Length-weight relationships and condition factors of the Groe Fish *Barbodes binotatus* (Pisces: Cyprinidae) in Nagan River, Aceh Province, Indonesia

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**Abstract.** The groe fish *Barbodes binotatus* is one of the commercial freshwater fish occurred in Nagan River, Aceh Province, Indonesia. To date, information on the growth pattern and condition factor of this species were not available. Hence, the objective of the present study was to examine the growth pattern and condition factors of the groe fish *B. binotatus* in Nagan River, Nagan Raya District, Aceh Province, Indonesia. The sampling was conducted for 12 months from January 2016 to December 2016. The sampling locations were determined based on the information from local fishermen. The Linear Allometric Model (LAM), Fulton’s and Relative Weight conditions factors were utilized to analyse the length-weight relationships and condition factors of the groe fish. A total of 409 fish samples were collected during the study. The results showed that the highest coefficient of $b$ was recorded in October, where the $b$ value was 5.19 with the average $b$ value was 2.91 indicates an isometric growth pattern. The average Fulton’s condition factor (K) was 2.41 and the average Relative weight (Wr) condition factor was 100.52. It is concluded that fish had an isometric growth pattern and based on K and Wr value, the results indicate that the waters are still in good condition and supports the life of fish. Furthermore, the availability of food sources, low competitors, and low predators indicate that the aquatic environment is in a stable condition.
1. Introduction
A total of 56 species of fish within Barbodes genus have been described worldwide [1], of these four species i.e., *B. binotatus*, *B. microps*, *B. brevis* and *B. lateristrigaare* occurred in Aceh waters [2-6]. *Barbodes* is one of the commercial freshwater fish utilized for consumption and ornamental fish [7], because this species had an attractive color [8]. *Barbodes binotatus* has a good adaptation to less favorable waters [9], and therefore, this species is distributing widely in Aceh waters [2].

Based on direct observation on the field showed that groe fish *B. binotatus* is one of the main targets for fishing by local fishermen because this species is easily finding and widely distributing. However, this species has been listed in the IUCN Redlist at the Least Concern category [10]. However, the pressure on this fish population is increasing along with intensive harvesting, environmental damage due to illegal logging, and the intensive introduction of alien fish species in Aceh waters [11, 12]. Therefore, the conservation strategy has to be initiated to protect these aquatic resources as early as possible. Information of the length-weight relationships (LWS) and condition factors are very crucial to plan a better management strategy of fish [13, 14], and currently, this information was not available. Therefore, the objectives of the present study were to analyze the length-weight relationships and condition factors of the groe fish *B. binotatus* harvested from Nagan River, Nagan Raya District, Aceh Province, Indonesia.

2. Material and Methods

2.1. Time and site
The study was conducted from January to December 2016 in Nagan River, Aceh Province, Indonesia. The sampling was conducted at three sampling locations along the Nagan River (Figure 1).

2.2. Sampling procedure
Sampling was conducted four times per month for 12 months; the fish was caught using gillnet and casting net from 08.00 AM to 18.00 PM. The sampling sites were determined purposively based on information from local fishermen. The sampled fish were counted, the temporary preserved in the crushed ice (4 °C) then transported to the laboratory in Syiah Kuala University. In the laboratory, the fish was weighed for body weight (g) and measured for total length (mm).

![Figure 1. Map of Nagan River, Nagan Raya District, Aceh Province, Indonesia showing location sampling (black dots)](image)

2.3. Length-weight relationship analysis
The Linear Allometric Model (LAM) was utilized to estimate the growth pattern of the fish as proposed by De-Robertis dan William [15] as follow:

\[ W = e^{0.56(aL^b)} \]

Where \( W \) is total body weight (g), \( L \) is the total length (mm), \( a \) is the regression intercept of the model, \( b \) is the regression coefficient, \( e \) is the variance of residual of the LAM model, 0.56 is correction factor.

2.4. Condition factors

Two condition factors namely Fulton’s condition factor (K) and the relative weight condition factor (Wr) were calculated in this study. The Wr was calculated based on Rypel dan Richter [16] as follow: \( W_r = \frac{W}{W_s} \times 100 \), where \( W \) is body weight (g), \( W_s \) is body weight prediction based on LAM model, while \( W_s = aL^b \).

