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Condtion Factor and Gonadosomatic Index Study of Nilem (*Osteochilus hasselti*) Catch in Teluk Lake, Jambi

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ABSTRACT

The nilem fish (*Osteochilus hasselti*) is one of the most easily caught fish in Teluk Lake. Currently, cage farming activity in the lake slightly exceeds the water carrying capacity, which is suspected to affect the life of fish in the lake, including nilem. This study aimed to determine the condition factor and Gonadosomatic Index (GSI) of the nilem catch in the lake. This study was conducted from August to September 2023 in Teluk Lake. This research used a survey method with simple census sampling techniques. The analysis of the length-weight relationship of nilem fish obtained from Teluk Lake showed a positive allometric relationship with a value of b = 3.7148. It showed that the increase in body weight of nilem fish was not linear with the increase in length. The catch results by fishermen for nilem fish found a male-to-female sex ratio of 1:2.15, with 90% of the captured fish in a mature gonad condition. The GSI for females ranged from 3.20% to 8.33% and for males, from 0.03% to 28.89%. The first maturation size (Lm) for male fish was 125.847, with a size class range of 116–126 mm. For female fish, the first maturation size calculation resulted in 112.996 with a size range in the 104–113 mm class. Lm is smaller than the average size of the captured fish, indicating that it is safe to catch, and there is a low likelihood of recruitment overfishing.

Keywords: GSI, Lm, *Osteochilus hasselti*, positive allometric, Teluk Lake, Top of Form Bottom of Form

INTRODUCTION

The lake waters in Jambi are an important ecosystem for maintaining biodiversity and play a role as a significant fishery resource. Lakes play an important role in maintaining the aquatic biota in the ecosystem (Heino *et al.* 2021). Teluk Lake, in Olak Kemang Village, Danau Teluk District, Jambi City, Jambi Province, is one of the water areas with the potential for a wealth of fishery resources to support the surrounding community's economy. In the flood season (rainy season), Teluk Lake has an area of ± 62.5 ha, which has a depth of 14.4 m; in the dry season, the lake's depth reaches 8 m with a lake area of ± 40.4 Ha. There are fishery activities in this water area, namely fish farming (30%), with the primary commodities of catfish farming and capture fisheries (70%) (Kaban 2017).

The diversity of fish owned by Teluk Lake is a species that comes from the flow of the Batang Hari River. The lake has approximately 75 types of consumed fish and 51 types of ornamental fish. Of the 75 types of fish, 22 have been marketed nationally and internationally (Nurdawati *et al.* 2017). The fish often consumed include tilapia or paweh fish, the local name for palau (*Osteochilus hasselti*). Research by Kristianto *et al.* (2014) shows that the number of floating net cages (KJA) operating in the lake is 878 units, which slightly exceeds the carrying capacity of the waters when viewed from the concentration of phosphorous (P), which is 695–865. The total P that enters the lake waters through fish waste is assumed to be as much as 20 kg P/ton of fish in the water. Increased concentrations of P in lake waters can have a significant effect on fish. In eutrophic waters, phosphorus is the primary nutrient that can cause abundant algal growth and decrease water quality (Zhang *et al.* 2004). This condition is suspected to affect the fish breeding process; if it continues to occur, it will threaten the existence of tilapia species so that extinction can occur. Excessive algae growth will cause turbidity in the water and reduce the intensity of light entering the waters, inhibiting phytoplankton growth. Disturbance of phytoplankton affects herbivorous fish feed and fish larvae in the waters of Teluk Lake. In addition, the availability of food in the habitat is the main factor affecting the development and growth of fish in terms of egg quality and reproductive time. At the gonad maturation stage, tilapia needs many nutrients from feed in the form of phytoplankton available in the waters. Suppose the availability of phytoplankton is reduced because of the lack of sunlight due to the presence of algae. In that case, the quality of fish eggs will be low, and it will take longer for gonadal maturation. If it continues to occur, it will threaten the

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existence of tilapia species so that extinction can occur. According to Wulanda *et al.* (2023), if fish feed has a low nutritional value (poor quality), it will result in reabsorption, which causes reduced fecundity and a delay in the egg maturation process in fish.

