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# Population Biology of Silver Barb Fish (*Barbonymus gonionotus*, Bleeker: 1849) in the Waters of Way Sekampung Dam, Pagelaran District, Pringsewu Regency, Lampung.

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**ABSTRACT**

Silver barb fish (*Barbonymus gonionotus*) is a freshwater fish found in Indonesia; it also has high economic value and is widely caught by fishermen, especially in the waters of the Way Sekampung Dam. This research was conducted from September to December 2024 and included a sample of 417 fish. The purpose of this study is to obtain information related to the biology of silver barb fish populations needed for management. Estimates of length-weight relationships, condition factors, growth parameters, and exploitation rates were calculated using Microsoft Excel and FISAT II. Results for the length-weight relationship were $W = 0{,}019L^{2{,}8083}$ for males, $W = 0{,}0087L^{3{,}1112}$ for females, and $W = 0{,}0113L^{2{,}9982}$ for the combined. Relative condition factors ranged from 0.8989 to 1.4867. Male silver barbs had better condition than females. Von Bertalanffy growth parameters for male silver barb fish have an infinite length ($L\infty$) = 282,58 mm, a growth rate (K) = 0,81/year, and an exploitation rate (E) = 0,07, which is considered underexploited. female silver barb fish have an infinitive length ($L\infty$) = 361,20 mm with a growth rate (K) = 1,5/year, and exploitation rate (E) = 0,78 which is included in over exploited. Moreover, for the whole silver barb, the infinite length ($L\infty$) = 378 mm, the growth rate (K) = 1,4/year, and the exploitation rate (E) = 0,74, which is considered underexploited.

**Keywords:** Exploitation rate, Growth parameters, Length-weight relationship, Silver barb fish.

## INTRODUCTION

Silver barb fish (*Barbonymus gonionotus*) is a popular freshwater fish in Indonesian society. According to the Ministry of Maritime Affairs and Fisheries, the production of silver barb fish in Lampung Province in 2019 was 113 tons (0,298%).

This silver barb fish has good nutritional value and a fairly high economic value. According to the Central Statistics Agency of Lampung Province in 2014, the price of silver barb fish ranged from Rp. 10,000 - Rp. 30,000/kg, so it is not uncommon for fishermen living around the dam to catch this fish for their own consumption or resale.

This encourages fishermen to over-catch without regard for the sustainability of these fish stocks, so that one day their existence will be threatened (Khoiriah & Pangerang, 2024). Based on the catches of fishermen in Way Sekampung Dam, who fish almost every day, the dominant catch is the silver barb. If fishing efforts are carried out continuously without management, they will affect the conservation of these fish resources (Fisesa, 2017). In addition, information on the biological and ecological aspects of silver barb fish remains very limited, especially for the population in the Way Sekampung Dam Area.

This study was conducted to determine biological aspects, including growth parameters, length-to-weight relationships, and exploitation rates, of silver barb (*Barbonymus gonionotus*). In this case, it is important to undertake conservation efforts to sustain the wild fish population.

## MATERIAL AND METHOD

### Sampling data of silver barb fish

This research will be conducted in the waters of the Way Sekampung Dam, Pagelaran District, Pringsewu Regency, Lampung Province (figure 1) for 4 months from September to December 2024. Fish samples were captured using fixed gill nets

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measuring 2 inches and spanning 10-50 m. The caught fish were then put into a cool box. Fish caught were placed in a cool box filled with ice cubes, then taken to the lab for further processing. Fish to be measured for length and weight were placed on a tray, dried with paper towels, and numbered with label paper—their lengths were measured using millimeter blocks with a number scale. The length of the fish measured is the total length (Fishbase, 2024).

Meanwhile, fish weight was measured using digital scales previously calibrated. The unit used to measure fish weight is the gram (g). The last step is to record the results of measuring the length and weight of the fish in the prepared worksheet, and then data analysis will be carried out.

