COMPOSITION AND ABUNDANCE OF PELAGIC SHARK CAUGHT BY DRIFT GILLNET IN CILACAP OCEANIC FISHING PORT, INDONESIA

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ABSTRACT

Drift gillnet fleets in the South of Java part of Indian Ocean were multi-species fisheries. The target of this fleet was tuna and skipjack tuna. Our studies on shark fisheries had been conducted since 2014-2015 and focused on drift gillnets fleets in eastern Indian Ocean, south Java waters around $8^0 – 10^0$ S and $106^0 – 110^0$ E. The aims of this paper were to presents the information about sharks composition, size distribution and nominal catch-per-unit-effort. A total 244 ton catch of sharks was recorded, consisted of 13 species, with an average catch of 9.5 tonnes/month and average CPUE (Vessel Catch/Day) were 12.87 kg/days. The greatest number of species caught with drift gillnet was from Family Alopidae (pelagic and bigeye thresher). Length frequency distribution of Alopias pelagicus from 55 to 185 cmFL (SD± 15.33) and for Alopias superciliosus ranged from 90 to 268 cmFL (SD± 27.05).

INTRODUCTION

Gillnetting is commonly referred to a passive fishing method, i.e. the gear itself is more or less stationary relative to the fish, operated by way put on the migration path so that fish become captured by swimming into the net wall. A gillnet can hold the fish in one of three ways, i.e. (i) Wedging; fish is held tight by a mesh around the body, (ii) gilling; the operculum of the fish is trapped in a mesh when the fish enters the mesh, (iii) tangling; the fish has not penetrated a mesh but is caught in the net by teeth, maxillaries or other projections (Sparre & Venema, 1992). Generally drift gillnets catch a pelagic shark by entangled.

Twenty one Indian Ocean coastal States (countries) fish with gillnets for tuna and tuna like species. Seven countries, such as India, Indonesia, Islamic Republic of Iran, Oman, Pakistan, Sri Lanka, and Yemen (Yamen is not yet a member of IOTC) are identified as the major contributors to gillnet catch in the Indian Ocean in which gillnets account for 40% of tuna and tuna like species reported to IOTC and 64% of shark catches (MRAG, 2012).

Fishing port Cilacap was classified in Oceanic fishing port (OFP). It's one of the bases drift gillnet fishery operating in the eastern Indian Ocean fisheries management region (Fisheries Management Area-FMA 573), was located in the Southern coastal of the Central Java Province, were drift gillnet was highly developed since years 2000, with the main target is tuna and tuna like including neritic tuna and sheerfish (Widodo & Satria, 2013). Cilacap drift gillnet fishery classified as artisanal according in the context of the Indian Ocean Tuna Commission, the term 'artisanal' is used loosely and can include vessels greater than or less than 24m in length that fish outside the flag state EEZ. FMA 573 was indicated as the most overfished area. A previous study found that the number of shark landings declined over the period 2006-2010 and the bycatch contributed for 4.7% per year (Fahmi & Dharmadi, 2015).

The aims of this study were to quantify shark bycatch from drift gillnet fishery and obtain an adequate understanding of pelagic shark bycatch in drift gillnet fishery. Daily and monthly catch data were used to examine annual catch patterns and describe the species and size composition of sharks caught in drift gillnet fishery. This study is expected to be useful as baseline information for management and conservation of pelagic sharks and an updated information previously reported by Fahmi & Dharmadi, 2015.

MATERIALS AND METHODS

Study area

Location of the study focused on the south of Java waters part of eastern Indian Ocean, which occupies the range between 8° - 10 ° S latitude and 106 ° E - 111 ° E Longitude (Figure 1). The fishing ground area based on data SL3 (statistic for capture fisheries) and trial scientific observer RITF (Research Institute for Tuna Fisheries) in gillnet fishery.

