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SPATIO-TEMPORAL VARIATIONS OF YELLOWFIN TUNA CAUGHT BY HANDLINE IN THE INDIAN OCEAN, SOUTH OF NUSA TENGGARA

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ABSTRACT

One of the main targets from small-scale handline tuna fishery is yellowfin tuna (*Thunnusalbacares*), where most, if not all of its operation depended heavily on the installment of the fish aggregating device (FAD). The objective of the study was to investigate the spatial and temporal distribution of catch and size of yellowfin tuna from FAD-associated handline fishery. The study was conducted from January to December 2018 with main observation location was in Labuhan Lombok fishing port, West Nusa Tenggara. The results showed that the highest catch rate was obtained during April-June, followed by the frequent emergence of large yellowfin tuna (>100 cm FL). On the other hand, January-March was considered as a low season, where most of the catch was dominated by juvenile yellowfin tuna (<50 cmFL). The spatial distribution of yellowfin tuna abundance is closely related to the presence of FADs, where all fishing operations are carried out around FADs. Also, aggregation of fish was more likely influence by temporal variation rather than the quantity of FAD. More abundant yellowfin tuna were found during the east monsoon (April-June) compared to another season where less fish occurred.

Keywords: Spatio-temporal; CPUE; size; yellowfin tuna; South of Nusa Tenggara.

INTRODUCTION

The utilization of tuna fisheries resources in Indonesian waters, especially in the southern waters of Nusa Tenggara, is developing in line with the development of fishing technology. The dynamics of the currents and the fertile waters condition make the waters in the south of Nusa Tenggara have considerable fishery potential. These waters are the confluence of currents from the Java Sea, Sulawesi Strait and Banda Sea in the north with the Indian Ocean in the south (Wyrtki, 1987).

Yellowfin tuna (Thunnus albacares) is one of the main catch targets for small-scale handline fishermen, whose fishing activities depend heavily on the existence of FADs as fish attractors. The FADs are scattered in the Indian Ocean south of Nusa Tenggara and are still in the Indonesian Exclusive Economic Zone (EEZ). Installing FADs makes it easier to determine fishing grounds more precisely and efficiently so that it saves more on fuel use. Installation of deep-sea FADs with purpose assist the development of small-scale tuna fisheries many have done in the waters of the Indian Ocean south of Java, Bali and Nusa Tenggara (Muhammad &Barata, 2012).

Fahmi et, *al*. (2019), said the catch of this commodity has increased due to an increase in fishing effort and the number of longline, gillnet, handline and purse seines. Significant growth has occurred in the small-scale fisheries catching yellowfin tuna in the Indian Ocean, where the proportion in the 2000s of 30% increased substantially to close to 50% in recent years.The current status of the yellowfin tuna fishery in the Indian Ocean is in an overfished condition which is indicated by the catch that exceeds the maximum sustainable potential value (MSY). The total catch of yellowfin tuna in the Indian Ocean in 2017 was recorded at 409.101 tonnes, while MSY yellowfin tuna was 403.000 tonnes (IOTC, 2018). The high demand for tuna in the world market today needs to be addressed properly. The increased fishing intensity in response to market demand must be accompanied by sound and responsible management strategies.

This paper aims to determine the spatial and temporal distribution of yellowfin tuna caught in the southern waters of Nusa Tenggara. This paper is expected to provide related information about the distribution of yellowfin tuna. Information of spatio-temporal variations is important in the context of exploitation while maintaining the sustainability of these fish resources. Temporal information on yellowfin tuna abundance can be useful to increase fishermen's catch.

RESEARCH METHODS

Data collection was carried out at the Labuhan Lombok fishing port in West Nusa Tenggara, from January to December 2018 by enumerators using a random sampling method. The data collected includes data on the composition, length and weight of yellowfin tuna as well as the catching area of hand-line fishing fleets operating in the southern Indian Ocean waters of Nusa Tenggara. Measurement of the fork length of each individual fish uses a calliper with an accuracy of 0.5 cm. At the same time, the weight is weighed using a digital scale with an accuracy of 1 g for yuwana size and manual scales for large fish with an accuracy of 0.5 kg.

