Composition of target species, bycatch, hook rate and fluctuation for longline tuna fishing

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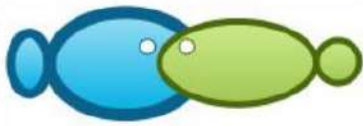

Composition of target species, bycatch, hook rate and fluctuation for longline tuna fishing in the Eastern Indian Ocean, Indonesia

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Abstract. The present research was conducted on the composition of target species and bycatch, hook rate and catch fluctuation with tuna longline fishing gear in Indian Ocean at positions 15^{0}00"–22^{0}00"S and 100^{0}00"–112^{0}00"E from November 2018 to April 2019. The results of the observations revealed a phenomenon that the composition of target species was 59% with a bycatch of 39%. The catch rate varied between 0.03 and 0.46 with a high catch rate occurred in January. In the target species group the dominant catch consisted of *Thunnus alalunga* whereas the bycatch fish group was dominated by *Lepidocybium flavobrunneum*. Both species are catches caught the most in the span of observation. Fluctuations in catches indicate that the fish season in the observation period occurs in successive months, namely December, January and February. Based on the type of fish caught, it is suspected that the setting of the branch line can reach the swimming layer of *T. alalunga* which is deeper than of *Thunnus obesus* and *Thunnus albacares*.
Key Words: tuna longline, tuna season, catch composition, tuna distribution, fishing ground.

Introduction. Indonesia is currently the largest producer of tuna in the Indian Ocean (Novianto et al 2019). Indonesia, there are various fishing gears to catch *Katsuwonus pelamis* such as: long line, hand line, pole and line, purse seine and gill net (Nainggolan et al 2017; Center for Marine and Fisheries Education 2015). Long line tuna is a fishing gear used to catch tuna, where in the long line series there are 1,000-2,000 hooks for a one time setting (Nainggolan 2007). The fishing gear is passive, after the fishing line is placed into the water, the boat's engine is turned off, so that the boat and the fishing gear are drifting (Saputra et al 2011).

According to Nugraha et al (2020a) environmentally friendly fishing gear is a fishing gear that has no negative impact on the environment and did not damage the bottom of waters. Tuna long line is an effective fishing gear for catching tuna (Watson & Kerstetter 2006). According to Baskoro et al (2014) tuna is effectively caught with a long line fishing gear because of its construction can reach the depth of the tuna swimming layer. The tuna longline yield is divided into the target species and bycatches. Determination of the fishing ground can be expected from the waters condition that is the habitat of a species (Nugraha et al 2020b).

The target species of tuna longline fishing gear are *Thunnus obesus, Thunnus albacares, Thunnus maccoyii* and *Thunnus alalunga*. The bycatch consists of catches that have economic value (by-product) and which have no economic value or are thrown back

into the sea (discard). Fish bycatch are fish caught on the tuna longline other than the target species (Setyadji & Nugraha 2012). The target species and bycatch of the present study can be seen in Table 1.

Table 1

Target species and bycatch during observation

Common name	Scientific name
Albacore	Thunnus alalunga
Yellow fin	Thunnus albacares
Big eye	Thunnus obesus
Bluefin	Thunnus maccoyii
Marlin	Istiophoridae rafinesque
Moonfish	Lampris guttatus
Black marlin	Istiompax indica
Narrow-barred Spanish mackerel	Scomberomorus commerson
Escolar	Lepidocybium flavobrunneum
Swordfish	Xiphias gladius
Leafscale gulper shark	Centrophorus squamosus

The value of the catch rate is an indicator of the high or low abundance of tuna in these waters. Catch rate value means the number of tuna caught per 100 hooks (Baskoro et al 2014).

Nainggolan (2007) stated that one of the aspects that support the success of tuna fishing operations is the determination of the right fishing grounds. Indian Ocean is the main commodity producer of fisheries resources owned by Indonesia, one of which is tuna fisheries (Widianto & Nikijuluw 2003). Construction and parts of tuna longline fishing gear can be seen in Figure 1.

