The Indo-Pacific tarpon (*Megalops cyprinoides*) growth analysis in Lake Siombak, Medan City, North Sumatra Province, Indonesia

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Abstract. Siombak Lake is an aquatic area with various human activities which has the potential to cause pollution and disruption of aquatic biota life cycle. The purpose of the present study was to determine the growth of Indo-Pacific tarpon (*Megalops cyprinoides*) in Lake Siombak, Medan City, North Sumatra Province. The study was conducted for seven months. The fishes were caught using gill nets. Water quality measurements were carried out in situ. Overall, the condition of Lake Siombak Medan City of North Sumatra Province is still within the tolerance of water quality standards. The length and weight value of *M. cyprinoides* in each month were negative allometric with a value of b<3 and the condition factor value of each station shows the FK value >1. The morphological condition of *M. cyprinoides* in Siombak Lake Medan City, North Sumatra Province is in a good condition.

Key Words: aquatic conditions, Elopiformes, maturity, negative allometric growth, water quality.

Introduction. Siombak Lake is located in Medan City, this lake is used by the local people for various activities, one of which was as a fishing area. Tarpon fish (*Megalops cyprinoides*) is one of the species found in Siombak Lake. Based on IUCN data (2016), Indo-Pacific tarpon have been listed as endangered (red listed), but data and information about these fish are still lacking.

The results of a survey conducted in the field show that *M. cyprinoides* are still found in the waters of Lake Siombak, but not much research has been conducted concerning this species. According to the information gathered from fishermen around, the *M. cyprinoides* were initially found at large quantities, and then declined dramatically for a while but lately this species began to be found again. This can be caused by changes in the condition of the aquatic environment that causes these fish to migrate from Belawan sea waters to this brackish lake.

M. cyprinoides must be preserved sustainably, so it is necessary to conduct research on the existence of the species in Lake Siombak. Growth is a very important parameter in efforts to manage fish resources, especially in the case of *M. cyprinoides*. Population growth is the evolution in the number of individuals within population in an aquatic environment at a certain time. The results of this study will be used as basic data in management efforts by knowing population structure that includes growth, length, weight correlation and condition factors (FK) of *M. cyprinoides* in nature, especially in Lake Siombak, Medan City.

Material and Method

Study sites. The study was carried out in Lake Siombak, North Sumatra Province, Indonesia. The study was conducted at eleven different locations as shown in Figure 1. Station 1 was close to residential areas, and as a place for boat mooring. Station 2, there were mangrove trees. Station 3 and 6 in the furrows, there were mangroves with a width

of 5-10 m. Station 4, its characteristic was that there were land vegetation and tourism activities. Station 5 there were mangrove vegetation and pond outlets. Station 7 was located in the middle of the lake, a location with a depth of >10 m. Station 8 was the lake's inlet as well as outlet. Station 9 in the Bedera River section, surrounded by ponds and mangroves. Station 10 was surrounded by mangroves, located in the River Falls section. The last, station 11 was located in the Paluh Besar River and surrounded by mangroves and ponds.