Fishing area information is obtained through interviews with the skipper and the position of latitude longitude is obtained by accessing the hand-line fishing fleet GPS. Catch per unit effort (CPUE) is obtained by dividing the total weight of the catch obtained by the number of fishing days in each fleet according to the point of the fishing location.

The data on the catch and catch effort obtained are then tabulated to determine the value of the catch per unit of fishing effort. In this research, the catching effort used is the number of fishing days. According to Gunarso & Wiyono (1994), the formula for knowing the value of the catch rate is as follows:

$$CPUE_i = \frac{C_i}{E_i} \quad \text{..... (1)}$$

Where : C = catch (kg); E = effort (fishing days); CPUE = catch per unit effort (kg/days)

Spatial and temporal variations based on composition, CPUE and the average size of yellowfin tuna are presented with the help of the QGIS Desktop 2.14.8 application and described temporally by dividing the presentation into four fishing periods (quarters) during one sampling year. The first period starts in January - March; the second period in April - June; the third period is July - September and the fourth period represents October - December.

RESULTS AND DISCUSSION

Composition of Catch

Hand-line fishing fleets operating in the southern waters of Nusa Tenggara catch tuna and skipjack tuna using the assistance of FADs. The FADs are scattered in the waters of the Indian Ocean, South Nusa Tenggara but are still within the Indonesian Exclusive Economic Zone (EEZ). The hand line fishing fleet catches tuna and skipjack with varying compositions based on time/season and geographic fishing area, as shown in Figure 1.

