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Indicators of Tuna Gigi Anjing (*Gymnosarda unicolor*) Growth Pattern on the Implementation of Sustainable Development Goals (SDGs)

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ABSTRACT

Tuna is a type of large pelagic fish migrating and spreading in tropical and subtropical waters. In general, Indonesian waters are one of the tuna migration routes. The waters of the western part of Indonesia, especially the Simeulue Waters in the Fisheries Management Area (WPP) 572 Indonesia. One type of tuna was found there, namely *Gymnosarda unicolor* species, Family: *Scombridae* with the general name dogtooth tuna while the local name is tuna sisik bergigi, and or tuna karang. The sustainability of tuna fish resources can be threatened if the size of the fish stock is not known, one of which is the suitable size for catching. This study examined and identified the length and growth pattern of tuna gigi anjing that were landed in fish auction area of East Simeulue. The research was conducted in May-July 2021. The data collected was in the form of fork length data. The frequency of fish length to determine the class interval was analyzed using the frequency distribution formula. Fish growth parameters were analyzed using ELEFAN 1 contained in the FISAT II program. The number of tuna gigi anjing (*Gymnosarda unicolor* (*Ruppell*)) that was successfully measured was 190 individuals. The size of the fork length ranged in the interval of 44.1 to 101.3 cm. The length of first caught tuna gigi anjing (Lc) was at 59.2 cm, the asymptotic length (L∞) was 98.7 cm, the growth rate (K) was 0.8/year and the zero fish growth rate (t_0) was of 0.09/year.

Key words *: Dogtooth tuna, Size, Growth pattern*

Introduction

Tuna is a type of large pelagic fish that migrates and spreads in tropical and subtropical waters. In general, Indonesian waters are one of the tuna migration routes. The waters of the western part of Indonesia, especially the Simeulue Waters in the Fisheries Management Area 572 Indonesia, found one type of tuna from the *Gymnosarda unicolor* species, Family: Scombridae. This type of fish is generally referred to as tuna gigi anjing, while the local name is called tuna sisik bergigi or tuna karang.

The mainland of Simeulue Island is surrounded by fringing reefs. Simeulue waters is directly adjacent to and surrounded by the Indian Ocean which is located in the western part of Sumatra Island,

Aceh Province (Burhanis *et al*., 2017). There are various fish resources in Simeulue Waters. One of the diversity and abundance of resources that have potential and economic value is tuna (Zulfadhli *et al*., 2017 and Burhanis *et al*., 2019).

The higher the intensity of fishing, the more tuna gigi anjing is experiencing fishing pressure (Burhanis *et al*., 2017). This results in a decrease in fish stocks both in terms of size and population, based on fish length data. Small catches of tuna will threaten the sustainability of the fish resources. The sustainability of tuna fish resources can be threatened if the size of the fish stock is not known, one of which is the size suitable for catching.

The application of responsible and sustainable principles in tuna fisheries must be carried out by all parties involved, both by fishermen and fishery business actors. Responsible and sustainable fisheries will later contribute to environmental, social and economic improvements so that in the end it will have a positive impact on fishermen's income and maintain sustainability for future generations. This is in accordance with one of the goals of the 14th Sustainable Development Goals (SDGs).

The study was conducted to identify the length and growth pattern of tuna gigi anjing that landed at East Simeulue's fish auction. By knowing the type and growth pattern of tuna gigi anjing, it is hoped that it can maintain stock conditions and the size distribution of the caught tuna, so that tuna gigi anjing can be managed and utilized optimally and sustainably (Burhanis *et al*., 2018).

Research Method

Research Time and Place

The research was carried out from May to July 2021, which was located at the East Simeulue Fish Landing Site, Simeulue Regency, Aceh Province.

Method of Collecting Data

Tuna gigi anjing data were obtained through direct observation and measurement of the catches of fishermen who landed at East Simeulue's fish auction. The fishing gear used in the process of catching tuna was namely handlines at water depths of 15-35 m. The activity of catching tuna gigi anjing was carried out by fishermen using the one day fishing method by not using aids in the form of FADs. The data collected were the fork length data of tuna gigi anjing. Furthermore, the data were tabulated to be processed for research purposes.