Fishery data

The data Collection was carried out from 2014 to 2015 by fisheries officers. The data was recorded daily landings. In order to ensure that the data collection is reliable, the fisheries officers were trained to obtain sufficient understanding, especially on shark identification prior to data collection. Sharks caught as bycatch were identified to species level, and the total weight of each species was recorded monthly. Data of length frequency distribution were collected by enumerator from Regional Office of Marine and Coastal Resources Management (Loka LPSPL) Serang- Banten Province and Statistical officer of Cilacap OFP. Sample data was collected over 10 months from February - October 2015 in Cilacap OFP.

Trial onboard observer

Trials trip scientific observer in drift gillnet fleets was conducted in three different vessels and periods from August to October 2016. The first trip was done from 7 – 20 August 2015, the second trip was done from 19 September – 08 October 2015 and the last trip was on 19 September – 3 October 2015. The data of vessel operational and biological data were collected. The vessel operational data consisted of specification of vessel, gear construction, fishing ground, setting and hauling information. The biological data consisted of catch composition, length and weight each species and species condition if discarded. Handling of bycatch on the deck was recorded.

RESULTS AND DISCUSSION

Drift Gillnet Fishery (Fleets and Shark Production)

The number of drift gillnet fleets registered in OFP Cilacap changes every year. The drift gillnet fleet reached a peakin 2013 with a fleet of 230 units (Figure 1). Drifting gillnet fleets were wooden boat size 10-30 GT with the main engine 120-160 HP and generator engine 24-30 HP. The boats were not equipped with refrigeration machine, and the catch was preserved with the ice. Generally, Drift gillnet fleets are set at dusk and hauled at dawn or in the morning. Number of crew each boat is about 10-14 persons with fishing trip duration is 10-15 days per trip with the effective days 8-12 for fleets without refrigeration machine. The fleet with refrigeration machine has longer fishing trips, about 30-45 days. The drift gillnet is a wall of fine, large-meshed synthetic netting with a series of floats attached in the corks line at the top and a series of weights (leads or concrete) at the bottom to maintain it vertical in mid water, in general, not far below the surface (Widodo & Satria, 2013). The total length of drift gillnets deployed by fishermen between 40 - 200 piece or about 1.2 – 5 kilometer,, where each piece of gillnet used is approximately 30m wide and

24m high. Webbing materialswere nylon multifilament and mesh size was 4 inch. This material consisted of two sizes, the width of upper area was 23 m and 0.08mm in diameter and the width of bottom area was 1 m has with diameter of 0.11 mm. Float materials were from styrofoam with 5 floats and 3 weights made from concrete (1.14 kg per piece) of drift gillnet. Two pieces of gillnet were equipped by 2 plastic of buoy with Ø 30 cm and buoy line 2-5 m in length for keeping the position of gillnet below the sea surface (Figure 2).

Figure 3, The graph of the number of fleet gillnets drift in OFP Cilacap fluctuated from 2007 to 2013. In 2014, The number of fleet was the lowest , which is in line with a fleet, sharks pelagic caught from drift gillnet fleets was also fluctuated each year. The trends were relatively similar, with the series varying along the period decrease and increase in production pelagic sharks where the lowest production occurred in 2010 and increased sharply in 2011, subsequently decreased until 2013 and increased rapidly in 2015 where is the highest peak catch of sharks pelagic drift gillnet fleets.

