Population Dynamics of bullet tuna (auxis rochei risso 1881)

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Research Article

Population Dynamics of Bullet Tuna (*Auxis rochei* Risso 1881) from the Indian Ocean, West Nusa Tenggara, Indonesia

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Abstract

The bullet tuna *(Auxis rochei)*, BLT or *tongkol lisong* (Indonesian) is a species of neritic tuna which is one of the target fish for small scale fishers. The problem of bullet tuna fisheries was that it has reached over exploitation and the immature bullet tuna are still caught. This study aimed to assess the population dynamics of the BLT and its size composition caught by small scale fishers in the Indian Ocean, West Nusa Tenggara. The location of this research was in Bangko-Bangko (West Lombok), Cemplung Beach (South Sumbawa) and Tanjung Luar Fishing Port (East Lombok) between July 2019 and June 2020. The data was derived from the measurement and weighing results of 1,217 BLT collected from the respective collector traders at each sampling location. The growth pattern of BLT was isometric (b= 2.99) which meant the ideal body shape (mesomorph) and length at first maturity (FLm) was 31.11 cm. The length-weight relationship curve showed that BLT was in an immature age group (adolescent fish). Meanwhile, the composition of BLT is worth selling (Condition Factor>1.00), fit for catch (FLc / FLm > 1.00), and worthy of maturity (FLc > FLm), respectively 99.92%, 0.82% and 0.00%. The BLT fish composition indicates that the stocks of resources and populations do not support current sustainable fisheries management.

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1. Introduction

Most of the neritic tuna caught by fishers are sold to retailers on landings site. The remaining fish caught by the fishers are sold to fish collectors around the coun- tries. The role of the neritic tuna fisheries in WNTs is important as it provides economic benefits for coastal communities and an inexpensive source of protein for the community.

Neritic tuna resources caught by Indonesian fishers in the national fisheries management area of the Republic of Indonesia (WPPN RI) were 573 species including little tuna (*Euthynnus affinis* Cantor, 1849), frigate tuna (*Auxis thazard* Lacepede 1800), long tail tuna (*Thunnus tonggol* Bleeker, 1851), and bullet tuna (*Auxis rochei* Risso 1810). The neritic tuna is one of the pelagic fish group that is highly valued by international consumers, national consumers, and West Nusa Tenggara (WNT) residents. The Indian Ocean in the South of West Nusa Tenggara Province is a potential habitat for four species of neritic tuna that have landed in Bangko-Bangko (West Lombok), Cemplung Beach (South Sumbawa), and Tanjung Luar Fishing Port (East Lombok). Furthermore, its exploitation uses surface longlines for 12 months a year. All types of fishing gear used in the coastal waters are classified as environmentally friendly fishing gears (Asrial *et al.*, 2020).

The utilization of bullet tuna in the Indian Ocean South Sumbawa Island has reached fully exploited status (Asrial *et al.*, 2020). This condition is not good for the security of resource reserves and the population of bullet tuna. It was reported that the fork length of BLT (FLc) caught was shorter than the fork length of BLT at first maturity (FLm) with a value of less than 1.00 (FLc < FLm; FLc / FLm <1.00) (Asrial *et al.*, 2020). This condition affects the ongoing decline of the BLT fish population. Currently, conditions status of fish population is an important issue in sustainable BLT fisheries management in the coastal waters of the Indian Ocean.

According to IOTC (2019), BLT fisheries management in the Indian Ocean is not supported by data to estimate BLT resources stocks, so that the status of BLT stocks in the Indian Ocean is unknown (IOTC, 2019a; IOTC, 2019b; IOTC, 2020). Utilization of BLT resources in Indian waters has been reported to reach an overexploited status (E = 80.0%) (Jasmine *et al.*, 2013; Rohit *et al.*, 2014). Sri Lanka faces a similar problem, namely limited data relating to distribution and migration of BLT fish (Dalpathadu *et al.*, 2019). Currently, there is no information regarding the status of BLT resource stocks in Southeast Asian waters (Kaewnuratchadasorn *et al.*, 2020). Thus, the Indian Ocean Tuna Council (IOTC) pays special attention to BLT species in the Indian Ocean within the territory of Indonesia (Fahmi *et al.*, 2019). BLT fish caught in the waters of the Indian Ocean in the southern part of Java Island and Lombok Island were dominated by the immature fish size population (Setyadji *et al.*, 2013; Tampubolon *et al.*, 2015). Based on the author's knowledge, the availability of data on BLT fish from coastal waters areas of NTB is very limited.