Mahé *et al.* (2023) stated that variations in morphological characteristics, such as length-weight relationships, can differ between sex, location, and reproductive period. Currently, there is no information on the morphometrics and reproduction of tilapia in the waters of Teluk Lake. Through this research, we hope to obtain preliminary information on Jambi City. Research has been conducted on tilapia's morphometric and reproductive biological conditions in the lake by analyzing the relationship between length, weight, and maturity of the gonads of tilapia. The results of this study can be used as a basis for sustainable fisheries management to preserve the Teluk Lake ecosystem.

METHODS

This study was conducted in September 2023. Nilem fish samples were obtained from fishermen's catches in Teluk Lake, Jambi City, Jambi Province (Figure 1). This study used a survey method. Tilapia were sampled using the simple census sampling method, which involves taking all tilapia caught by fishermen using fishing gear (Rochmatin *et al.* 2014)). Sampling was carried out 3 times with a time interval of 7 days. Fish samples were caught by fishermen from morning to evening and taken from several fishermen. The equipment used are fishing gear, rulers, digital scales with an accuracy of 0.01 g, and dissecting kits. The research materials are in the form of tilapia and nilem gonads. The research procedure is that the fish catch obtained from fishermen is taken to the Animal Husbandry Laboratory of the University of Jambi. Then, the total length of the fish (L) is measured with a measuring device, and the weight of the fish (W) is weighed with a digital scale.

Data Analysis

- **Length-weight relationship**

The relationship between length and weight in tilapia can be identified through the following calculations (Cren 1951)):

$$W = a\ Lb$$

where
W = Fish weight (g)
L = Total length of fish (mm)
a and b = Constants

The above formula is then transformed into a logarithmic form, forming a linear equation as follows:

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

Then, with a regression equation where y is Log W and x is Log L, the values of a and b will be obtained which then becomes y = a + bx.

Fish growth can be categorized as allometric or isometric based on the value of b in the long-weight relationship. When b = 3, then isometric growth; if the value of b ≠ 3, this indicates allometric growth, where the increase in fish weight is not proportional to the increase in length (Muttaqin *et al.* 2016). If b = 3, then the weight gain is balanced by the increase in length (isometrics). If b < 3, then the increase in length is faster than the increase in weight (negative allometric). If b > 3, then the weight gain is faster than the length gain (positive allometric) (Ibrahim *et al.* 2018).

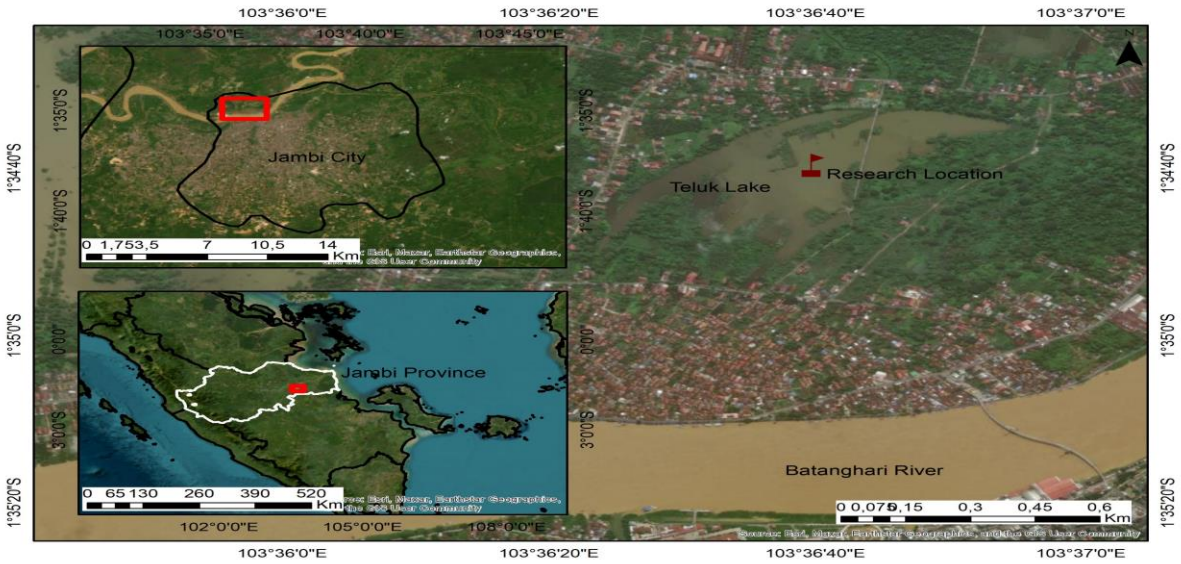

Figure 1 Map Location of tilapia *(Osteochilus hasselti*) sampling point in Teluk Lake, Jambi City.

