FISHING GROUND, CACTH COMPOSITION, HOOK RATE AND LENGTH DISTRIBUTION OF BILLFISHES CAUGHT BY TUNA LONG LINE IN INDIAN OCEAN

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ABSTRACT

Billfishes area by cacth of tuna long line vessels in Indian Ocean. Billfish are consist of swordfish Xiphiasgladius, black marlin Makairaindica, indo facific blue marlin Makairamazara, stripe marlin Tetrapturusaudax, indo facific sailfish Istiophorus platypterusand shortbill spearfish Tetrapturusangustirostris. Besides that, billfishes also have important economic value compared with tuna as an exsported species such as swordfish and marlin. To optimize the catch of billfishes in Indian Ocean, data and information of potential fishing ground, size and catch composition of this species are needed. The billfishes cacth composition collected in 2011 were dominated by 45% swordfish, 20% black marlin, 19% blue marlin,9% short bill spearfish, 6% sailfish and 1%stripe marlin. The billfishes size range which were caught between 60 - 280 cm LJFL (Lower Jaw Fork Length). The sword fish average length was 150 cm, blue marlin 197 cm, black Marlin 189 cm, sailfish 150cm ,short bill spearfish 144 cm and stripe marlin159 cm. From this observation, it was found that most of billfishes caught were in mature.

KEYWORDS: Billfishes, Fishing Ground, Indian Ocean, Long line and By Cacth

INTRODUCTION

The term “BillFishes” has been widely accepted by both commercial and sport fisherman as well as scientist, to apply to the large fishes of the xiphiidae and istiophoridae families, characterized by the prolongation of the upper jaw, much beyond the lower jaw, into a long rostrum which is flat and sword like (swordfish) or rounded and spear like (sailfishes, spearfish and marlin). Billfishes tend to inhabit waters further below the surface during the day than at night, and they tend to inhabit frontal zones. Billfishes tolerate water temperatures from 5° to 27°C, with their optimum range between 18° to 22°C, while bill fish eslarvae have been found only at temperatures exceeding 24°C (Nakamura, 1985).

The contribution of BillFishes to the Indonesian fishery was signify cant. The catch of BillFishes in 2007 by all fleets was 400.000 MT (Mahiswara & Prisantoso, 2009). In 2008, the cacth of BillFishes decreased to 22,548 MT, that mainly landed in port of Benoa, Cilacap, Palabuhanratu, Jakarta and Bungus (Widodo *et al.,* 2011)

Knowledge of the Indian Ocean BillFishes biology and fisheries especially in Indonesia, and the status of BillFishes species remains unclear due to the lack of data and information of the fishery. This research aimed to analyze the cacth composition, potential fishing ground, length distribution of billfishes caught by long line gear in Indian Ocean in 2010-2011.

MATERIALS AND METHODS

The data analyzed from direct observation onboard of tuna long line vessel fishing in Indian Ocean, conducted from March 2010 to December 2011. The number of data analyzed came from 7 trips observation with 244 setting and coordinate range of fishing ground 8p S - 15p SE latitude and 111-120 p E longitude. The data of BillFishes length used Lower Jaw Fork Length (LJFL) (The fresh BillFishes measurement from lower jaw to caudal fork length; in centimeters) (Figure 1), Hook rate (Number of fish per 100 hooks). Species identification based on Nakamura (1985); Pepperel & Grewe (1999).

RESULTS

The data collected by the observer, came from Indian Ocean tuna long line vessels in 2010 – 2011. The geographic area of fishing ground was between 8-16p S and 100-120p E. According to Natalia *et al.* 2005, every 1p (longitude/latitude) of the area comparable with 111.3 km^2. Because of this, the coverage area of this research was 160p (S/E),or equivalent as 17.800 Km^2.

Catch Composition

There were six species of billfishes caught from Indian Ocean including eastern and western part of the sea. There are 2 families of billfishes, Xiphiidae (*Xiphiasgladius*) and Istiophoridae (genus Istiophorus:

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Istiophorusplatypterus; genus Tetrapturus: *Tetrapturusaudax*, *Tetrapturusangustirostris*; genus Makaira: *Makairamazara*, *Makairaindica*) (Nakamura, 1985).

The unit of cacthcomposition based on a number of fish(N/pcs) that was collected. This observation showed that cacth were dominated by swordfish (*Xiphiasgladius*) 45%, black marlin (*Makairaindica*) 20%, blue marlin (*Makairamazara*) 19%, shortbill spearfish (*Tetrapturusangustirostris*) 9% and followed by sailfish (*Istiophorusplatypterus*) 6% and stripe marlin (*Tetrapturusaudax*) 1%. (Figure 2).

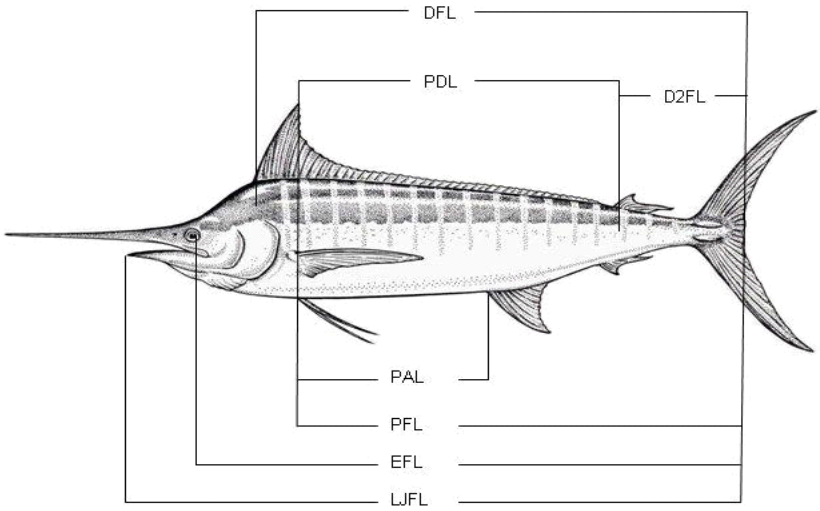


Figure 1. Type of measurement used for billfish remarks:
PAL : Pectoral Anal Length
PFL : Pectoral Fork Length
EFL : Eye-Fork Length
LJFL : Lower Jaw-Fork Length
DFL : Dorsal-Fork Length
PDL : Pectoral-Dorsal Length
D2FL : Second Dorsal Fork Length
Source: Poisson & Taquet (2000) after IOTC (2005)