Research on the resources and population of *A. rochei* (Risso, 1881) in the TNB area, particularly in the waters of the Indian Ocean, are limited and was carried out by Asrial *et al.* (2020) and Tampubolon *et al.* (2015). For this reason, it is necessary to study more deeply about the resources and population of BLT originating from the Indian Ocean in the southern part of the WNT.

The present study aimed to determine the eligibility status and size composition of BLT resources and population for the sake of implementing sustainable fisheries management policies in Indonesia.

2. Materials and Methods

2.1 Study Area

This research was carried out from July 2019 to June 2020. Samples of BLT were obtained from fish landing centers, namely Bangko-bangko (Lombok Barat District), Tanjung Luar Fishing Port (Lombok Timur District), and Cemplung Beach – Labangka (Sumbawa District) (Figure 1).

Figure 1. Map of sampling location of BLT fish

2.2 Procedures

A descriptive dependent survey method was used for the data collection in which the authors rely heavily on other parties to obtain samples and data as well as other information about the phenomena occurring. The data collection techniques consisted of sampling, observation, interviews, and documentation. The main material for this study was the BLT samples caught by fishers, obtained from fish collector trader that were residents of each study location. Fishers caught the BLT in the coastal waters of the Indian Ocean using surface longlines and motorboats as means of transportation to the fishing ground.

BLT samples were measured and weighed for a total of 1217 individuals. The data from the sampling results, which have been recorded, were tabulated in excel format to be processed quantitatively using several equations. Furthermore, the results of analyzed data processing are used according to the needs and objectives of this study.

2.3 Data Processing and Analysis

The data processing was carried out to estimate the eligibility status of the resources and the population dynamics of the BLT fish in the Indian Ocean coastal waters. The eligibility consists of the composition of the number of fish worth selling, worth catching and worth spawning, as well as growth patterns and fish age groups. For fish population dynamics study, the length of infinity, growth rate, mortality, exploitation rate, maximum length, recruitment, growth, and composition of fish age group members were calculated.

2.3.1 Growth pattern and the model

The growth pattern is the growth rate of the length and weight of the fish at the same time, which is measured simultaneously. The value was obtained by analyzing the length of the fish and weight data using a simple regression method designed to estimate the body shape of the fish. In this case, the data used were the FL and BW size of the BLT sample. Since fish are living organisms that grow, move, and regenerate in free water (wild), first the data was converted into natural logarithms (ln). The output of data processing follows a mathematical model: model: $\ln BW = a + \ln FL$, where: a = intercept coefficient and b= coefficient of FL variable. The next step was to perform a t-test following the steps described in section "Worth catching". The status of growth patterns and body shape, represented by the value b, consists of: (a) $b < 3.0$ (minor allometric) = thin (ectomorph), (b) $b = 3.0$ (isometric) = slim / streamlined (mesomorph), and (c) $b > 3.0$ (major allometric) = fat (endomorph).

2.3.2 Length at first maturity (Lm)

The size of the fish for the initial gonad maturity (Lm) is the range of length of fish when 50% of the gonad has matured. The fish with gonads maturity level (GML) I and GML II are classified as immature while GML III and IV are classified as mature. The size estimation of first time gonad matured fish ($Lm = L_{50}$) length of the fish under 50% maturity conditions was carried out using a logistic curve approach (Sparre and Venema, 1998). The equation is $Q = 1/\{1 - e^{-a(FL-FL_{50})}\}$ where Q = fraction of fork length class maturing gonads (GML III and IV), 1 = 100% ripe gonads, e = 2.718, a = constant, FL = mean class of fish fork length, and FL_{50} = fork length of fish at 50% maturity of gonads. Furthermore, the equation is converted into linear form: $\ln(Q/1-Q) = aFL_{50} - aFL$. By using linear regression, it was obtained that the length of the fish when the gonad has matured was $FL_{50} = aFL / a$ where aL = intercept and a = slope.

2.3.3 Fish age group

The results of the fork length to body weight (LWR) analysis were used in estimating the age group of the fish. Based on $LWR = BW/aFL^b$ (Ndimele et al., 2010; Kurniawan et al., 2019) where: BW = body weight (g), FL = fork length (cm), a = intercept, and b = growth exponent. The data for LWR analysis were FL and BW, which were not converted in any form, also known as "raw data". The graph used was an exponential curve that can provide a phenomenon for the age group of fish by observing the trend in the direction of the graph line.