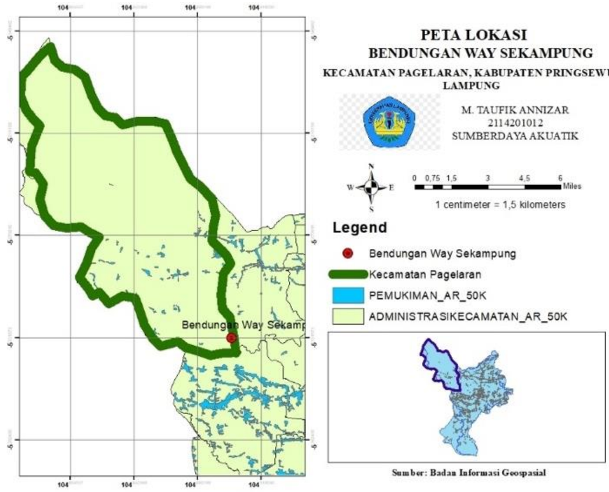



**Figure 1.** Research location at Way Sekampung Dam, Pagelaran Subdistrict, Pringsewu Regency, Lampung

### Data Analysis Program

The programs used to analyze silver barb data were Microsoft Excel and FiSAT II. Microsoft Excel was used to estimate biological parameters of silver barb fish, including length-weight relationships and condition factors. The FiSAT II program (FAO-ICLARM Fish Stock Assessment Tools) was used to analyze and estimate the growth parameters of silver barb and its exploitation rate (Sparre & Venema, 1999).

### Data Analysis

### Length and Weight Relationship

The model used in estimating the length and weight relationship (Effendie, 1979) is an exponential relationship as follows:

$$W = aL^b$$

Based on the linear relationship pattern, it can be seen that:

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

Notation:
W: silver barb weight (g)
L: silver barb length (mm)
a: intercept (the intersection of the fish length-weight relationship curve with the y-axis)
b: slope (estimation of fish length-weight growth pattern)

To determine whether the value of b obtained is equal to 3 (isometric growth pattern) or not equal to 3 (allometric growth pattern), it is tested with the formula in calculating t-count as follows:

$$t_{hit} = \left| \frac{b-3}{Sb} \right|$$

Notation:
b: slope
Sb: standard deviation

Testing the value of b = 3 or b ≠ = 3 is done using a t-test (partial test) with the hypothesis: H0: b = 3; the relationship between length and weight is isometric. $H_1$: b ≠ 3, the relationship between length and weight is allometric

This hypothesis is used to estimate the growth pattern of the value of b, which is a process or effort to reject or accept the hypothesis we make (Steel & Torrie, 1989). With the following criteria:
1) If obtained b = 3, then the weight gain is equal to the increase in length (isometric). 2) If obtained b < 3, then the increase in length is faster than the increase in weight (negative allometric). 3) If obtained b > 3, then the increase in weight is faster than the increase in length (positive allometric).

Furthermore, to determine the pattern of fish growth, hypothesis testing where t-count will be compared with t-table using a 95% confidence interval, the decision rules according to Walpole (1993), are as follows: 1) if the t-count value > t-table then the decision rejects the null hypothesis ($H_1$). 2) If the t-count value < t-table, then the decision accepts the null hypothesis ($H_0$).

### Condition Factors

Condition factors are calculated based on growth patterns derived from fish length-weight relationships. If the fish growth pattern is isometric, the formula used is as follows (Effendie, 1979):

$$K = \frac{10^5 w}{L^3}$$

Moreover, if the growth pattern is allometric, the formula used is as follows (Effendie, 1979):

$$K = \frac{w}{a\,L^b}$$

Notation:
K: condition factor
L: total length of fish (mm)
W: weight of fish (gram)

a, b: constants

Determination of the value of the condition factor in fish with the following hypotheses:

1) K > 1, then the fish has a lot of meat with high economic value or worth catching and selling. 2) K = 1, then the fish has enough meat with economic value or worth catching, but not worth selling. 3) K < 1, then the fish has less meat with low economic value or is not worth catching and selling.

### Growth Parameters

Growth parameters were analyzed using the FiSAT II program using the ELEFAN I method. Estimation of growth parameters can be determined by the von Bertalanffy equation (Sparre & Venema, 1999) as follows:

$$Lt = L\infty\ (1 - \exp^{-k(t - t_0)})$$

The value of t0 can be known by using the equation (Pauly, 1984) as follows:

$$\text{Log}(-t_0) = -0{,}3992 - 0{,}2752\ (\text{Log}\ L\infty) - 1{,}038\ (\text{Log}\ K)$$

Notation:

Lt : length of fish at age t (mm)

L∞ : maximum length or asymptotic length (mm)

K: length growth rate constant per year

t: age of fish in years

$t_0$: theoretical age of fish when length equals zero (years)

The value of L∞ can be determined using the following equation:

$$L\infty = \frac{a}{(1 - b)}$$

Notation:

L∞ : maximum length or asymptotic length (mm)

a: intercept

b: slope

The value of K can be found by using the following equation:

$$K = -\ln(b)$$

Notation:

K: growth coefficient (year)

b: slope

### Exploitation Rate

The exploitation rate can be estimated with the following equation:

$$E = F / Z$$

Notation:

E: exploitation rate

F: capture mortality rate

Z: total mortality rate

According to Octoriani *et al.* (2015), the optimal exploitation rate of fish resources is 0.5, meaning that natural mortality equals capture mortality. If the value of E > 0.5, the exploitation rate of fish resources is in a state of over-exploitation, while if the value of E < 0.5, the exploitation rate of fish resources is under-exploitation.