- **Sex ratio**

Sex ratio of fish was calculated according to Saputra *et al.* (2009):

$$NK = Nbi / Nji$$

where
NK = Sex ratio
Nbi = Number of female (head)
Nji = Number of male (head)

- **The first size of gonad maturity (Lm)**

The first size of the gonads of mature fish (Lm50%) was calculated using the following formula:

$$Ln\,[1-p/p]$$
$$Lm = a/r$$
$$r = -b$$

where
Lm = The size of the fish first maturity gonads
p = Proportion
a = Intercept
b = Slope

- **Gonad maturity level (GML) and gonad maturity index (GMI)**

The GML in this study refers to the Omar (2010) classification based on the shape, color, size, and development of gonadal contents. Gonadal maturity was analyzed using the formula that has been applied by Abudi and Nane (2021):

$$GMI = Wg/Wt \times 100\%$$

where
GMI = Gonadal maturity index
Wg = Fish gonad weight (g)
Wt = Fish body weight (g)

RESULTS AND DISCUSSION

Tilapia (*Osteochilus hasselti*) caught in September 2023 comprised 63 fish. Fish weighed 10– 54 g and had a body length of 104–60 mm. Jusmaldi *et al.* (2020) stated that tilapia in the waters of the Benanga Reservoir has a length range of 106–141 mm. The tilapia obtained amounted to 20 males and 43 females. Sample fish were obtained from fishermen caught using fishing gear without bait and were 0.5 inches in size. Tangkul is a lifting net installed in the waters using a rectangular raft made of wood or bamboo, consisting of a net with each end tied to two pieces of bamboo or wood. The two ends are smoothed (pointed) and then installed crosswise with each other at an angle of 90 degrees (Kirana *et al.* 2015).

Length and Weight Relationship of Fish

The results of the analysis of the long-length relationship between the weight of Nilem fish obtained from the catch of Teluk Lake fishermen were W = 0.0017L3.7148 (Figure 2). The regression equation results showed a value of b > 3, indicating that the growth of tilapia shows positive allometric traits.

The value of the weight–length relationship obtained in tilapia with a value of b = 3.7148 shows that the growth of fish weight is not linear to the growth of its length. In a positive allometric relationship, a change in the length of the fish will result in a more significant weight change than expected if the relationship is linear. It shows that the larger the fish, the more significant the difference in weight (weight growth was more dominant). Ibrahim *et al.* stated that the value of b is greatly influenced by the length and weight of the fish, so the factors that affect the size of the fish's body will indirectly affect the pattern of variation in the value of b. The results of this study are similar to those of tilapia caught in the Benanga Reservoir, Samarinda City, East Kalimantan Province (Jusmaldi *et al.* 2020).

