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THE DYNAMICS OF FISHING SEASON AND TUNA FISHING IN THE INDIAN OCEAN WATERS (FMA) 573

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ABSTRACT

Knowledge of the existence of fish in the sea is very important to decide the right time for fishing operation. The aim of this study is to decide the right time for fishing operation in the Indian Ocean FMA 573, through 1) information about fishing season of tuna in three different waters in the Indian Ocean i.e, East Java Province, Yogyakarta Province and East Nusa Tenggara Province; and 2) information about size of tuna being caught. Result of the study showed that fishing season of tuna in the Indian Ocean South of Java shifted from east to west and there is a different pattern of fishing season in the water south of East Nusa Tenggara. Size composition of tuna being landed or caught showed differences from the samples taken in different months. In June-July, tuna caught in south of Java are relatively big, while in August-September the size of catch began to smaller. Based on these, the right time to catch tuna in the Indian Ocean is in June-July in south of Java while in May and October-November in the south of East Nusa Tenggara.

INTRODUCTION

The Waters of the Indian Ocean South of Java, Bali and Nusa Tenggara are included as Fisheries Management Areas (FMA) 573. These territorial waters are very potential for their tuna resources such as *albacore* (*Thunnus alalunga*), *yellowfintuna* (*Thunnus albacares*), *bigeyetuna* (*Thunnus obesus*), *southern bluefintuna* (*Thunnus maccoyii*), and *skipjacktuna* (*Katsuwonus pelamis*). Trolling is the most common catching tool being used in the Indian Ocean Waters in catching tuna (Nurani *et a*l., 2012). Trolling uses FAD sor rumpon as a tool in fishing. The use of FADs is aimed to lure fish behavior which like to associate with floating objects so they gather around the FADs and this will increase the effectiveness of fishing operation (Freon and Dagorn, 2000; Castro *et al*., 2002; Jaquemet *et al*., 2011). Kinds of tuna to be targeted by FADs are yellowfin (*Thunnus albacares*), bigeye (Thunnus obesus) and skipjack (*Katsuwonus pelamis*) (Fontenau *et al*., 2000; Miyake *et al*., 2010; Guillotreau *et al*., 2011). Nurani *et al*. (2012) said that catches from trolling in the Indian Ocean south of East Java is dominated by baby tuna. Tuna catches at Tamperan fishing port is dominated by yellowfin measuring 45-64 cm (61%) and at Sadeng fishing port is dominated by bigeye measuring 34-50 cm (90%). The small composition of tuna catches will endanger sustainability of tuna resources because the fish has yet to reach its maturity. Fromentin and Fonteneau (2000) said that yellowfin tuna will reach its length maturity at about 105 cm, weight 25 kg and 2.8 years old; while bigeye at about 115 cm, weight 31 kg and 3.5 years old.

The success of fishermen in utilizing tuna resources will depend on the existence of fish in the sea. Knowing how to find fish in the sea is very essential to predict the right location and the right time to catch fish. Fish life pattern cannot be

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separated from the oceanographic parameters such as temperature, salinity, sea currents, and chlorophyll-content. Every kind of fish has its own habitat with different oceanographic conditions to support its life optimally. Oceanographic conditions, particularly temperature of sea surface and chlorophyll-content are affected to the spread of fish in one water and as an indicator of potential fishing ground and fishing season (Laevastu and Hayes 1981). Tuna is a far migrated fish; its existence in the sea is also affected by environmental factors such as temperature, salinity, water masses, *front*, *upwelling*, *termoklin*, and condition of sea currents. In general, there is a positive relationship between the existence of yellowfin tuna and temperature of sea surface as well as chlorophyll-a. Existence of tuna in the Indian Ocean is very much affected by environmental factors. Changing of water conditions alongside with changing of season in the Indian Ocean has caused the existence of tuna is unstable throughout the year. Tuna used to migrate from one water to other water (Subani and Barus (1988).