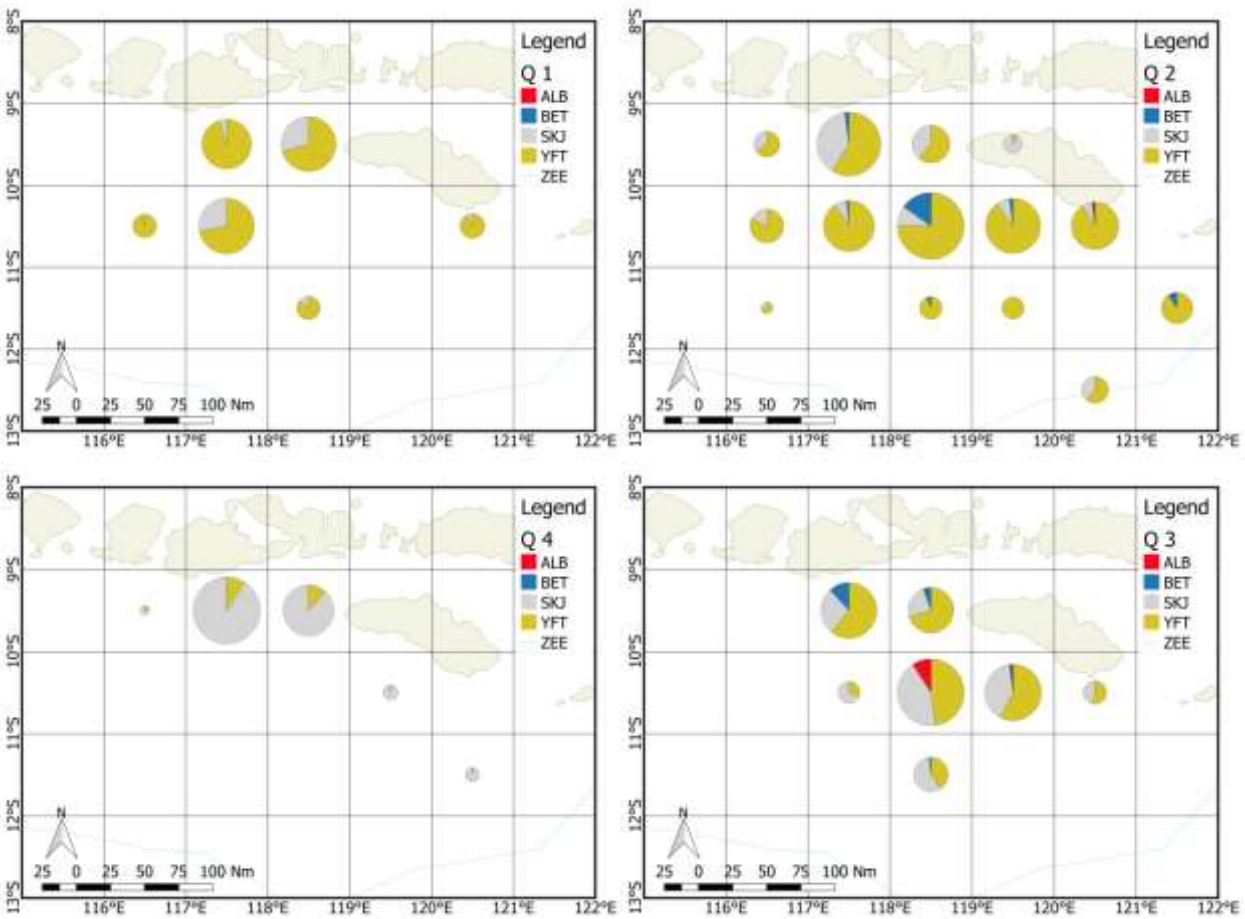

Figure 1. Handline Catch Composition in The Indian Ocean, Southern Waters of Nusa Tenggara Based on Season And Fishing Ground
(ALB = albacore tuna; BET = bigeye tuna; SKJ = skipjack tuna; and YFT = yellowfin tuna)

High abundant of juvenile yellowfin and skipjack tuna are commonly found during the first quarter of the year, concentrated in the area between 9-11oS and 117-119oE. Closer fishing ground during this period is understandable since most of the fishermen are non-locals and usually not available until the beginning of March. More over, high waves, strong wind and torrential rain are expected at these particular months. On the later period (Q2, April-June) the catch distributed in more larger area, as well as the improvement on the weather and the returning of fishermen from Sulawesi. Thing to notice was the appearance of bigeye tuna in the species composition. Low catch of albacore is starting to be seen in the fishing area in the south of the Sumba Island. The third period (Q3, July - September) is a period when the composition of the catch is starting to be balanced between yellowfin tuna and skipjack tuna. The composition of bigeye tuna and albacore is slightly higher than the previous period, but it has not been able to shift the dominance of yellowfin and skipjack tuna. In the fourth period (Q4, October - December), there was a significant decrease in

the composition of the yellowfin tuna catch. The number of catches is only dominated by skipjack tuna with a small amount of yellowfin tuna without bigeye tuna and albacore.

Yellowfin tuna is the most dominant commodity caught by hand-line fishing fleets, especially in the January - September 2018 period and in most of the fishing locations in the southern Indian Ocean waters of Nusa Tenggara. It is not the first time that yellowfin tuna catches dominance. According to Muhammad & Barata (2012), yellowfin tuna is the main catch of handline fishermen who operate in the waters around deep-sea FADs. The increasing number of hand line fishers operating around deep sea FADs is closely related to the high demand for large tuna (> 10 kg) in both local and international markets. The tuna processing industry has an essential role in tuna marketing because all the tuna caught by handline fishermen can be accommodated.

The dominance of yellowfin tuna in handline catch also occurs in several waters in the results of other studies. Yellowfin tuna dominate the catch by 74.54% in the southern waters of Bali, followed by bigeye and albakora tuna (Sulistyaningsih et al., 2011). The 75% dominance of yellowfin tuna was also recorded in the handline catch in the Banda sea around the Nusa Laut island in the January-March 2016 period (Rahmat & Thamrin, 2016). This dominance is thought to be due to the depth of the fishing rod used. The results of the research by Barata et *al* (2011) stated that the distribution of yellowfin and albacore is in the depth range of 35 - 299 m and bigeye tuna is in the depth range of 92 - 470 m. Sulistyaningsih et al (2011) further stated, albacore is rarely caught because this type of fish is not included in the group of fish that can be associated with FAD even though it is at the same depth distribution as yellowfin.

