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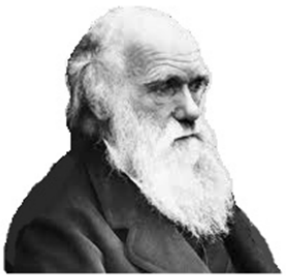

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Relationship between Length and Mouth Opening of Skipjack Tuna (*Katsuwonus pelamis*) in the Waters of Palabuhanratu Sukabumi Regency

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ABSTRACT

Skipjack tuna (*Katsuwonus pelamis* (Linnaeus, 1758)) is one of the main commodities of Palabuhanratu capture fisheries with a percentage of 14% or 422.701 kg of total capture fisheries production in 2017. The purpose of this research is to analyze the correlation between length and mouth opening of skipjack tuna (*Katsuwonus Pelamis*) in the waters of Palabuhanratu Sukabumi Regency. The sample was collected in June until August 2019 at the Palabuhanratu Fishing Port, Sukabumi Regency. Skipjack tuna observed during the research had a total length range from 250 until 730 mm FL. The pattern of length and opening mouth relationships of skipjack tuna can be seen from the regression and correlation values. The results obtained were collected combined Y = 0.8064x – 0.2283 and R2 = 0.7786. Correlation value of the length and mouth opening relationship of skipjack tuna was 0.88. The level of length-mouth opening relationship of skipjack tuna is highly interrelated.

***Keywords*:** length-mouth opening relationship, correlation value, Palabuhanratu waters, skipjack tuna, *Katsuwonus pelamis*

1. INTRODUCTION

Skipjack tuna (*Katsuwonus pelamis*) is one of the main commodities of Palabuhanratu capture fisheries with a percentage of 14% or 422.701 kg of total capture fisheries production in 2017. Skipjack tuna production from 2013 until 2017 in Palabuhanratu waters is 422.701 kg, the most *Katsuwonus pelamis* production was 606.044 kg in 2015, while the least production

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was 134.792 kg in 2016. This decrease in catch can be caused by increasing consumer demand, increased fishing efforts by fishing gear that are different from skipjack tuna.

Skipjack tuna spreads in the Indian Ocean and Atlantic Ocean region between 40º N - 40º S. Specifically in Indonesia, tuna species are spread almost in all Indonesian waters. The spread of skipjack tuna is divided into two kinds, namely horizontal distribution, and vertical distribution, namely distribution according to depth. The spread of skipjack tuna is directly and indirectly affected by oceanographic conditions, such as temperature, salinity, dissolved oxygen, thermocline structure, basic topography, water clarity, currents, water mass and biological productivity. These oceanographic characteristics are important for the spatial distribution of skipjack tuna in tropical waters, such as Indonesia. Skipjack tuna usually occupy high-salinity waters which is around 32-35 ppt. The condition of water salinity is related to the emergence of currents that cause abundant food availability.

Catching tuna (**Figure 1**) can be done throughout the year. The fishing season usually occurs during the east season and not the fishing season occurs during the west season. During the east monsoon, the condition of the waters is relatively calm so that it makes catching easier. In the west monsoon, the large waves and strong currents make it difficult to catch. Skipjack tuna are sensitive to changes in environmental conditions because they are capable of large-scale relocation in the search for suitable environmental conditions that satisfy their physiological needs.

Fishing gear used by skipjack tuna fishermen in the waters of Palabuhanratu Sukabumi Regency is in the form of trolling. Trolling or troll line fishing is a traditional fishing gear that is operated to catch pelagic fish species, such as tuna, skipjack tuna, and cob. Trolling is operated during the day by the habit of eating large pelagic fish. In general, troll line ships are equipped with navigation tools such as Global Position System (GPS) and compass. Tonda operation is done by pulling it horizontally with the bait position still close to the surface of the water. The fishing line is given false bait which, due to the influence of the moving in the water, can stimulate the fish to grab it.

Mouth dimensions represent the largest size of food that can be swallowed by fish or ontogenetically, the larger the size of a fish, the bigger size of food can be swallowed. Increasing the age and length of the body will be followed by an increase in the width of the fish's mouth opening as an adaptation of food habits strategies.

There are various types of fish's mouth shape and it is closely related to the type of food it eats. Morphological characters of the mouth were observed including the position of the mouth, the position of the upper and lower jaw and the shape of the mouth tip.