Note:
1. Main line
2. Buoy line
3. Branch line
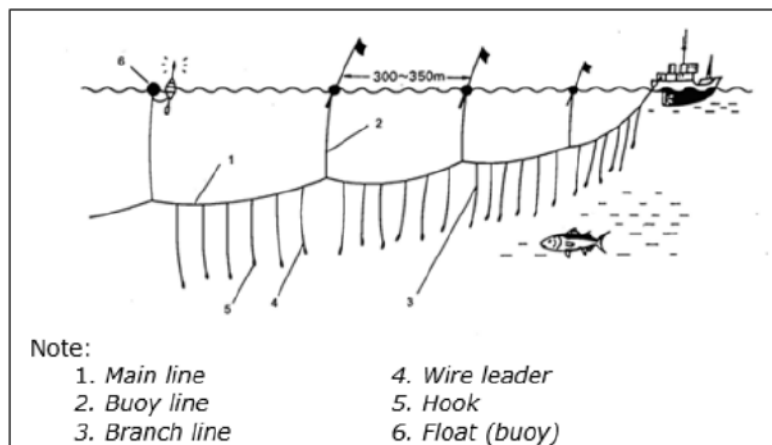4. Wire leader
5. Hook
6. Float (buoy)

Figure 1. Long line (PPKP 2015).

The present study aimed to identify the composition of the target species, bycatch, hook rate and catch fluctuation of a tuna longline fishing operation in the Eastern Indian Ocean which was carried out within 5 months from November 2018 to April 2019 with the fishing ground at the position of $15^000"-22^000"S$ and $100^000"-112^000"E$.

Material and Method. Data was obtained from fishing operations using tuna long line fishing gear then the catches were tabulated according to several types which were grouped in two large groups as target species and bycatch. The hook rate reflects the number of catches per hundred hooks. Catching composition was calculated according to

the target species and bycatch ratio, while the catch fluctuations during the fishing operation were tabulated monthly to see the best catch time in during the observation.

Results and Discussion

Target species and bycatch. The catches obtained during fishing operations were represented by 1,714 fish samples with the detailed species presented in Table 2.

Table 2

Total tuna longline catching in the Eastern Indian Ocean from November 2018 to April 2019

Species	Amount (fish)	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019
Thunnus alalunga	836	7	278	241	214	38	108
Thunnus albacares	21	4	0	1	9	1	6
Thunnus obesus	73	24	3	17	9	6	14
Thunnus maccoyii	34	1	5	6	16	4	2
Istiophoridae rafinesque	13	1	3	3	3	2	1
Lampris guttatus	27	1	8	7	4	2	5
Istiompax indica	1	1	0	0	0	0	0
Scomberomorus commerson	43	1	4	13	17	7	1
Lepidocybium flavobrunneum	498	1	91	146	174	39	47
Xiphias gladius	14	1	2	0	3	1	7
Centrophorus squamosus	103	2	25	19	16	26	15

From Table 2 it can be concluded that, during data acquisition, there were 11 species consisted of 4 tuna species, which where categorized as target species and 7 other species of fish which were categorized as bycatch fish.

The identification results concerning the catch composition showed 59% target species and 41% bycatch.

In Figure 2 it can be seen that the distribution of catch composition in the target species was dominated by *T. alalunga*, other tuna species were present in relatively small percentage. The data distribution gives an indication concerning the higher catch which was represented by *T. alalunga* as a target species.

The dominance pattern of the catch of the target species is also found in the bycatch phenomena data where there are species of *Lepidocybium flavobrunneum* that were caught in a very high percentage.

The distribution of data also shows that there was a large size catch of 103 *Centrophorus squamosus* included in the bycatch type.
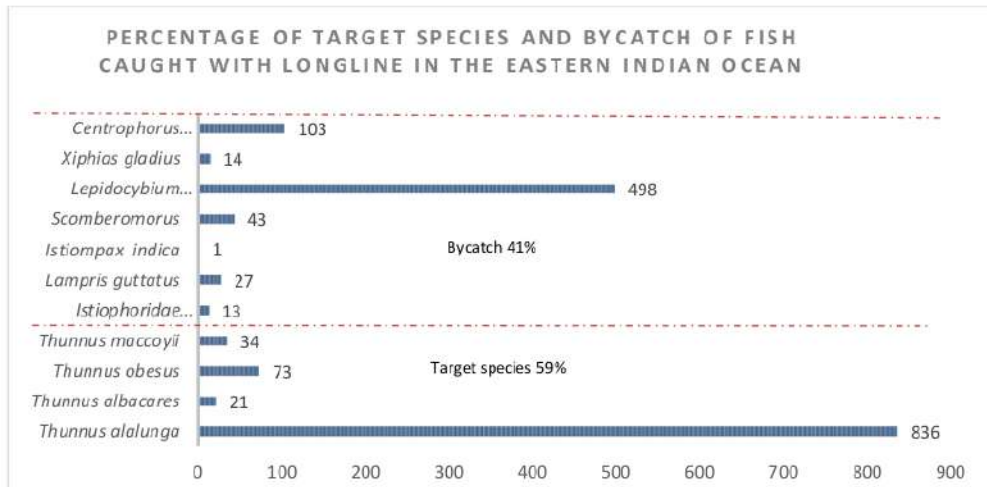
Figure 2. Percentage of target species and by catch of fish caught with tuna longline in the Eastern Indian Ocean from November 2018 to April 2019.