Catch per Unit Effort (CPUE)

The number of catch per unit effort (CPUE) of yellowfin tuna by hand line fishing fleets in the first period (February - March), the third period (July - September) and the fourth period (September - December) looks quite small (no more than 50 kg/day). The smallest value occurred in the fourth period and was evenly distributed in almost all fishing locations. Meanwhile, the highest CPUE value occurred in the second period (April - June) with the highest catch reaching more than 100 kg/day in the south and southeast of the island of Sumba (11-12 ° S and 119-122 ° East) as shown in Figur

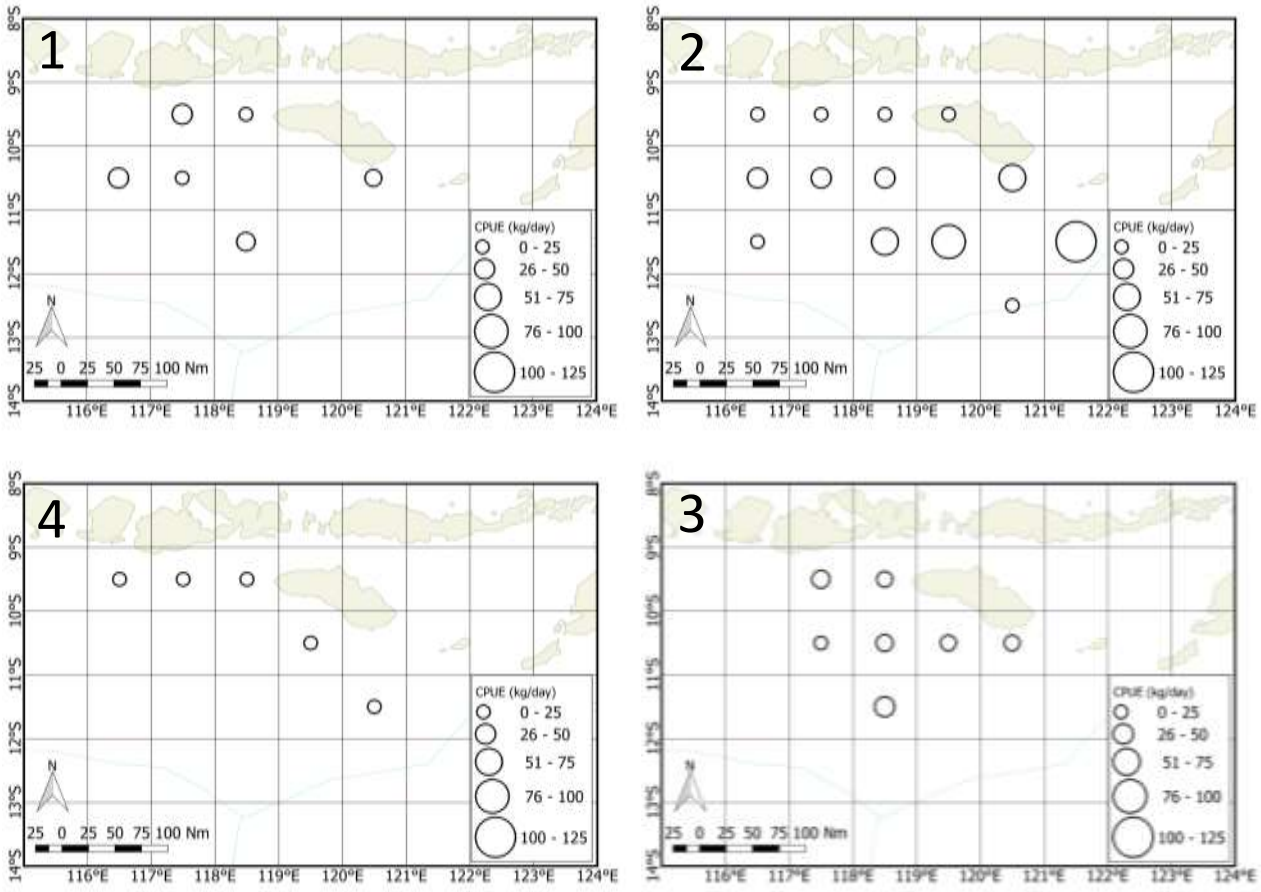

Figure 2. Catch Per Unit Effort (CPUE) of Yellowfin Tuna Caught by Handline in The Indian Ocean, Southern Waters of Nusa Tenggara

