The productivity and the pattern of yellowfin tuna (*Thunnus albacares*) fishing season in Morotai Island waters

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**Abstract.** Tuna fisheries in Morotai Island have great potential economic value. The production of Tuna in 2016 as much as 325 tons. This condition then made Tuna as the superior commodity in this territory [3]. Know the productivity and the pattern of tuna fishing season can maximize tuna production in Morotai Island. The purpose of this research was to investigate the productivity and Yellowfin Tuna fishing season in Morotai Island waters. The study used a survey method by conducting, the preliminary study in June 2018, and collecting data in the field during July-August 2018. The primary was obtained from fishing results data, numbers of the fishing trip from Tuna’s fishers. For the time series secondary data were derived from DKP Morotai Island is the time series data year 2009-2016, DKP Province Maluku Utara, The Log Book of Pacific Tuna Fishers Cooperative, and BPS Morotai Island. The analyzing consisted of CPUE analysis and time series (moving average) analysis. The research results showed that productivity catching Tuna is 0.798 tons/year. Although the productivity in every year was fluctuating but have a low trend, because of the catching of Tuna in Morotai Island used motorboat with small capacity, which is 1.5-3 GT. The analysis results of time series (moving average) analysis showed that the season for fishing Tuna happened throughout the year, with the peak of season happened in March and June.

1. **Introduction**

Tuna is one of the highest no oil and natural gas export commodity in Indonesia. According to the National Commission of Stock Assessment (Komisi Nasional Pengkajian Stok), the potency of Tuna fisheries in Indonesia is quite huge although the level of utilization in several regions still low [1]. One of the potential regions for Tuna’s fishery is the regency of Morotai Island. The potency of Tuna’s fishery in Morotai Island is very promising, [2] mentioned that the production of Tuna on 2016 as much 325 ton, which makes Tuna as the excellent commodity at the region [3].

The productivity of fishing was the ability of a fishing vessel to produce targeted catching fish within a year. The productivity of fishing business can be a benchmark of the utilization of fish resources. The utilization of Tuna is not left from the long-distance strive from the characteristic of fish sources, therefore, it needs the fathoming of fishing season management. The pattern of fishing season is important to know as the reference for the fishers on maximized the fishing operation.

The purpose of this research are (1) to analysis the productivity of fishing Tuna in the regency of Morotai Island’s waters; (2) to analysis the pattern season of fishing Tuna in the regency of Morotai Island’s waters. The significance of this research is to be a reference to the local government to determine the good steps of Tuna fishery’s management in the regency of Morotai Island.
2. Material and methods
There are two steps of the research, first is the introduction study for a month in June 2018. The second step is collecting data on the location of research for two months, on July – August 2018. The location of this research is regency of Morotai Island as in Figure 1. The productivity of tuna on the regency of Morotai Island from the calculation of CPUE meanwhile the fishing season pattern get to know with time series analysis (moving average). The collecting data on field used survey method. The data consist of primary data and secondary data. The primary data is the interview with Tuna’s fishers, and then the secondary data is the time series of the catch result and the sum of fishing trip, which is from DKP of regency Morotai Island, Logbook of Pacific Tuna Fishers Cooperative, and statistic data sources from internet.

![Research location map](image)

**Figure 1.** Research location map

2.1. The productivity
The calculation for Productivity of catching result (catch per Unit Effort) used the pattern as below:

\[
CPUE = \frac{\text{Volume of catching (kg)}}{\text{Sum of catching trip}}
\]

2.2. Fishing season
The fishing season can count by used time series analysis (Moving Average) for the catching result data. [4], has arranged the steps as follows:

1) Arranging the CPUE series in the five years period
2) Arranging the average moves of CPUE in 12 months (RG)

\[
RG_i = \frac{1}{12} \left( \sum_{t=I}^{I+5} CPUE_t \right)
\]

Information:
- \( RG_i \) : the average moves in 12 months order to-\( i \)
- \( CPUE_i \) : CPUE order to-\( i \)
- \( I \) : 7,8,...., n+5

3) Arranging the average moves of the centered CPUE (RGP)
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RGP_i = \frac{1}{2} \left( \sum_{i=1}^{n} RG_i \right)

Information:
RGP_i : the average moves of centered CPUE to-i
RG_i : the average moves in 12 months order to -i

4) Average ration every month (Rb)

\[ Rb_i = \frac{CPUE_i}{RGP_i} \]

