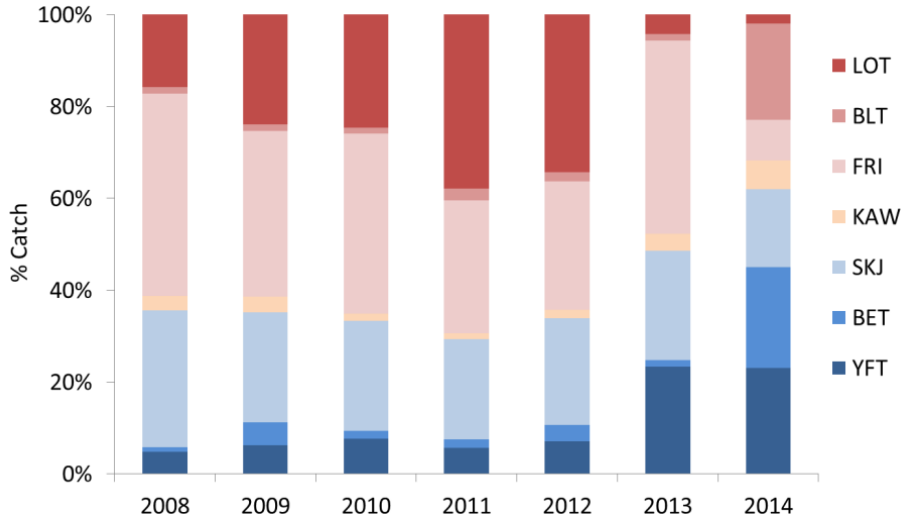


Fig.16 Species composition of West Sumatra 2008 – 2014.

