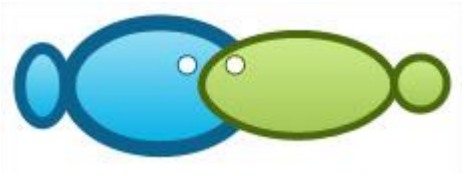

Season pattern of pole and line skipjack tuna (*Katsuwonus pelamis*) catching in Kupang, Indonesia

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Abstract. Increased production of *Katsuwonus pelamis* in Kupang can still be increased, if the capture operation can be carried out in an effective and efficient manner. One way is to know the fishing season, so that better preparation can be done to conduct more targeted fishing operations. Research on the fishing season of *K. pelamis*, was conducted in the waters around Kupang, Indonesia. The data used were the catch and the number of fishing trips with pole and line per month, at the Tenau Fishing Port and Oeba Fishing Port during 2014-2018. Analysis of fishing season patterns used the average percentage method. From the results of data analysis it was found that *K. pelamis* in Kupang waters can be caught throughout the year. The fishing season *K. pelamis* in Kupang is from February to April, September to November, while January, May to August, and December are not fishing seasons.
Key Words: fishing potential, CPUE, season catch index, Oeba fishing port, Tenau fishing port.

Introduction. Kupang is one of the regions in Indonesia that has considerable fish resource potential and has good prospects for capture fisheries activities, one of which is *Katsuwonus pelamis* fisheries.

K. pelamis fishing in Indonesia in general uses pole and line consisting of bamboo, fishing lines and hooks (Diniah et al 2001). According to Mustasim (2016) one way to increase *K. pelamis* production is through an increase in unit effort by deploying fishing fleet units to locations that are thought to be densely populated. In order to maintain the sustainability of *K. pelamis* resources, rational management is needed, which includes estimating fishing season patterns and how they change in response to exploitation activities.

According to Wibowo (2018) the pattern of *K. pelamis* fishing season is throughout the year. Increasing *K. pelamis* production in the waters around Kupang can still be increased, if the fishing operation can be carried out in an effective and efficient manner. One way is to know the fishing season, so that better preparation can be done to conduct more targeted and profitable fishing operations (Kurniawan 2015).

Knowledge of fishing season patterns is one of the important factors in *K. pelamis* resource exploitation activities, especially in determining the right time to increase the intensity of fishing while determining the right time to reduce the intensity of fishing (Tilik et al 2014).

The purpose of this study was to determine the pattern of *K. pelamis* fishing season with pole and line based on the catch landed at the Tenau Fishing Port and Oeba Fishing Port and the number of trips (efforts) of catching per month in the interval of 2014-2018.

Material and Method

Fishing season patterns. Analysis of fishing season patterns used the average percentage method which is based on times series analysis (Spiegel 1961 in Kekenusa 2006). The procedure is as follows:

1. Calculation of CPUE = Catch Per Unit of Effort = U per month (U_i) and the monthly average CPUE in a year ($\bar{U}$).

$$\mu = \frac{1}{m} \sum_{i=1}^{m} U_i$$

$\bar{U}$: CPUE monthly average in a year (ton trip^{-1})
U_i : CPUE per month (ton trip^{-1})
m : 12 (number of months of the year)

2. Calculation of U_p, which is the ratio of U_i to $\bar{U}$ expressed in percent:

$$U_p = \frac{U_i}{\mu} \, x \, 100$$

3. Calculation of:

$$IM_i = \frac{1}{t} \sum_{i=1}^{t} U_p$$

IM_i : Season index i
t : Number of years of data

4. If the IM_i amount is not 1,200 (12 months x 100), then adjustments to the formula (3) are required as follows:

$$IMS_i = \frac{1200}{\sum_{i=1}^{m} IM_i} \, x \, IM_i$$

IMSi : Adjusted Season i Index

5. If in the calculation there is an extreme value on U_p, then the U_p value is not used in the calculation of the Season Index (IM), then the median (Md) of the IM is used. If the total Md value is not 1,200, the following adjustments should be made:

$$IMMdS_i = \frac{1200}{\sum_{i=1}^{m} Md_i} \, x \, Md_i$$

6. The criteria for determining fish season is if the season index is more than 1 (more than 100%) or above the average, and not the season if the season index is less than 1 (less than 100%). If IM = 1 (100%), this value is equal to the average monthly price so that it can be said to be in a normal or balanced state.