CPUE value of yellowfin tuna in the first, third and fourth periods is relatively small (not more than 50kg /day). This period is the northwest monsoon where the north monsoon across the equator turns eastward creating less friendly water conditions (BRPL, 2004). Meanwhile, the highest CPUE value occurred in period II (April - June) in the south and southeast of the island of Sumba, which coincided with the eastern season where the water conditions were

conducive to fishing. This result is in line with Bahtiar et.al, (2013)[s] research, which states that the highest fishing rate for yellowfin tuna occurs in May.

One of the advantages found in the waters of the Nusa Tenggara strait is that these waters are included in the area through which the Indonesian Cross Flow (Arlindo) passes. Arlindo is a current system that connects the Pacific Ocean with the Indian Ocean (Stewart, 2002). The Arlindo line starts from the waters between Mindanao and Halmahera, flows in through the Makassar Strait as its main route and then leaves Indonesian waters through the Lombok Strait and most of the rest turns through the Flores Sea, the Banda Sea and into the Indian Ocean. Arlindo plays a very important role in the regional climate system.

Average Size of Yellowfin Tuna

The average size of yellowfin tuna at each fishing point in the first period ranged from 33.2 - 41.7 cmFL. In the third and fourth periods, it was noted that the average size of the yellowfin tuna had increased in size variations, ranging from 28.6 - 73.7 cmFL. However, the highest variation in the average size of yellowfin tuna also occurred in the second period, with a size range of 33.9 - 144.7 cmFL. The average size of the longest yellowfin tuna in the second period was found at locations located between 11-12 ° S and 118-122 ° East.