Shark Composition

Previous research has been done by Fahmi & Dharmadi, 2015. They found that there were 10 species of pelagic sharks landed in Cilacap OFP from gillnets tuna Fishery (drift gillnet), where Alopias pelgicus and Alopias superciliosus are dominant catches of pelagic sharks (Figure 4a). In this study, we found that there are 13 species of pelagic shark landed in Cilacap OFP during 2014-2015 (table 1) and 1 species (*Isistius brasiliensis*) has identified from observer data (Table 2). Shark composition similar each year where Alopias spp. are dominant catches in this fishery. There were considerable differences in species composition between sharks caught in tuna gillnets and those caught on tuna longlines. The blue shark Prionace glauca dominated the shark bycatch in the longline fishery, whereas thresher sharks Alopias spp. were the most common sharks caught by gillnets (Fahmi & Dharmadi, 2015). Over the study period, the smalltooth thresher shark Alopias pelagicus contributed 47.70% of the total shark bycatch in the gillnet fishery in Cilacap, whereas the bigeye thresher shark A. superciliosus accounted for 14.25 %, blue shark P. glauca contributed 9.10 %, longfin mako Isurus paucus and silky shark Carcharhinus falciformis 6.20 % and 6.02 respectively. In comparison, P. glauca contributed about half (50.85%), on average, to the total shark bycatch in the tuna longline fishery, whereas thereser shark nei (Alopias spp.) contributed only about 1.23 % (Novianto et al., 2014).

Size composition

Figure 5 showed size composition each shark caught by drift gillnet fishery. Size distribution in fork length. Length structure showed average shark cught by drift gillnet fleets were immature size. Length frequency distribution of CSK shows 60-86 cmFL (SD± 7.79) while from longline fishery length of CSK greater between 39-106 cm, as well as to the size of blue sharks caught in tuna longline fishery has a size larger than the drift gill net fishery (Novianto et al., 2014). Length frequency distribution of scalloped hammerhead shark showed that the frok length of SPL distributed from 123 to 240 cmFL (SD± 38.17), where the size of mature male smaller than mature female (White et al., 2006). Length frequency distribution of PTH showed distributed from 55 to 185 cmFL (SD± 15.33). According to their maximum size, Alopias pelagicus from the Indian Ocean can reach a maximum length of 365cm. Males reach adulthood at a size of about 240-250 cm and females at 260-285 cm (White et al., 2006; White, 2007). Length frequency distribution of BTH showed distributed from 90 to 268 cmFL (SD± 27.05). BTH reaches a maximum size total length of 340 cm and begins to mature in total length between 247-269 cm for male, and 246-290 cm for female (Compagno, 2002). Length frequency distribution of LMA showed distributed from 108 to 245 cmFL (SD± 20.89). Mako sharks reach sexual maturity at 7-8 years for both sexes where female longfin mako sharks mature at approximately 245 cm, while males reach maturity at 205 – 228 cm (Last & Stevens 2009). Length frequency distribution of SMA showed distributed from 106 to 286 cmFL (SD± 24.03), in the western and central North Pacific, males attain maturity at a much smaller size (156cm) than females (256cm) (Semba et al., 2011). Length frequency distribution of FAL showed distributed from 60 to 206 cmFL (SD± 27.84), where FAL attained maturity were 2156 mm and 15 years for females and 2076 mm and 13 years for males (Hall et al., 2012). Length frequency distribution of CCB showed distributed from 52 to 238 cmFL (SD± 54.43), while Males mature at ~130 cm TL, or at 4-5 years of age, females at 150-155 cm TL or 7-8 years of age (Burgess, 2009). Length frequency distribution of CCP showed distributed from 150 to 272 cmFL (SD± 26.05), while Maximum possibly to 3 m but otherwise to 239 cm or less for adults; males maturing at 131 to 178 cm and reaching 224 cm; females maturing at 144 to 183 cm and reaching 234 cm; size at birth 56 to 75 cm (FAO, 1984). Length frequency distribution of CCQ showed distributed from 69 to 140 cmFL (SD±

23.51), In Australia, size at maturity 90 cm TL for males) and 95cm TL for females (Pillans et al., 2009). Length frequency distribution of OCS showed distributed from 100 to 139 cmFL (SD± 19.97), while males mature at about 170 to 96 cm and females at 170 to 190 cm TL (Baum et al., 2015). Length frequency distribution of TIG showed distributed from 186 to 200 cmFL (SD± 19.97), while the size at maturity of male Tiger Sharks is 226-290 cm TL and in females 250-350 cm TL (Simpfendorfer, 2009).

