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CPUE analysis of skipjack tuna (*Katsuwonus pelamis*) at the Sibolga Nusantara Fishery Port

To cite this article: A Fadhilah *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **260** 012112

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CPUE analysis of skipjack tuna (*Katsuwonus pelamis*) at the Sibolga Nusantara Fishery Port

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Abstract. The study aims to analyse the value of CPUE and the factors which influenced the Skipjack Tuna fishing production at the Sibolga Nusantara Fisheries Port (PPN). This research was conducted at PPN Sibolga, Central Tapanuli Regency. The research was conducted using a descriptive method with sample of 40 fishermen of purse seine vessels (ship captains) determined through purposive sampling technique. Data analysis techniques were carried out by using CPUE value analysis and multiple linear regression analysis. The results showed that: (1) CPUE value of Skipjack Tuna landed at PPN Sibolga for a period of 6 years (2011-2016) experienced fluctuating decline and increase. The average CPUE value was 199.70 kg/trip. The highest CPUE value occurred in 2016 was 412.24 kg/trip and the lowest CPUE value occurred in 2015 was 32.70 kg/trip; (2) partially, the factors of the fisherman experience, the size of the ship, the power of the engine and the length of the trip had a significant effect on the skipjack tuna fishing production. Meanwhile, the amount of fuel did not have a significant effect. Trip duration was the dominant factor or had a strong influence in the fishing production of skipjack tuna.

1. Introduction

Sibolga is one of the municipalities in the North Sumatra Province which is located on the West Coast of Sumatra and is directly opposite to the Indian Ocean and is one of the fishing grounds in Sibolga. Sibolga becomes one of the cities with a population are mostly fishermen. Fisheries in Sibolga have shown a relatively significant progress. This can be seen as the fisheries businesses become the main livelihood of the population occupying the coastal area of Sibolga. The development of fishing production in Sibolga City also experienced ups and downs periods. Based on BPS data from Sibolga, fish production in Sibolga in 2012 reached 54,880 tons, in 2013 it reached 54,098 tons, in 2014 reached 54,840 tons, in 2015 reached 52,445 tons and in 2016 reached 48,921 tons [1].

The fisheries production in Sibolga experienced fluctuations in every year [2]. This proves that the fishing potential in the coast of West Sumatra is quite large and promises to manage and improve the welfare of the community. From the total amount of fisheries production, there are various kinds of fish produced by fishermen in Sibolga.

Skipjack tuna (*Katsuwonus pelamis*) is one of the largest fish species in the Sibolga waters which are potential and have high economic values. Therefore, lots of fishermen use various types of fishing gears and varying levels of technology to catch the fish, one of which is purse seine. The utilization of skipjack fish resources could be seen a lot, especially in Sibolga. The increasing demand for fish certainly has a positive effect for fisheries development.



In order to maintain the sustainability of the fish resources, an important step needs to be done is to conduct stock assessments to determine the sustainable potential, optimum efforts and the utilization of skipjack fish so that these fish resources remain sustainable and available in the future without damaging the population. Optimal effort is a fishing trip effort carried out to get the optimal fishing without damaging the sustainability of the resources [3]. The benefits of performing optimum effort level estimation so that the loss of time, effort and fishing operation costs can be minimized and the fishing effort carried out is expected to always achieve optimal results [3].

There are many factors that can be analysed directly and indirectly in fishing production. The direct factors are the number of crew members, number of feeds, and the number of trips. Meanwhile, the indirect factors are the size of the vessel (ships) / GT, engine power, and the amount of fuel. Production factor analysis is used to see the relationship between production and production factors [4]. The production factors used in this analysis are the amount of fuel (kilo litres), the experience of fishermen (years), the size of the ship (GT), engine power (PK), and the trip length (days).

This study aims to identify the value of CPUE of skipjack tuna and to analyse the production factors of skipjack tuna in the Sibolga Nusantara Fishery Port.

2. Materials dan method

2.1. Time and place

The research was conducted in Sibolga Nusantara Fishery Port, Saruddik District, Central Tapanuli Regency, which is geographically located at the coordinates of $1^{\circ} 43'7.66''$ LU and $98^{\circ} 47'44.56''$ BT. Figure 1.



Figure 1. Research location.

2.2. Research procedure

The research was carried out in two stages: 1) field survey of the research location in December 2017, and 2) field data collection from January to March 2018. The research method was descriptive method by reviewing data and focusing on a certain case of CPUE value and also the factors that influence the Skipjack Tuna fishing at the Sibolga Nusantara Fishing Port. The sample in this study was 40 purse seine ship captains who were determined by purposive sampling technique.