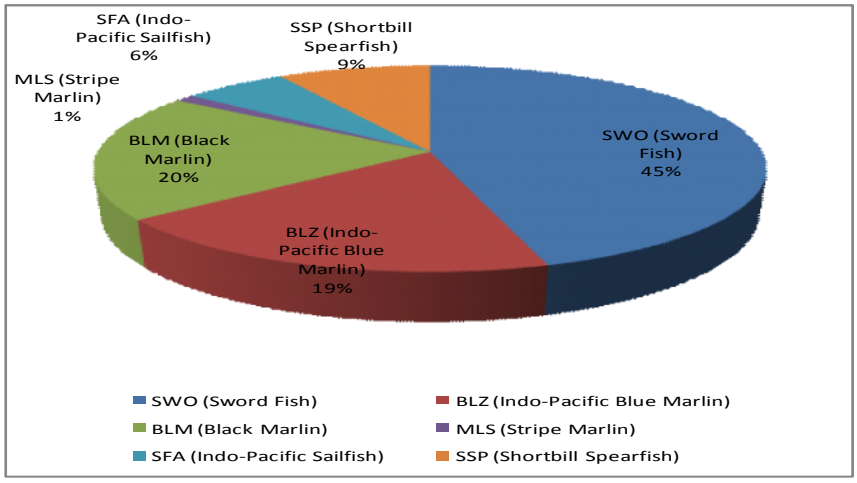


Figure 2. Catch composition of billfishes in Indian Ocean based on observer data from (March 2010 – December 2011).
Remarks: SWO (swordfish; *Xiphiasgladius*), BLM (black marlin; *Makairaindica*), BLZ (blue marlin; *Makairamazara*), MLS (stripe marlin; *Tetrapturusaudax*), SFA (sailfish; *Istiophorusplatypterus*), SSP (shortbill spearfish; *Tetrapturusangustirostris*).

The detailed information of cacth composition in each coordinate/position of fishing grounds showed in the following table 1.

Hook Rate

Hook Rate is (a Number of fish per 100 hooks). According to the data analyzed. The Hook Rate Values of billfishes species are shown on table 2.

Swordfish (Xiphiasgladius)

The total length distribution of this species caught in various position in the Indian Ocean collected by observers onboard between 2010 to 2011.

Blue marlin (Makairamazara)

The data showed that hook rates of blue marlin range between 0.000-0.116% from various fishing ground. The hook rates tend to increase from lower latitude 8p -12p S and more stable at 12-15p S.

Table 1. Catch composition of billfishes depend on different position in Indian Ocean from March 2010 – December 2011.

Fishing Ground			Number of Species (pcs)					
Lat. (^{0}SE)	Long.(^{0}E)	Area (Km²)	SWO	BLZ	BLM	MLS	SFA	SSP
8 sd 9	100-120	2,226	11	0	3	0	0	0
9 sd 12	100-120	6,679	14	0	2	2	0	0
12 sd 13	100-120	2,226	3	7	4	0	1	2
13 sd 14	100-120	2,226	26	8	4	0	1	16
14 sd 15	100-120	2,226	22	11	21	0	9	2
15 sd 16	100-120	2,226	9	9	3	0	0	1

Table 2. Hook Rate of billfishes depend on different position in Indian Ocean from March 2010 – December 2011.

Latitude	Longitude	Area	Average of Hook Rate (%)					
(^{0}S)	(^{0}S)	(Km²)	SWO	BLZ	BLM	MLS	SFA	SSP
8	112-114	223	0.161	0.000	0.109	0.000	0.000	0.000
9	111-116	1,670	0.136	0.074	0.071	0.000	0.000	0.000
12	117-120	334	0.129	0.116	0.104	0.063	0.104	0.000
13	116-118	223	0.106	0.100	0.096	0.465	0.072	0.127
14	115-117	223	0.111	0.092	0.128	0.000	0.123	0.083
15	114-116	223	0.094	0.098	0.097	0.000	0.000	0.083

The distribution on Hook Rate of Billfishes could be described infigure 3 below.