## RESULT AND DISCUSSION

### Result

The research successfully identified several growth patterns of silver barb fish originating from Way Sekampung Dam, including length-weight relationships, condition factors, growth parameters, and exploitation rates.

### Length-Weight Relationships

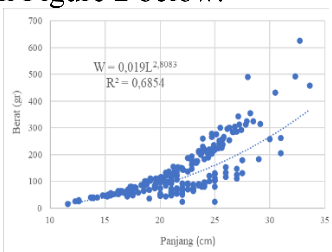
The equation for the length-weight relationship of silver barb fish can be seen in the following table:

**Table 1**. Results of length-weight relationship analysis of silver barb (*Barbonymus gonionotus*)

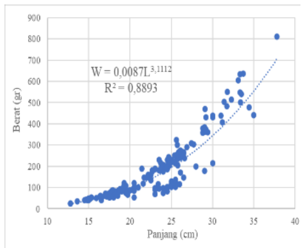
| Gender | N | Equation | $R^2$ | $t_{count}$ | $t_{table}$ | Growth pattern |
|---|---|---|---|---|---|---|
| Male | 250 | $W = 0{,}019L^{2{,}808}$ | 0,685 | 0,342 | 2,25 | Negative allometric |
| Female | 167 | $W = 0{,}0087L^{3{,}111}$ | 0,889 | 0,435 | 2,26 | Isometric |
| Male + Female | 417 | $W = 0{,}0113L^{2{,}998}$ | 0,814 | 0,554 | 2,24 | Negative allometric |

Description: N = NumberNumber of samples; W = Fish weight; L = Fish length; $R^2$ = Coefficient of determination.

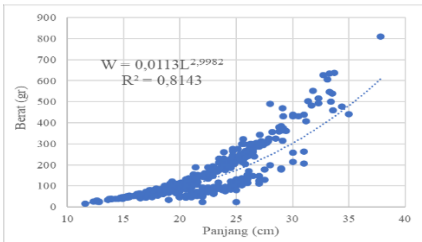
The results of the research conducted showed that the Number of silver barb fish was 417. obtained the results of a linear graph showing that any increase in the value of fish length is followed by an increase in the value of fish weight, as shown in Figure 2 below.




(a)




(b)




(c)

**Figure 2.** Length-weight relationship of silver barb fish (a) male; (b) female; (c) Male+Female.

## Condition Factors

Condition factors describe the maturity of fish, expressed in terms of length and weight data. The condition factor indicates the state of a fish in terms of its physical capacity for survival and reproduction (Ibrahim *et al.*, 2017). The average condition factor values for September to December 2024 vary between males and females. The following condition factor values for silver barb are shown in Table 2 for each month.

**Table 2**. Analysis results of silver barb fish condition factor values

| Sex | Body lenght (mm) | Body weight (gr) | Average condition factor | | | | |
|---|---|---|---|---|---|---|---|
| | | | September | October | November | December | Average |
| Male | 116-336 | 16-626 | 0,89 | 1,11 | 1,35 | 1,48 | 1,21 |
| Female | 128-378 | 24-810 | 0,99 | 1,25 | 1,35 | 0,91 | 1,13 |

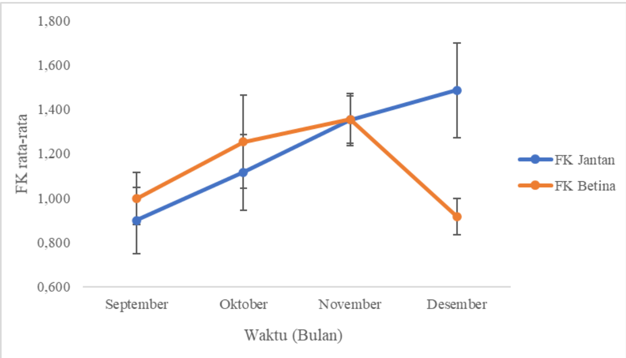


**Figure 3.** Graph of average condition factor values of silver barb fish

## Growth Parameters of Silver Barb Fish

The growth parameters of silver barb fish living in the Way Sekampung water environment are used to estimate the von Bertalanffy Growth Model. The Von Bertalanffy model assumes that fish growth is continuous until it reaches its maximum size. The main parameters of this model include the maximum length ($L\infty$), the growth rate (k), and the zero time ($t_0$) (Firdaus *et al.,* 2013). The results of the analysis of silver barb fish parameters are shown in Table 3.