Catch rate of pelagic shark

Figure 6, showed monthly average catch rate of pelagic shark caught by drift gillnet fleets. The catch rate of pelagic shark calculate with formulas obtained through the trip (days) divided by the number of sharks caught (kg). The catch rate average were 17 kg/days in 2014 and 9 kg/days in 2015. The lowest average daily catches occurred in May 2014 (Zero catches) and March 2015 (0.85 kg/days), whereas the highest was recorded in March 2014 (57.54 kg/days) and June (22.57 kg/days). The average catch rate of shark were higher during the period between June and October, which generally corresponds to the south-east monsoon season. Usually during southeast monsoon period, movement of the wind can trigger upwelling process on coastal area, particulary on coastal of southern Java-Bali and coastal of southern Sumatra (Hendiarti, 2003; Hendiarti et al., 2004; Susanto and Marra, 2005; Susanto et al., 2006). Hendiarti et al. (2005) concluded that the “pelagic fish season” develops during the southeast monsoon where maximum and minimum peaks during Jun.-Sep. and Nov.-Jan. respectively. This condition allegedly causing migratory pelagic sharks follow they prey.

Trial onboard observer data

Drift gillnet fleets in the South of Java part of Indian Ocean were multi-gears and multi-species fisheries. Besides the drift gillnet as main gear, this fleet also used fishing hook in the operation, such as tuna fishing hooks, lemadang fishing hooks, kuplou fishing hooks, tongkol fishing hooks, layang fishing hooks, kite fishing hooks and squid jigging. The name of the fishing hook were related to the operation method and the fish target. The species composition of the catch drift gill net fleet consists of 28 species (Table 2). Twenty species are only caught in drift gill nets, three species only caught in fishing line and four species were caught on both.

Handling of bycatch were divided into two method, The fish hold because it has a high economic value (by-product) and discar because it has low economic value or the protected species and also there are prohibition catches for some species like turtle and dolphins, according ancestral beliefs fishers, if violated it will cause bad luck for fishing. In trial observer trip, turtles and dolphins are released in living conditions whereas Cookie-cutter shark and other species discarded in death dan broken conditions. Percentage of drift gillnets are dominated by the target species about 52%, while fish of bycatch about 48% consisting of high economic value (by-product) by 25% and not economical (discard) about 23%. In this case although neritic tuna (*Auxis* spp.) including economical fish, but in certain occasions this species will be discarded due the condition of fish that have rotted caused long period soaking nets.

Management effort

National Plan of Action of the Shark (NPOA-Shark) is a national action plan for conservative management of shark and rays in Indonesia which is derived from the International Plan of Action of the Shark (IPOA-Shark). The NPOA-Sharks, which has been in place since 2010, suggests a number of management actions, including: (i) reviewing the status of Indonesian shark fisheries, both targeted and bycatch, to identify the effect of different kinds of fishing gear; (ii) optimising the quality of catch data at the main landing sites to enable the condition of the shark fisheries to be determined more accurately; (iii) conducting population studies on common and threatened shark species; (iv) improving socio-economic studies to determine the level of dependency of local communities on shark commodities; (v) developing awareness about shark conservation among local fishers, traders and other stakeholders; (vi) determining and protecting critical habitats such as shark nursery areas; and (vii) regulating the number of commercial fishing vessels, the types and quantities of fishing gear, and the length and timing of fishing seasons in order to reduce the amount of shark bycatch (Fahmi & Dharmadi, 2015).

Implementation and observation: (i) Implementation of the Regional NPOA Homeland applied, (ii) Evaluation of implementation progress reports NPOA conducted once every 1 year, (iii) NPOA implementation assessment should be done every 5 years, so that new information will always be available, the same thing to review some of the action required. In order to ensure effective implementation, it will be imperative to gain broad support from all major stakeholders and, in particular, to minimise any negative effects on small-scale fishers that currently derive considerable economic benefits from shark fisheries (Fahmi & Dharmadi, 2015).