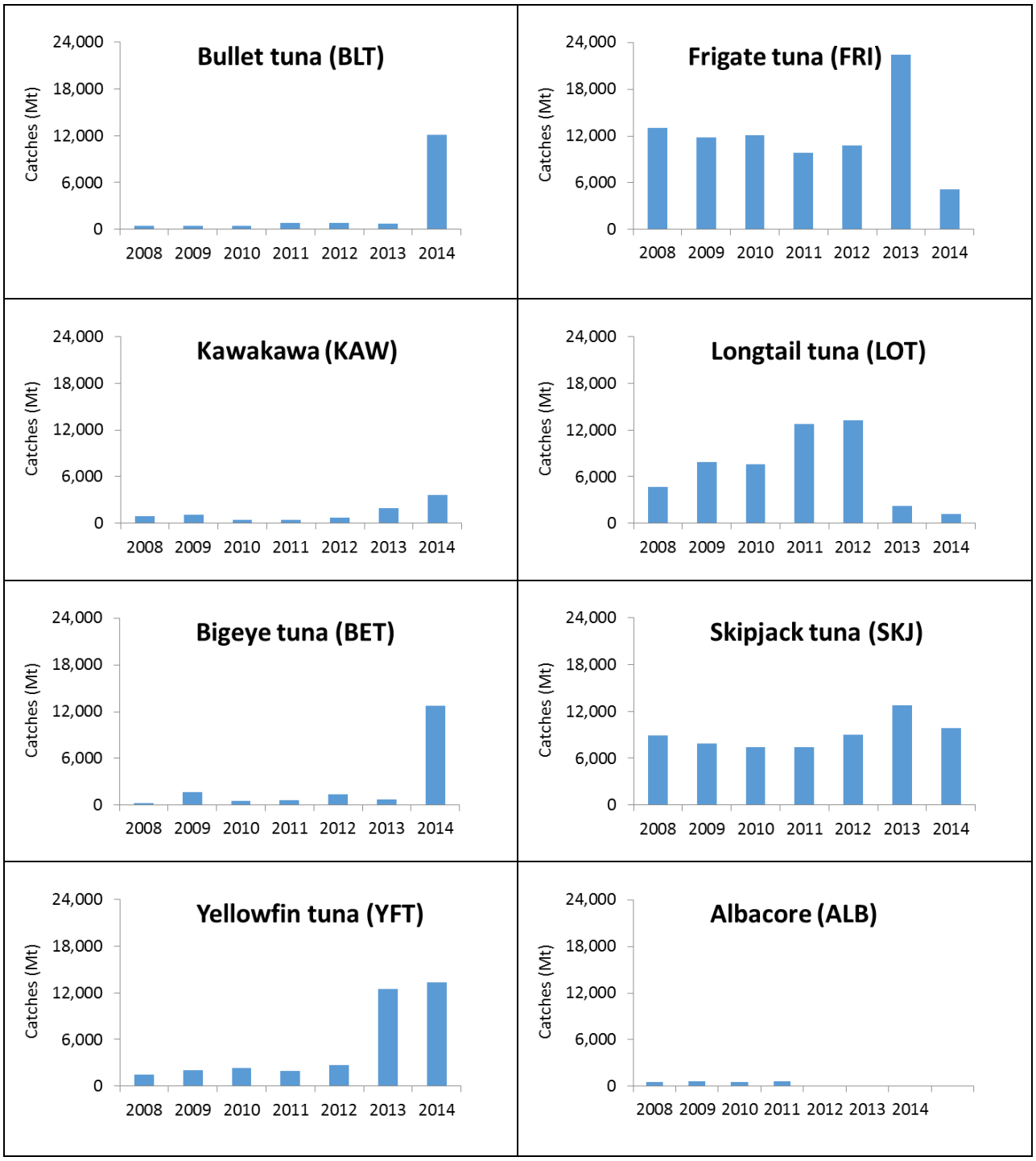


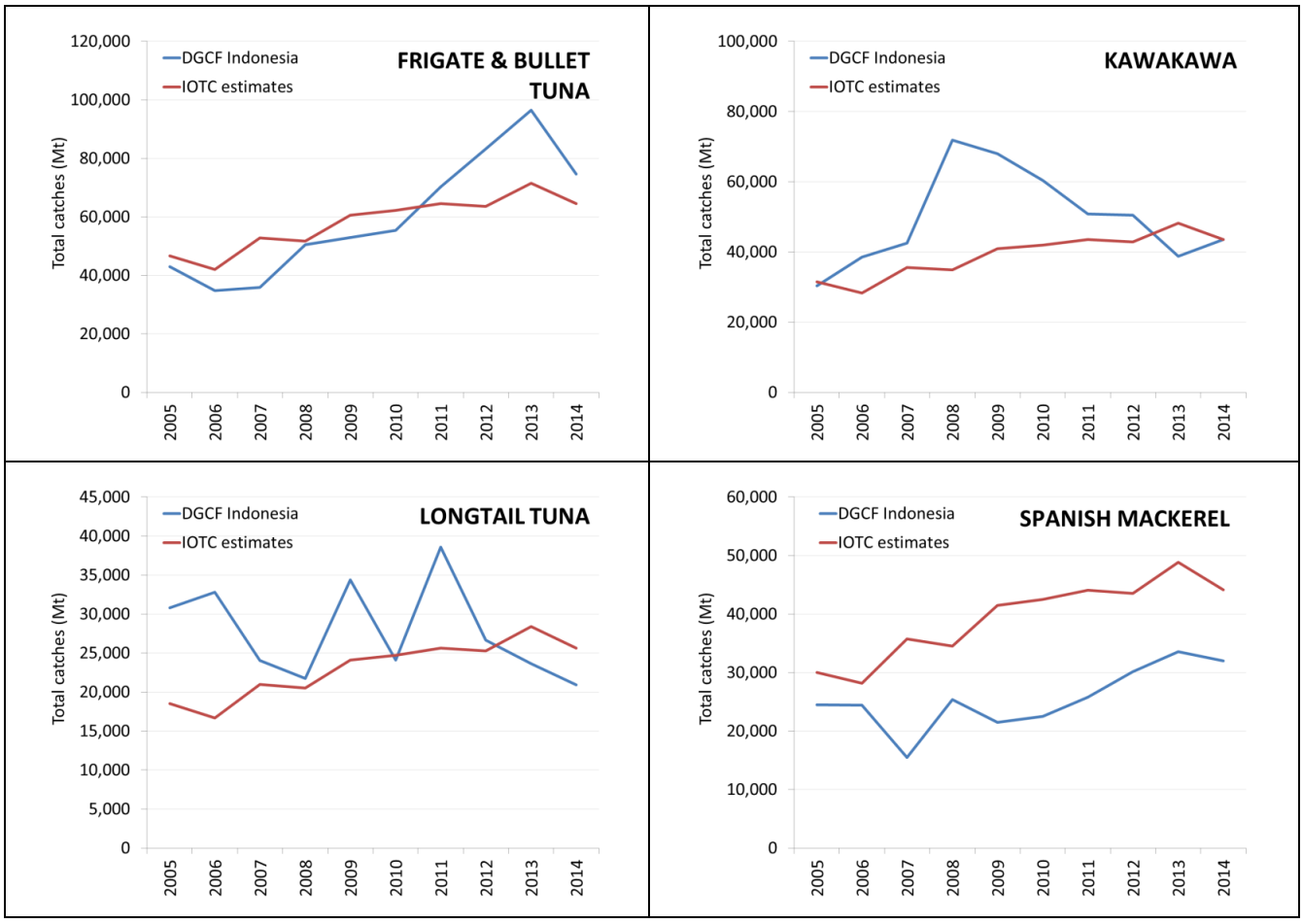
Fig.17a-f Official DGCF catch statistics for West Sumatra, for selected IOTC species. Source: DGCF