Results

Fisheries production pole and line. Catching *K. pelamis* in Kupang is dominated by pole and line as the main fishing gear. Pole and line fishing in Kupang has increased over the past 5 years. Pole and line production in 2014 only reached 1,666.77 tons, while in 2018 it reached 2,697.87 tons (Table 1). This of course greatly affects the value of the production produced.

Table 1

Pole and line production and trip in Kupang

Year	*Total catch (Ton)*	*Trip*
2014	1,666.69	497
2015	1,914.39	472
2016	2,144.15	458
2017	2,431.86	785
2018	2,697.87	970
Total trip		3,182

From Table 1 it can be seen that *K. pelamis* production has increased over the past 5 years along with the increase in the value of its effort. Catching efforts *K. pelamis* conducted in Kupang that were landed at the Tenau Fishing Port and Oeba Fishing Port occur throughout the year despite of fluctuations in catch every month. The fishing season lasts throughout the year and moves according to food availability and the temperature that can be tolerated by the species (Mallawa 2010). *K. pelamis* in the territorial waters of Eastern Indonesia are available throughout the year, especially in the Maluku Sea, Halmahera Sea, Banda Sea, Seram Sea and Flores Sea (Uktolseja et al 1989). *K. pelamis* catch and efforts per trip in 2014-2018 can be seen in Figure 1 and Table 2.

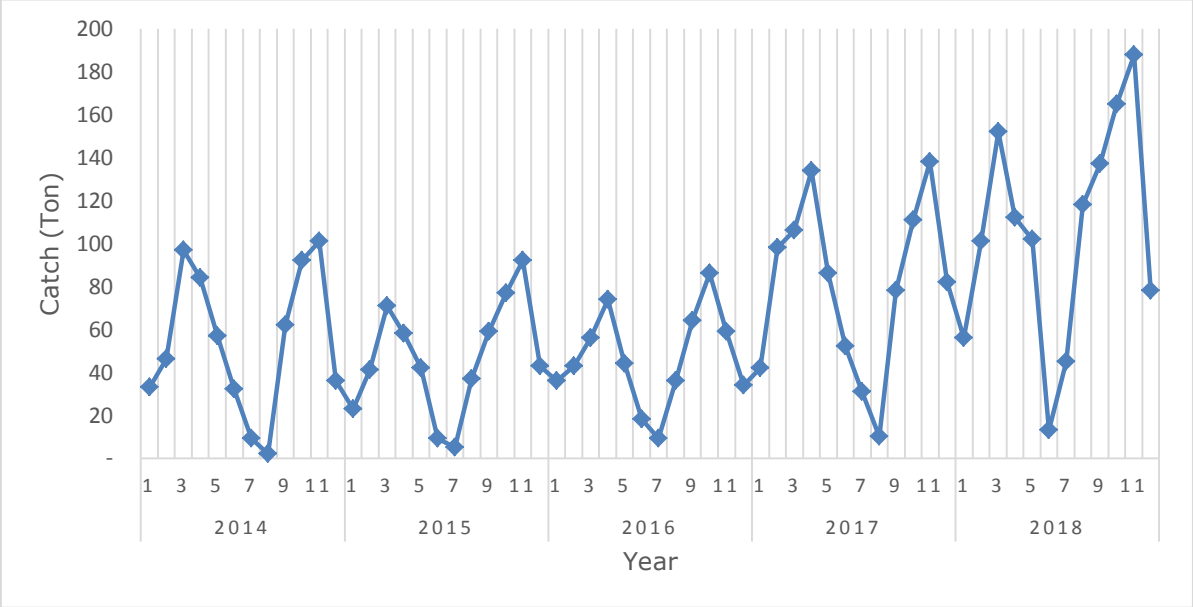

Figure 1. Monthly pole and line catch graphs for 2014-2018.