Production of tuna in the waters of the Indian Ocean south of East Java has formed a pattern i.e, increasing ineast season and decreasing in west season. Size composition of tuna being landed at these watersis different from the samples taken in different months. In June-July, tuna catches is relatively big, about 66% of tuna being landed is sizable to be caught at Tamperan fishing port and 98% at Pondokdadap fishing port. From August to September, size of catches is getting smaller, about 35% is sizeable to be caught at Tamperan fishing port and 90% at Pondokdadap fishing port (Nurani *et.al*. 2014; Nurani *et.al*. 2015). Based on the above, it is important to make a study in relation with season and size of tuna being caught in order to determine the right time for fishing operation. The aim of the study is to decide the right time for fishing of tuna in the Indian Ocean FMA 573, through 1) information about fishing season of tuna in three different waters in the Indian Ocean i.e, East Java Province, Yogyakarta Province and East Nusa Tenggara Province; and 2) information about the size of tuna being caught.

MATERIALS AND METHODS

Materials

The materials being used are data of tuna production and size of tuna being caught from the samples taken in different months and years. Data of tuna production is obtained from the data of tuna production at Pondokdadap fishing port in Malang Regency East Java, Tamperan fishing port in Pacitan Regency East Java, Sadeng fishing port in Yogyakarta, Tenau and Oeba fishing ports in East Nusa Tenggara. Data of production is a 5 year time series data, period2008-2012 (East Java); period 2009-2013 (Yogyakarta); period 2010-2012 (East Nusa Tenggara). Data of size of tuna being caught are collected from Tamperan and Pondokdadap fishing ports in June-July and August-September 2013, from Sadeng fishing port in August 2014, and from Tenau and Oeba fishing ports in September 2014.

Data of Analysis

The data of analysis to be used are:

- Analysis of tuna fishing season. The analysis is conducted in order to find out the pattern of fishing season of tuna. The determination of fishing season is done by using moving average approach.
- Analysis of composition of tuna catches and its size; Analysis of composition of tuna being caught is done by measuring the length of the fish. The analysis is used to find out the sizeable of tuna being caught by trolling. The composition of size and length then to be compared with existing literatures to know the sizeable of the catches. The sizeable of tuna to be caught is referred to Rohit and Rammohan (2009), who said that tuna measuring 80 cm is almost reach its maturity, and it is predicted maturity for the first time will start at measuring 90-95cm.

Both information above is required in order to find out the most appropriate time to catch tuna.

RESULTS

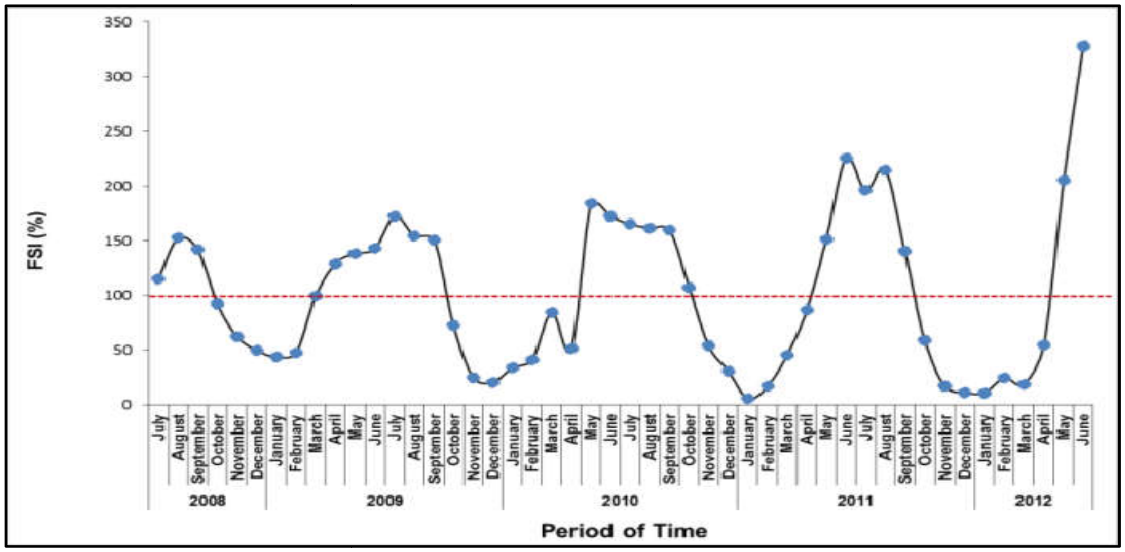
Fishing Season of Tuna

In general, tuna fishing activities in the Indian Ocean are continued almost throughout the year; however the catches are fluctuated depending on location and season. The data which is analyzed is from the catches of tuna by trolling which is dominated by yellowfin and bigeye. The analysis result which is based on monthly production data within 5 years from three different locations in the Indian Ocean FMA 573 by using moving average approach, showed fluctuation of fishing season index (FSI) below and above 100%.The index below 100% showed no fishing season while above 100% is fishing season (Figure 1).