Data collection methods were observation and survey by collecting primary data and secondary data. Primary data were obtained by cross section through interviews with fishermen or purse seine ship captains by providing some questionnaires. Secondary data were obtained from daily TPI data at Sibolga Nusantara Fisheries Port (PPN) from 2011-2016.

2.3. Data analysis

2.3.1. *CPUE analysis.* The Skipjack fish caught were grouped based on the amount of fishing results and fishing effort (trip). Furthermore, the amount of skipjack fish caught per fishing effort or CPUE (Catch Per Unit Effort), was calculated by the following formula [5]

$$CPUE_i = \frac{catch_i}{effort_i} \tag{1}$$

$i = 1, 2, 3 \dots, n$

2.3.2. *Cobb-douglas model* to analyse the factors that influenced Skipjack fishing, the researcher used multiple regression analysis. Multiple regression is a statistical method to find the relationship between two or more variables by using the least square method (Ordinary Least Square) [6]. The analysis model for the production function is used in the Cobb-Douglas production function model. The model of the Cobb-Douglas function equation is as follows [7]

$$\ln Y = \ln \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \mu \tag{2}$$

Explanation:

- Y = Production results of skipjack tuna fishing
- X₁ = Amount of fuel
- X₂ = Fishing experience
- X₃ = Ship size
- X₄ = Engine power
- X₅ = Length of fishing trip
- β₀ = Constant
- β₁₋₆ = Variable regression coefficient X

3. Results and Discussions

3.1. Production of skipjack fish at Sibolga Nusantara Fishery Port

From 2011 to 2016, the production of skipjack tuna in the Sibolga PPN varied greatly and experienced a very fluctuating increase and decline. The highest production of skipjack tuna fishing in 2016 was 3,501.80 tons with an average production of 87.54 tons. The lowest fishing production occurred in 2014 which was 300.48 tons with the average production of 7.52 tons. This can be seen in Figure 2. Other facts showed that the production of skipjack tuna at Bitung PPS over a period of 5 years (2009-2013) increased every year. A significant increase occurred in 2013 which reached 48.5% of total production [8].

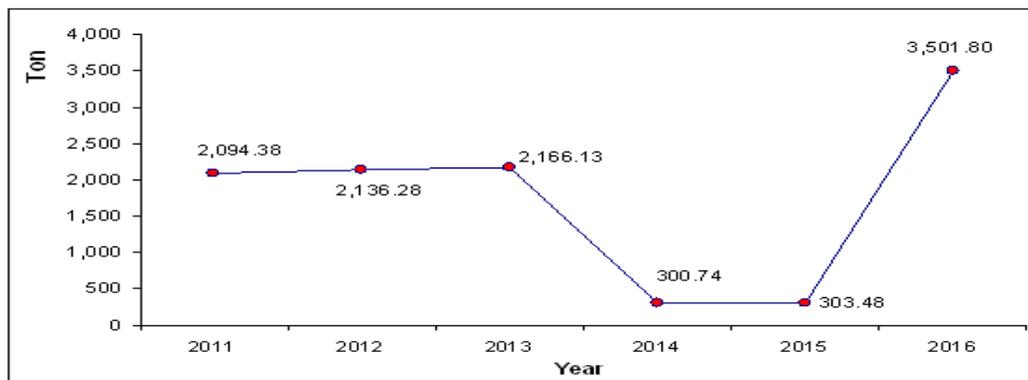


Figure 2. Production of skipjack fish at Sibolga Nusantara Fisheries Port (2011-2016).

3.2. Fishing effort (length of trip)

The fishing effort of skipjack tuna (Length of trip) by fishermen in this study was calculated in units of days per year. The trip length data in this study were obtained in the 6 years period (2011-2016). The results of the analysis showed that trip length of skipjack tuna fishing from 40 ship captains ranged from 125-275 days/year. This can be seen in Table 1.

Table 1. Fishing Effort (Length of Trip) (2011-2016)

| No. | Year | Length of Trip (days) | Average Length Trip (days) |
|--------------|------|--------------------------|-------------------------------|
| 1 | 2011 | 9,085 | 227.13 |
| 2 | 2012 | 8,445 | 211.13 |
| 3 | 2013 | 9,502 | 237.55 |
| 4 | 2014 | 9,176 | 229.40 |
| 5 | 2015 | 9,282 | 232.05 |
| 6 | 2016 | 8,313 | 207.83 |
| Total | | 53,803 | 1345.08 |

The total number of fishing effort (Length of Trip) by 40 fishing ships for 6 years (2011-2016) was 53,803 days with the average number of the length of trips for 6 years was 1,345.08 days. In 2011, the total length of trip was 9,085 days or the average was 227.13 days/ship. In 2012, the total length of trips was 8,445 days or the average length of trip was 211.13 days/ship. In 2013, the total length of trips was 9,502 days or the average length of trips was 237.55 days/ship. In 2014, the total length of trips was 9,176 days or the average length of trips was 229.40 days/ship. In 2015, the total length of trips was 9,282 days or the average length of trip was 232.05 days/ship. In 2016, the total length of trips was 8,313 days or the average length of trips was 207.83 days/ship.