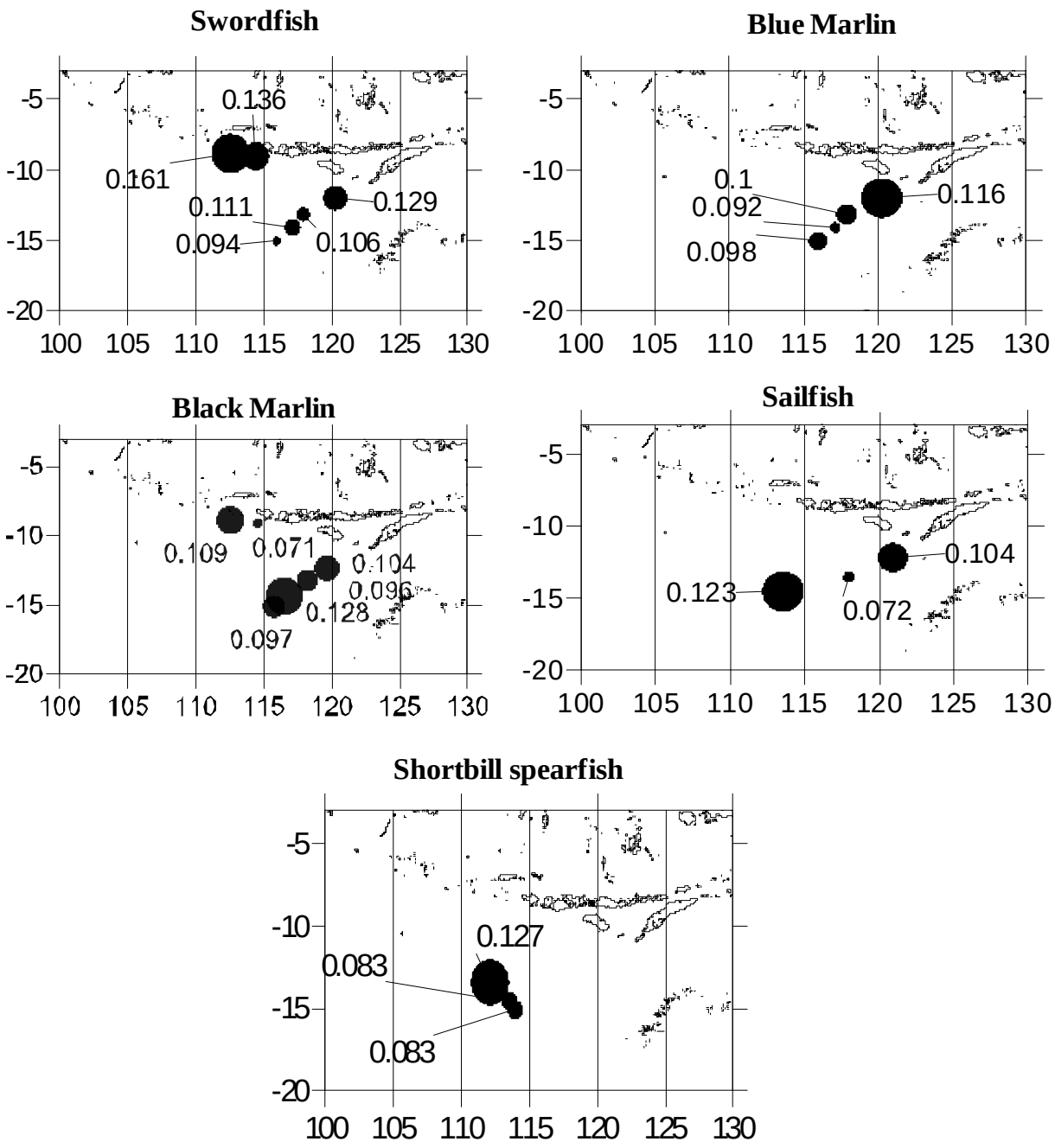


Figure 3. Distribution of swordfish in Indian Ocean in the latitude 8p - 15p SE and longitude 111-120 E. Circles indicate mean of Hook Rate (Number of fish per 100 hooks).

Length Class Distribution

Total length class distribution of billfishes showed in table 3.

Table 3. Length Class distribution of billfishes of tuna long line vessels in Indian Ocean.

Length Class	Frequency					
(Cm)	SWO	BLZ	BLM	MLS	SFA	SSP
61-70	6	0	0	0	0	1
71-80	0	0	1	0	0	0
81-90	2	0	0	0	0	0
91-100	6	0	0	0	0	0
101-110	9	0	0	0	0	2
111-120	7	0	0	0	0	0
121-130	7	1	0	0	2	0
131-140	1	1	2	0	3	0
141-150	9	2	1	0	1	0
151-160	6	2	2	1	3	6
161-170	3	0	2	1	0	4
171-180	8	2	3	0	2	1
181-190	3	6	6	0	0	1
191-200	4	5	10	0	0	1
201-210	5	7	4	0	0	0
211-220	2	4	3	0	0	0
221-230	2	1	0	0	0	0
231-240	4	1	0	0	0	0
241-250	0	0	0	0	0	0
251-260	0	2	2	0	0	0
261-270	0	0	1	0	0	0
271-280	0	1	0	0	0	0