According to Abulias and Bhagawati (2012), the location or position of the fish's mouth can be divided into four namely inferior, subterminal, terminal, and superior. Skipjack tuna is one of the fish that is included in the terminal mouth position.

Determination of fish mouth opening values, according to Shirota (1977), can be measured by measuring the width of the mouth opening and the length of the fish's maxilla. Measuring fish mouth openings is done by measuring fish mouth from top to bottom when the fish's mouth is wide open. Therefore the measurement of fish mouth openings is usually performed in vertical fish mouth opening position.

The position of the mouth of a fish that can be puffed up (jaw protrusion) in some groups of fish is thought to help increase the success of catching prey. Not only attacking suddenly, but when it will catch its prey, the fish is able to poke its mouth to increase the distance of about 35% of the length of the head so that it has a longer reach to catch prey.

Length-mouth opening relationships information in biological fisheries is one of the information that should be acquired for determining fishing gear selectivity in order to catch only decent-sized fish.

Figure 1. Pacific Skipjack tuna (*Katsuwonus pelamis* (Linnaeus, 1758))
(Sea Grant California, 2018)

The purpose of this research is to analyze length-mouth opening relationships of skipjack tuna in Palabuhanratu waters. This research is expected to give an information and advice for management of skipjack tuna in Palabuhanratu waters Sukabumi Regency, West Java, Indonesia.

2. MATERIALS AND METHODS

2. 1. Time and Research Location

This research was conducted in March until September 2019. The sample was collected in June until August 2019 at the Palabuhanratu Fishing Port, Sukabumi Regency, West Java.

2. 2. Materials and Tools

The material is *Katsuwonus pelamis* caught using troll line in Palabuhanratu waters. The instruments used in this research were ruler (1 cm accuration), calipers, stationery, and camera.

2. 3. Methods

Fish sampling was carried out using the stratified random sampling method. Fish samples were taken from five different piles that randomly selected. Fish samples were taken based on how small, medium and large sizes in each pile. The fish samples were collected from the five stacks of 90-100 each. Sampling was done once every month for three months.

2. 4. Data Analysis

2. 4. 1. Length-Mouth opening Relationship

Analysis of the length-mouth opening (**Figure 2**) relationship was done using the equations by [18] as follows:

$$D = \sqrt{2.AB}$$

where : D = fish mouth opening (cm)
A = the upper end of the jaw
B = the meeting point between the upper jaw and the lower jaw.

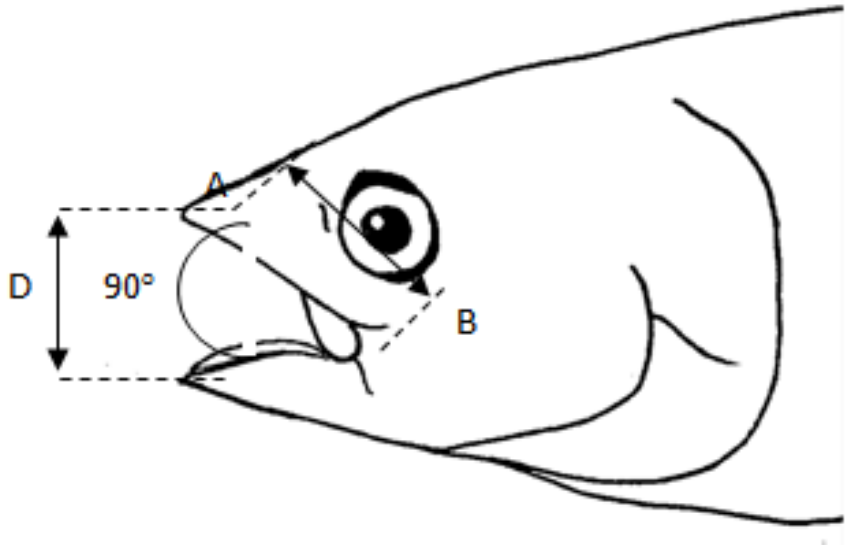


Figure 2. Measurement of Skipjack Tuna's Mouth Opening

Linear regression was used to compare the length of fish with the mouth opening of skipjack tuna [22]. Simple linear regression equation:

$$Y = a + b\,(x)$$

where : a = constant
b = regression coefficient
x = independent variable
Y = dependent variable.