2. IOTC database: Secretariat estimates

For a number of years the IOTC Secretariat has disseminated their own estimates of catches for Indonesia due to continued issues with the reliability of officially reported data.

The current IOTC methodology is based on a 2012 review of Indonesia's historical catch data (starting from the 1970s), conducted by an independent IOTC consultant and approved by the IOTC Scientific Committee (Moreno, 2012), and which combines information from a number of sources including IOTC, IPTP and DGCF.

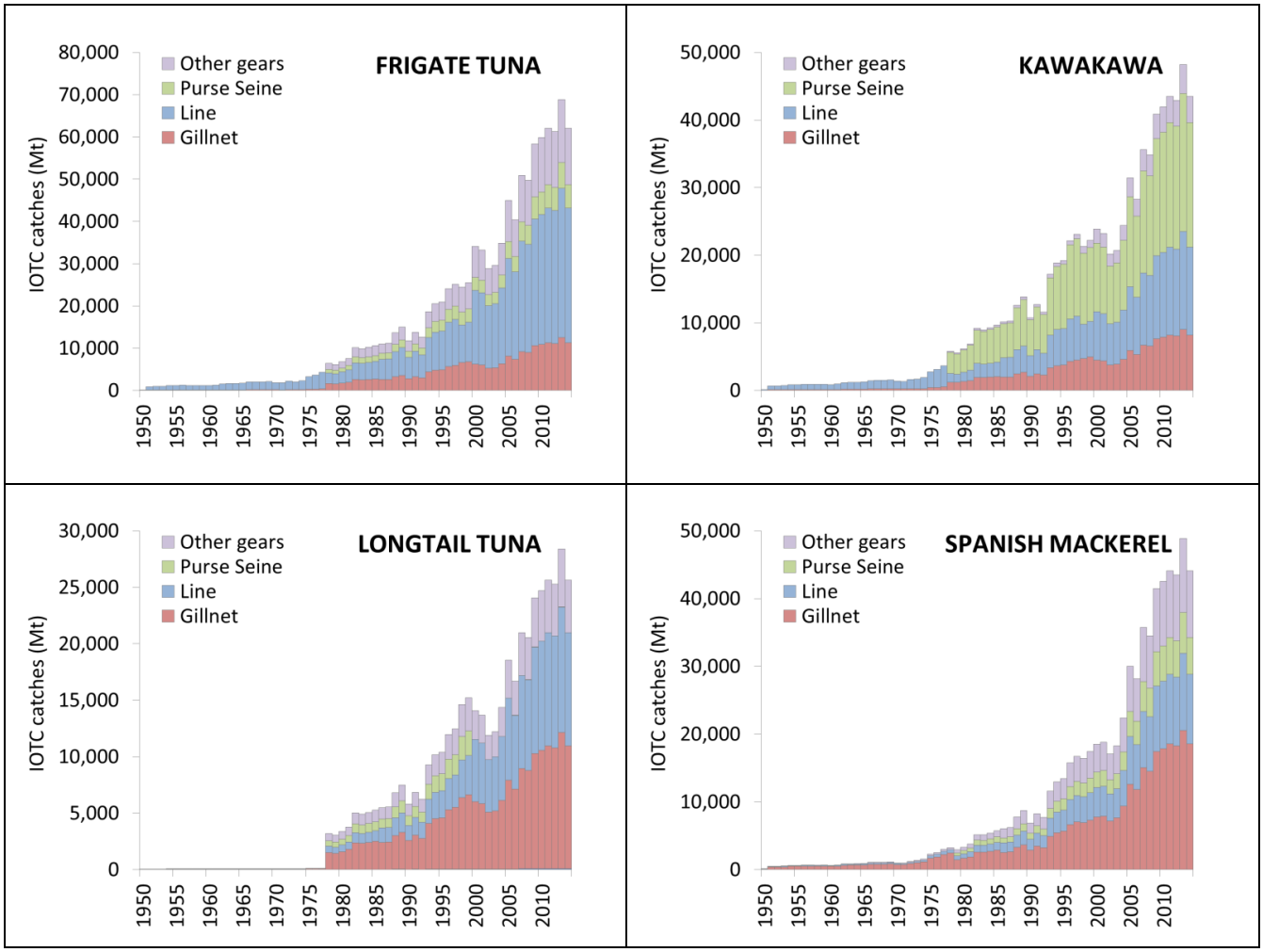
The methodology takes the total catches of IOTC species, as reported by DGCF to the IOTC Secretariat, which are then disaggregated by species and gear according to recommendations in the 2012 review based on a combination of data source and empirical studies. The methodology ensures greater consistency in the time series and that changes to the fishery – including the introduction of new gears or changes in targeting of species – are reflected more accurately in the revised data series (**Figs.18a-d**). Current nominal catches for Indonesia published by the Secretariat for the IOTC Working Parties and Scientific Committee are produced using this method.



Figs.18a-d. Comparison of IOTC estimates and official DGCF catches for selected species, 2005-2014.

While IOTC estimates are considered an improvement over official catches reported by DGCF, the approach is grounded on a number of assumptions of changes in the fishery, as well as occasionally conflicting data sources. The estimation also uses a procedure of fixed ratios to allocate catches by species and gear, according to defined time periods coinciding with the introduction of news gears or fisheries by Indonesia. In doing so, the approach inadvertently creates artificial breaks in the time series as catches are assigned to new gears or species (**Figs.19a-d)** – rather than gradual changes in the fisheries which are more realistic to expect (e.g., purse seine kawakawa catches in the mid-1970s; or the start of longtail tuna catches, also from the mid-1970s).

In addition, IOTC estimates are still heavily dependent on DGCF data – i.e., estimates of total catches – and therefore any errors reported by DGCF (in terms of overestimation or underestimation of total catches) will also be reflected in total catches estimated by the IOTC Secretariat. While the current IOTC methodology is considered an improvement over DGCF reported data, the estimates should not be considered an adequate substitute for improvements required in the data collection, for example based on a sample-based approach of catches proposed by the pilot Project.



Figs.19a-d. IOTC estimates for selected species, by gear, 1950-2014.

8. Conclusions and recommendations

8.1 Implications for future IOTC estimates of catches for Indonesia

Continued uncertainties with Indonesia's officially reported catches means that, for the present, the IOTC Secretariat disseminates their own nominal catch estimates by gear and species for Indonesia, using the methodology recommended by the 2012 IOTC review. While IOTC estimates are considered to be an improvement over official catches reported by Indonesia, there are limitations of the current approach and the need to further refine the methodology.