Information:
Rb_i : average ration in every month to-i
CPUE_i : CPUE order to-i
RGP_i : average move of centered CPUE to-i

5) Arranging the average value in a matrix with the size i x j which arranged in every month, start from Juli-Jun. Next, count the total value of average ration in every month, and then calculate the overall total average ratio and the catching season pattern.

a. Average Rasio for a month -i (RBB_i)

\[ RBB_i = \frac{1}{n} \left( \sum_{j=1}^{n} Rb_{ij} \right) \]

Information:
RBB_i : the average from Rb_{ij} for month-i
Rb_{ij} : monthly average ration in sized matrix i x j
I : 1, 2, ..., 12
J : 1, 2, 3, ..., n

b. The total of monthly average ratio (JRBB)

\[ JRBB = \sum_{i=1}^{12} RBB_i \]

Information:
JRBB : a total of monthly average ratio
RBB_i : the average Rb_{ij} for a month -i
I : 1, 2, 3, ..., 12

C. The catching season index

\[ FK = \frac{1200}{JRBB} \]

Information:
FK : correction factor value
JRBB : a total of monthly average ration

The calculation of catching season index was used the formula:

\[ IMP_i = RBB_i \times FK \]

Information:
IMP_i : caching season index month -i
RBB_i : average ration for a month -i
FK : correction factor value
I : 1, 2, 3, ..., 12
3. Result and discussion

3.1. Result

3.1.1. The productivity of Tuna in Regency Morotai Island. The data result of production and efforts on fishing Tuna in the regency of Morotai Island’s waters on years 2009-2016 can see on Table 1, which is showed that the more efforts on catching Tuna will decrease the productivity of it. This can be seen from the CPUE got decreased if the catching effort value increased.

| No | Years | Catch (ton) | Effort (Trip) | CPUE (ton/trip) |
|----|-------|-------------|---------------|-----------------|
| 1  | 2009  | 808.81      | 1260          | 0.642           |
| 2  | 2010  | 808.18      | 1260          | 0.641           |
| 3  | 2011  | 1156.5      | 840           | 1.377           |
| 4  | 2012  | 1089.1      | 672           | 1.621           |
| 5  | 2013  | 1050        | 2880          | 0.365           |
| 6  | 2014  | 1219.3      | 730           | 1.670           |
| 7  | 2015  | 1350.3      | 40908         | 0.033           |
| 8  | 2016  | 1350.3      | 40908         | 0.033           |
|    | Total | 8832.490    | 89458         | 6.382           |
|    | Average value | 1104.061 | 11182.250 | 0.798 |

Source: [5–12]

![Figure 2. CPUE value and trendline](image)

3.1.2. The pattern of fishing Tuna’s season in Regency of Morotai Island. The pattern of fishing Tuna’s season in the regency of Morotai Island was analyzed using the time series analysis (moving average). From the analysis result of moving average it got season pattern index (IMP) value which can see in Table 2. The highest value of season pattern index showed the peak of fish season.

| No | Months | IMP Value (%) |
|----|--------|---------------|
| 1  | January| 89.46         |

![Table 2. Catching season index](image)
3.2. Discussion

Table 1 and Figure 2 showed that although the fluctuated production was an inclined increase, the productivity was decreased. This can indicate to be the reduction of catching efforts. [8] and [12] showed that there is a change of types and numbers of catching Tuna’s merchant in regency of Morotai Island. In 2009 there is the merchant fish (Tuna)’s line and fishing rod as tools to catch Tuna. Meanwhile in 2016 until now he fishing tools that used just fishing rod and catching merchant with low capacity, which is 1.5-5 GT. [13] said that the used of simple catching technology is one of the causes of Tuna’s utilization as it has not optimal in Indonesia.

Figure 3 showed that fishing Tuna’s season in Regency of Morotai Island’s waters happened in the whole year when the peak season happened in March and May. The peak season of catching Tuna on March is not only happened in the regency of Morotai Island’s waters, but also in the other places. [1] Lintang et al. (2012) said that the peak of fishing Tuna’s season in the ocean of Maluku also happened in March. By acknowledging the pattern of fishing season could be the way of increasing the production of Tuna. The improvement from the effort’s unit of catching on Tuna’s peak season, which is March and May are certainly can give the optimal result to the fishers.

4. Conclusion

The conclusions of this research are: (1) The productivity of catching Tuna in the regency of Morotai Island is 0.78 tons/year; (2) The catching fish season in the regency of Morotai Island is happening throughout the year with the peak of on March and May.
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