Correlation value is used to measure how close the relationship between length and mouth opening of fish refers to the guidelines for interpretation of correlation coefficients according to Akoglu (2018), which can be seen in the following **Table 1**.

Table 1. Guidelines for interpreting the correlation coefficient.

Coefficient Interval	Relationship Level
0.00-0.19	Very low
0.20-0.39	Low
0.40-0.59	Middle
0.60-0.79	Strong
0.80-1	Very strong

3. RESULTS AND DISCUSSION

3. 1. Distribution of Length Frequency

Skipjack tuna observed during the 3-month study from June to August 2019 totaled for 334 fish: a total of 100 in June, 100 in July, and 134 in August. The minimum length of skipjack tuna caught is 236 mmFL and the maximum length of fish caught is 730 mmFL.

In June 2019 the minimum length of skipjack tuna caught was 250 mmFL and the maximum length caught was 730 mmFL. In July 2019 the minimum and maximum length of skipjack tuna caught was 310 mmFL and maximum length caught was 615 mmFL, whereas in August the minimum length of fish caught was 236 mmFL with the maximum length of skipjack tuna caught of 650 mmFL. Overall the highest skipjack tuna frequency is 160 fish at intervals of 341 - 446 mmFL, with a minimum length of caught 236 mmFL and a maximum length of caught equaling 730 mmFL (**Figure 3**).

Based on Figure 3, in June 2019 the minimum length of skipjack tuna caught was 250 mmFL and the maximum length caught was 730 mmFL. In July 2019 the minimum and maximum length of skipjack tuna caught was 310 mmFL and 615 mmFL, whereas in August the minimum length of fish caught was 262 mmFL with the maximum length of skipjack tuna caught equaling 670 mmFL. Overall, the highest skipjack tuna frequency was 86 fish at intervals 341-393 mmFL and 74 tails at intervals of 394-446 mmFL, with a minimum length of caught 250 mmFL and a maximum length of caught equaling 730 mmFL.

The results of the long frequency analysis can be seen in Figure 3 the length frequencies obtained during the study ranged from 250-730 mmFL. The maximum length of skipjack tuna found in the waters of Palabuhanratu is 730 mmFL. Based on research by Nurdin and Anthony (2018) [24] conducted in Palabuhanratu, the maximum length of fish caught is 620 mmFL. The most caught tuna in Palabuhanratu waters are in the class 341-393 mmFL with 86 fish and 74 fish at an interval of 394-446 mmFL.

The first measure of gonad skipjack tuna in Palabuhanratu waters, both male and female, was 520 mmFL. Based on the research results of skipjack tuna in the waters of Palabuhanratu, Sukabumi Regency, there were 180 fish from a total of 334 fish (53.89%) of fish caught at the mature gonad age.