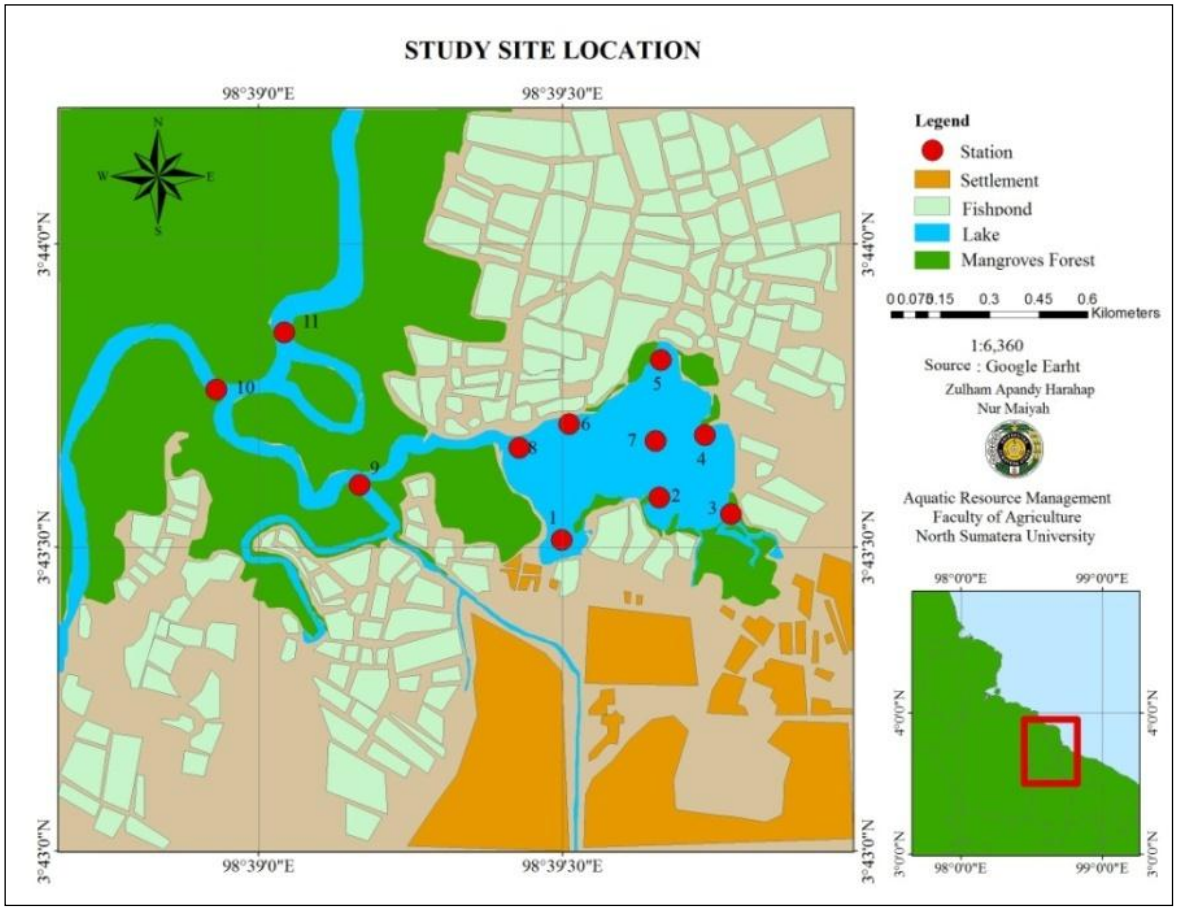

Figure 1. Study site location.

Data type and source. The data used in this study are primary data including the number of fish catches, length and weight of fish, sexes of the fish and physical and chemical parameters of the environment that were taken in the location (study site).

Measurement of physical and chemical parameters. The physico-chemical parameters of water measured were temperature, brightness, depth, salinity, pH and DO. All parameters were recorded in situ.

Fish catching. Fishes were catched by using gill nets every month, from September 2018 to March 2019. The collected fish were placed in plastic bags, labeled and then each station was counted for the number of individuals, measured the total body length and bodyweight of the fish, and then analyzed the fish data for months.

Data analysis

Length frequency distribution. The steps in creating a long frequency distribution were as follows:

1. Determination of the number of size groups needed by the formula:

$$n = 1 + 3.32 \text{ Log } N$$

Where:
n = Number of size groups
N = Number of observed fish
2. Determination of the class width of each size group by the formula:

$$C = \frac{a - b}{c}$$

Where:
C = Class width
c = Class
a = The maximum length of fish for months
b = Minimum length of fish for months
3. Determination of the lower limit of the first size group then adds to the width of the class minus one to get the upper limit of the next size group.
4. Same determinations to the n^{th} size group.
5. Enter the frequency of each existing size group then add up the frequency column whose number must be the same as the entire data (Walpole 1992).

Length-weight correlation. The length-weight relation of the *M. cyprinoides* analyzed by considering the length-weight relationship through linear regression analysis (Sparre & Venema 1999) as follows:

$$W = a\, L^{b}$$

Where:
W = weight (g)
L = total length (cm)
a and b = constants

According to Effendie (2002), to examine the determination of the value of b, a t-test is performed, where there is an attempt to reject or accept a predetermined hypothesis. With the following formula:

$$\text{Tcount} = \frac{b1 - b0}{sb1}$$

Where:
b1 = slope (relationship of length to weight)
b0 = intercept (3)
Sb1 = coefficient deviation b

The close relationship between fish length and weight is shown by the correlation coefficient (r) obtained from the formula $\sqrt{R^2}$. Values approaching 1 ($r>0.7$) illustrate the close relationship between the two and values away from 1 ($r<0.7$) illustrate the non-close relationship between the two (Walpole 1992).