The Fulton’s condition factor (K) was calculated based on Muchlisin et al. [14] as follow: \( K = \frac{W}{W_s} L^{-3} \times 100 \), where \( W \) is body weight (g), \( L \) is the total length (mm), -3 is length coefficient to ensure that the K value tends toward one. Based on Morton and Routledge [17], the K value was divided into five categories: very bad (0.8 0-1.0), bad (1.1 - 1.2), balance (1.3 - 1.4), good (1.5 - 1.60), very good (>1.6).

3. Results and Discussions

The analysis of the \( b \) value of the fish showed that the higher \( b \) value was found at December (5.19) and the lower \( b \) value was recorded in January (1.93) with the average \( b \) value within the year was 2.91 (Table 1). The allometric positive growth pattern was recorded during November and December (Figure 2). However, in general, the \( b \) values tended to 3 (2.91), indicate an isometric growth pattern. Isometric growth patterns indicates the balanced weight increments with additional length, the negative allometric representing the body length growth faster than weight gain so that fish appear slim, while positive allometric growth patterns represent the vice versa [18-20].

| Month     | n   | \( b \) | \( r^2 \) | K     | Wr    |
|-----------|-----|---------|---------|-------|-------|
| January   | 33  | 1.93    | 0.91    | 2.43  | 100.31|
| February  | 32  | 2.65    | 0.94    | 2.54  | 100.42|
| March     | 39  | 2.67    | 0.88    | 2.56  | 100.46|
| April     | 36  | 2.23    | 0.94    | 2.42  | 100.59|
| May       | 33  | 3.26    | 0.88    | 2.41  | 100.49|
| June      | 30  | 2.40    | 0.70    | 2.48  | 100.55|
| July      | 36  | 2.79    | 0.91    | 2.28  | 100.53|
| August    | 38  | 2.84    | 0.98    | 2.38  | 100.51|
| September | 31  | 2.82    | 0.98    | 2.57  | 100.04|
| October   | 38  | 2.67    | 0.95    | 2.40  | 100.89|
| November  | 33  | 3.51    | 0.96    | 2.11  | 100.23|
| December  | 30  | 5.19    | 0.88    | 2.37  | 101.25|
| Average   | 34.08 | 2.91 | 0.91    | 2.41  | 100.52|

Note: \( n \) = total sample, \( b \) = Regression coefficient, \( r^2 \) = Determination coefficient, K = Fulton’s condition factor, Wr = Relative weight condition factor.

Fulton's condition factor has been commonly used in recent decades to predict fish growth and to assess ecological conditions [21-23]. The study revealed that Fulton's condition factor (K) was higher in
September (2.57) and the lowest value was found in November (2.11) with an average value of 2.41 (Table 1). Based on the mean value of K, it was shown that the fish in good condition. This is in agreement with Froese [24] that the K value can be categorized as stable if it is higher than 1.7 in small (100 mm) and K> 2.0 for larger fish (500 mm). A good K value indicates good waters conditions, and it supports fish health [25].

The average Relative weight condition factor (Wr) of groe fish was 100.52, where the highest value was found in December (101.25), and the lowest was recorded in September (104). According to Muchlisin et al. [26] and Batubara et al. [27] state that the Wr value> 100 indicates a stable environmental condition. This is suggesting that the low number of predators, food sources are available and competition for foraging among fish populations is low [28-30]. Besides, Wr values also represent the health and physiological conditions of fish that are directly related to the ecology of the waters where fish live [31-33].
Figure 2. Monthly length-weight relationship of *Barbodes binotatus* (January 2016 to December 2016)
Figure 3. Comparison of observed and predicted growth for *Barbodes binotatus*. Total number of fish = 409 samples

4. Conclusion
*Barbodes binotatus* has an isometric growth pattern. The mean $K$ and $Wr$ were 2.41 and 100.52, respectively indicate the presence of low predators, available food sources, and stable environmental conditions.
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