Data Analysis

Length Frequency

Fish length frequency analysis was carried out to determine the class interval, mean value and frequency in each group. Fish length was calculated using the frequency distribution formula k = 1 + 3.32 log n (Walpole 1995).

Estimation of Lc (length at first capture)

The data on the frequency of the length of the fish collected were applied to determine the estimated length of the first fish caught (Lc). Furthermore, the estimation of length was first captured by making an S-shaped graph (between the Y Axis and X Axis). Length at first capture at 50% showed the length of the fish 50% first caught, which was calculated using the following equation (Sparre and Venema 1999).

$$S_L est = \frac{1}{1+\exp(S1-S2*L)}$$

$$Ln\left[\frac{1}{SL} - 1\right] = S1-S2*L$$

$$L_{50}\% = \frac{S1}{S2}$$

Where:
SL = Logistic Curve;
S1 and S2 = Constant at logistic curve formula;

Growth Parameters

Fish growth parameters (K and L) used the ELEFAN I sub-program contained in the FISAT II software (Gayanilo *et al*., 1996). Fish length data were used as material for analysis, with the equations used were the Von Bertalanffy Growth Function (VBGF) growth equation and the $L_t = L\infty\ (1\text{-}e^{-k(t-t0)})$ equation (Beverton and Holt 1956).

Mortality

Natural mortality (M) was calculated based on empirical values (Pauly 1984). Total mortality (Z) was converted from the length of the catch curve (Pauly 1979). Exploitation (E) was calculated using the formula $E = \frac{F}{Z}$, while fishing mortality (F) was calculated using the formula F = Z - M (Sainsbury 1982 and Appeldoom 1988; Kantun and Amir 2013). The

stock that would be said to be in overfished condition was not based on the assumption of an optimal value of E (E_{opt}) > 0.50. This assumption also meant that sustainable results would be obtained when the value of F > M (Gulland, 1971) with the following equation:

Log (M) = -0.0066-0.279 Log (L∞) + 0.654 Log (K) + 0.4634 Log (T)

where;

M = Natural Mortality;
L = Asymptotic Length;
K = Growth Coefficient;
T = Average Temperature of 31 ^{0}C (field data)

Results and Discussion

Length Frequency

The class size of tuna gigi anjing (*Gymnosarda unicolor*) caught by fishermen varied widely. There were 56 tuna gigi anjing caught by fishermen in the waters of East Simeulue. The fork length of the tuna gigi anjing ranged from 44.1 to 101.3 cm. The frequency of the fork length can be seen in Figure 1.

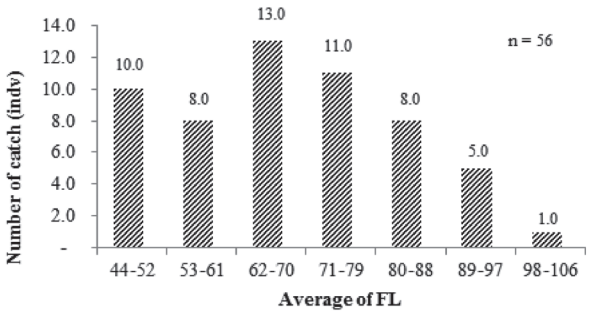

Fig. 1. Frequency Distribution of Tuna Gigi Anjing Caught in East Simeulue Waters.

The catch of tuna gigi anjing based on the size of the fork length were grouped into 2 (two) categories, namely juvenile (immature) and adult. The fork length of tuna gigi anjing caught in the waters of East Simeulue was more in the class size of 62-70 cm, namely as many as 13 individuals. Furthermore, in the 98-106 cm size, only 1 fish was caught. Difference in the size of the morphometric characters caught by tuna gigi anjing is closely related to habitat characteristics, whether including spawning site, or growing large and/or looking for food. Furthermore, with regard to variation in maturity level according to location, the length of tuna gigi anjing off the coast of India (without discriminating between male and female sex at maturity) was first estimated to have a fork length ranging from 65-70 cm (Sivadas and Anasukoya, 2005). On the other hand, the difference in the size distribution of fish caught is closely related to the selectivity of the fishing gear used by fishermen (Alaudin *et al*., 2021).