Condition factor (K). Analysis of condition factor can be determined by length and weight. It was calculated according to (Le Cren 1951):

$$K = \frac{100\, W}{L^3}$$

Where:
K = condition factor
W = weight of fish months (g)
L = total length of fish months (cm)
a and b = constants

Results

Measurement of physical and chemical parameters. The average value of the water quality of Lake Siombak can be seen in Table 1.

Table 1

Average values of water quality in Lake Siombak

Parameters	Station										
	I	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*IX*	*X*	*XI*
Temperature (ºC)	30.7	30.7	30.7	31.7	30.9	31.5	31.9	30.6	30.2	29.7	29.9
Brightness (cm)	107.9	90.7	45.7	50.7	42.5	45.7	45.7	90.7	59.3	50.7	50.7
Depth (m)	2.4	3.1	1.1	3.1	0.9	3.1	4.9	2.5	2.3	1.7	2.7
Salinity (‰)	6.3	5.7	5.0	5.3	5.0	5.0	5.4	5.4	5.0	4.9	6.9
pH	7.6	7.4	7.4	7.3	7.3	7.5	7.4	7.2	7.1	7.0	7.1
DO (mg L^{-1})	4.1	4.6	3.0	3.8	4.1	4.9	5.7	5.1	4.1	2.6	3.7

The results showed that the temperature range of the eleven stations were not very different and were still within the tolerance range of the aquatic biota (30.2-31.9^{o}C). Saputra et al (2008) stated that the optimal temperature for the life of aquatic organisms ranges from 25 to 32^{o}C. Water's brightness at each station shows that the waters of Lake Siombak are relatively turbid, according to the Ministry of Environment Decree No. 51/2004 concerning seawater quality standards for marine biota, which states that the quality standard value for seawater brightness is >3 m. If the water's brightness is <3 m, the waters can be categorized as turbid due to its organic load.

The highest water depth was at Station VII because it is located at the very center of the lake, is not affected by land activity and the lowest was at Station V because this station is an outlet area of the pond that is close to the edge of the lake so that it is influenced by the process of pond effluent sedimentation.

The highest salinity occurred at station XI of 6.9‰ because it is a river that is directly related to the waters of the Belawan Sea, close to the estuary so that the tidal effect is higher at this station. According to Nybakken (1992), salinity is influenced by tides, rainfall, evaporation, precipitation, and topography of water.

The pH values obtained at the eleven research stations in each station were still relatively neutral and suitable for the life of aquatic biota in general, due to its value close to 7. According to Fitra (2008), the ideal pH for the life of aquatic organisms generally ranges between 7 and 8.5.

DO values obtained at eleven stations ranged from 2.6 to 5.7 mg L^{-1}. These results indicate that the condition of the waters of Lake Siombak is not good. Barus (2004) states that the value of dissolved oxygen in waters should range between 6 and 8 mg L^{-1}, the lower the DO value, the higher the level of pollution of the ecosystem. However, the DO fishing environment in Lake Siombak is still within tolerance limits, in accordance with Decree of the Ministry of Environment No. 2/1988 that the dissolved oxygen content allowed for group C (fishery) water bodies is higher than 3 mg L^{-1}.

Length frequency distribution. The highest amount of *M. cyprinoides* caught in Lake Siombak, Medan City, were at class 249-276 mm, with 114 individuals and the lowest catch was at class 137-164 mm with only 1 individual caught. The frequency distribution of fish lengths can be seen in Figures 2, 3 and 4.