Table 2

Catches and efforts trip^{-1} in 2014-2018

Month	*2014*		*2015*		*2016*		*2017*		*2018*	
	Catch	*Effort*	*Catch*	*Effort*	*Catch*	*Effort*	*Catch*	*Effort*	*Catch*	*Effort*
January	63,780	23	105,680	28	127,882	26	129,290	47	177,927	72
February	102,372	32	171,850	29	188,250	37	207,144	74	259,960	88
March	169,204	48	211,582	58	233,774	50	248,901	78	329,399	91
April	160,495	53	209,066	45	255,067	52	282,785	82	243,052	94
May	123,128	50	180,475	42	230,305	44	235,486	86	199,685	63
June	96,035	32	10,937	12	17,563	18	188,739	62	25,292	13
July	22,955	12	1,995	5	9,479	9	63,654	31	186,433	68
August	2,792	2	162,708	32	194,998	36	16,138	10	220,781	94
September	191,245	49	202,322	51	227,194	52	214,970	62	238,334	99
October	281,579	74	226,252	55	276,735	58	261,792	78	295,963	103
November	397,155	86	235,484	72	199,894	42	357,896	93	343,643	110
December	55,951	36	196,041	43	183,009	34	225,070	82	176,539	75
Total	1,666,690	497	1,914,392	472	2,144,150	458	2,431,865	785	2,697,008	970

Prediction of K. pelamis catch per unit effort. The results and efforts of catching depends on the number and efficiency of the fishing gear, the duration of operation, the availability of fish, the state of the waters and their changes and also the weather. Based on the catch and effort of *K. pelamis* fishing, CPUE data was obtained per month (ton trip^{-1}) during 2014 to 2018. Detailed CPUE per months and years can be seen in Table 3 and the monthly average CPUE is showed in Figure 2.

Table 3

Monthly CPUE average

Month	*Year*					*Average monthly CPUE*
	2014	*2015*	*2016*	*2017*	*2018*	
January	2.77	3.77	4.92	2.75	2.47	3.14
February	3.20	5.93	5.09	2.80	2.95	4.04
March	3.53	3.65	4.68	3.19	3.62	3.86
April	3.03	4.65	4.91	3.45	2.59	3.99
May	2.46	4.30	5.23	2.74	3.17	3.22
June	3.00	0.91	0.98	3.04	1.95	2.03
July	1.91	0.40	1.05	2.05	2.74	1.78
August	1.40	5.08	5.42	1.61	2.35	3.41
September	3.90	3.97	4.37	3.47	2.41	3.94
October	3.81	4.11	4.77	3.36	2.87	3.81
November	4.62	3.27	4.76	3.85	3.12	3.71
December	1.55	4.56	5.38	2.74	2.35	3.22
Average	2.93	3.72	4.30	2.92	2.72	3.35
Total	35.18	44.60	51.55	35.06	32.59	-

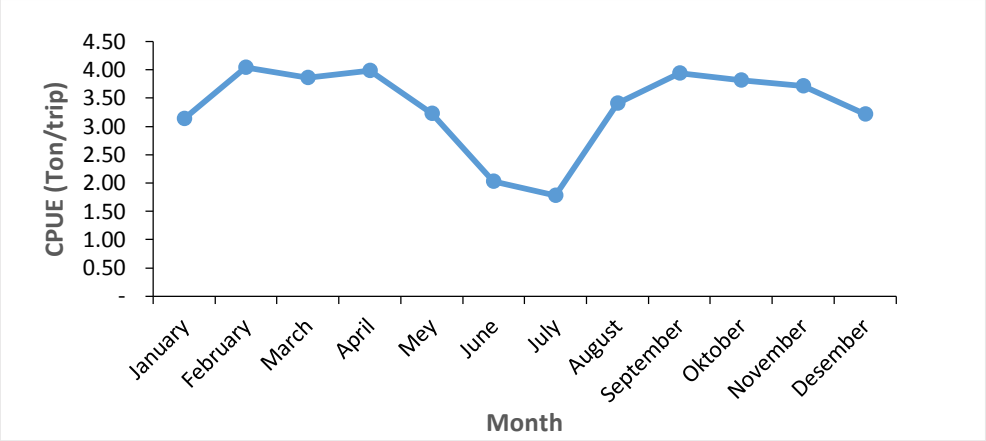

Figure 2. *Katsuwonus pelamis* CPUE.

The abundance of *K. pelamis* is very dependent on the oceanographic conditions of the waters, especially on the water temperature that is in accordance with the body temperature tolerance of *K. pelamis* and the abundance of food. Potential fishing zones are strongly influenced by oceanographic physical, chemical and biological parameters of water including sea surface temperature or horizontal and vertical temperature distribution, salinity, chlorophyll-a concentration and front and upwelling phenomena (Simbolon 2009). Meanwhile, according to Nugraha et al (2020), the distribution of sea surface temperature does not affect the amount of *K. pelamis*. Changes in catches in a particular month due to the influence of the presence of fish and the success rate of fishing operations, causing the CPUE value to fluctuate. According to Setyaji et al (2018), local weather (wind speed) and fast tied are very influential on fishing activities that affect the dynamics of CPUE.