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Figures

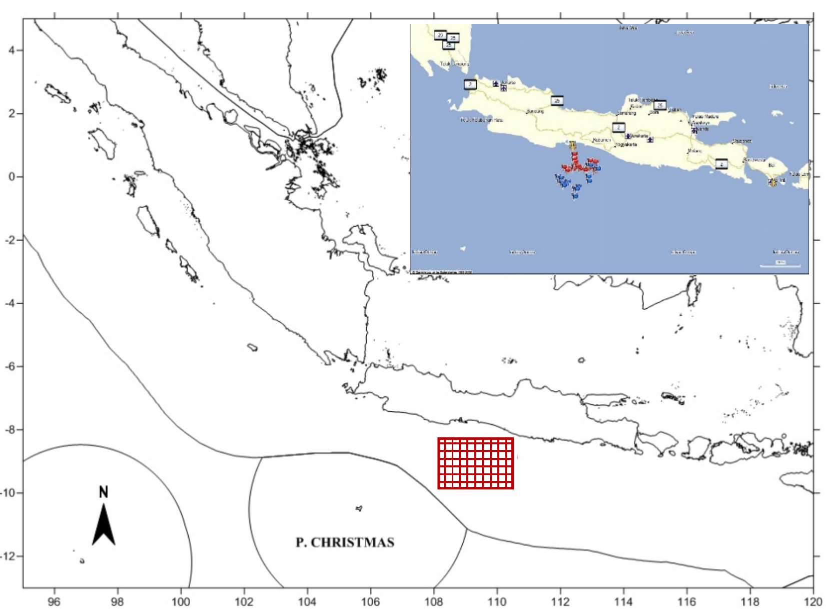


Figure 1. Fishing ground of drift gillnet fishery based on observer data and SL3 data