Hook rate. According to Bahtiar et al (2013) the value of the hook rate from December to April from 2005 to 2010 was 0.13. The hook rate ratio comparison between our results and literature is not too significant; the difference is only 0.09. The range of hook rate in the period of capture ranged from 0.03 to 0.46. The hook rate values appeared to be relatively small sized in November and March. The overall distribution of hook rate is presented in Figure 3.
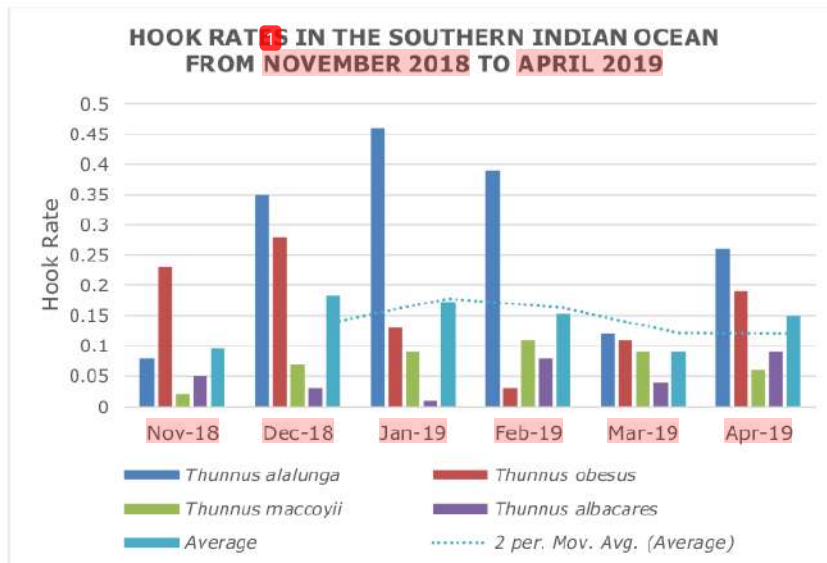
Figure 3. Distribution of tuna longline hook rates in the Indian Ocean from November 2018 to April 2019.

The distribution of the hook rate during the observation showed the peak value of the hook rate in January which was dominated by *T. alalunga* catch. The analysis shows that there is a pattern of distribution of the hook rate that forms a normal distribution with

the peak in January. The distribution also shows that a good hook rate was found in three consecutive months, namely December, January and February.

Analysis of the moving average shows that the average hook rate forms a peak and it is assumed that the hook rate will rise again after April. The distribution of the hook rate value is small in March but the distribution is relatively the same for each target species.

Fluctuations of target species. Fluctuations of target species show a pattern that is relatively the same as the pattern of catching rate distribution. High catches occurred in the three consecutive months of December, January and February, with the catching peak in January (Figure 4).
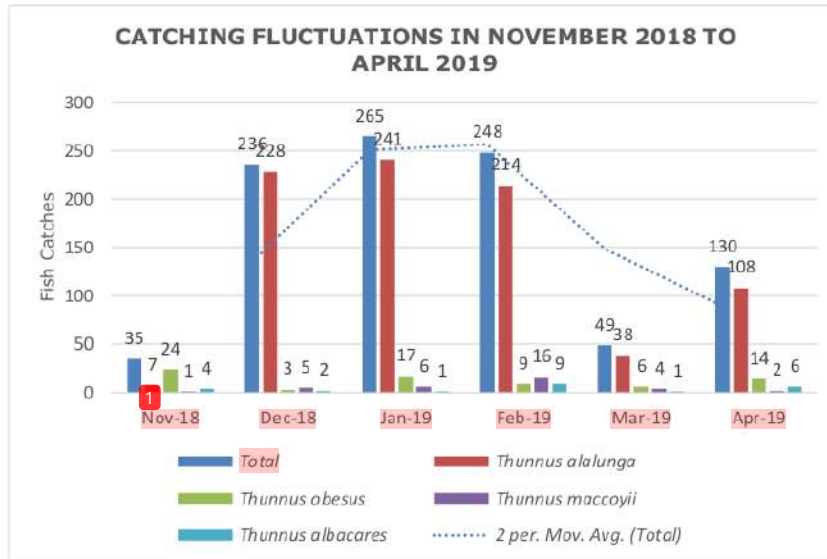

Figure 4. Catching fluctuation.