K. pelamis catching season index. From the CPUE data as shown in Figure 2, it is converted into a percentage form which can explain the index of seasoning pattern of *K. pelamis* catching (Table 4).

Table 4

Percentage index of *Katsuwonus pelamis* fishing season in 2014-2018

Month	*Year*				
	2014	*2015*	*2016*	*2017*	*2018*
January	95%	102%	114%	94%	91%
February	109%	159%	118%	96%	109%
March	120%	98%	109%	109%	133%
April	103%	125%	114%	118%	95%
May	84%	116%	122%	94%	117%
June	102%	25%	23%	104%	72%
July	65%	11%	25%	70%	101%
August	48%	137%	126%	55%	86%
September	133%	107%	102%	119%	89%
October	35%	130%	111%	111%	115%
November	24%	158%	88%	111%	132%
December	24%	53%	123%	125%	94%

From Table 4 can be seen the fluctuations that occur in the percentage of the fishing season index that occurred during the last 5 years. The fluctuation of the catch season index can be seen in Figure 3.

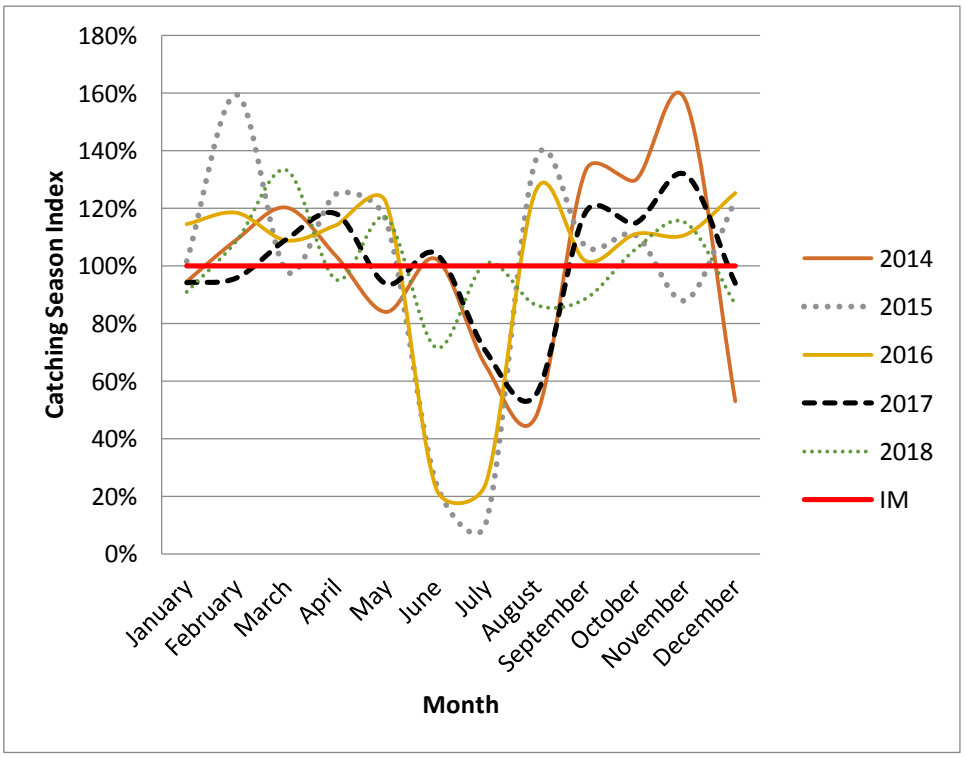

Figure 3. Chart of season catching index for 2014-2018.

Discussion. Monthly CPUE data (ton trip^{-1}) is presented in Table 3 in the calculation of the Season Index (IM) of *K. pelamis* capture using the formulas in equations (1) to equation (5), which is briefly presented in Table 5. The Season Index used is the Season Index with adjusted percentages (IMMdS).

Table 5

Season index (IM) value of *Katsuwonus pelamis*

Month	*Monthly CPUE*	*Average IMP (%)*
January	3.14	86%
February	4.04	105%
March	3.86	102%
April	3.99	101%
May	3.22	91%
June	2.03	58%
July	1.78	49%
August	3.41	82%
September	3.94	100%
October	3.81	101%
November	3.71	104%
December	3.22	84%

IM values of more than 100% (more than 1) indicate capture season, while those less than 100% (less than 1) indicate non-fishing season. Based on the analysis of fishing season using the average percentage method (Table 5 and Figure 4), it is seen that *K. pelamis* in Kupang can be caught throughout the year. From February to April and September to November as a fishing season, whereas January, May to August and December are not catching seasons.