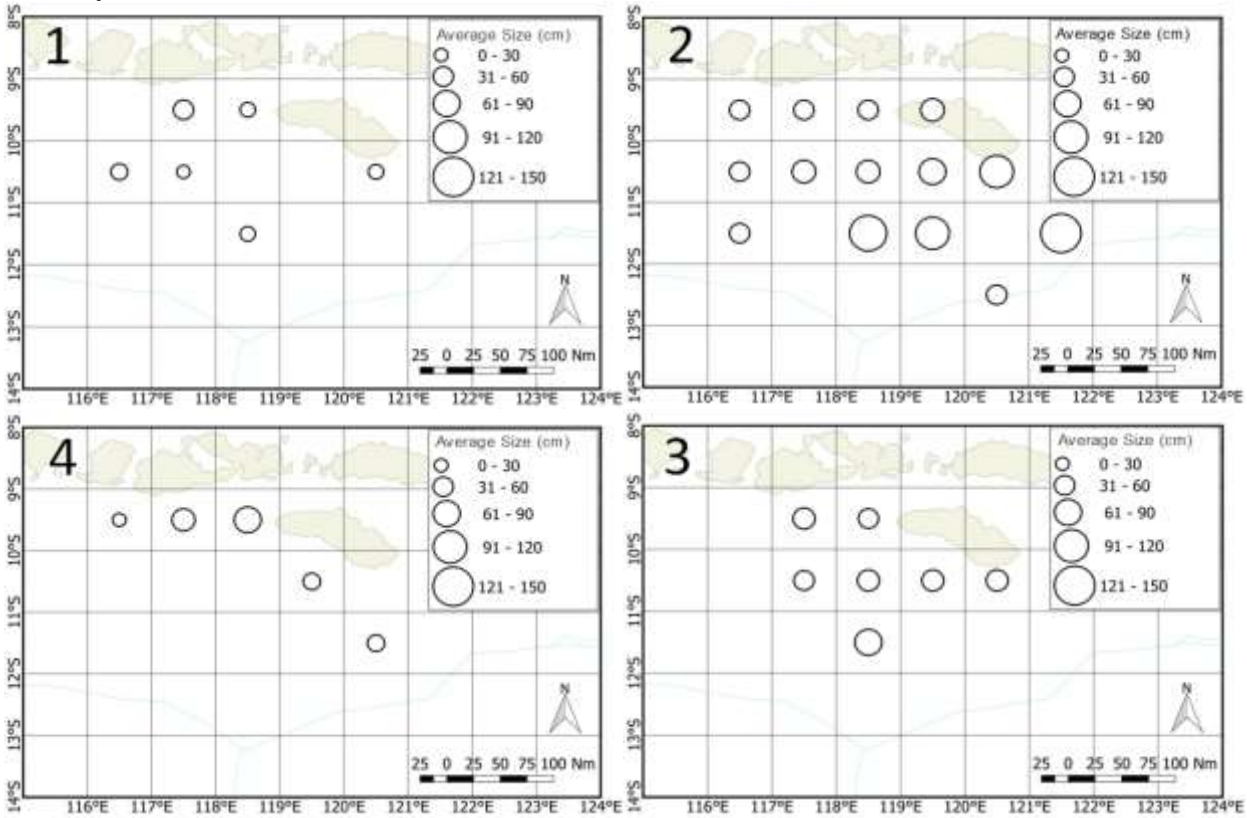

Figure 3. Average Size of Yellowfin Tuna Caught by Handline in The Indian Ocean, Southern Waters of Nusa Tenggara

The highest variation in the average size of yellowfin tuna occurred in the second period, with a size range of 33.9 - 144.7 cmFL. The average size of the longest yellowfin tuna in the second period was found at locations located between 11-12 ° S and 118-122 ° East. Furthermore, according to Muhammad &Barata (2012), yellowfin tuna caught in the waters around the FADs of the Indian Ocean south Java to Lombok is estimated to be 3-5 years old. The large number of yellowfin tuna caught from April to June indicates recruitment for spawning or foraging purposes. From July to October, the size of the fish caught is getting smaller. This finding explains that the dominance of small yellowfin tuna (Juvenile) is mostly gathered in the waters around FADs.

Babaran (2006) revealed that the length of yellowfin tuna caught by handline around FADs in the waters of Moro Bay (Philippines) ranged from 108 - 113 cm FL, while in Indonesian waters south of Java, it was dominated by class 123-128 cmFL. Meanwhile, the results of the research by Muhammad and Barata (2012) show that yellowfin tuna caught in the waters around the southern FADs of Bali and Lombok have a length range between 81-170 cm FL, with a positive allometric growth pattern and the first length of yellowfin tuna caught with a hand line is 126.7 cmFL. Yellowfin tuna caught in the waters around the FADs of the Indian Ocean are dominated by fish that have experienced gonad ripening or are suspected of having spawned.

While in the southern waters of Palabuhanratu, Mertha et al. (2006), stated that yellowfin tuna caught by hand line fishing fleets ranged from 25-119 cm with a 45-48 cm mode. Furthermore, Nurhakim&Suprapto, (2009), presented data on the yuwana production of yellowfin tuna and big eyes from hand-line fishing rods from August to October which landed in Kedonganan was more dominant (82.97%) when compared to yellowfin tuna (17.02. %) of large size as the main catch of the hand line fishing fleet.

CONCLUSION

Based on the results of this study, it can be concluded that the highest catch rate was obtained during April-June, followed by the frequent emergence of large yellowfin tuna (>100 cmFL). On the other hand, January-March was considered as a low season, where most of the catch were dominated by juvenile yellowfin tuna (<50 cmFL). In addition,aggregation of fish was more likely influence by temporal variation rather than the quantity of FAD. More abundant yellowfin tuna were found during the east monsoon (April-June) compared to another season where less fish occurred.

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