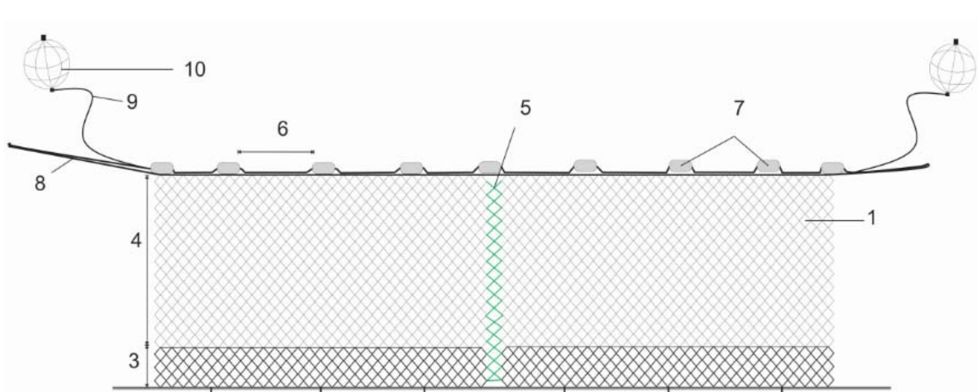


Figure 2. Contruction and specification of drift gillnets in OFP Cilacap

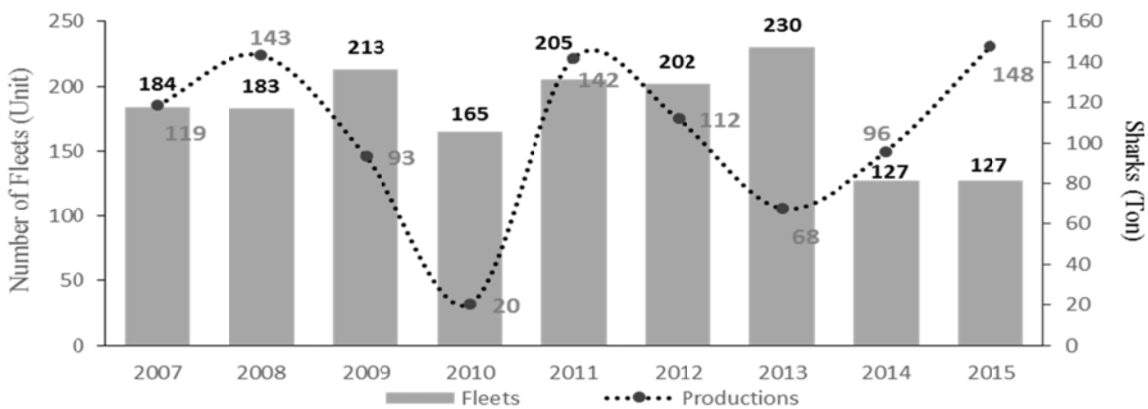
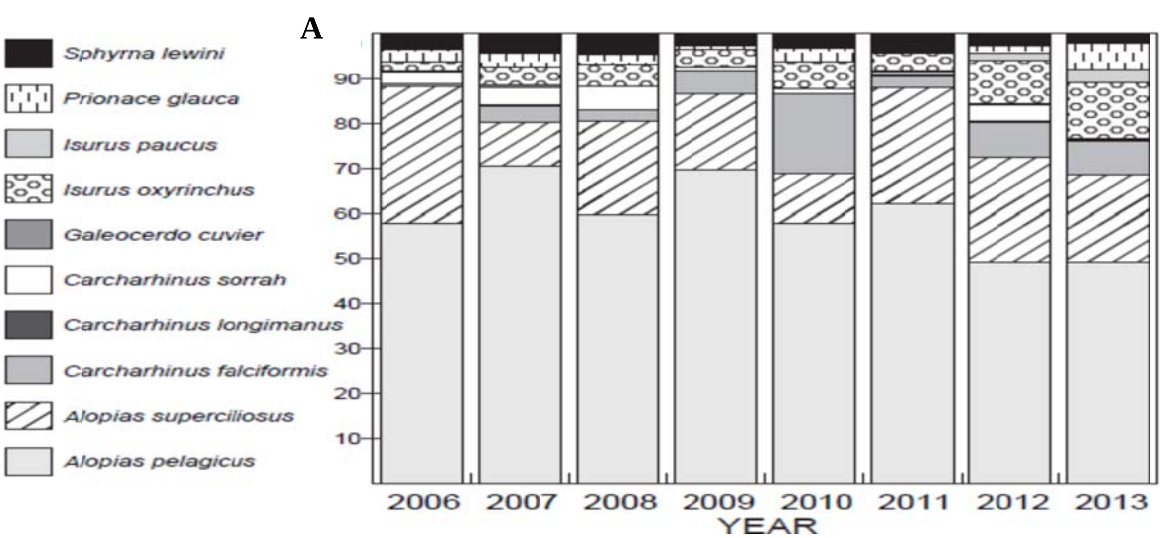
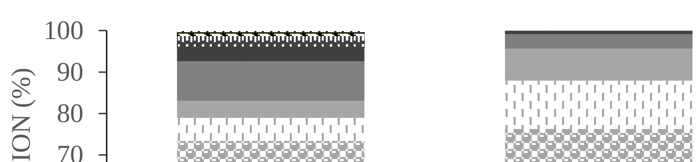


Figure 3. Total annual number of drift gillnet fleets and production of sharks landed at Cilacap OFP, 2007–2015.