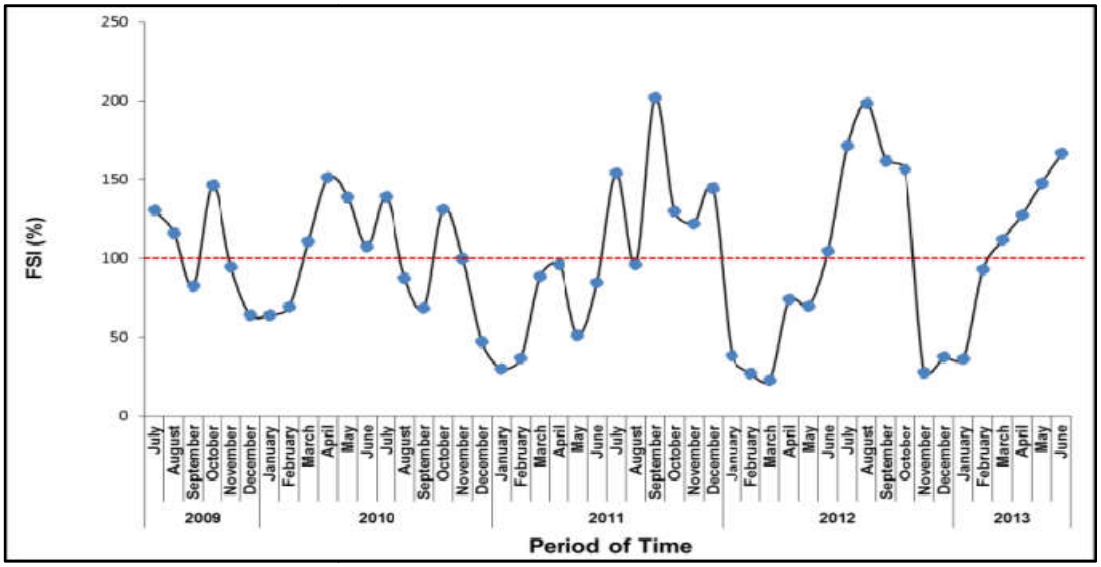
The above average pattern of tuna fishing season then was made into general pattern of fishing season (Figure 2). In general, tuna fishing season in the waters south of East Java begins in May up to September with the peak season occurs in June. Fishing season index (FSI) ranged between 23., 27% and 168., 36%. Tuna fishing season in south of DI Yogyakarta generally occurs much longer starting from April to October with the peak season in July. FSI ranged from 41., 81% to 146., 97%. Meanwhile, tuna fishing season in the waters south of East Nusa Tenggara generally happens in April-June and October-November, with the peak season in October and November. FSI ranged from 57., 421% to 170., 087%.