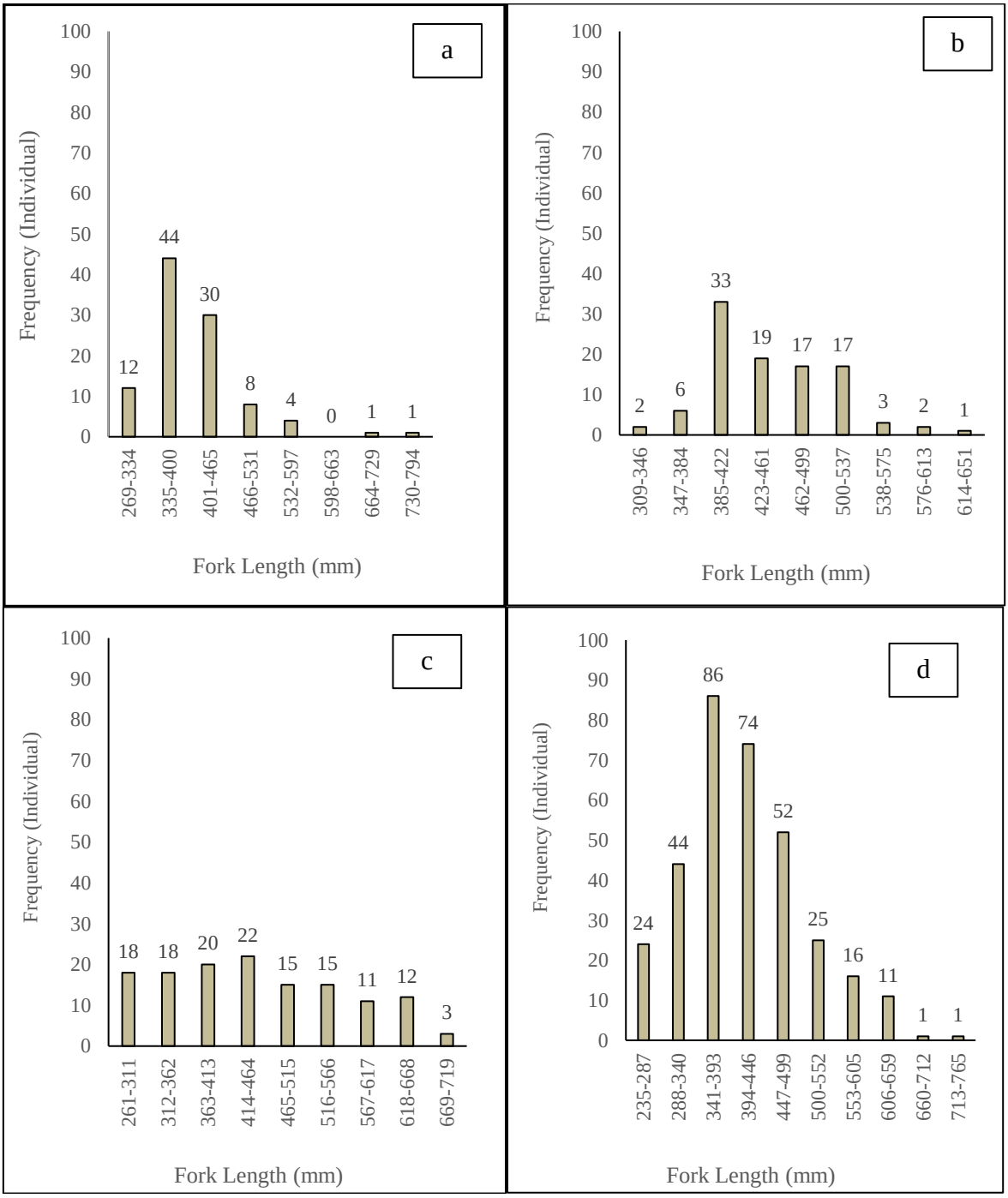


Figure 3. Frequency Distribution of Skipjack Tuna in 2019 based on the Month: a) June, b) July, c) August, d) Combined (Remark: FL stands for Full Length // Fork Length)

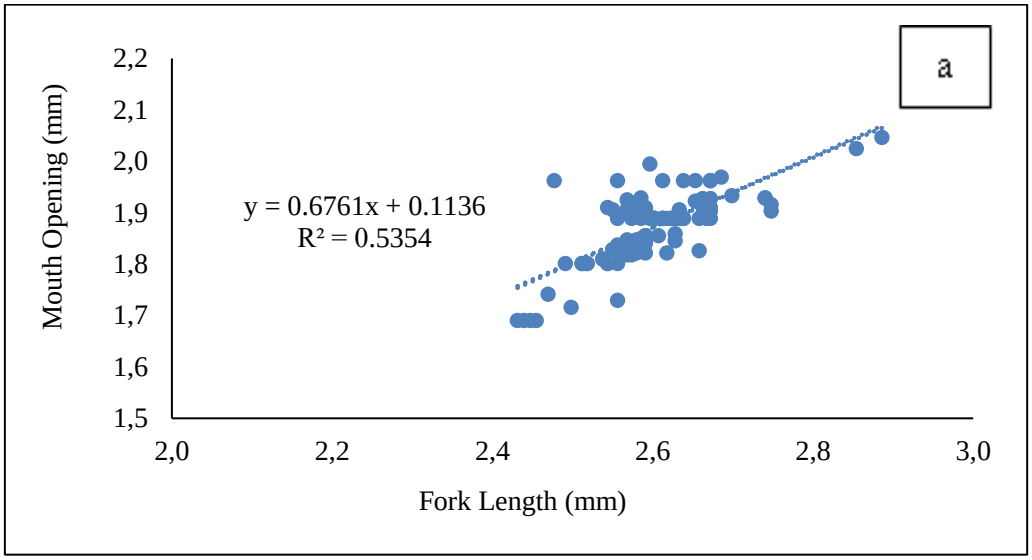
Based on the results of the study, the smallest size of the skipjack tuna caught was 250 mmFL. The fork length of the results of this study is the same as that of Restiangsih and Khairul (2018), the length of the fork length ranges from 250-740 mmFL.