3.3. CPUE (Catch Per Unit Effort) analysis

CPUE is a development indicator of sustainable fisheries resource utilization. The rising CPUE trend illustrates that exploitation can still develop, if CPUE trends are flat means the exploitation is near the saturation of effort, whereas if the CPUE trends decrease it is an indication of exploitation leading to overfished [9]. This can be seen in the table 2.

Table 2. Calculation of CPUE Skipjack Fish for 2011-2016

| No. | Year | Total of Production (kg) | Total Fishing Effort (trip) |
|----------------|------|-----------------------------|--------------------------------|
| 1 | 2011 | 2,094,378 | 9,085 |
| 2 | 2012 | 2,136,284 | 8,445 |
| 3 | 2013 | 2,166,132 | 9,502 |
| 4 | 2014 | 300,735 | 9,176 |
| 5 | 2015 | 303,478 | 9,282 |
| 6 | 2016 | 3,501,799 | 8,313 |
| Total | | 10,502,806 | 53,803 |
| Average | | 1,750,467.67 | 8,967.17 |

The declining trend of CPUE values of skipjack tuna in Sibolga waters indicates the presence of exploitation of skipjack fish resources and if it continues, it will lead to an over-fishing situation. Efforts

to regulate fishing and CPUE are not only by increasing the efficiency efforts or reducing business inputs, because CPUE is often associated with increased fishing operation skills, while fish stocks in the waters are decreasing. Therefore, the management actions in order to reduce fishing efforts will only partially be successful. However, exploitation using purse seines needs to pay attention to the symptoms of CPUE increase, because the impact of using trawls on the aquatic environment is very negative towards sustainable fisheries [10].

3.4. F Test

To analyse the simultaneous effects of production factors (the amount of fuel, the experience of fishermen, the size of the ship, the engine power and the length of trip) on the fishing production of skipjack, the researcher used the F test.

Table 3. Results of F-Test Analysis

| ANOVA ^b | | | | | | |
|--------------------|------------|----------------|----|-------------|---------|-------------------|
| Model | | Sum of Squares | df | Mean Square | F | Sig. |
| 1 | Regression | 1.100 | 5 | .220 | 127.148 | .000 ^a |
| | Residual | .059 | 34 | .002 | | |
| | Total | 1.159 | 39 | | | |

The analysis results obtained F-value of 127.148 with a significance value of $0.000 < 0.05$. Thus, it can be concluded that the factors such as the amount of fuel, the experience of fishermen, the size of ships, the power of engine and the length of trip simultaneously have a significant effect on the production of skipjack tuna. This can be seen in Table 3.

3.5. t- Test

The factors such as the amount of fuel, the experience of fishermen, the size of the ship, the power of engine and the length of trip influence partially the fishing of skipjack tuna which can be analysed using the t-test. The analysis results can be seen in Table 4.

Table 4. Results of t-Test Analysis

| Coefficients ^a | | | | | | |
|---------------------------|-------------------------|-----------------------------|------------|---------------------------|--------|------|
| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | -2.678 | .619 | | -4.322 | .000 |
| | Amount of Fuel | -.127 | .088 | -.105 | -1.449 | .157 |
| | Experience of Fishermen | -.045 | .019 | -.094 | -2.372 | .024 |
| | Size of ships | .235 | .039 | .395 | 6.076 | .000 |
| | Power of Engine | -.154 | .061 | -.193 | -2.535 | .016 |
| | Length of trip | 1.189 | .130 | .888 | 9.132 | .000 |

a. Dependent Variable: Results of Skipjack Catches

Partial analysis results obtained as follows:

- Amount of fuel variable (X1) partially has no significant effect on the fishing production of skipjack tuna. This is indicated by the significance value (sig.) of $0.157 > 0.05$.
- Fishermen experience variable (X2) partially has significant effects on the fishing production of skipjack tuna. This is indicated by the significance value of $0.024 < 0.05$.
- Size of ships variable (X3) partially has significant effects on the fishing production of skipjack tuna. This is indicated by the significance value of $0.000 < 0.05$.

- d. The engine power variable (X4) partially has significant effects on the fishing production skipjack tuna. This is indicated by the significance value of $0.016 < 0.05$.
- e. The length of trip variable (X5) partially has significant effects on the fishing production of skipjack tuna. This is indicated by the significance value of $0,000 < 0.05$.

