Length frequency distribution and length-weight relationships of *Euthynnus* sp. in North Sumatera, Indonesia

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**Abstract.** North Sumatra is one of the provinces that has a large fishery potential. The total catch of in North Sumatra reached 380,349 tons in 2016. This research to determine the growth pattern of *Euthynnus* sp. that caught in the waters of Nias Island, North Sumatra. Sampling was carried out in July 2020. The study was conducted by following fishing operations on purse seine vessels start from Sibolga City. Sample of 59 fish were taken randomly during the operation of the fishing gear in one trip. Length of fish was measured using a ruler (nearest: 1 mm) and weight of fish was measured using a digital scale (nearest: 1 g). The result of this research was the total length of the fish about 350–530 mm. There were 7 classes Length Distribution of fish that caught in July 2020. The highest frequency of total length was 401-427 mm. The growth pattern of *Euthynnus* sp. was positive allometric growth (b > 3). The Formula for Length-Weight Relationships is $W = 0.06L^{3.2611}$ ($r = 0.97$). The length-weight relationship can describe the condition of fish population growth and the symptoms of fishing in nature. This is necessary to support the management of fishery resources.

**Keywords:** growth pattern; length-weight relationships; length frequency distribution.

1. Introduction

Province of North Sumatra is one of the provinces that has a large enough fishery potential. In 2016, based on data from BPS Province of North Sumatra, the catch of North Sumatra fishermen reached 380,349 tons [1]. North Sumatra Province has 33 regencies and cities, some of which are one of the largest potential areas for fisheries man agement [2]. The fishing gear used by fishermen are purse seines, lift nets, gillnets, traps, seine nets, hook and line. Purse seine is the dominant fishing gear. The production of purse seine in one trip about 22,699,000 kg [3]. The fishing area for purse seine fishing gear is in deep water areas, namely in WPP 572 (Indian Ocean west of Sumatra and the Sunda Strait). The dominant fish species caught by purse seine vessels are tuna (*Euthynnus* sp.), skipjack (*Katsuwonus* sp.), bloated fish (*Rastrelliger* sp.) and baby tuna (*Thunnus* sp.) [4] [5]. The catch is unloaded and accommodated in fish landings orlanding sites, besides being marketed locally, it is also exported outside the region [6].

*Euthynnus* sp. is a large pelagic fish, belonging to the Scombridae family. The common name of *Euthynnus* sp. in Indonesia is Tongkol [7]. *Euthynnus* sp. is a pelagic species and fast swimmer, this fish is often found and lives in the neritic zone [8]. *Euthynnus* sp. is carnivorous with the main food being anchovies [8]. The fish consumed by the Indonesian people mainly comes from small pelagic fish, and 10% of them are types of *Euthynnus* sp. [9]. The production fluctuations, especially the increase in production value resource can occur the over exploitation. In this case, tuna in Sumatra waters raises concerns about the potential of these resources, so there is a need for an assessment to regulate the utilization of tuna resources [10] [11].

The length-weight relationship is useful for study of fisheries because: (a) use in stock assessment models, because it can be conversion of the growth-in-length equation to growth-weight; (b) can be used to estimation of biomass if the observation was a long time; (c) can be estimation the condition of fish, and (d) can be useful for comparisons of cross-regional the life histories of some species of fish [12] [13].
They are an important component of the Fish Base [14]. Therefore, the length-weight relationship often be a popular tool to provide the information that supporting the assessment of fish stocks in the world [15][16]. The research of the length–weight relationship of fish was to determine the specific weight and length variations of fish individually or in groups of individuals as an indicator of factor condition, health, productivity and physiological conditions including gonadal development [17][18]. In this study, the relationship between length and weight also length frequency distribution of Euthynnus sp. caught by purse seine that operating around the waters of Nias Island, North Sumatra was analysed.

2. Materials and methods

2.1. Sampling technique

The study was conducted in July 2020. The study was conducted by following the operation of a purse seine ship departing from the Nusantara Fisheries Port (PPN) Sibolga, North Sumatra. The fishing grounds are located around the waters of Nias Island, North Sumatra. The research area is presented in figure 1. The data taken in the form of data on length and weight of tuna caught during the fishing trip. Samples were taken randomly. Length of fish was measured using a ruler (nearest: 1 mm) and weight of fish was measured using a digital scale (nearest: 1 g).