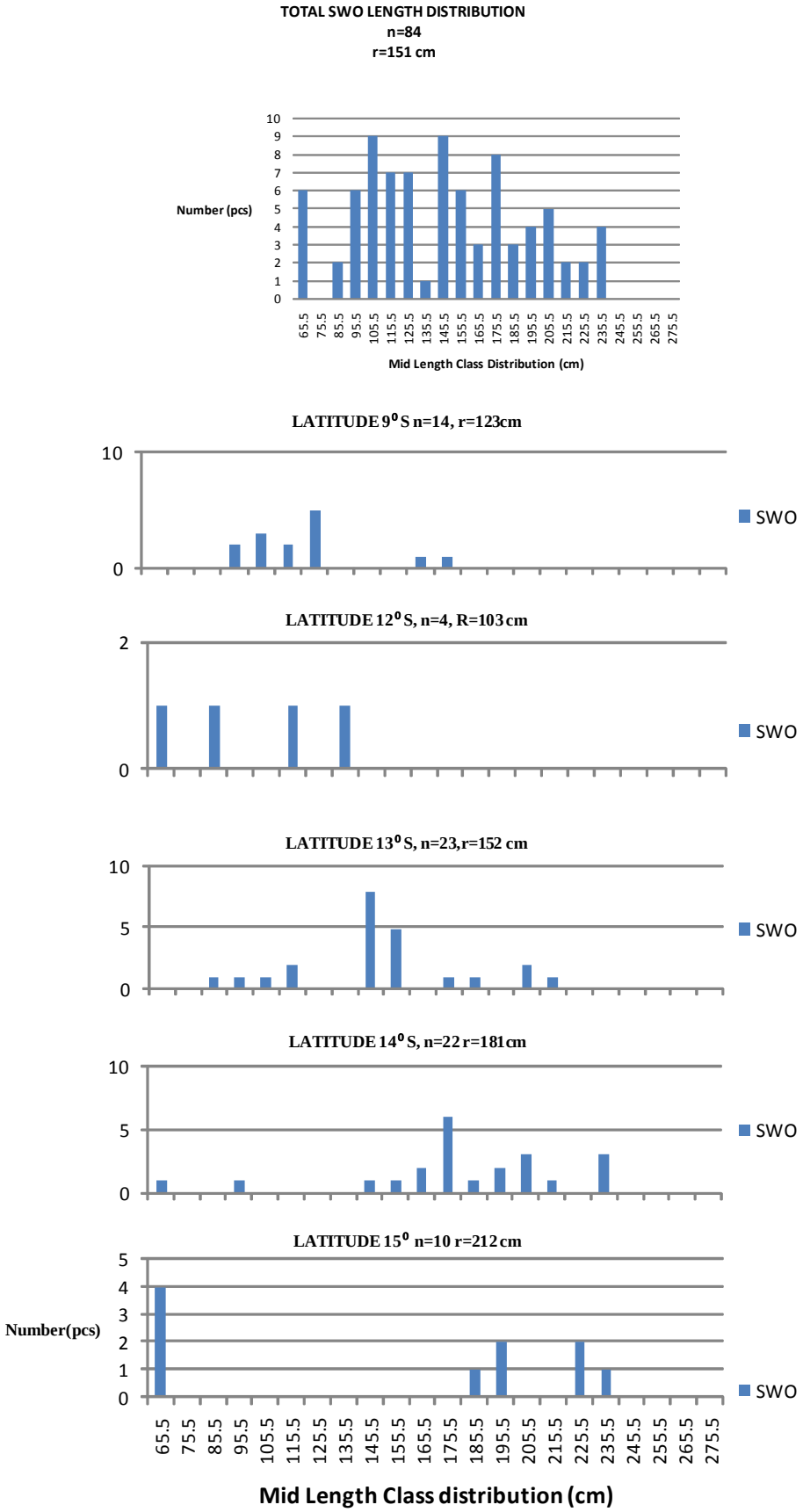
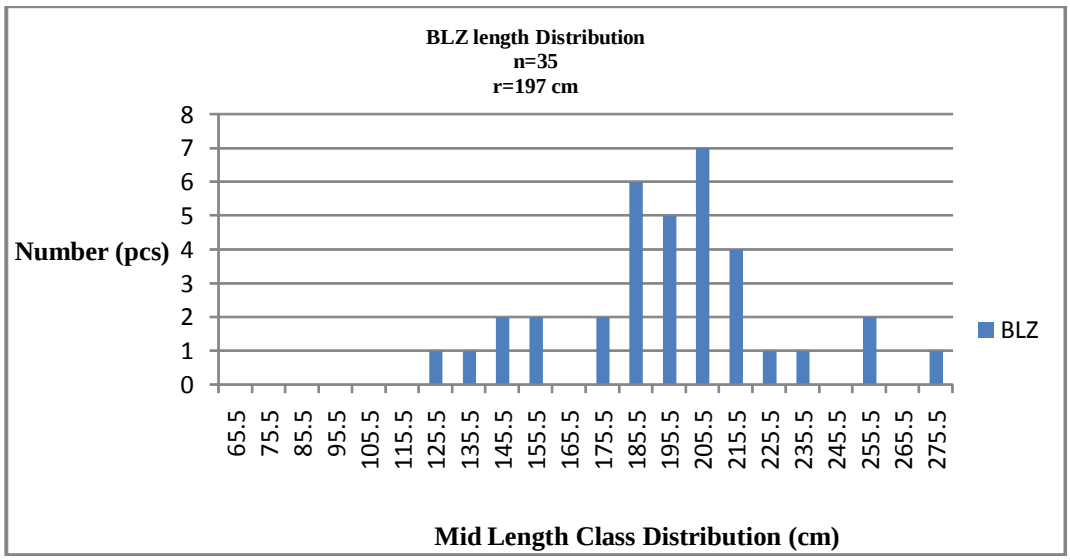


Figure 4. Swordfish length distribution from various position/coordinate in Indian Ocean.