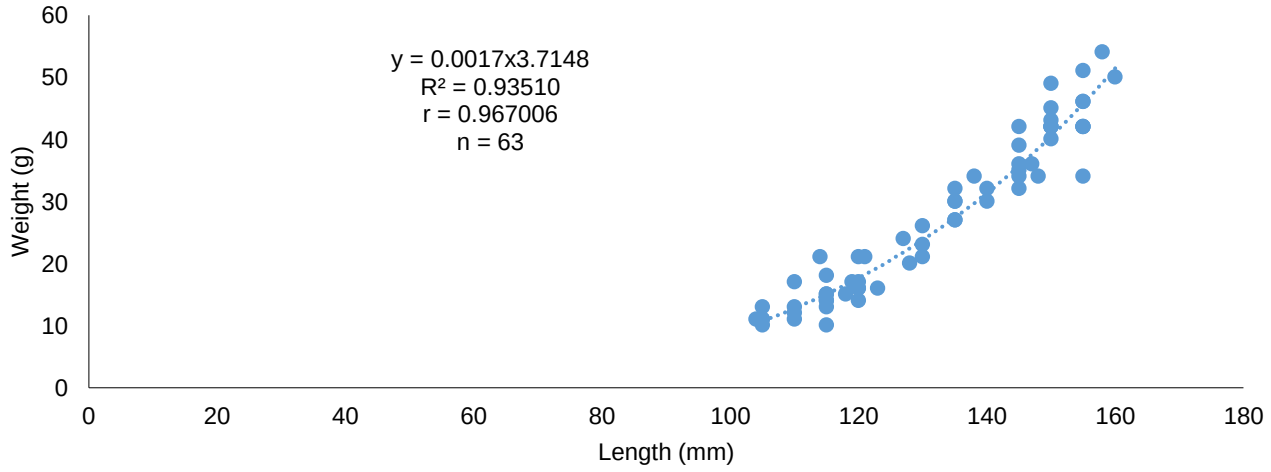

Figure 2 The long-term relationship of the weight of tilapia (*Osteochilus hasselti*) caught naturally in Teluk Lake, Jambi City in September 2024.

However, different results were found in tilapia in Lake Buyan, which was negative allometrically with a value of b = 2.8 (Sravishta *et al.* 2017), and tilapia obtained in Lake Talaga which is allometric negative with a test result of t ($p<0.5$) which means $b \neq 3$ (Putri *et al.* 2015). However, different results were found in tilapia in Buyan Lake, which was negative allometric with a value of b = 2.8 (Sravishta *et al.* 2017), and tilapia obtained in Lake Talaga which is allometric negative with the test result t ($p<0.5$), meaning $b \neq 3$ (Putri *et al.* 2015).

The coefficient value of determination (R2) in tilapia is 0.93510, which means that the weight size of the tilapia can be estimated to be 93% of the length of the fish and already represents the actual state in nature of 93%. The determination coefficient (R2) ranged from 70 to 90%, indicating a very close relationship between length and weight in the studied fish species, namely Odontesthes argentinensis, Urophycis brasiliensis, and Brevoortia aurea (Biolé *et al.* 2020; Dutta 2022; Kojadinović *et al.* 2023; Massaro *et al.* 2020; Sui *et al.* 2015).

Condition Factors

The tilapia condition factor was 2.1554–3.0947, with an average of 1.026948. 2.7368 ± 0.2363 standard deviations. When viewed from the average value of the condition factor, which has a value of more than one, the condition of the waters of Teluk Lake still supports the life of tilapia. This is in accordance with Cren's statement (Cren (1951) that the condition factor is indicated in the good category if the value obtained ranges from 1 to 3. The results of the condition factor in Teluk Lake are almost the same as the category of condition factors in tilapia in Rawa Pening Lake, which has a value of 0.46-1.66 (Maulidyasari and Djumanto 2020). The value of K shows that the state of the fish has the condition of the water based on the state of the fish. If the K ranged from 0 to 0.99, the fish was in a thin state with poor water conditions. If the K ranges from 1 to 3, then the fish is in a thin state and the water is in good condition. The K value ranges from more than 3.1, indicating that the fish are in a fat state and that the waters are in very good condition. The variation in the size of the fish that will spawn can be influenced by length and weight because spawning can be one of the causes of changes in the value of fish condition factors (Shasia *et al.* 2021: Aisyah *et al.* 2017).

In the waters of Teluk Lake, there are 878 units of floating net cage activities for tilapia and catfish cultivation. This number exceeds the carrying capacity of the waters, which are suspected to cause an increase in the number of P concentrations in the waters (Kristianto *et al.* 2014). However, this condition did not have a significant effect on tilapia. Nilem can adapt to the conditions of the waters of Teluk Lake. Based on the existence of floating net cages, tilapia can be used to look for plankton organisms attached to floating nets as feed. Nilem are herbivores with trophic levels between 1.03% and 1.45%. Nilem mainly feeds on plankton and periphytons attached to floating nets (Yustiati *et al.* 2017).