Fish growth is described in the form of a curve that relates length and weight to time or age. The shape of the fish growth curve resembles the letter S in such a way that it is said to be a sigmoid curve (S curve). In order to estimate this, the LWR diagram must be compared with the fish growth curve (S-curve). The S-curve divides the age group of the fish into three age groups (a) childhood and adolescence fish (immature) on the lag phase, (b) adulthood fish (mature & high productivity) on the exponential phase, and (c) old age fish (mature & low productivity) on the stationary phase (Figure 2).

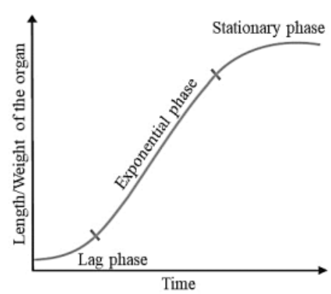

Figure 2. Sigmoid curve (S curve)

2.3.4 Worth selling

The marketability of fish for sale (worth selling) was estimated using the condition factor (CF) approach, based on body weight (BW) and fork length (FL) data. According to Effendie (2002), condition factor (CF) is estimated based on an economic approach in order to determine if the fish have reached the status of "worth selling" (Effendie, 2002). In order to generate the CF values, data processing uses the equation: $CF = 10^2 BW / FL^3$, where: CF = condition factor, BW = body weight (g), FL = fork length (cm), a = intercept, and b = coefficient (Effendie, 2002). The equation is used when the growth pattern is isometric ($b = 3.0$).

The closeness of the relationship between the two variables can be confirmed by the value of b by performing a t-test (Effendie, 2002). The hypothesis consists of: (1) H_0 = isometric when the value of b = 3.00 and (2) H_1 = allometric when the value of b> 3.00 or b <3.00. Next was to perform the t-test using the equation: $t - stat = (3 - b) / Sb$, where: b = the calculated value of the FL and BW ratio of fish and Sb = standard deviation of b. The next step was to compare the t-stat value with the t-table value. The decision follows the following conditions:

- value of t-stat > t-table: H_0 is rejected and H_1 is accepted, so the growth pattern is allometric ($b \neq 3.0$)
- value of t-stat < t-table: H_0 is accepted and H_1 is rejected, so the growth pattern is isometric ($b = 3.0$).

Marketable BLT status, developed and modified from the classification compiled by Fathurriadi *et al.* (2020). The conditions are as follows: (1) $CF \leq 1.00$: the body of the fish is slightly shallow and not yet fleshy, therefore it has little economic value, immature age group, it is not worth catching and selling, and it can also become a broodstock candidates, (2) $CF = 1.00 - 3.00$: the body of the fish is flat and fleshy, therefore it has a high economic value, mature age group, and it can be caught and sold (marketable), and as potential broodstock candidates, and (3) $CF \geq 3.00$: fish body is less flattened and thick fleshy, it has highest economic value, mature age group, and it is very suitable to be caught and sold (marketable), but not suitable to be used as broodstock because their productivity has decreased. The value of CF also describes the fertility of the waters related to the availability and adequacy of feed. The categories are as follows: (1) $CF > 1.0$: the feed available in the wa- ters is very sufficient to support activities, growth, and reproduction, (2) $CF = 1.0$: the availability of feed in the waters is only enough for movement and body growth, and (3) $CF < 1.0$: the feed available in the waters is sufficient to survive.

2.3.5 Worth catching

The worth catching status of BLT was estimated using the fork length (FLc) data, which was compared with the fork length at first maturity (FLm), using equations: FLc / FLm. When the value is $FLc / FLm > 1.00$, the fish is classified as "worth catching" which means that BLT fish caught have spawned and released their eggs into the waters. In this study, if the value of $FLc / FLm < 1.00$, it was agreed that the BLT was immature gonads, and therefore it was "unworthy to catch". The category for determining the worth catching fish status consists of: (1) Damage ($FLc / FLm < 1{,}0$), (2) Inadequate ($FLc / FLm = 1{,}0$), and (3) Eligible ($FLc / FLm > 1{,}0$) (Fathurriadi *et al.*, 2020). The categories are prepared on the basis of the precautionary principle in accordance with recommendations for responsible and sustainable fisheries resource management.