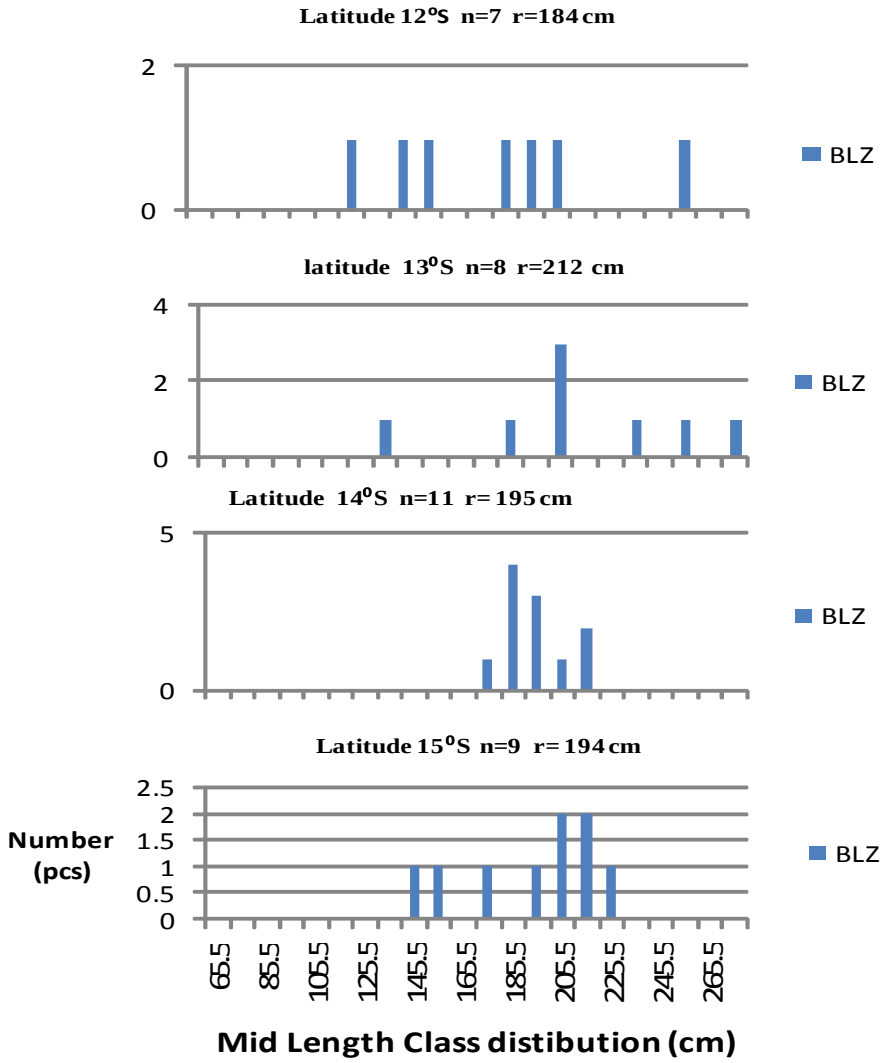


Figure 5. Blue marlin length distribution from various position/coordinate in Indian Ocean.

Black marlin (Makairaindica)

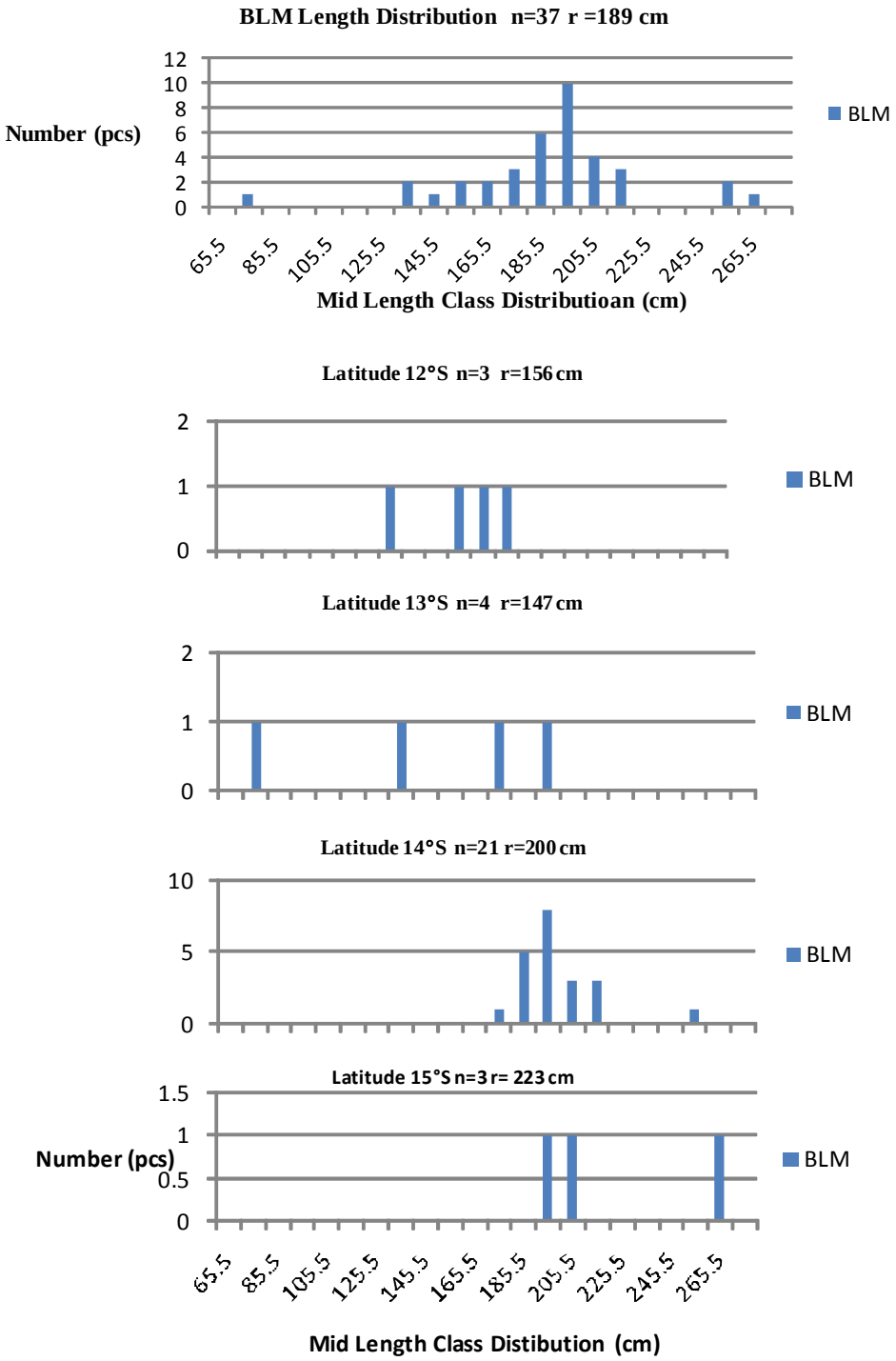


Figure 6. Black marlin length distribution from various position/coordinate in Indian Ocean.