Size Composition of Catches

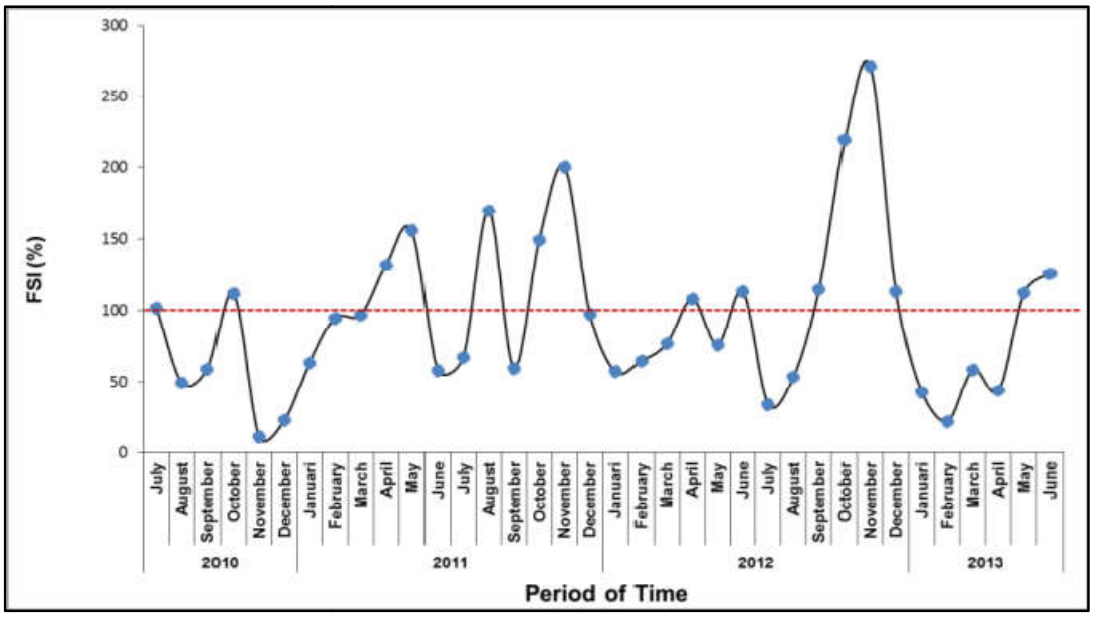
Length composition of tuna caught by trolling which is landed at the East Java province showed different composition for different location and time when the sample is taken. Figure 3showed length composition of tuna landed at Tamperan fishing port. The picture clearly showed that between June and July, size of tuna being caught is relatively big with about 66% is sizeable catches. Between August and September, size of the catches is getting smaller with about 35% is sizeable catches. Figure 4showed tuna catches landed at Pondokdadap fishing port. The figure showed that in June-July, about 98% of the tuna is sizeable catches. In August-September, 90% of the tuna catches is sizeable.



a. The waters of the Indian Ocean south of East Java

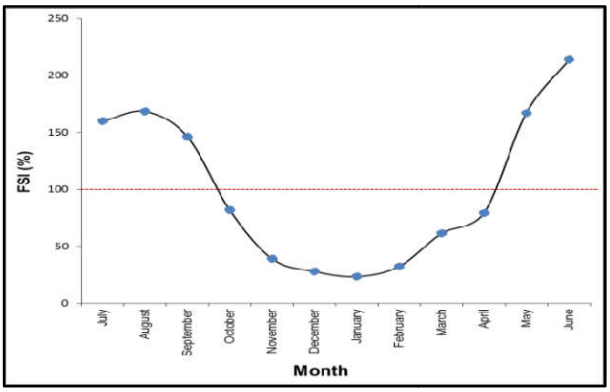


b. The waters of the Indian Ocean south of Yogyakarta

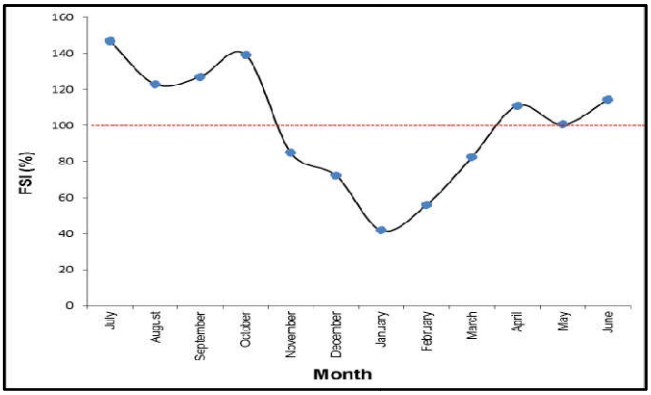


c. The waters south of East Nusa Tenggara

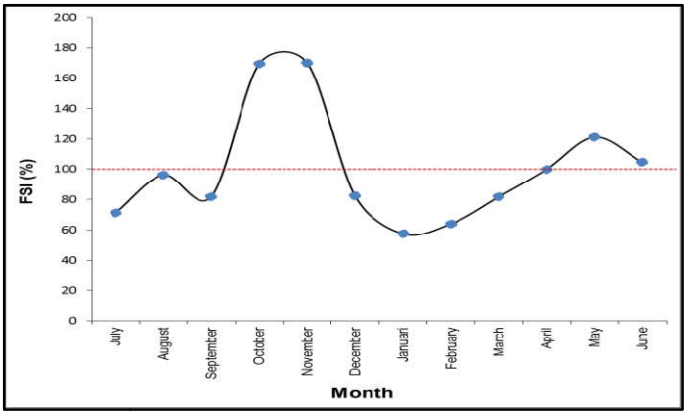
Figure1.Pattern of tuna fishing season in the last 4-5 year period in the waters of the Indian Ocean FMA 573