2.3.6 Worth spawning

BLT wish suitable for spawning are discovered in adult fish especially those that have reached the size for the first time experiencing gonad maturation. The estimation of the spawning fish follows the fork length equation, which is longer than the length at the first maturity of the gonads (FLc>FLm). In order to estimate the composition of the number of BLT fish suitable for spawning, FL data from the BLT sample and FLm data from BLT in other waters areas in the Indian Ocean were estimated.

The number of fish suitable for spawning was obtained from the number of fish samples that have a value of FLc > FLm. The authors decided that in the interests of sustainable BLT fisheries resource management and the safety of the BLT fish resource reserves, the standard population of adult BLT fish is at least 12% of its population. This value is estimated based on the following technical assumptions: (1) fecundity = 36,480 eggs/ind. (Hadi, 2020), (2) the survival rate of larval to post larva size = 5.00%, (3) the survival rate of post larvae to adult fish size is at least 5.00%, and (4) the number of eggs that hatch until it reaches adult fish is at least 53.73%.

3. Results and Discussion

3.1 Results

3.1.1 Size composition

The tuna neritic fishing activities at the study location were carried out by fishers using surface longlines and motorboats to catch fish in coastal waters (0-12 nautical miles) of the Indian Ocean. The bullet tuna species *(A. rochei)* dominates the catches and very few little tunas *(E. affinis)* landed in Cemplung Beach - Sumbawa (Asrial *et al.*, 2020).

The BLT sample was measured and weighed by no fewer than 1217 individuals. The fork lengths of BLT caught by fishers ranged from 20.00-30.60 cm/ind. and an average of 23.86 cm/ind. Out of the 11 classes of fork length (FL) frequency of BLT (Figure 3), the dominant size was class 22-23 cm of about 406 individuals (33.36%), followed by the 23-24 cm class of about 211 individuals (17.34%), and the 21-22 cm class of 180 individuals (14.79%).

The body weight (BW) of 1,217 BLT sample individuals from the study location was divided into 7 classes. The lightest was 95.00 g/ind., the heaviest was about 415.00 g/ind., and the average weight was 193.03 g/ind. (Figure 4). The majority of BLT were in classes 154-185 g and 124-154 g, 446 individuals (36.65%) and 306 individuals (25.14).

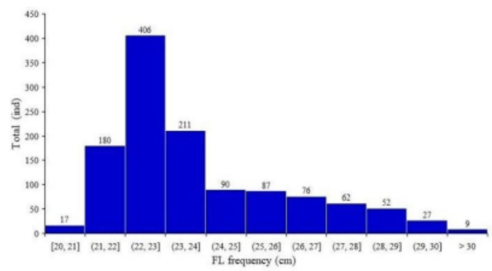

Figure 3. Fork Length of BLT from Indian Ocean, WNT

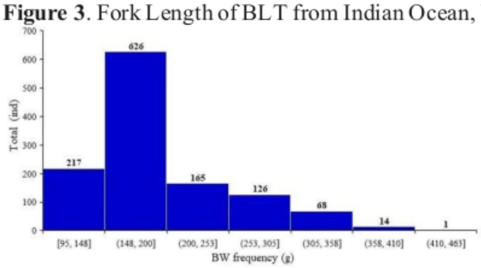

Figure 4. Body Weight of BLT from Indian Ocean, WNT

The average FL of BLT fish from the study location is longer than those that landed in Cemplung Beach - Labangka, namely 23.49 cm/ind. (Asrial *et al.*, 2020) and Prigi Fishing Port, which is 20.22 cm (Agustina and Rochman, 2019). Meanwhile, the average FL of BLT fish from Tanjung Luar Fishing Port and the Indian Ocean West of Sumatra, respectively was about 26.29 cm/ind. (Arapat, 2020) and 25-26 cm (Noegroho and Chodrijah, 2015), which is longer than BLT from the Indian Ocean in South of NTB.