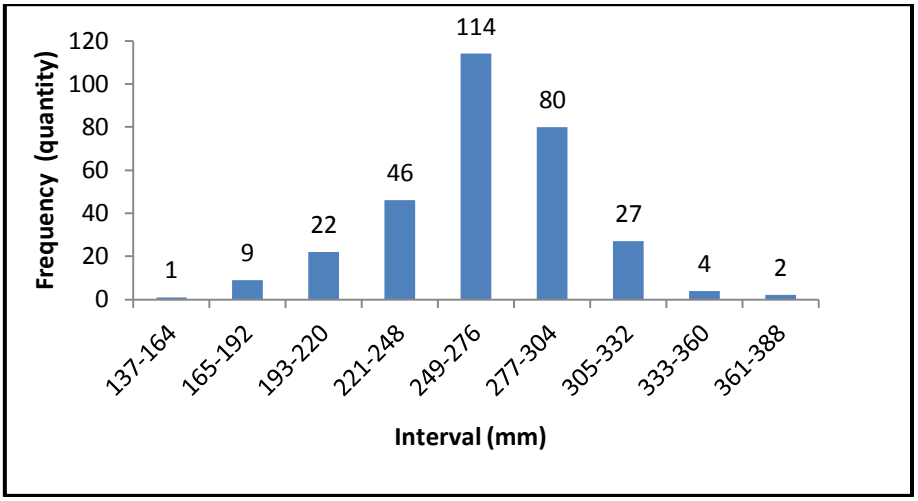

Figure 2. The length frequency distribution of *Megalops cyprinoides*.

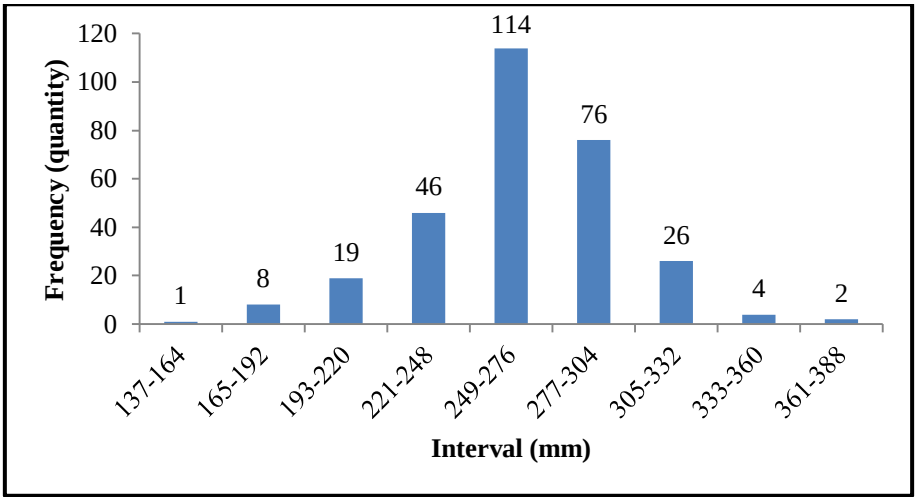

Figure 3. The length frequency distribution of male *Megalops cyprinoides*.

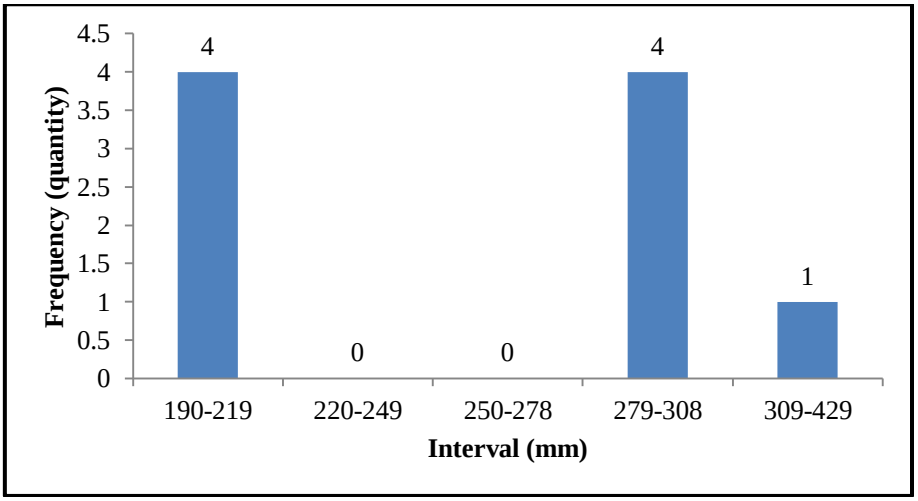

Figure 4. The length frequency distribution of female *Megalops cyprinoides*.