**Table 3.** Growth parameters of silver barb fish

| Silver Barb Fish | $L\infty$ (mm) | K (year$^{-1}$) | $t_0$ (year$^{-1}$) |
|---|---|---|---|
| Male | 282,58 | 0,81 | -0,9718 |
| Female | 361,20 | 1,5 | -1,2789 |
| Male+Female | 378 | 1,4 | -1,2532 |

Description: $L\infty$ = Theoretical maximum length, K = Growth coefficient, $t_0$ = Theoretical age at zero length.

A graph related to the von Bertalanffy growth equation for silver barb fish can be seen in the following figure (Figure 4).

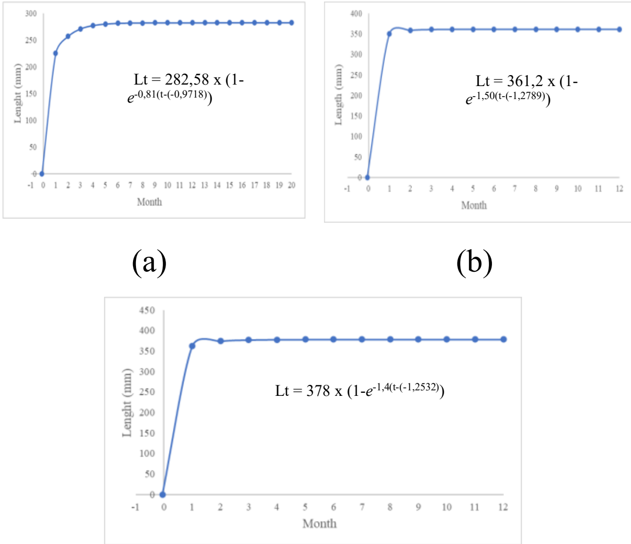



**Figure 4.** Relationship between age and length of silver barb (a) male; (b) female; (c) male+female

## Exploitation Rate

In this study, the exploitation rate of silver barb fish (*Barbonymus gonionotus*) in the Way Sekampung reservoir shows variation, with some showing a low exploitation rate and others a high one. More details can be seen in the following table (Table 4).

**Table 4**. Exploitation rate (E) of silver barb

| Silver Barb Fish | E (Year$^{-1}$) |
|---|---|
| Male | 0,07 |
| Female | 0,78 |
| Male+Female | 0,74 |

## Discussion

The results of the analysis of the length-weight relationship of silver barb with a sample of 417 fish, consisting of 250 male fish and 167 female fish, are presented in Table 1. Growth patterns were analyzed using the equation from Effendie (1979) and then tested using regression with a 95% confidence level. The hypothesis for growth pattern is: reject $H_1$, accept $H_0$ if b = 3 (isometric), and reject $H_0$ or accept $H_1$ if b ≠ 3 (allometric). Based on the results of the analysis (Table 1), the growth pattern of male and combined silver barb showed b≠= 3 with a value of 2,8083 and 2,9982, while female silver barb showed b = 3 with a value of 3,1112. In the t-test results, female silver barb fish showed $t_{count} < t_{table}$, indicating an isometric growth pattern in which weight growth is balanced with length growth. Meanwhile, male and combined silver barbs exhibit a negative allometric growth pattern, with fish length growing faster than weight growth.

According to Purnomo and Surnano (2009), the value of the constant b is influenced by ontogenetic factors, including age, level of gonadal maturity, and sex. In addition, according to Ibrahim *et al*. (2017), the influence of the size of the length and body weight of the fish is very large on the value of b, so that indirectly the factors that affect the size of the fish body will affect the pattern of variation of the value of b. Food availability and variations in fish body size can also cause differences in the value of b. The size of the value of b (slope) is also influenced by the value of a (intercept), so that the greater the value of the intercept, the greater the effect on the final result of the growth pattern (Ningrum *et al.,* 2015). Based on Figure 2, the linear graph shows that increases in fish length are accompanied by increases in fish weight, and vice versa. This shows the effect of length increase on fish body weight gain, as indicated by the $R^2$ (Coefficient of determination), which is close to 1: 0,6854, 0,8893, and 0,8143. The Coefficient of determination ($R^2$) is a measure to determine the suitability or accuracy of the relationship between the independent variable and the dependent variable in a regression equation. If the $R^2$ value is close to 1 (the value is getting bigger), it means that the contribution of the independent variable to the dependent variable is 100%. Conversely, if the $R^2$ value is close to 0 (the value is getting smaller), it means that the contribution of the independent variable to the dependent variable can be said to be almost nonexistent (Zubair, 2015). In this equation, the independent variable is the increase in length, and the dependent variable is the increase in weight.