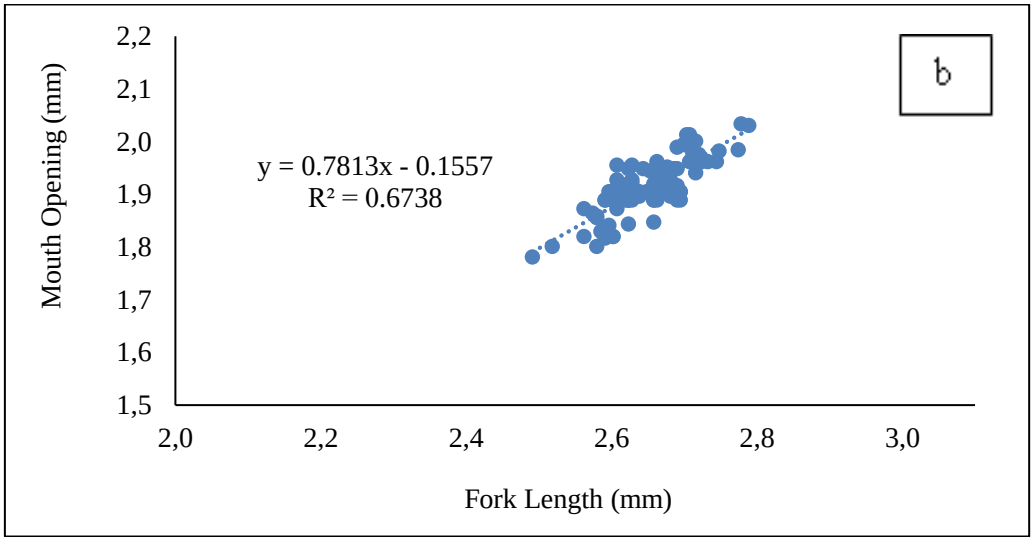
Size difference of skipjack tuna in Palabuhanratu waters, with research carried out in the waters of the bay of Maluku and the waters of Maluku Province is allegedly due to differences in fishing gear used, environmental conditions, and variations in the fishing intensity.

The difference in frequency of each size class is caused by several factors, among others. Internal factors that can affect the growth of fish such as heredity, sex, age and disease. It is obvious that external factors which affect fish growth are temperature and food (27-28). The maximum total length of skipjack tuna caught in Palabuhanratu waters is 730 mmFL greater than the maximum total length of skipjack tuna originating from the same waters based on research results which is 600 mmTL. This can indicate a high fishing pressure on skipjack tuna.

3. 2. Length-Mouth opening Relationship

The length of the skipjack tuna is closely related to the mouth opening, the existence of a relationship between the two can be seen in **Figure 4**.