From the graph above, it can be concluded that the number of male fish caught the most was in the class interval of 249-276 mm with 114 individuals and the lowest catch iwas in the class interval of 137-164 mm with 1 sample captured. Whereas in the female *M. cyprinoides*, the highest catch was in the class interval of 190-219 and 279-308 mm, each with 4 individuals and the lowest catch was represented by the class interval of 220-249 mm and no catch was recorded in the class interval of 250-278.

The highest caught was in the class interval of 249-276 mm with 114 samples and the lowest catch was in the class interval of 137-164 mm with only one captured individual. This is due to the fact that tarpon fish are pelagic fish that live in marine waters until freshwater; freshwater is used as a feeding area for *M. cyprinoides*, while adult fish live in sea waters, therefore very small or adult fish were not found. According to Khairul et al (2014), one type of fish that is in the habitat of mangrove ecosystems for foraging is *M. cyprinoides*. According to Adams et al (2014) *M. cyprinoides* in the juvenile stage are in estuary areas that have mangrove forests. These conditions allow young fish that enter the aquatic environment only ventured to find food to enter the adult phase.

M. cyprinoides become a red list species that are vulnerable to extinction because these fish have a population growth time that is long enough so that if these fish are continuously caught at any time then the chances of breeding will be lower because the fish caught have not spawned. This is supported by Cheung et al (2005) who stated that the fish population doubling time is a minimum of 1.4-4.4 years and this fish is classified as high vulnerabile.

Length-weight correlation. The results of the analysis of the relationship of fish length and weight from September 2018 to March 2019 produced a length-weight curve with a value of determination (R^2) of 0.830. The determination value (R^2) of male *M. cyprinoides* was 0.822 while the female *M. cyprinoides* had a determination value (R^2) of 0.978. The correlation between the length and weight of the fish can be seen in Table 2 below.

Table 2

Length-weight correlation of *Megalops cyprinoides*

Month	*Length-weight correlation equation*	R^2	*r*	*Growth pattern after T-test (α=0.05)*
September 2018	$y = 0.00001x^{2.901}$	0.921	0.959	Negative allometric
October 2018	$y = 0.00004x^{2.711}$	0.929	0.963	Negative allometric
November 2018	$y = 0.0001x^{2.526}$	0.767	0.875	Negative allometric
December 2018	$y = 0.00004x^{2.693}$	0.832	0.912	Negative allometric
January 2019	$y = 0.000005x^{3.081}$	0.961	0.980	Positive allometric
February 2019	$y = 0.00004x^{2.698}$	0.823	0.907	Negative allometric
March 2019	$y = 0.00002x^{2.867}$	0.718	0.847	Negative allometric

The correlation coefficient (r) of the *M. cyprinoides* obtained is close to 1. This value indicates that the relationship between the length and bodyweight of the *M. cyprinoides* has a very strong positive correlation; this means that if the length increases, the weight gain will follow it and vice versa. This indicates that the fish caught are in good condition. This is consistent with the opinion of Walpole (1992), where a value close to 1 ($r>0.7$) illustrates a close relationship between length and weight of fish whereas, value far from 1 ($r<0.7$) illustrates a non-close relationship.

The results of the analysis of the relationship between the length and weight of *M. cyprinoides* obtained are: in September 2018 the value of b = 2.901; October 2018 value of b = 2.711; November 2018 the value of b = 2.526; December 2018 the value of b = 2.693; January 2019 value of b = 3.081; February 2019 value of b = 2.698; and in March 2019 the value of b = 2.867. These results mean that the growth of fish in each month on average is negative allometric with a value of $b<3$, except in January 2019 when was positive allometric. In January when the growth was positive allometric, it is suspected as a result of the gonad's maturity level, the higher the gonad's maturity, the weight of the fish will increase. This is in accordance with Rahardjo & Simanjuntak (2008) who stated that the diversity of exponential values (b) the relationship between length and weight between fish species is closely related to ontogenetic development, age differences, gonad maturity, sex, geographical location, and environmental conditions (fishing activity), stomach fullness, disease, and parasitic pressure.