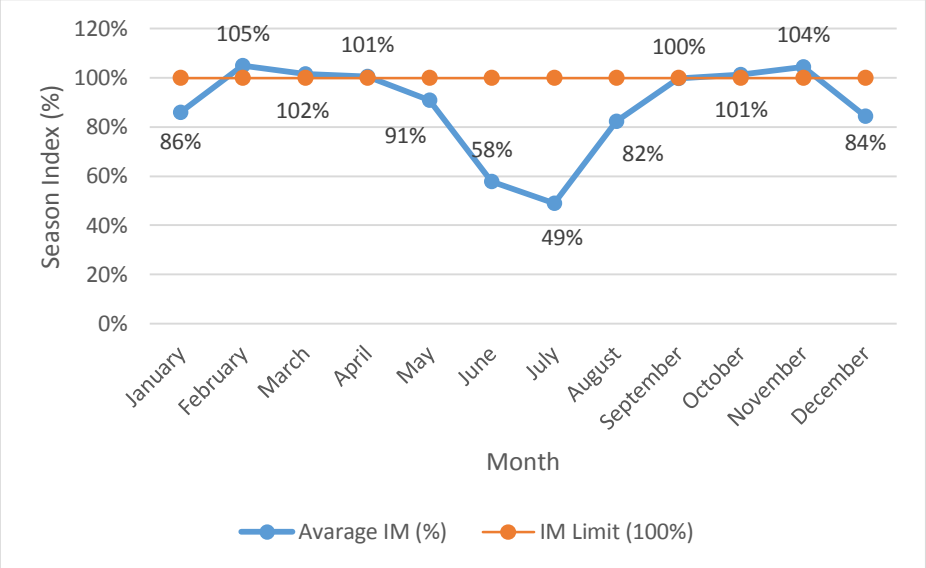

Figure 4. *Katsuwonus pelamis* catch season pattern index.

The season for capturing *K. pelamis* generally occurs twice a year, peaking in February and November. From February to April the catch is still high, but from May to August the catch tends to decrease. The smallest catch occurred in June.

Since many fishermen from outside Kupang catch fish using purse sine, there are often disputes between fishermen. The use of purse seine with the help of Fish Aggregating Device (FAD) leads to a high amount of small fish (not yet feasible to catch) catch. Before the FADs, the *K. pelamis* catching area by fishermen in Kupang was still less than 30 miles from the coastline. After the FADs, the fishing area is farther to the middle, around the FADs that are installed in the Indonesian Exclusive Economic Zone, owned by other vessels that have FADs. This is because pole and line fishermen do not have FADs. The use of attractors in the form of FADs and live fish baits in the process of fishing pole and line fishing activities requires a significant cost (Wiratama et al 2017).

Factors affecting the decline in *K. pelamis* catch in 2018 in Kupang are the result of:

1) Increased fishing efforts by pole and line fisheries;
2) Catching pressure with purse seine.

Pole and line tends to capture smaller sizes and fewer class sizes compared to purse seines. The pole and line selectivity can be modified by changing the size of the hook, the weight of the rod, and the size of the bait, but the most meaningful is choosing the size of the fish horde. The selectivity of purse seine size can be varied by selecting a schooling fish and adjusting the size of the mesh according to the size of the fish caught or larger (Matsumoto et al 1984). According to Nurdin & Panggabean (2018) catching *K. pelamis* should be directed at the time of the fishing season by taking into account the size of adult fish so that the utilization of *K. pelamis* can be done optimally and sustainably.

In June the catch decreased, generally due to a large choppy west monsoon that reduced the number of fishing trips. The difference in fishing season may be due to differences in the number of fishing fleets at the time of the study. Different sources and accuracy of the data obtained can also lead to different results.

The results of this study are expected to be valuable information, especially for fishermen and fishery entrepreneurs, involving *K. pelamis*, in managing their business more efficiently in determining fishing time and number of fleets. This research is also useful for the Government in determining efficient and sustainable *K. pelamis* fisheries planning.

Conclusions. Based on the results of the analysis and discussion it can be concluded that, *K. pelamis* in Kupang can be caught throughout the year. Fishing season is from February to April, September to November, while January, May to August, and December are not fishing seasons.

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