***Sail Fish (Istiophorusplatypterus)* and *Shortbil spearfish* (*Tetrapturusangustirostris*)**

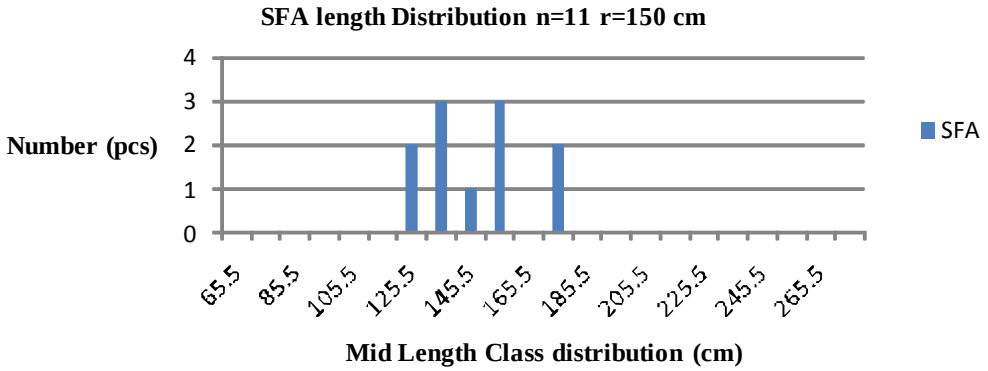


Figure 7. Sailfish length distribution from various position/coordinate in Indian Ocean.

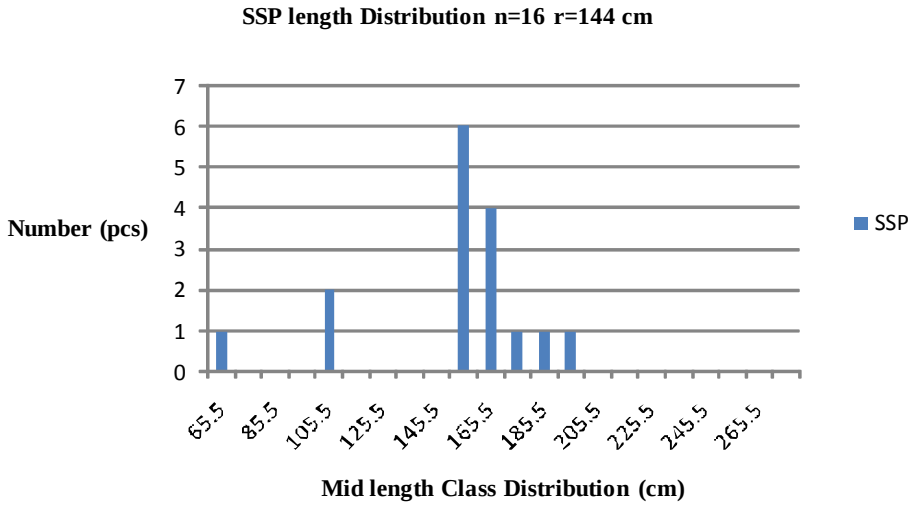


Figure 8. Shortbill spearfish length distribution from various position/coordinate in Indian Ocean.

DISCUSSION

The abundant and distribution of these species have been hyphothesized to correlate with several factors such as temperature, oxygen content, prey availability,ocean fronts, zooplankton, salinity, island, seamount, and presence of others organism (sea bird, porpoises and etc) (Worm *et al*., 2005). Billfishes will more frequenly conduct long distance migrations. These a large billfishes tend to seasonally migrate each year between the feeding zone (most often in cold water, often located at temperate latitude) and the spawning zone. The spawning zone are most often located in warm waters in subtropical or equatorial area. This zone has environmental condition that will allow good survival for their larva and early juvenile (Fontenneau *et al*., 1998).

The billfish distribution isdepend on horizontal and vertical movement. The distribution of billfishes do not form school, but they do apparently aggregate along specific oceanic features, such as temperature fronts, which can be areas of increased productivity and relatively high prey abundance (Podesta *et al*., 1993; Olson *et al*., 1994; Bigelow *et al*., 1999).

According to Barata *et al*. 2011, based on the results of measurements using *minilogger*, known in term of "*depth operation*", tuna long line vessel devided into 3 types : *shallow long line*, *halfway long line* and *deep long line*. The fishing depth range of *shallow long line* is 90-185 m with temperature range 21.84-26.80 p C. *Halfway long line* is 90-350 m depth with temperature range 10.22-21.83 p C. *Deep long line* is 85-450 m depth with temperature range 8.34-25.50 p C figure 1.

Most of tuna long line vessel at benoa port dominated by halfway long line with deep range 90-350 m with average range temperature 10.22-21.83 p C.