3.1.2 Growth pattern and the model

Processing of FL and BW data from BLT transformed into logarithmic data (natural logarithm / ln) uses a simple regression method. The choice of the natural logarithmic (ln) aims to: (a) avoid heteroscedas- ticity, (b) find out the coefficients that show elasticity, and (c) make the data scale closer (Ghozali, 2011). The result is the value of the variable that is used to test the feasibility of the model as follows:

- The correlation (r) = 97.61% means that there is a very close relationship between the variable BW and FL (r > 80%)
- Determination (R^2) = 95.28% means that the FL variable is very strong in determining the BW variable (R^2 > 80%), and the model suitable for forecasting (R^2 > 60%)
- The adjusted R Square (Adj. R^2) = 95.27% can be interpreted that the sample has a high ability to find answers in its population (Adj. R^2 > 50%)
- Standard Error (SE) = 5.85% means the model deviations that occur can be tolerated/accepted (SE ≤ 25%)

The value of variables indicates that the data used are very eligible for further processing. Therefore, the results of data processing can be used for decision making.

The results of data processing show the value of the growth pattern (coefficient b) = 2.994. The value of the growth pattern is in the isometric category, with the growth rate of fork length equal to that of growth. Therefore, the body shape of BLT is ideal. As for the growth pattern model is *In BW* = -4.263 + 2.994 *In FL*. The model is classified as "positive equation". The meaning of this equation is that each additional 1.0 unit of fork length (FL) increases the value of body weight (BW) by 2.994 (coefficient value b).

3.1.3 Length at first maturity (Lm)

The number of BLT fish samples measured was 1,217 individuals. There were 63 ind. (5,18%) of the fish that had reached the mature stage of the gonads and 1,154 ind. (94.82%) had not yet reached the mature stage (Figure 5).

BLT fish samples have reached the gonadal maturity phase at a fork length class size of 23-24 cm and the highest distribution of fish with matured gonads is in the length class interval size of 26-27 cm. The analysis result shows that the fork length at first maturity (FLm) is 31.11 cm.

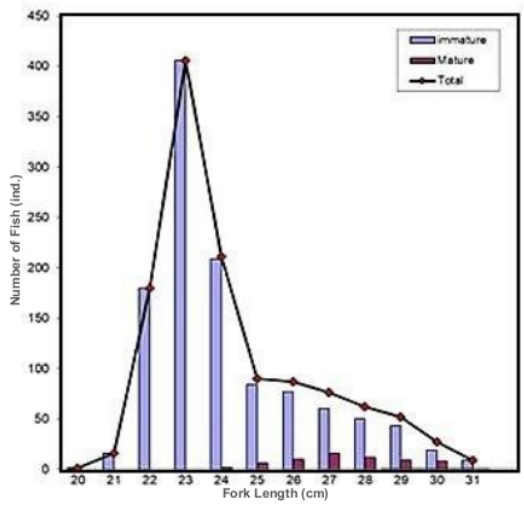

Figure 5. Fork Length composition of BLT fish samples

3.1.4 Fish age group

The BLT age group was estimated through the LWR graph using BW and FLm data. The LWR curve derived from the equation $BW = 4{,}479FL^{0.319}$ (Figure 4). Based on the t-test with a confidence level of 95%, the growth of bullet tuna was minor allometric. When the LWR curve (Figure 6) was compared with the fish growth curve (S curve), the sample fish are classified as age group of immatures (adolescence fish).

According to Expósito (2015), the age group of BLT fish can be estimated using FL data, namely the immature group is equivalent to FL < FLm (31.11 cm). Based on the FL size of all BLT fish samples, the BLT fish population in the study location only consisted of one group of fish age, namely the immature group (Figure 7).