2.2. Data analysis

2.2.1. Length frequency distribution. The length frequency distribution is obtained by determining the class interval, the width of the class interval, the middle value of the class, and the frequency in each length group. The long frequency distribution that has been determined in the same class interval is then plotted in a chart.

2.2.2. Length-weight relationship and growth pattern. Measurements of length and weight were used to calculate parameters a and b that used a linear allometric model [19]. The allometric model:

\[ W = aL^b \]  

Where:  
\( W \) = body weight (gram)  
\( L \) = total length (mm)  
\( a \) and \( b \) = polynomial equation constants
The equation model (1) was transformed into a linear equation as follows:

\[ \ln W = \ln a + b \ln L \]  

(2)

\[ Y = a + bX \]  

(3)

The values \( a \) and \( b \) in equation (3) are constant regression equations obtained through simple linear regression analysis with independent variables (X) is "\( \ln L \) data" and dependent variables (Y) is "\( \ln W \) data" in linear regression equations (2). The coefficient of determination \( (r^2) \) and correlation \( (r) \) of the equation of the length and weight relationships were calculated using Microsoft Excel.

These are the criteria for fish growth patterns based on the constant \( b \) value test:

- \( b = 3 \), isometric growth pattern, meaning that the weight gain of the fish is balanced with the increase in length;
- \( b \neq 3 \), allometric growth pattern, meaning that the weight gain of fish is imbalanced with the increase in length;

There are 2 types of allometric growth pattern as follows:

- \( b > 3 \), positive allometric growth pattern, meaning that the weight gain of fish is faster than the length gain
- \( b < 3 \), negative allometric growth pattern, meaning that the weight gain of fish is slower than the length gain.

Figure 2. Length frequency distribution of *Euthynnus* sp.

Figure 3. Length-weight relationship of *Euthynnus* sp.
The value of \( b \) can be obtained by performing t-test (anova) on the data in the form of "ln L data" and "ln W data".

**3. Results and discussion**

**3.1. Length frequency distribution**

The number of samples of tuna (Euthynnus sp.) that observed in the study were 53 individuals. Based on the research, the caught of Euthynnus sp. has a total length of 350 – 530 mm (figure 2.) Based on the analysis of the length frequency distribution, the length frequency of tuna (Euthynnus sp.) samples that the most caught is 401-427 mm. Another study stated that the total length of gray tuna (Thunnus tonggol) is 39.5 cm – 67.5 cm and the fish weight is between 956 - 4847g [8]. The total length of tuna (Euthynnus affinis) between 10-28.2 cm [20]. Food factors and environmental factors greatly affect the growth of fish resources, in this case including tuna [21]. The diet of tuna usually includes Crustaceans, Mollusca, Anthophyta and some small pelagic fish (Stolephorus sp. and Sardinella sp.). Supporting environmental conditions and oceanographic parameters that affect the growth of tuna [22].

**3.2 Length-weight relationship and growth pattern**

The fish growth patterns can predicted by the polynomial length-weight equation [23]. Based on the analysis of the relationship between the length and weight of Euthynnus sp., it can be seen that the tuna caught in the waters of the North Sumatera has a positive allometric growth pattern. This is known based on the value of \( b \) on t-test and the results of the power graph analysis (figure 3) with the equation \( W = aL^b \).

The value of \( b \) based on the t-test (\( \alpha=0.5 \)) is 3.280 (\( b>3 \)). The tuna caught in the waters of the North Sumatera has a positive allometric growth pattern. This means that the weight growth of the fish is greater than the growth of the length of the fish. Growth patterns in fish can vary. Another study stated that the growth pattern of gray tuna is negative allometric with \( b \) value of 2,792 [8]. Growth patterns can be influenced by several factors, including gender and condition factors. The value of \( b \) depends on physiological and environmental conditions such as temperature, salinity, geographic location, and biological conditions such as gonad development and food availability [23]. Euthynnus sp., that caught in the waters of North Sumatera around Nias Island, has a body weight of between 500-2500 grams.

**4. Conclusion**

There were seven classes in length distribution of fish Euthynnus sp., that caught in July 2020. The caught of Euthynnus sp. has a total length of 350 – 530 mm. The highest frequency of total length is 401-427 mm. The growth pattern of Euthynnus sp. was positive allometric growth (\( b>3 \)). The Length-Weight Relationships (LWRs) this species based on July 2020 observation was \( W = 0.06L^{3.2611} \) (to the power of) 3.2611 (\( r = 0.97 \)).
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