Nilem Sex Ratio

The number of tilapias caught by fishermen was 68% and females 32%, with a ratio of 1:2.15 (Figure 3). It shows that more female fish were caught than male fish. In water, a sex ratio of Cyprinidae fish of 1:1 is ideal, or there are at least more females than males so that the population can be maintained despite natural mortality and capture (Rochmatin *et al.* 2014; Wahyuni *et al.* 2015). Male tilapia with a total length of 105–155 mm, average body length of 120 mm, standard deviation of ± 13.84, and weight of 10–42 g. While female tilapia had a total length of 104–160 mm with an average body length of 137.67 mm, a standard deviation of ±15.85, and a weight of 11–54 g. The highest weight was found in female fish, indicating that at the time of the study, the fish were in a mature gonad

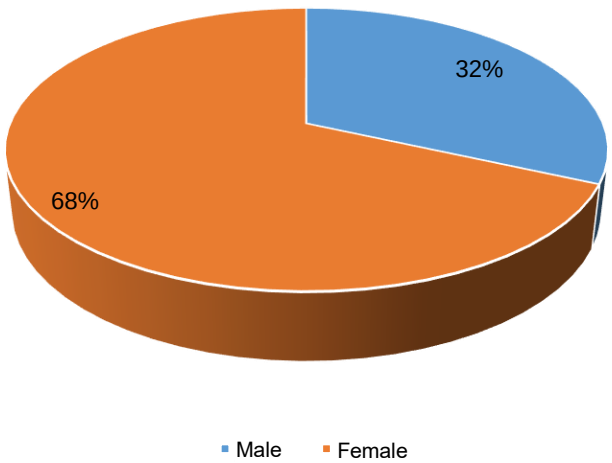

Figure 3 Sex ratio of tilapia *(Osteochilus hasselti*) caught in Teluk Lake, Jambi City.

state, so there was an increase in weight due to the gonads. The body weight of female fish in GML III was 11–35 g, while GML IV ranged from 13 to 54 g. The increased body weight of the female fish indicates the fish's need for abundant and quality food in the maturation of the egg, which makes the female fish eat more. Regulation of gene or protein expression dysfunction gene or protein expression can result in reabsorption. If the food eaten is of poor quality, it will result in reabsorption, subsequently causing the late maturation of eggs. (poor quality), Moreover, failure to grow within a few hours after fertilization is a factor for fish to seek out and eat foods with high protein content (Reading *et al.* 2018; Wulanda *et al.* 2023).

The Size of Fish Ripening Gonads for the First Time

The results of the observation of fish with GML III, which are categorized as mature gonads, showed a size class of 105-137 mm for males and 104–163 mm for females. For GML IV in male fish, there was a size class of 114–155 mm, and in female fish, there was a size class of 110-160 mm. In each species of fish, when the gonads first mature and are not the same size, this also applies to fish of the same species (Abubakar *et al.* 2019).

The analysis results of the first size of mature gonad fish (Lm) male tilapia were 125.847 mm with a size class range of 116–126 mm. In the finfish, the calculation of the size of Lm is 112.996 mm with a range of 104–113 mm. The yield of this Lm was lower than the average size of the male or female fish caught. This is consistent with the results of a study on tilapia in the waters of the Rawa Pening Lake, Tuntang District, Semarang Regency by Rochmatin *et al.* (2014). If the size of Lm is smaller than the average size of the fish caught, it is safe to catch, and there is little chance of recruitment overfishing because mature nilem fish have not been caught and could spawn.

Gonad Maturity Level

Visually, the gonad maturity level of tilapia caught in Teluk Lake was 57 fish in a mature gonad state and 6 fish in an immature gonad. Most of the fish that matured gonads in this study were female fish, with a total of 42 mature gonads, whereas as many as 15 male fish were in a mature gonadal condition. The large number of female fish caught is suspected to be due to the spawning season; females tend to flock, causing more female species to be caught than males (Jusmaldi *et al.* 2020). The high number of female fish caught is due to the spawning season, so female fish tend to flock, which causes a higher number of female species to be caught than male types.

In male tilapia, no gonadal stiffness level (GML) I is found, and most fish are in a mature gonadal condition. Male tilapia with GML IV dominated the size class of 149–159 mm (Figure 4). In female tilapia, GML I was found in the size class of 134–143 mm, but no fish were found in GML II condition in all fish classes (Figure 5). The number of fish caught was dominated by female fish in GML IV, with the highest number in the 144-153 mm class, with as much as 30% of the female fish caught. The results of the relative frequency analysis found that the higher the size class, the higher the fish class, and the higher the fish GML. Higher maturity is often associated with higher GML (Niu *et al.* 2023). The results of this study indicate that the tilapia obtained during the study were in the spawning period of tilapia. Most tropical freshwater fish, particularly those from the Cyprinidae family, spawn seasonally, with peak spawning occurring during the rainy season (Kebede *et al.* 2018).