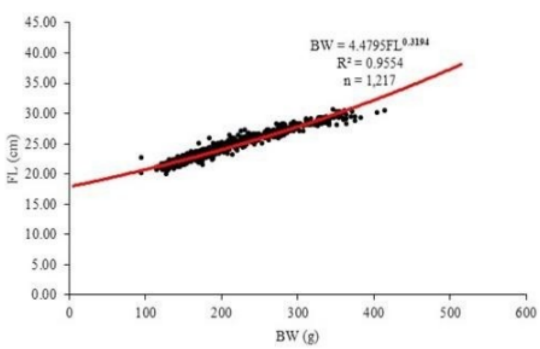

Figure 6. LWR of BLT from Indian Ocean, WNT

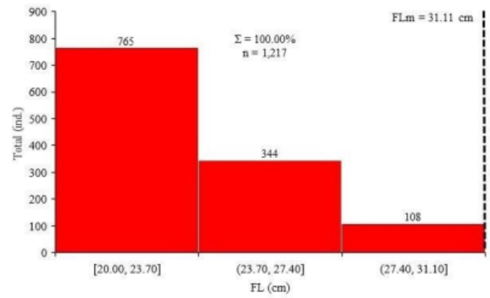

Figure 7. BLT age group from Indian Ocean, WNT

3.1.5 Worth selling

The processing results of FL and BW data of BLT fish resulted in a condition factor (CF) value of more than 1.00 (Figure 3). The resulting CF values consist of CF_{min}, CF_{max}, and $CF_{average}$ are 0.82, 1.79 and 1.38 respectively. The $CF_{average}$ value indicates that the body shape of the BLT is "flattened", which means that it is "fleshy" and therefore it has a high selling price. Another meaning is that the feed available in the waters is very sufficient to support activities, growth, and reproduction. In study location is known that 1.2016 ind. (99.92%) of the BLT are worth selling and only 1 ind. (0.08%) of the BLT is not worth selling (Figure 8).

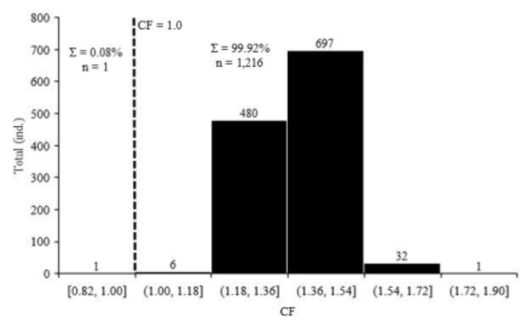

Figure 8. The BLT worth selling from the Indian Ocean, NTB

3.1.6 Worth catching

The worth catching estimation of BLT is the ratio of FLc and FLm based on the standard FLm = 31.11 cm (this study). BLT fish is declared fit for catching if FLc / FLm > 1.00, meaning that the fish caught have spawned at least once.

The frequency of fork lengths of BLT caught (FLc) in the study locations ranged from 20.0 cm to 30.6 cm and averaged 23.90 cm. Furthermore, with regards to the FLm of BLT fish (31.11 cm), the composition of

BLT from the study location that is not fit for catching is about 1.207 ind. (99.18%) and fit to be caught is about 10 ind. (0.82%) (Figure 9). Therefore, for every 1 ind. of the BLT that deserved to be closed, there were 120-121 ind. worthy of being caught. Based on the FLc average value data, the FLc / FLm value = 23.86 cm / 31.11 cm = 0.77 (FLc / FLm <1.00), which means that the BLT fish resources from the study location are "not worth catching" and the status is "damage".

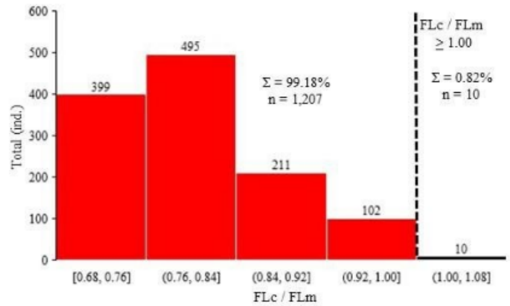

Figure 9. The BLT worth catching from the Indian Ocean, WNT

Table 1. The fork length (FL) frequency of the BLT fish from Indian Ocean

Indian Ocean	Fishing Gears Type	Frequency (cm)	Modus (cm)	References
Indian Waters	Longline, surface gill net	14-40	22-26	Rohit *et al.* (2014)
Cilacap (Central Java)	Gillnet	20-45	40.00	Widodo *et al.* (2011)
Cilacap (Central Java)	Mini purse seine	23-32	30.00	Setyadji *et al.* (2013)
South of Sumba Island	Purse seine (industrial scale)	20-28	20-22	Setyadji *et al.* (2013)
West of Sumatra	Purse seine, fish net, lift net, troll line	11-42	25-26	Noegroho and Chodrijah (2015)
Sendang Biru (East Java)	Surface longline / *rinta*	18.5-32.0	23.55	Fitriah (2018)
North & West of Sumatra	Purse seine	19-38	-	Salmarika *et al.* (2018)
Prigi Bay (East Java)	Purse seine	13.3-26.0	20.22	Agustina and Rochman (2019)
Labangka (Sumbawa)	Surface longline / *rinta*	21.0-29.2	23.50	Asrial *et al.* (2020)
Research location	Surface longline / *rinta*	20.0-30.6	23.86	Present study

3.1.7 *Worth spawning*

Based on several scientific information, it is known that BLT reaches gonad maturity at different FLm. The frequency of FL of BLT caught by fishers in the study location ranged from 20.00 - 30.60 cm and the average was 23.86 cm/ind.