a. The waters of the Indian Ocean south of East Java

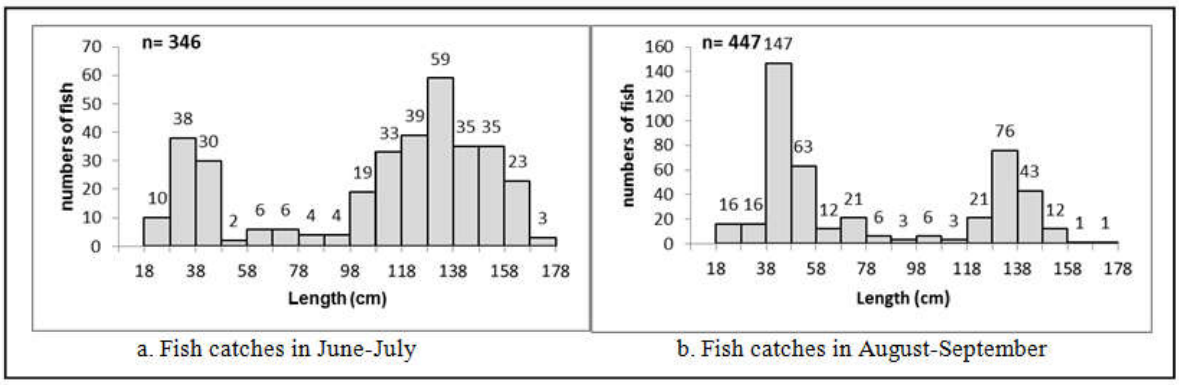


b. The waters of the Indian Ocean south of DI Yogyakarta



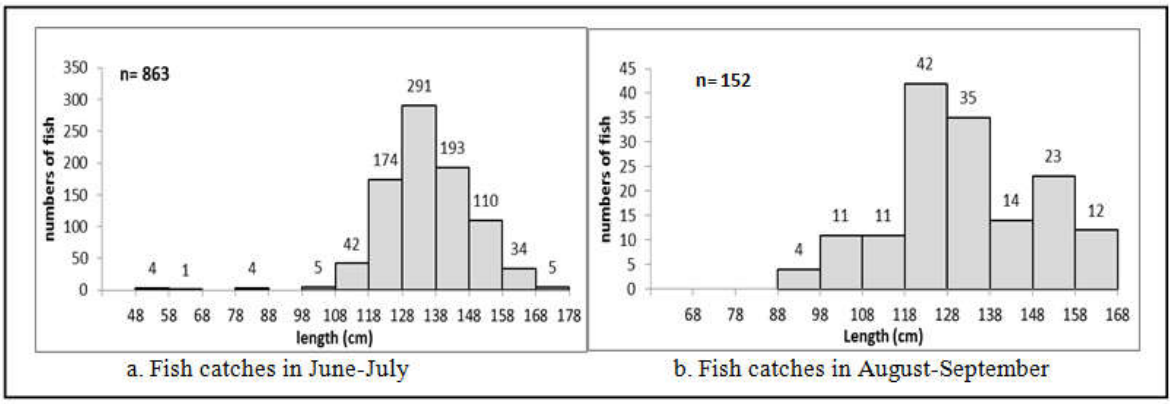
c. The waters south of East Nusa Tenggara

Figure 2. General pattern of tuna fishing season in the waters of the Indian Ocean FMA 573



a. Fish catches in June-July b. Fish catches in August-September

Figure 3. Length composition of tuna caught at Tamperan fishing port East Java Province



a. Fish catches in June-July b. Fish catches in August-September

Figure 4. Length composition of tuna caught at Pondokdadap fishing port East Java province

Length composition of tuna caught by trolling which is landed at Sadeng fishing port in Yogyakarta is shown in Figure5. The figure showed that sizeable catches of tuna at Sadeng fishing port based on the sample taken in August is about 31%.