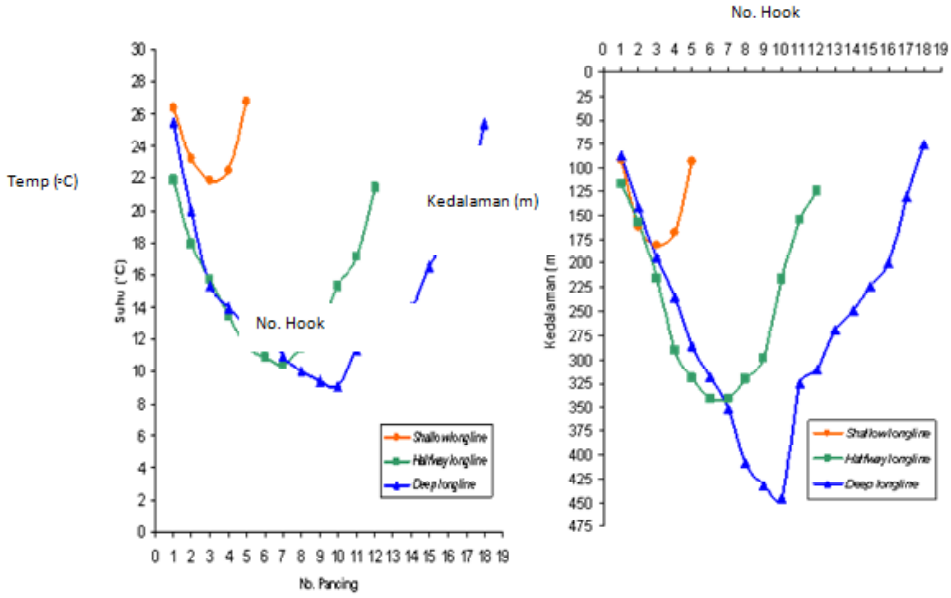


Figure 9. Type of construction tuna long line based on depth of water

Source : Barata *et al.* (2011)

***Swordfish* (*Xiphiasgladius*)**

Most of the observation area was still in subtropical or equatorial zone with the coordinate between 8-16 p S and 100-120p E and the coverage zone was about 17.800 km^2. The cacth composition was dominated by this species and reaching up to 45 % of the total cacth of billfishes. Approximately at coordinate 8-12 p S and 100-120p E swordfish was dominated by 80% of the total billfishes cacth. It's accordanced with Widodo *et al.* (2011)Base on the data collected onboard by observer in the year of 2010, the catch composition of billfish of tuna long line fleets were dominated by swordfish *Xiphiasgladius* 55.56% followed by blue marlin *Makairamazara* 33.33% and black marlin *Makairaindica* 11.11%.

The hook rate of this species was 0.094-0.161%. The hook rate tend to decreased at higher latitudes (Table 2), but from the data indicated that although lower latitude has higher of hook rates (0.106-0.161 %) but referring to length composition indicated swordfish collected from this position were immature (<150 cm LJFL) and dominated by juvenile . According to Poisson *et al*. 2009, size of the first maturity (L-50) of female and male of swordfish was estimated in Indian Ocean for the first time. L-50 was 170 cm LJFL for female and 120 cm for male. The spawning season of swordfish in Indian Ocean occurred from October to April.

The swordfish has a very wide range area in this water with length class distribution between 61 - 240 cm of LJFL. According to mid length class distribution, swordfish has 3 mode value, there were 105.5 cm, 145.5 cm and 175.5 cm. Mode of mid length class distribution was increase as the increasing of fishing latitude coordinate. Latitude 8p S (105.5 cm), latitude 9p S (125.5 cm), latitude 12p S (135.5 cm), latitude 13p S (145.5 cm), latitude 14p S (175.5 cm), latitude 15p S (195.5 and 225.5 cm).

At latitude 8-12p S, the SWO population was dominated by immature species of swordfish and we found a lot of swordfish juvenile with length under 135.5 cm . It is not recomended to catch this species at this position, to give the opportunity for juvenile to grow and reaching mature brood stock. It is likely that this area provide nursery ground of the fish. At coordinat 13-15p S dominated by mature species with length class over 150 cm LJFL. The average length of total onboard observation was 150.82 cm. This is indicated that swordfish cacth from Indian ocean was mature species.

Juvenile sword fish are commonly found in tropical and sub tropical water and migrate to higher latitude as they mature. Swordfish grow in length very rapidly, with both males and the faster-growing females reaching lower-jaw-fork lengths (LJFL) of more than one meter during their first year. Swordfish begin reaching maturity at about five years of age, when they are about 150 to 170 cm in length, and all are

mature in six years. For fish greater than 170 cm in length, the proportion of females increases with increasing length(IAATC, 2010).Globally, the average size of sword fish taken by long line tends to increase with latitude (WTBF, 2009). Yabe *et al*. (1959) estimated the body size at sexual maturity for male and female swordfish to be 150-170 cm for EFL (or 168-189 cm for LJFL) according to the relationship between LJFL and EFL in (Sun *et al* (2002)), which means most of the swordfish landed had reach its first maturity. A large, solitary adult swordfish were most abundant at 15–35° north and south of the equator. Swordfish distribution also varies with sex: larger females are more common at higher latitudes and males more common in tropical and subtropical waters (WTBF, 2009).

Blue Marlin (Makairamazara)

It's about 19% of the total cacth of billfishes was blue marlin. Blue marlin was dominant over latitude 12p S with hook rate between 0.092-0.116%. The average of total length distribution LJFL (lower Jaw Fork Length) was 197 cm (Figure 5).The blue marlin also has a wide range area in this ocean with length class distribution between 121-280 cm of LJFL and mode of mid length class distribution was 205.5 cm. Mode of mid length class distribution was increase as the increasing of fishing latitude coordinate. Latitude 12p S (125.5 cm), latitude 13p S (205.5 cm), latitude 14p S (185.5 cm), latitude 15p S (215.5 cm).

Nakamura (1985) mentioned that size at first maturity of blue marlin males was estimated to range from 130 – 140 cm eye fork-length EFL or (over 150 cm for LJFL) Sun *et al.* (2002). The indication showed that mature species dominated in this observation especially over latitude coordinate 13p S.

According to Sun *et al* (2002), The estimated sizes-at-maturity (EFL-50) of *blue marlin* in Western Pacific Ocean were 179.76 ±1.01 cm (mean ±standard error) for females and 130 ±1 cm EFL for males or (LJFL-50, 206.45 for female and 150.15 for male).