The fork length class of tuna gigi anjing caught by fishermen in East Simuelue waters was not much different from the results of research by Joshi *et al* (2012) in Indian waters, where the catch of tuna gigi anjing ranges 32.5-162 cm. Sivadas and Anasukoya (2005) state that in the waters of the Atlantic Ocean, tuna gigi anjing reaches a fork length of 110-150 cm. The difference in tuna length is caused by genetic change, as well as the migration process carried out to find food and spawn (Ricklefs and Miller 2000; Arrizabalaga *et al*., 2002; Dhurmeea *et al*., 2016).

Estimation of *length at first capture* (Lc)

Based on the results of the study, the length of the tuna gigi anjing first caught in Simuelue Waters was 59.2 cm. This can be seen in Figure 2. The depth of the water plays an important role in the distribution of the size class of tuna gigi anjing catches. Fishing activities are carried out by Simeulue fishermen in the traditional way using simple and environmentally friendly fishing gear (Burhanis *et al*., 2021 and Martahadi, 2017). The existence of schools of tuna spreads on the surface layer and the thermocline (Barata *et al.* 2011). Furthermore, small tuna (<100 cm) were caught in the surface layer or above the thermocline layer. These fish were located adjacent to the mainland in large numbers. This was in contrast to large groups of tuna (>100 cm), which were spread from the surface to deep waters with fewer schools.

Tuna gigi anjing first matures at a fork length of about 65 cm with a maximum length of 274 cm

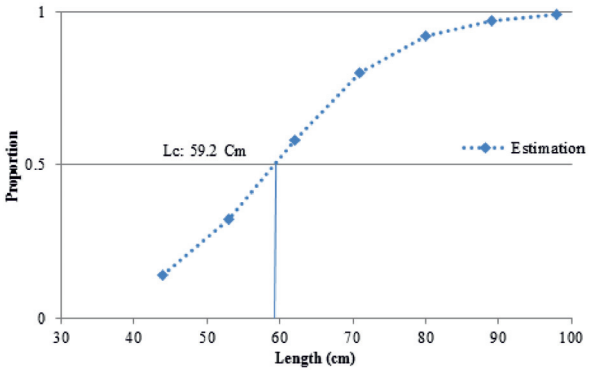

Fig. 2. Prediction of Tuna Gigi Anjing First Caught in East Simeulue Waters.

(Lewis *et al*., 1983; Sivadas and Anasukoya, 2005). The size of the fork length ranges from 48-74 cm. In this case, the length of the tuna gigi anjing < 70 cm is the size of the fish that are immature or in immature position of the gonads (Sivadas and Anasukoya 2005).

Environmental conditions have a relationship with the distribution and abundance of tuna gigi anjing. This indicates that variation in aquatic environmental condition at the study site did not become a limiting factor for the survival and presence of tuna. One of the factors affecting the abundance of fish in a waters is the availability of food sources needed by fish.

Growth

The results of the analysis of the frequency of the length of tuna gigi anjing used the Von Bertanlanffy method with maximum length data (L∞) of 98.7 cm, K value of 0.80 per year, theoretical age of 0.09 years. This can be seen in Figure 3.

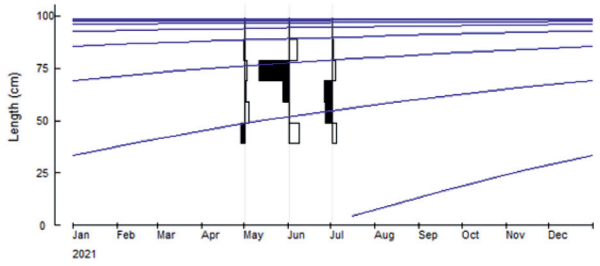

Fig. 3. Growth of tuna gigi anjing using the Von Bertanlanffy model in East Simeulue waters.