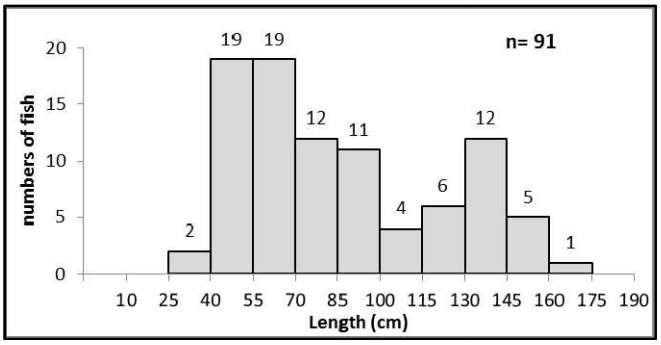


Figure 5. Length composition of tuna caught at Sadeng fishing port Yogyakarta

Length composition of tuna caught at Kupang (Tenau) and Oeba fishing ports East Nusa Tenggara is shown in Figure6. Sizeable catches of tuna landed at Tenau and Oeba fishing ports based on sample taken in September 2014 is about 29%.

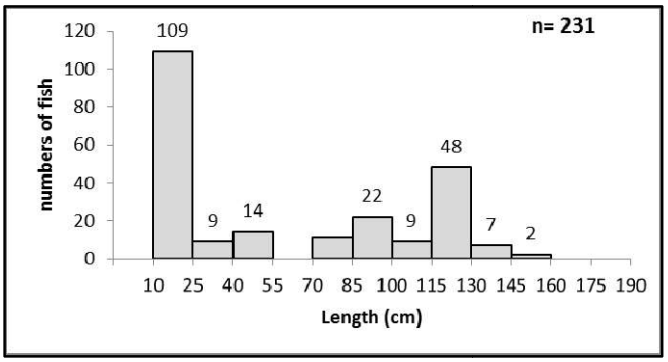


Figure 6. Length composition of tuna caught at Kupang and Oeba fishing ports East Nusa Tenggara

DISCUSSION

Changing of waters condition alongside with changing of season in the Indian Ocean has caused the existence of tuna is unstable throughout the year. Tuna usually migrating from one water to other water. Description of the pattern of fishing season from three different locations in the Indian Ocean south of Java showedthat tuna migrating from east to west. This can be seen from the result of the study, where tuna fishing season has shifted from June in the water south of East Java to July in the water south of Yogyakarta. It is understandable from the oceanographic conditions of this water, especially in connection with Temperature of Sea Surface (TSS). Relatively high temperature of sea surface in the water south of Java during west season and relatively low during east season resulting from the influence of water masse in the Indian Ocean. During west season in the Indian Ocean, northwest monsoon has occurredbringing Java Coast Current (JCC) along the southern coast of Java.JCCis a narrow current which moving along the south coast of Java from west to east, to the contrary with Southern Equatorial Current (SEC). According to Quadfasel and Cresswell (1992) in Farita (2006), JCCin surface layer brings warmer temperature (more than 27., 5 ºC) with low salinity. Warm water masse carried by JCC in the waters south of Java-Sumbawa comes from southwest coast of Sumatra and also Java sea that goes through the Sunda Strait. Laevastu and Hayes (1981) said that small changes in water temperature (about 0., 02 ^{o}C) could cause changes in density of fish population in one water (subtropical region). Water temperature is also affecting fish growth; activity and mobility; migration, spreading and abundant; schooling, maturity, fecundity and spawning; incubation and hatching as well as survival of fish larvae. Changing of water temperature from normal or its optimum temperature could also change movement activity and feeding activity as well as affecting ongoing process of spawning. Unlike water condition in west season, in east season sea surface temperature in the water south of Java tends to be lower. Low temperature of sea surface during this east season is caused by *upwelling* phenomenon occurred in that water. According to Wyrtki (1962); Purba (1995) in Gaol (2003); Nontji (2005) during east season in the waters of the Indian Ocean the blowing of southeast monsoon has caused Southern Equatorial Current (SEC) growing along the southern coast of Java. SEC which moving along the southern coast of Java has pushed water masse in that area to southwestern creating emptiness and this emptiness then is filled with water masse from deeper layer or known as *upwelling* phenomenon. The *upwelling* phenomenon in the waters of the Indian Ocean brings nutrients from the bottom layer to the surface.