Gonadal Maturity Index

The gonadal maturity index (GMI) study provides an important indication of spawning; the GMI increases along with the maturity of the fish's gonads and reaches its maximum in the highest GML period (Kiran 2015).

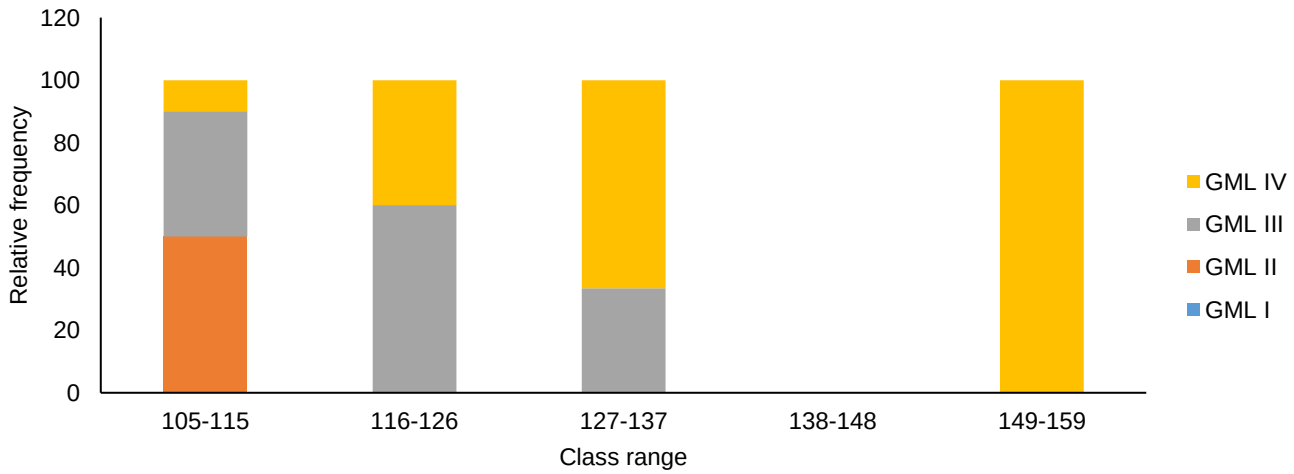

Figure 4 The number of male tilapia fish maturing gonads based on the gonad maturity level (GML) of each class and the relative frequency of size.