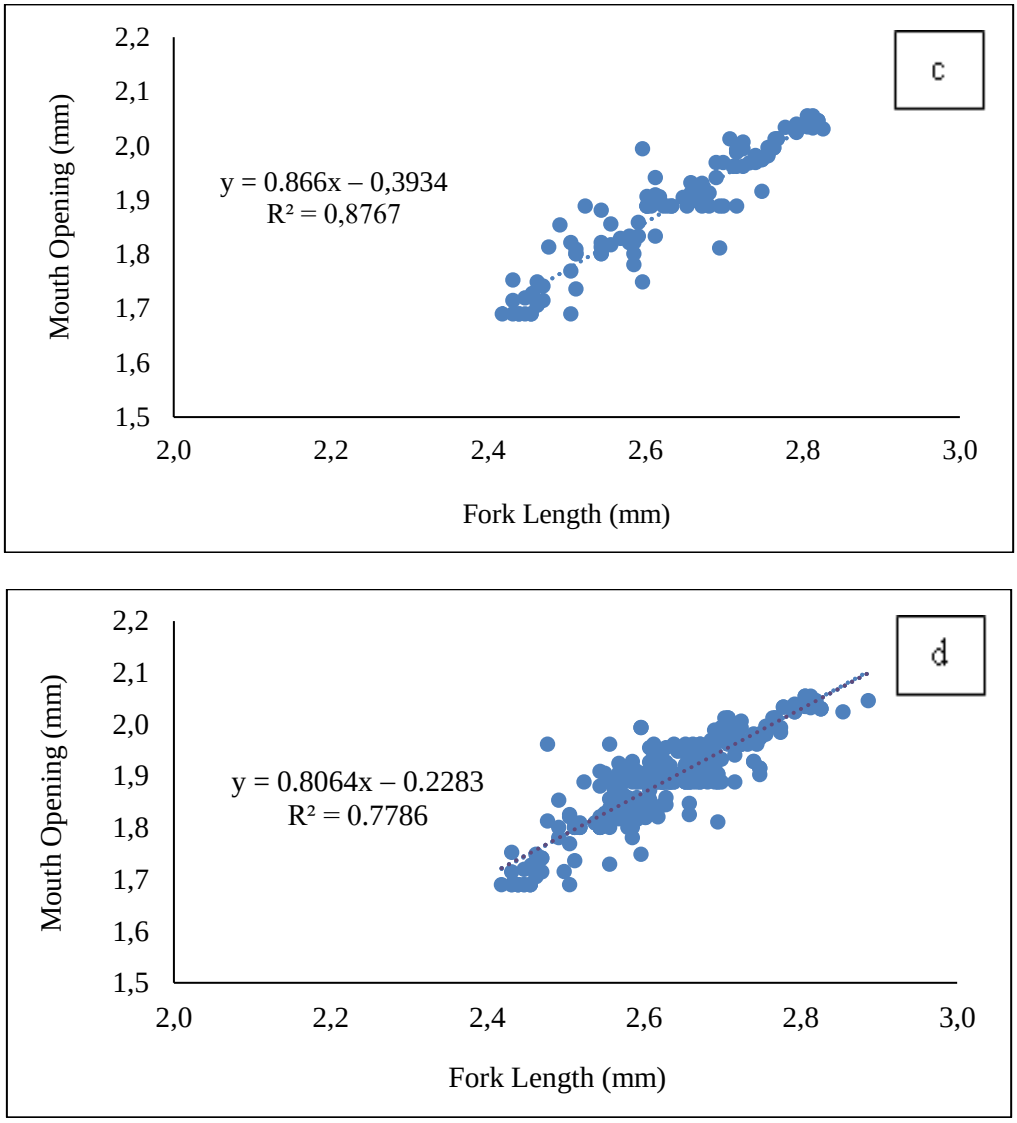


Figure 4. Long Regression with Mouth Openings of Skipjack Tuna in the waters of Palabuhanratu in 2019 by month: a) June, b) July, c) August, d) Combined (Remark: FL stands for Full Length // Fork Length)

The pattern of long and opening relationships of skipjack tuna can be seen from the regression and correlation values. Regression value (R^2) is used to see the percentage of the magnitude of the effect of length on fish mouth openings. Correlation value is used to measure how close the relationship between length and mouth opening of fish refers to the guidelines for interpretation of correlation coefficients according to Akoglu (2018) which can be seen in the following **Table 2**.

Based on Figure 4, the results of each sampling conducted during the study showed that the long relationship with the mouth opening of the tuna is not much different in each month. The results obtained when combined (Figure 4d) are Y = 0.8064x – 0.2283 and R^2 = 0.7786. The coefficient of determination (R^2) shows the relationship between length and mouth opening

of fish 77% is influenced by the length of skipjack tuna. Correlation value of the length and mouth openness of skipjack tuna obtained by 0.88 is in the coefficient interval of 0.80-1, meaning that the level of relationship between length and mouth opening of the tuna is very strongly interrelated, because the longer the skipjack tuna, the more skipjack tuna mouth openings are also wide. The length and opening relationship of skipjack tuna tends to increase and remain. This can help fishermen in choosing the size of the fishing rod that will be used by fishermen to get the desired size of the tuna.

Table 2. Guidelines for interpreting the correlation coefficient.

Coefficient Interval	Relationship Level
0.00-0.19	Very low
0.20-0.39	Low
0.40-0.59	Middle
0.60-0.79	Strong
0.80-1	Very srong

4. CONCLUSIONS

The Skipjack tuna (*Katsuwonus pelamis* (Linnaeus, 1758)) in Palabuhanratu water had a fork length range of 250-730 mmFL. Correlation value of the relationship between the length and mouth opening of skipjack tuna by 0.88 shows the level of relationship between them is very strong in the aspect of growth.

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