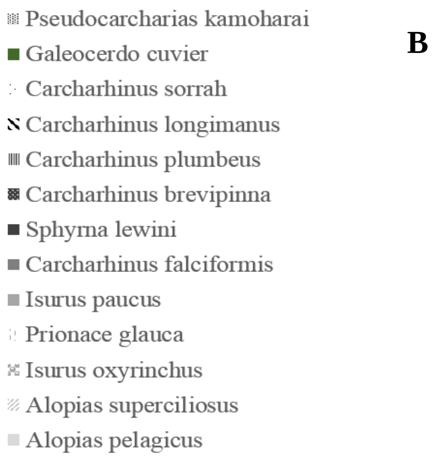
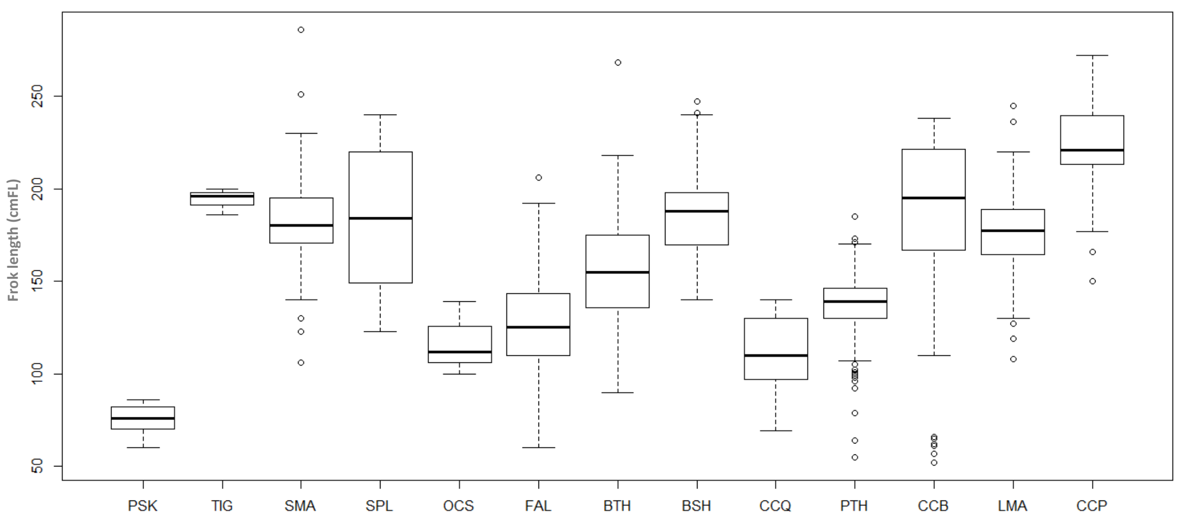


Figure 4. (A) The composition of shark from Previous study **(**Fahmi & Dharmadi, 2015); **(B)** composition shark of current study.