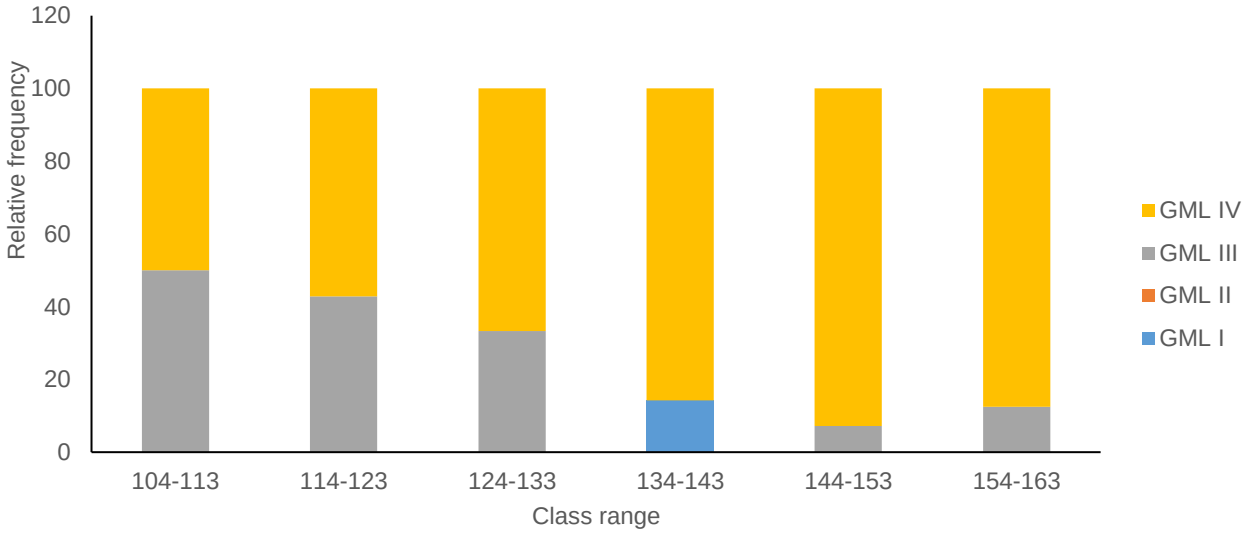

Figure 5 The number of female tilapia maturing gonads based on the gonad maturity level (GML) of each class and the relative frequency of size.

The value of the GMI in male tilapia in this study ranged from 3.20 to 8.33%, while that in female tilapia was from 0.03 to 28.89%. The average males GMI ranges from 4.28 to 5.65%, while the females range from 0.03 to 15.25% (Table 1).

In male fish in GML II, GML III, and GML IV, the average GMI values were 4.28%, 6.20%, and 5.65%, respectively (Figure 6). The GMI values of female fish in GML I, GML III, and GML IV were 0.03%, 15.70%, and 15.25 %, respectively (Figure 7). The average GMI in male fish was lower than in female fish because female fish in mature gonadal conditions experience a more significant increase in ovarian weight than the testicles of male fish. The weight of the ovaries and GMI is significantly higher than that of the testicles because, in the ovaries, there is a process of forming the yolk, which makes the volume of the ovaries increase compared to the size of the testicles and then makes the weight of the female gonads increase more than that of male fish (Xie *et al.* 2021; Walidaini and Elvyra 2022).

The Size of Fish Maturity Ripening Gonads for the First Time

The results of the observation of fish with GML III, which are categorized as mature gonads, showed a size class of 105–137 for males and females from sizes 104–163. For GML IV in male fish, there was a size class of 114–155, and for female fish, there was a size class of 110–160. In each species of fish, when the gonads on the first day are not the same size, this also applies to fish of the same species (Abubakar *et al.* 2019).

The results of the first size analysis of mature gonad fish (Lm) of male tilapia were 125,847, with a size class range of 116–126. In the calves, the calculation of the size of Lm was 112,996, with a range of classes 104–113. These Lm were lower than the average size of the male or female fish caught. This is consistent with the results of a study on tilapia in the waters of the Rawa Pening Lake in Semarang Regency by Rochmatin *et al.* (2014). If the size of Lm is lower than the average size of the fish caught, it is safe to catch, and there is little chance of recruitment overfishing because mature nilem have not been caught and could spawn.

Table 1 Average gonadal maturity index (GMI) of male and female tilapia

GML	Female		Male	
	Average GMI	St, dev	Average GMI	St. dev
I	0.03	0.00	0.00	0.00
II	0.00	0.00	4.28	1.00
III	15.70	4.37	6.20	1.04
IV	15.25	5.10	5.65	1.41

CONCLUSION

The relationship between the length and weight of tilapia in the waters of Teluk Lake was positive allometric. The average condition factor is higher than 1, which shows that although the number of floating cage units slightly exceeds capacity, food availability in the waters still supports tilapia's life, where the fish's weight is more dominant than the length of the fish. It is thought that this is because tilapia have a high environmental tolerance, where they can take advantage of plankton and periphyton attached to floating nets. In August-September, it is suspected that the gonad maturity period of tilapia fish, where 90% of the fish caught, is in a mature gonad condition with an IKG value of 0.03%–28.89%. Several methods can be used to manage fishery resources, including