According to IOTC. 2011, there is a little known on the biology of the blue marlin in the Indian Ocean. Thus, the information detailed here pertains to information from other oceans, primarily the Pacific and Atlantic Oceans. Blue marlin is a highly migratory, large oceanic apex predator that inhabits tropical and subtropical waters of the Indian, Pacific and Atlantic Oceans. It is known to make regular seasonal migrations (in the Atlantic Ocean) moving toward the equator in winter and away again in summer. In the Pacific Ocean one tagged blue marlin is reported to have travelled 3000nm in 90 days. Blue marlin is a solitary species and prefers the warm offshore surface waters (>24°C); it is scarce in waters less than 100m in depth or close to land. The blue marlin's prey includes octopuses, squid and pelagic fishes such as black in tuna and frigate mackerel. Feeding takes place during the daytime, and the fish rarely gather in schools, preferring to hunt alone.

Black Marlin (Makairaindica)

The average of cacth composition of this species was about 20 % of the total cacth of billfishes of tuna long line vessels. Black marlin was widely available from the edge to offshore (latitude 8-15p S/ Longitude 100-120p E). The hook rate was about 0.071-0.128% and higher at latitude 14-15p S (0.128%). The average of total length LJFL was 189 cm and mode of mid length class distribution was 195.5 cm LJFL (Lower Jaw Fork Length).

Similar with blue marlin, mode of mid length class distribution was increase as the increasing of fishing latitude coordinate. Latitude 12p S (145.5 cm), latitude 13p S (175.5 cm), latitude 14p S (195.5 cm), latitude 15p S (205.5 cm) (figure 6).The indication showed that mature species dominated in this observation. Nakamura (1985) mentioned that size at first maturity of black marlin males is up to 137.23 cm (PFL) (± 181 cm LJFL) according to the relationship between LJFL and PFL in Sun *et al.* (2002).

Sailfish (Istiophorusplatypterus*), *shortbill spearfish* (*Tetrapturusangustirostris*) and *stripemarlin (Tetrapturusaudax)

According to IOTC. 2012, the Indo-Pacific sailfish is one of the smallest-sized billfish species, but is relatively fast growing. Individuals may grow to over 3 m and up to 100kg, and live to around 7 years. Young fish grow very quickly in length then put on weight later in life. Sexual dimorphism in size, growth rates and size and age at maturity - females reach larger sizes, grow faster and mature later than males.

The cacth composition of sailfish only 6% of the total billfishes cacth of tuna long line vessels. Sailfish only caught at coordinat 12-14 (p SE) with hook rate lowest at 13(p SE) 0.072% and highest at 14 (p SE) 0.123% with average 0.050%. While At latitude 8-9(p SE) the hook rate of sailfish was zero.The average length class distribution was 150cm with mode of mid length class distribution was 165.5 cm LJFL. Varghese *et al*., 2005, mentioned that length at first

maturity of sailfish was 175 cm FL or (158.49 cm LJFL according to Zhu e al. 2008).This study determined that majority of this species in mature condition.

The cacth composition of short bill spearfish only 9% of the total billfishes cacth of tuna long line vessels in Indian Ocean. Short bill spearfish only caught at latitude 13-15 (p SE) with hook rate lowest at 15(p SE) 0.083% and highest at 13 (p SE) 0.127% with average 0.049%. While at latitude 8-12(p SE) the hook rate of sail fish is zero. The average length class distribution was 144 cm with mode of mid length class distribution was 165.5 cm LJFL (Lower Jaw Fork Length).

Nakamura. (1985), said that based on long line catches, it cacth range is between 40ÚN to 35ÚS in the Pacific Ocean and from 20ÚN to 35-45ÚS in the Indian Ocean. Short bill spearfish is thought to be strongly oceanic, preferring deeper mesopelagic waters, and is rarely encountered in coastal waters. Short bill spearfish is rarely targeted directly, but is incidentally caught by sport fishers targeting game fish, commercial long liners targeting tuna, and to a lesser extent, by purse seine, troll, and hand line fishers. Because it is not a major target of any fishery, very little is known about its biology or population structure. There are no literature mentioned about Lm (length at first maturity) of this kind of species.

The average length of Stripe marlin (*Tetrapturusaudax*) from the observation is 159 cm. Nakamura (1985) mentioned that size at first males maturity *T. audax*was approximately 80 cm eye-fork length. Size at first maturity generally estimated between 140 – 150 cm eye-fork length (Bromhead *et al*., 2004; Nakamura, 1985) (over 160 cm for LJFL according to the relationship between LJFL and PFL in Sun *et al* (2002).

CONCLUSION

According to the onboard observation data collected during 2010-2011, catch composition of billfishes was dominated by Swordfish (*Xiphiasgladius*)of 45%, Black marlin (*Makairaindica*) of 20%, Blue marlin (*Makairamazara*) of 19%, Shortbill spearfish (*Tetrapturusangustirostris*) of 9% and followed by Sailfish (*Istiophorusplatypterus*) 6% and Stripe marlin (*Tetrapturusaudax*) 1%. The size of billfishes caught in range between 60 - 280 cm LJFL (Lower Jaw Fork Length). The swordfish (*Xiphiasgladius*) average length was 150cm, Blue marlin (*Makairamazara*) of197 cm, Black Marlin (*Makairaindica*)of 189 cm, Sailfish (*Istiophorusplatypterus*) of 150 cm, Shortbill spearfish (*Tetrapturusangustirostris*) of 144 cm and Stripe marlin (*Tetrapturusaudax*) of 159 cm. Most of the BillFishes caught trough the observation were sexual mature.

The fishing ground range of the observation between 8-15p S latitude and 110-120 longitude. The increasing of this position followed by increasing of length but decreased in hook rate. The increasing of length followed by the increase of maturity stage.

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