The theoretical age of tuna gigi anjing when length equaled zero was estimated using the Von Bertalanffy growth equation model: $Lt = 98.7(1-exp^{-0.8(t-0.09)})$.

Tuna gigi anjing had a maximum length (L∞) of 101.3 cm, K value of 0.8 per year, theoretical age of 0.09 year. The age of tuna gigi anjing was estimated to be a maximum of 12 years old (Joshi *et al*., 2012). Difference in fish growth patterns was caused by difference in water temperature, water salinity, food availability and other habitat conditions affecting fish body development (Wood, 1953; Barlow 1961; Shaklee and Tamaru, 1981; Pauly, 1994). The relationship between length and weight of fish is influenced by factors of habitat, environment, season, type of food, gonad maturity, health and sex.

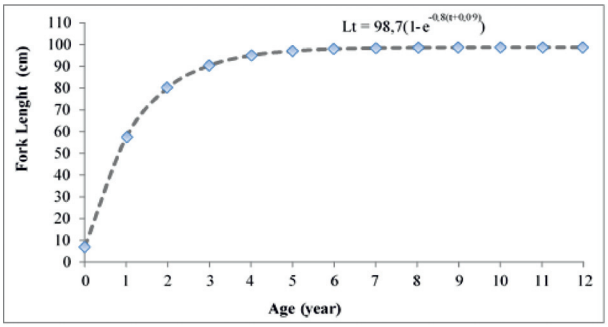

Fig. 4. Estimated growth curve of tuna gigi anjing caught in East Simeulue waters.

The length-weight relationship can be used to determine possible difference between the same type of fish in different stocks (King, 2007). Physical boundary among marine fish population is not always clear, but the formation of a population depends on environmental (ecological) and genetic conditions influencing morphological variation (Hauser *et al*., 1995; Joyeux *et al*., 2001; Hajjej *et al*., 2013). Parameters affecting the abundance of fish in a waters are the presence or absence of the required food source, the availability of food sources related to the fertility of the waters indicated by the high content of nutrients and nutrients (Realino *et al*., 2007). Furthermore, Burhanis *et al*. (2018) state that the physical limit on marine fish population is not always clear. However, the formation of a population depends on environmental (ecological) and genetic conditions that influence morphological variation.

Mortality

The results of the length-converted catch curve analysis showed that the total mortality value (Z) was 1.50, natural mortality (M) was 1.14 with a temperature range of 30 ^{0}C, fishing mortality (F) was 0.36, exploitation ratio (E) was 0.24. As presented in Figure 5.

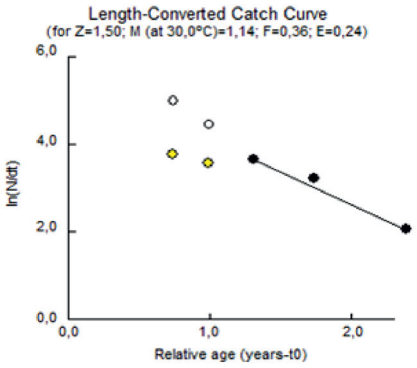

Fig. 5. Catch curve based on length of fish in East Simeulue waters.

The mortality in this study indicates that the condition of the tuna gigi anjing resource in Simeulue waters was still sustainable. The results of the analysis revealed the M value (natural mortality) was 1.5, the F value was 0.36. (M > F) and the exploitation value of E was 0.24. If using the Beverton and Holt method, a fish stock was said to be sustainable if the fishing mortality was equal to the natural mortality (F = M) or the exploitation level (E = 0.2). Based on the results of the study, the condition of the tuna gigi anjing resource in the waters of East Simeulue was in sustainable or not overcaught.

Conclusion

Based on the results of the study it can be concluded that, Tuna gigi anjing were mostly caught in the 62-70 cm size class. Growth pattern of tuna gigi anjing reached 98.7 cm which was caught in the waters of East Simeulue. The category of tuna gigi anjing caught in the waters of East Simeulue were in a sustainable condition or not overcaught, seen from the value of fishing mortality (F) and exploitation level (E).

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