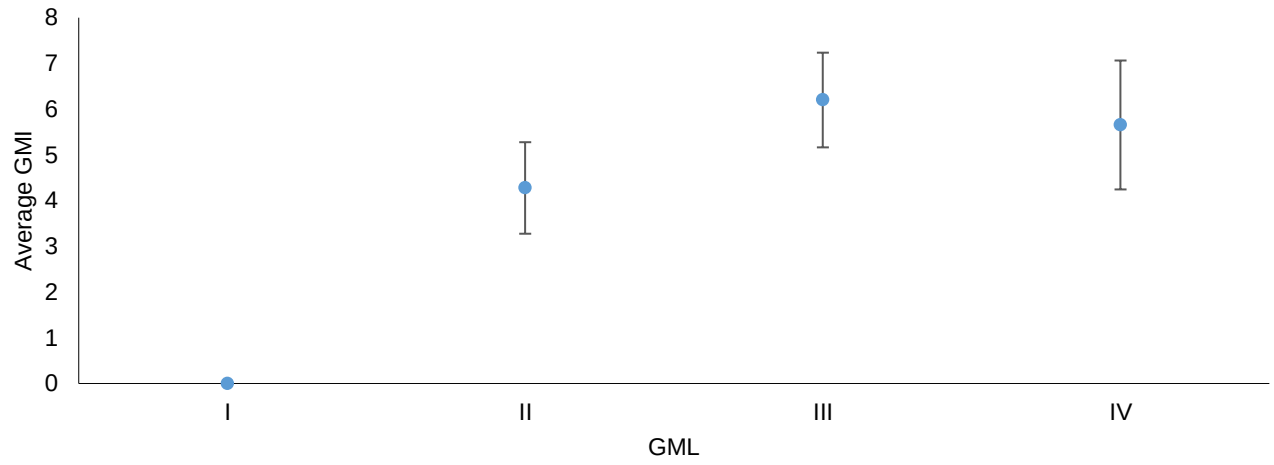

Figure 6 Average gonadal maturity index (GMI) of male tilapia.

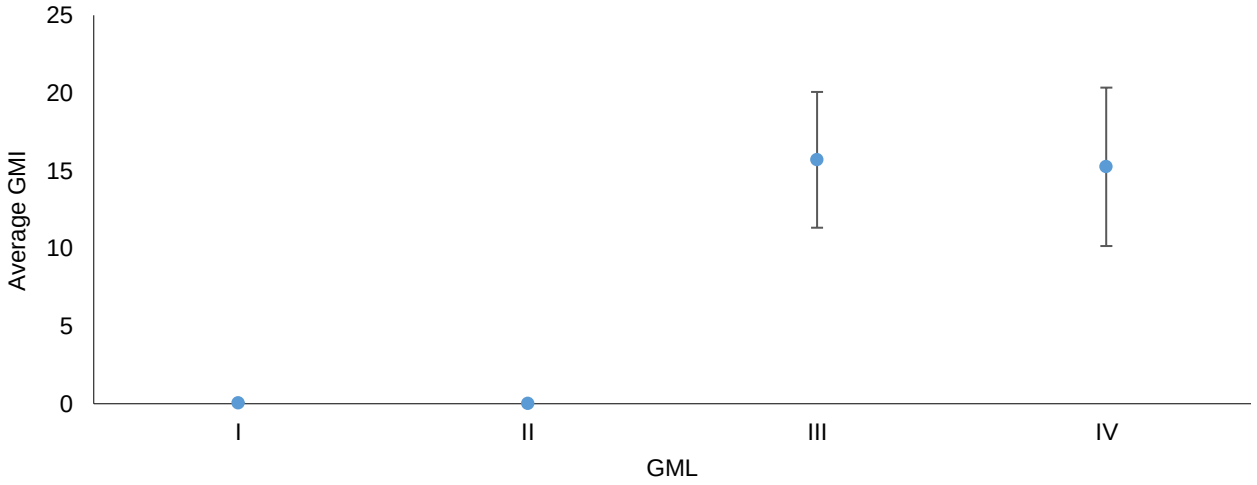

Figure 7 Average gonadal maturity index (GMI) of female tilapia.

maintaining the net's size and reducing the fishing intensity during the spawning period of fish at least once in their life.

The relationship between the length of tilapia weight in the waters of Teluk Lake is positive allometric, with a condition factor of 2.1554–3.0937. The GMI in male fish in this study was 3.20% to 8.33%, whereas in female fish was from 0.03% to 28.89%. Lm (the size of the first time the gonad matures) in male tilapia is 125,847 with a size class range of 116□126 mm. In female fish, the calculation results of the size of Lm 112,996 were in the range of 104-113 mm size class.

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