Based on the FLm of BLT in the study location, which is 31.11 cm, the composition of BLT caught by fishers in the study location, 100.00% of the samples were not worth spawning (FLc < FLm) (Figure 7). This means, in the waters of the Indian Ocean South of WNT, it is estimated that there are no potential BLT brood- stock candidates in the population.

3.2 *Discussion*

Gonads, gonad maturity, and Lm of fish are important parts in the discussion of fish reproductive biology. The factors that can affect gonad maturity in fish include genetic factors (Kuparinen and Merila, 2007; Olsen et al., 2004) and overfishing (Rochet and Trenkel, 2003).

The FL size of BLT fish from the Indian Ocean in the WNT region ranged from 20.00-30.60 cm and averaged of 23.86 cm, which results from the measurements of 1,217 samples. The FL size of BLT fish from other regions in the Indian Ocean within the National Fisheries Management Territory (NFMT) of the Republic of Indonesia varies widely, with a range of 11.0 – 42.0 (Table 1). The study location (WNT region) is at NFMT 573, which is very wide and covers the Indian Ocean waters in the south of the region of Java Island, Bali Island, WNT Province, and East Nusa Tenggara Province (ENT).

There are differences in the frequency of FL at each BLT landing site, where these differences are likely caused by differences in the types of gear used by fishers and fishing grounds (Table 1) (Asrial *et al.*, 2020). The FL frequency of BLT fish caught by Sendang Biru (East Java) fishers using *rinta* is longer than that caught by Prigi Bay (East Java) fishers using a purse seine, even though Prigi Bay is located close to Sendang Biru. The FL size of BLT fish landed in Sendang Biru (18.5-32.0 cm) was identical to the one that landed in Labangka (21.0-29.2 cm) and the South of WNT (20.0-30.6 cm), which was caught using *rinta* fishing gear. Furthermore, rinta is a type of surface longline operated by being pulled using a boat, such as a troll line in such a way that the position of the rinta rope becomes diagonal in the waters. *Rinta* fishing gear, operated by fishers from Sendang Biru, Labangka, and the South of WNT, is a fishing gear that is selective to the size of the fish caught and is environmentally friendly. Meanwhile, the purse seine fishing gear used by Prigi Bay fishers is a type of fishing gear that is not selective on the size of the fish. According to Sumardi *et al*. (2014), the level of purse seine selectivity is low. Naturally, mature fish groups are caught in coastal waters and around small islands (Collette, 1995), and more young fish groups swim in oceanic waters (Collette and Aadland, 1996). In this study, the difference in the size of BLT fish caught by fishers in WNT tends to be caused by different types of fishing gear.

The eligibility of fish can be evaluated using FL and BW data to determine the growth rate (b) status of fish which ends by setting the status of the fish's body shape. Other eligibility estimated using that data (FL and BW) are status of fit for sale (CF), fit to be caught ($Lc / Lm > 1.0$), and worth spawning ($Lc > Lm$) (Table 2).

The status of the BLT growth pattern at the study location is isometric (b = 2.99), which indicates that the body shape is slim / streamlined (mesomorph). The growth pattern is identical to that of the BLT fish that landed in Tanjung Luar (b = 2.99), but different from BLT fish in Sumbawa (b = 3.22) and Sendang Biru - East Java (b = 3.39) that has the major allometric status indicates that the body shape is fat (endomorph). The BLT fish that live in the waters of western Sumatra have a minor allometric status (and the body shape is thin (ectomorph). Based on the status of growth patterns (isometric), it can be concluded that the waters in the study location (South of NTB) are sufficiently fertile to meet the vital needs and growth of the BLT fishery resources. This conclusion is in line with the statement that fish plumpness is deter- mined by eating habits, feed availability, growth period, and water fertility (Liestiana *et al.*, 2015; Sasmito *et al.*, 2016). Other factors that support the growth pattern are nutrition and feed consumed by the fish (Sonnaria *et al.*,2015).