By identifying the catch rate and the catch fluctuation distribution as analyzed from the catching data distribution, it can be said that in December, January and February is the season of fish with large size catches on *T. alalunga* species. This fact can be seen from the number of catches for these months, reaching values between 200 and 260 fishes with a catch rate of 0.35 to 0.46.

Composition and percentage of target species. The target species categories for tuna longline fishing gear are various types of large size tuna. In the present study the target species are tuna species as shown in Figure 5.

During the observation there were 924 tuna as target species from total catching for six months in the Eastern Indian Ocean from November 2018 to April 2019 (Table 3).
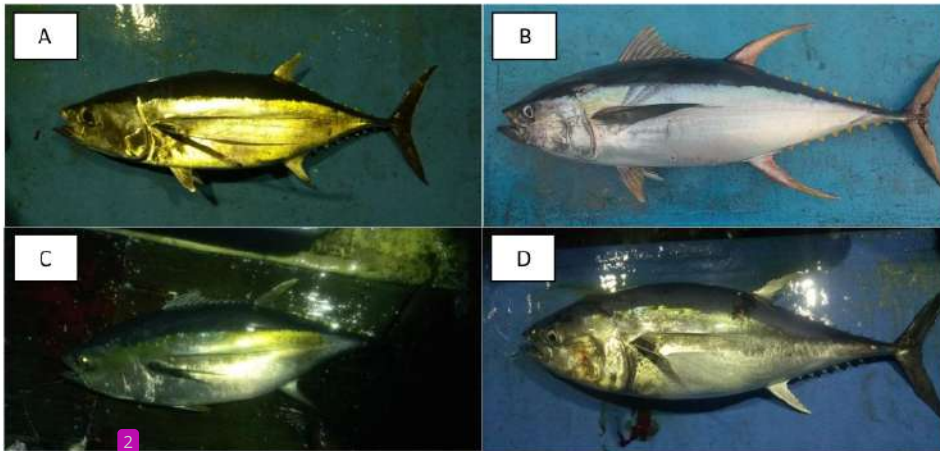
Figure 5. *Thunnus alalunga, Thunnus albacares, Thunnus obesus, Thunnus maccoyii* (original).

Table 3

Percentage of target species

Time	Thunnus alalunga	Thunnus obesus	Thunnus maccoyii	Thunnus albacares	Total
November	7	24	0	4	35
December	228	3	5	0	236
January	241	17	6	1	239
February	214	9	16	9	243
March	38	6	4	1	44
April	108	14	2	6	127
Total	836	73	33	21	924
Percentage (%)	87	8	3	2	100

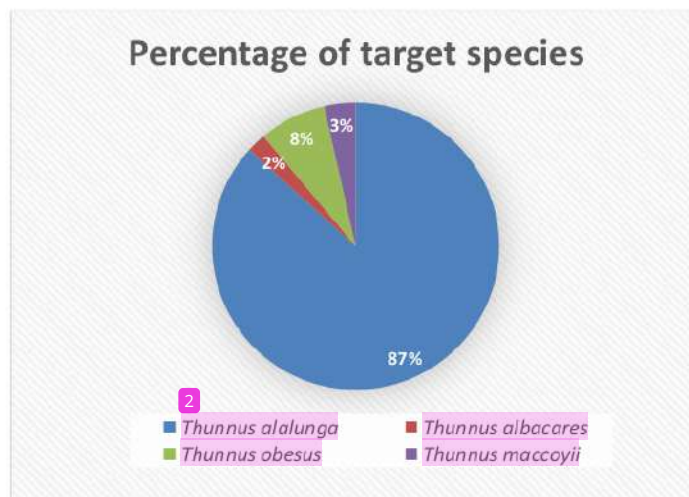A graphical representation concerning the percentage of the target species can be seen in Figure 6.

Figure 6. Percentage of target species.

Conclusions. The present study concluded that the ratio of the target species to the bycatch from this observation was 59% to 39% with the catches dominated by *T. alalunga* in the target species group and *L. flavobrunneum* in the bycatch category.

We obtained a relatively similar distribution pattern between the distribution of the catch rate and the distribution of catch fluctuations with the peak catching time occurred in January.

Further, full year round observations should be performed so that we can get an overview of the information on all the parameters above in a complete cycle of seasons in Indonesia.

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