This condition has made the waters in the Indian Ocean fertile. The condition above is strengthened with the result of study by Nurani *et al*. (2015), which shows monthly variation of oceanographic parameter such as temperature and chlorophyll-a spreading in the south of Java. Spreading of chlorophyll-a concentration in general showed an increment during east season and slowing during west season. Susanto *et al*. (2006) said that during east season (April-October), cold wind from Australia blows to the waters south of Java which stirring masse of water and bring nutrients to the surface and causing *upwelling*in that area. Pattern of fishing season in the waters south of East Nusa Tenggara showed a different with the pattern in the waters south of East Java and Yogyakarta. The fishing season occurred in May and October-November. This condition is as explained by Nontji (1993), who said that fisheries experts predict that stock of tuna from The Indian Oceans and stock of tuna from Pacific Ocean meet in Indonesia, probably around Flores sea and Banda sea, but how and how long the fish mingle to each other is remained unknown. Spreading of this fish is continuously from the Pacific Ocean through the waters between the Islands in Indonesia to the Indian Ocean.

Pattern of fishing season which occurred in the waters of the Indian Ocean south of Java is strengthened with numbers and size of the tuna being caught. In June-July tuna catches is quite plenty and size is much bigger compared to catches in August-September. The plenty and much bigger size of tuna catches in June-July is predicted because of *upwelling*. This is as explained by Saji *et al*. (1999); Springtall *et al*. (2000); and Manyilizu (2014), in general, waters conditions of the Indian Ocean is influenced by the movement of monsoons. During southeast monsoon (April-October), southeast wind from

Australia creating *up welling* and bring cooler water masse and nutrients up to the surface. The opposite condition occurred during northwest monsoon (October-April). Susanto *et al*. (2006) said increasing intensity of southeast monsoon speed has caused increasing intensity of *upwelling*. Increasing intensity of *upwelling* from June to August has caused increasing current of cold water from the bottom layer to the surface. Along with the increasing of month, temperature of sea surface gradually slowing down from June to August. Result of the study showed that there is a seasonal condition of tuna catches in the waters of the Indian Ocean FMA 573. Tuna catches in south of Java started to increase in May-August and reach its peak in June-July. From September, the tuna catches began to slowing down. Nurani *et al*. (2014) said that in August-September, a lot of baby tuna are caught in the waters of the Indian Ocean south of East java.

Based on this study it can be said that the right time to catch tuna in FMA 573 south of Java is in June-July, while for south of East Nusa Tenggara is in May and October-November. Other times is not recommended to catch fish by trolling because it is feared to catch small tuna which will affect sustainability of stock resources. Concern over declining stock resources of tuna in the Indian Ocean has been expressed by Pillai and Satheesh Kumar (2012) who said tuna catches from the waters of the Indian Ocean was sharply increased during 1980-1995 period, and kept on increasing up to 2005. The catches reached about 1.201.465 tons per year, or about 26% from total tuna catches in the world, with main catches are cakalang and yellow fin. Stok tuna in the Indian Ocean has indicated o*verfishing*, and IOTC has made some recommendations for the sustainability of tuna resources. Fishing operation of tuna has caused ecological impacts on the resources.

Conclusion

Based on the result of the study it is concluded that:

- Tuna fishing season in the waters of the Indian Ocean South of Java shifted from east to west. Tuna fishing season in south of East Java occurs in May-September and reach its peak in June. Meanwhile, in south of Yogyakarta occurs in April up to October and reach its peak in July. On the other hand, in south of East Nusa Tenggara in general occurs in May-June and October-November and reach its peak in November.
- Two kinds of tuna which are mostly caught are yellowfin dan bigeye. Size composition of tuna landed in East Java province showed differences for the sample taken in different month. In June-July, size is relatively big; with percentage of sizable catches in each location is about 66% and 98%. In August-September, size of catches is getting smaller; with sizable catches is about 35% and 90%. Meanwhile, based on sample taken in August 2014, sizable catches of tuna at Sadeng fishing port is about 31%. Sizable catches of tuna based on sample taken in September 2014 at Kupang and Oeba fishing ports is about 29%.

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