Table 2. Parameters of eligibility of BLT fish

Indian Ocean	Growth Pattern	Condition Factor (CF)	CF > 1.00 (%)	FLc / FLm	FLc / FLm >1.0 (%)	FLc > FLm (%)	References
West of Sumatra	2.82	1.50	100.00	1.05	100.00	100.00	Kurniawan *et al.* (2019)
Sendang Biru (East Java)	3.39	-	-	1.04	-	-	Fitriah (2018)
North & West of Sumatra						30.00	Salmarika *et al.* (2018)
Prigi Bay (East Java)	-	-		0.75	-	6.86	Agustina and Roch-man (2019)
Labangka (Sum-bawa)	3.22	1.44	100.00	1.26	100.00	100.00	Fathurriadi (2019)
Tanjung Luar (Lombok)	2.97	1.25	49.11	1.06	95.15	76.02	Arapat (2020)
Study location	2.99	1.38	99.92	0.99	25.72	29.01	Present study

The results of the condition factor (CF) analysis showed that 99.82% of the BLT fish landed in the study area were salable (CF = 1.38) (Table 2). The BLT fish in the study locations have the same status with the ones in the waters of Western Sumatra (Kurniawan *et al.*, 2019), Labangka - Sumbawa (Fathurriadi, 2020), and Tanjung Luar - Lombok (Arapat, 2020) are fit for sale (CF > 1.00) (Table 2). Only BLT fish from Tanjung Luar were fit for sale (Arapat, 2020), the number (49.11%) is much less than those from the study location. Meanwhile, the number of BLT fish fit for sale from the Indian Ocean West of Sumatra and Labangka is almost the same as that of the study location. The BLT fish in the study lo- cations were of high quality (CF = 1.38) and almost all (99.92%) were worth selling at high / expensive prices (IDR 30,000 / kg). The conclusion is in line with the opinion of Effendie (2002), which explains that the condition factor is an indication that individual fish are already fleshy, that they are suitable for sale (economy) and that fish are ready to spawn (pregnant), and there- fore that they are fit to become broodstock. According to Fathurriadi *et al.* (2020), the value of CF = 1.0 - 2.0 indicates that the fish have high economic value, can be caught, can be sold, and have the potential to become BLT fish.

The fish to be caught, expressed as the value of Lc in relation to Lm, must be greater than one (*FLc / FLm* > 1.0). BLT fish in the study location have a value of FLc / FLm = 0.99, which means that they are not suitable to be caught because *FLc / FLm* < 1.00. However, about 25.72% of BLT fish from the study location were fit to be caught. The number is higher than the number of fish that can be caught in Prigi Bay - East Java which only reached 6.86% (Agustina and Rochman, 2019). The size of the fish to be caught (catchable) is when the body length of the caught fish (Lc = length caught) is longer than the body length at gonadal maturation (Lm = length at first maturation) or Lc> Lm.

BLT fish in the study location are fit for spawn- ing and have the potential to become productive brood- stock candidates whose FLc size is longer than FLm (broodstock = *FLc* > *FLm*). About 29.01% of BLT fish from the study locations were suitable groups for spawning. This number is almost the same as the number of broodstock candidates of BLT fish (30.00%) from the Indian Ocean waters of the West and north of Sumatra (Salmarika *et al*., 2018).

4. Conclusion

The BLT fish caught by the fishers had a fork length (FL) = 20.0-30.6 cm (average 23.86 cm), and body weight (BW) = 95.00-415.00 (average 193.03 g). The BLT growth pattern is isometric (the ideal body), and has a single age group that is an immature. The BLT is not eligible to be caught and is not yet eligible for spawning. In contrast, almost all of the BLT were "fleshy". In order to conserve BLT resources and sus- tain BLT fisheries management, fishers are advised to increase the size of the *rinta* fishing gear.

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Author's Contributions

The authors have contributed very well, from designing the research to reviewing the final draft of the manuscript before sending to the journal managers. Evron Asrial; designed and carried out surveys, moni- tored data processing and analysis activities, also wrote research reports and scientific publication manuscripts. Yasir Arapat and Usma Kurniawan Hadi; compiled, tabulated, and separated the data, especially the bullet tuna sampling results. Erwin Rosadi, Daduk Setyohadi and Muhammad Junaidi; carried out quantitative data processing and wrote down the resume. Ruly Isfatul Khasanah; analyzed the results of data processing. Meanwhile, Lalu A.T.T.W.S. Kalih, Lalu Samsul Rizal, Ishani Nelunika Rathnayake and Mita Ayu Liliyanti; revised and perfected sentences and vocabulary in the publication manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest or conflict of interest between them.

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