The results of the t-test show that the fishermen experience variables (X2), ship size (X3), engine power (X4) and trip length (X5) partially have significant effects on the fishing production of skipjack tuna at Sibolga Nusantara Fisheries Port. While the fuel amount variable (X1) has no significant effect. The fishermen experience variable has a significant effect on the fishing production of skipjack tuna. In doing fishing efforts at the West coast of North Sumatra waters, most of the fishing areas were determined by fishermen by using traditional methods such as instincts or experiences by paying attention to the condition of the waters. This indicates that the fishermen experience is one of the influential factors of fishing efforts especially in the skipjack fishing production in Sibolga. The data from research findings show that the majority (37.5%) of respondents have experienced being fishermen ranged from 15 to 22 years.

The experience of the ship's captain has a real and significant effect on the fishing results of the purse seine vessels. The more skilled or experienced the captain in fishing, the bigger impact on increasing fishing production will be. The experience of understanding the waters conditions will certainly be very useful, especially to determine the fishing grounds [11].

The ships size (GT) is also one of the influential factors of fishing production. In this case, the larger the size of the ships (capacity or volume of the ships), the more fish can be carried. The findings of the study show that the size of fishing boats used by the respondents or research samples ranged from 35-99 Gross Tonnage (GT) and the majorities (35%) have a ship size between of 71-90 GT.

Engine power (PK) is also an influential factor of the fishing production. The engine power of the ship greatly determines the speed of the ship needed when chasing the fish hordes and circling the purse seine fishing gear around the moving fish hordes. Therefore, the fishermen must optimize the strength of the machine when processing the fishing gear. The dimensions of the fishing ships used must also be adjusted to the engine power (PK). The research findings show that the engine power of the purse seine in Sibolga ranges from 160-420 PK and the majority (60%) have engine power of ships between 301-400 PK. Ships with relatively high speeds can block or compete with fish swimming speeds. Therefore, fishing ships that move relatively faster than fish swimming speed will increase the chances of catching the fish. With a strong engine power, the process of circulating and blocking the fish hordes is also faster, so the possibility of fish to escape is also smaller [12].

3.6. Production factor analysis

The production function model used in the analysis of the influential factors of the skipjack fishing using purse seine fishing gear is a multiple regression model of Cobb-Douglas production function. The results of the analysis were obtained through the following equation:

$$\ln Y = -2.678 - 0.127 \ln X_1 - 0.045 \ln X_2 + 0.235 \ln X_3 - 0.154 \ln X_4 + 1.189 \ln X_5 \quad (3)$$

Explanation:

- Ln Y : Skipjack tuna fishing production (Ton)
- Ln X₁ : Amount of fuel (Kilo litre)
- Ln X₂ : Experience of fishermen (Year)
- Ln X₃ : size of ships (GT)
- Ln X₄ : power of engine (PK)
- Ln X₅ : length of trip (Day)

The assumptions that can be explained from the results of the Cobb-Douglas production function multiple regression model are factors in the amount of fuel (-0.217), fisherman experience (-0.045), ship size (0.235), and engine power (-0.154) that has an elasticity value of < 1 , which means that the proportion of the addition of amount of fuel, fisherman experience, ship size, and engine power factors

exceeds the proportion of additional production of skipjack tuna (Decreasing return to scale). While the length of trip factor has an elasticity value of > 1 , which means that the proportion of the addition of the length trip factor will result in an increase in the production of larger skipjack tuna (Increasing return to scale).

The Cobb-Douglas multiple regression equation model shows that all four factors of fishing production namely the amount of fuel, the experience of fishermen, the size of the ship, the engine power and the length of trip have an effect on declining and increasing the fishing production of skipjack tuna. These results indicate that the length trip is a dominant factor or has a strong influence on the fishing production of skipjack tuna.

4. Conclusions

The value of CPUE (catch per effort) of skipjack tuna at Sibolga Nusantara Fisheries Port over a period of 6 years (2011-2016) shows a fluctuating decline and increase. The average CPUE value is 199.70 kg/trip. The highest CPUE value occurred in 2016 which was 412.24 kg/trip and the lowest CPUE value occurred in 2015, which was 32.70 kg/trip.

Factors such as the amount of fuel, the fishermen experience, the ship size, the engine power and the length of trip simultaneously (concurrently) have a significant effect on the fishing production of skipjack at the Sibolga Nusantara Fisheries Port. Partially, the fishermen experience, ship size, engine power and the length of trip factor have a significant effect on the fishing production of skipjack. Meanwhile, the amount of fuel does not have a significant effect. The length trip is the dominant factor or has a strong influence in the fishing production of skipjack tuna.

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