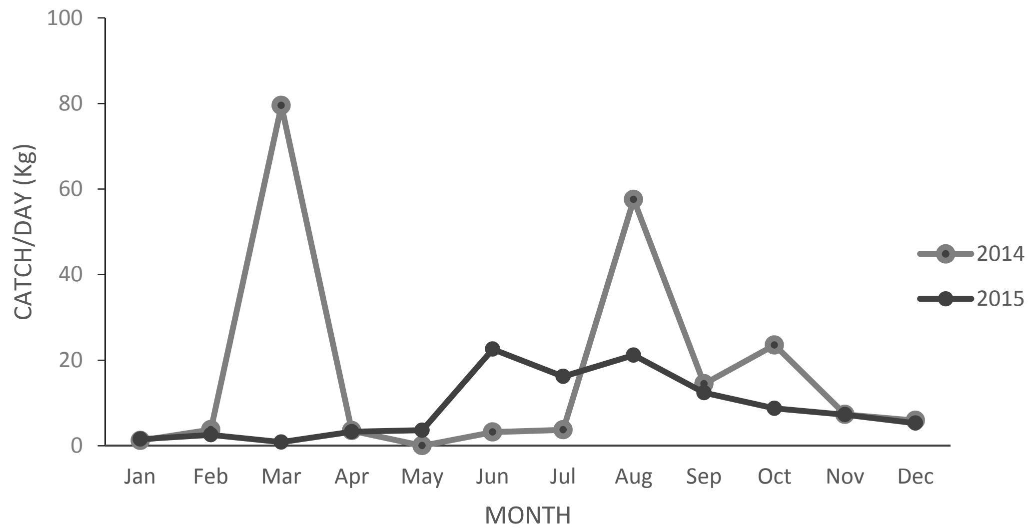


Figure 5. Length frequency of sharks caught by drift gillnets

Figure 6. Monthly average catch rate of drift gillnet fleets, 2014-2015.

Table

Table 1. Shark composition caught by drift gillnet fleets, 2014-2015 (SL3 data)

Common name	Scientific name	FAO code
Crocodille shark	*Pseudocarcharias kamoharai*	PSK
Tiger shark	*Galeocerdo cuvier*	TIG
Shortfin mako	*Isurus oxyrinchus*	SMA
Longfin mako	*Isurus paucus*	LMA
Oceanic whitetip shark	*Carcharhinus longimanus*	OCS
Silky shark	*Carcharhinus falciformis*	FAL
Bigeye thresher	*Alopias superciliosus*	BTH

Pelagic thresher	*Alopias pelagicus*	PTH
Spot tail shark	*Carcharhinus sorrah*	CCQ
Blue shark	*Prionace glauca*	BSH
Spinner shark	*Carcharhinus brevipinna*	CCB
Scalloped hammerhead	*Sphyrna lewini*	SPL
Sandbar shark	*Carcharhinus plumbeus*	CCP

Table 2. Catch composition from observer data

No	Local name	Common name	Scientific name
	Target species		
1	Cakalang	Skipjack	*Katsuwonus pelamis*
2	Madidihang	Yellowfin tuna	*Thunnus albacares*
3	Tuna mata besar	Bigeye tuna	*Thunnus obesus*
4	Setuhuk hitam	Black marlin	*Makaira indica*
5	Setuhuk biru	Blue marlin	*Makaira nigricans*
6	Ikan Pedang	Swordfish	*Xiphias gladius*
	By-product		
7	Hiu tikusan	Pelagic thresher	*Alopias pelagicus*
8	Hiu pahitan	Bigeye thresher	*Alopias supeciliosus*
9	Pari plampangan	Japanese devilray	*Mobula japanica*
10	Lemadang	Common dolphinfish	*Coryphaena hippurus*
11	Bawal perak	Rays bream	*Brama brama*
12	Bawal bulat	Bigbelly pomfret	*Brama orcini*
13	Kakap hitam	Tripletail	*Lobotes surinamensis*
14	Nyunglas	Wahoo	*Acanthocybium solandri*
15	Gindara	*Escolar*	*Lepidocybium flavobrunneum*
16	Cumi	Indian squid	*Loligo sp.*
17	Layang	Indian scad	*Decapterus russelli*
18	Ayam-ayam	Scawled leatherjacket	*Aluterus scriptus*
19	Ikan kambing kambing	Rough triggerfish	Canthidermis maculata
20	Bubara	Whitemouth jack	*Uraspis uraspis*
21	Kuwe batu	Longfin yellowtail	*Seriola rivoliana*
22	Layur hitam	Snake mackerel	*Gempylus serpens*
	Discard		
23	Tongkol lisong	Bullet tuna	*Auxis rochei*
24	Tongkol balaki	Frigate tuna	*Auxis thazard*
25	Madah	Bariene surgeonfish	*Acanthurus bariene*
26	Hiu cerutu	Cookie-cutter shark	*Isistius brasiliensis*
27	Lumba-lumba	Bottlenose dolphin	*Tursiops truncatus*
28	Penyu hijau	Green turtle	*Chelonia mydas*