Table 2 shows that the condition factor in male silver barb fish has increased each month. The highest condition factor value for male silver barb fish was 1,487 in December, and the lowest was 0,899 in September. While the female silver barb fish also showed an increase from September to November, followed by a decrease in December, the highest condition factor value was 1,354 in November, and the lowest was 0,917 in December. The graph (Figure 3) above shows that silver barb fish living in the Way Sekampung Dam environment have a condition factor value $> 1$, which is the value expected under the hypothesis, indicating fish with a lot of meat, high economic value, or worth catching and selling. The graph also shows a steady increase in male silver barb fish, indicating that the fish are in good condition. This is supported by a statement from Fuadi (2016): factors that affect the value of the condition factor are the Number of organisms, the condition of organisms, the availability of food in the aquatic environment, and the quality of the waters themselves. A high condition factor indicates a match between the fish and their habitat. In addition, a high condition factor in fish indicates fish in gonadal development, while a low condition factor indicates fish lacking food intake. Differences in condition factor values can be influenced by differences in age, environmental conditions, gonad maturity, food availability, and behavior (Aisyah *et al.,* 2017).

Based on the table above (Table 3), the growth parameters of silver barb fish (*Barbonymus gonionotus*) studied with the Von Bertalanffy model method resulted in the value of male silver barb fish growth parameters, namely asymptotic length ($L\infty$) = 282,58 mm, growth coefficient (K) = 0,81 year$^{-1}$, and the age of male silver barb fish when the length is zero ($t_0$) = -0,9718. Female silver barb fish had an asymptotic length ($L\infty$) = 361,2 mm, growth coefficient (K) = 1,5 year$^{-1}$, and the age of female silver barb fish when the length was zero ($t_0$) = -1,2789. In comparison, silver barb fish as a whole had an asymptotic length ($L\infty$) = 378 mm, growth coefficient (K) = 1,4 year$^{-1}$, and the age of silver barb fish as a whole when the length was equal to zero ($t_0$) = -1,2532. If the K value is lower and has a large $L\infty$ value, then the recovery of fish population conditions in certain waters will be slower. Conversely, if the K value is higher and the $L\infty$ value is small, recovery of fish population conditions in these waters will be faster (Iriansyah *et al*., 2022). In addition, the difference between $L\infty$ and K values is thought to be caused by differences in the maximum length of fish obtained during sampling, the NumberNumber of samples taken, the location of capture, and differences in stock and recruitment (Kurniawan *et al*., 2022). Correia *et al*. (2009) noted that growth coefficients differ across species, seasons, habitats, and sexes. According to Sparee (1999), fish length increases proportionally with time, but the growth rate decreases with age and approaches zero as the fish ages. In addition, Lagler (1962) stated that age can affect growth factors. Old fish growth will continue but slowly, generally have a lack of excess food in their growth, because most of the food absorbed by the body is used in maintaining the body and movement, either to find food (feeding ground), to reproduce, or to avoid predators and climate factors and influence (Yonvitner *et al.,* 2023).

According to Sparre and Venema (1999), if E = 0,5, the exploitation rate is considered sufficient. However, if the value of E > 0,5, the exploitation rate of fish resources is in a state of over-exploitation, while if the value of E < 0,5, the exploitation rate of fish resources is in a low condition (under-exploitation). From this statement, the exploitation rate of female and combined silver barb with a value of 0,78 and 0,74 respectively (Table 4) is included in over-exploitation, because fish that have been over-exploited will have an impact on reducing the population of adult fish that are caught first and have not had time to spawn at least once in their life cycle (Austin *et al*., 2008). In contrast, male silver barbs have a value of 0,07, indicating a low exploitation rate. This is supported by a statement from Hedianto & Satria (2017), which indicates that local fishermen have not optimally utilized fish with a low exploitation rate.

## CONCLUSION

It can be concluded that silver barb fish living in Way Sekampung Dam Waters exhibit negative allometric growth patterns in male fish and combined isometric growth patterns in female fish. The condition factor of silver barb fish is more pronounced, with a value above 1, indicating that the fish has a high meat content and is worth catching and selling. The maximum length of male fish is 282.58 mm; female fish is 361.20 mm, and combined fish is 378 mm. Meanwhile, the exploitation rate of silver barb fish shows overexploitation in female fish and combined fish, while male fish are underexploited.

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