Incorporating information from the pilot sampling (e.g., species composition of sampled catches for West Sumatra, vessel activity, and fishing effort) to *inform* further improvements to the methodology appears the most logical step forward, noting the limited scope of the Project in terms of space and time (i.e., that data is available for over a 12 month period for only six of the eight landing sites selected for the pilot). Sampling at the pilot landing sites has been continued by DGCF since the end of formal project activities in October 2015, and the results of sampling will be re-evaluated by the IOTC Secretariat later in 2016.

In terms of the implications of revisions to specific species, the following observations are noted:

Longtail tuna

- Almost no catches of longtail tuna were recorded at the landing sites covered by the pilot project in West Sumatra, besides relatively small quantities at Air Bangis that likely originate from Mentawai.
- Around 15% of catches recorded at the Project landing sites were classified by traders under the commercial category of juvenile tunas (*tongkol*), of which the majority of catches were identified as frigate tuna, skipjack tuna, and kawakawa by enumerators – rather than longtail tuna, as previously assigned by District officials.
- While Indonesia ranks second in importance of catches of longtail tuna in the Indian Ocean (behind I.R. Iran), Indonesia accounts for around 17% of total catches of longtail tuna – a much smaller proportion than compared to other neritic species. Assuming that the species composition of the pilot Project is representative of West Sumatra, and for the sake of argument, is similarly representative of Indonesia's coastal fisheries as a whole, then any downward revision of Indonesia's longtail catches is unlikely to have a significant impact on current catch trend trajectories for or biomass estimates for longtail across the Indian Ocean.

Tropical tunas

- While results of sampling confirm the likely overestimation of longtail tuna in previous years, they also appear to confirm a much higher proportion of coastal catches are composed of juvenile tropical tuna species – i.e., skipjack tuna and yellowfin tuna in particular.

- The report therefore recommends that the results of sampling be used to revaluate current IOTC estimates of skipjack and yellowfin tuna, by gear, and assess the extent to which the current methodology reflects the species composition reported by the pilot Project.

8.2 Revision of official DGCF and District level data

Preliminary results from the pilot Project have highlighted major differences between the results of sampling and official data – in terms of the species composition of catches, but also number of landings and estimates of total catches for the selected landing sites – that can be used more directly to correct data collected at the landing site and District level.

The results of sampling confirm also appear to confirm that longtail tuna is caught in negligible quantities, or at least much smaller quantities than previously estimated by DGCF. While almost no catches of longtail were recorded at the landing sites covered by the pilot project in West Sumatra, the report also acknowledges there are important gaps in the sampling coverage, given the limited number of landing sites and gears covered by the pilot project, that need to be covered in the future.

The results also confirm the extent to which the species composition of commercial categories such as tongkol vary by gear and landing site, and the importance of a sample based approach to estimating the catches by species. Simply assigning catches of tongkol as yellowfin tuna or even bullet tuna (as appears to be the case since 2013 according to official data), may be as equally misleading as the reporting the catches as longtail tuna.

8.3 Future development of the pilot sampling

Despite to the limited scope of the pilot Project – covering 8 landing sites in total, which were then reduced to six due to practical difficulties of sampling at some landings and also recruitment of enumerators – the Project results are encouraging, and have highlighted a number of deficiencies in the current data collection systems conducted by Districts.

Sustained improvements in the quality of Indonesia's fisheries information systems can only be achieved by continued investment in the data collection, processing and reporting systems, and to this end the report strongly recommends that the sample based approach piloted in North Sumatra and West Sumatra be continued, and extended to other landing sites and Provinces throughout Indonesia.

Additional support is also planned for post-pilot activities in 2016 by the IOTC-OFCF Project, including further review of the sampling protocols, extending the coverage of landing sites and gears, and possibility of training additional enumerators. DCGF has confirmed financial support for sampling until the end of 2016, when a further revaluation of the results will be conducted by the IOTC Secretariat.

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