The results of the calculation of the length-weight relationship in the observation area have negative allometric properties with a value of b≠3, these conditions explain that the growth of fish length is more dominant than the growth of fish weight, because genetically this fish is indeed included in the form of fusiform fish (torpedoes). Meanwhile, according to the level of gonad maturity, this fish has not entered into the maturity period of the gonad. According to Sonyenzellnd et al (2015), differences in the value of b can be caused by differences in external factors, namely microclimate, and internal factors, namely gender and gonad maturity level. This factor is explained by Mardiah (2014), that the growth of length increases when the clean energy in the body of the fish increases or the energy that is metabolized is in a fixed position.

M. cyprinoides caught in Siombak Lake were young fish, with a body length ranging from 137 to 385 mm and body weight ranging from 39.29 to 364.09 g. Emmanuel et al (2011) stated that whitebait have a total length range of 27.0-28.5 cm and a weight of 212-220.1 g. The total length of *M. cyprinoides* is between 40.20-42.10 cm and weighing 783-800 g.

The factors influence the growth of *M. cyprinoides* in Lake Siombak, namely internal factors such as genetics, gonad maturity, etc. and external factors such as food availability, water parameters, the presence of predators etc. Because of that, every month the fish are negative allometric, which means that the growth in the length is faster than the weight growth because the fish caught were dominated by immature male and female individuals; while in January the fish were positive allometric. This is usually associated with a limited supply of food in water body. This is thought to be because by January the *M. cyprinoides* had an abundance of food in the form of both shrimps and crabs. According to Mulfizar et al (2012) factors that influence growth include physiological and environmental conditions such as temperature, pH, salinity, geographical location, food availability, and sampling techniques.

Condition factors of the M. cyprinoides. The results of data analysis during the study, concerning the value of *M. cyprinoides* condition factors obtained for each month can be seen in Table 3.

Table 3

Condition factor values for *Megalops cyprinoides* according months

Month	*K*	*Note*
September 2018	1.431	Bonny
October 2018	1.068	Bonny
November 2018	1.074	Bonny
December 2018	1.006	Bonny
January 2019	1.019	Bonny
February 2019	1.054	Bonny
March 2019	0.794	Thin

Condition factor of *M. cyprinoides* in Lake Siombak show a comparison between length and weight. Where higher is the ratio of the weight to the length of the fish in the months, the monthly yield of the fish will be higher. Condition factor is influenced by the physico-chemical factors of the waters and the availability of food in the aquatic environment of Lake Siombak. According to Wujdi et al (2012), the condition factor is a state that describes the rate of fish plumpness with numbers and values which are affected by age, sex, food, and gonad maturity level.

The results of the condition factor analysis of *M. cyprinoides* performed for each month showed an average value K>1. Detailed are as follows: 1.431 (September 2018); 1.068 (October 2018); 1.074 (November 2018); 1.006 (December 2018); 1.019 (January 2019), 1.054 (February 2019) and 0.794 (March 2019). This shows that the condition of *M. cyprinoides* in Lake Siombak, Medan City, morphologically can be said to have good plumpness. This is in accordance with Effendie (1997), who states that if the

value of the condition factor ranges from 1 to 2, it shows a less flat (plump) shape. Based on this aspect, it can be said that the body condition of the fish is still in good condition.

Another interesting aspect to be explored is the distribution of condition factor values of fishes in Lake Siombak which is relatively similar. The distribution of relatively uniform condition factor values with the status of the plump category is thought to be caused by seasonal factors, where at the time of the study it coincided with the beginning of the rainy season which affected the abundance of natural food so that food availability, according to Syahrir (2013), at the beginning of the rainy season is abundant so that the availability of food for somatic growth is fulfilled. Besides that, the most caught fish were males, so a combination of the relative uniform condition factor. According to Mayekiso & Hecht (1990), in general, the condition of male fish is better than of the female fish because the energy obtained by female fish is invested more for gonad development.

Difference Factors (K) are related to environmental conditions such as the presence of mangrove forests. According to Adams et al (2014) that juvenile *M. cyprinoides* will be abundant in an aquatic environment if there is a mangrove forest ecosystem to support the availability of food. Fish distribution areas cover almost all coastal waters, lagoons, bays and estuaries, especially mangrove areas.

Conclusions. The analysis of the relationship between the length and weight of *M. cyprinoides* obtained at Lake Siombak shows that the growth is negative allometric with an average value of b<3, amounting to 2.659. And the condition factor values for each month showed FK values >1 except in March 2019, respectively the FK values from September 2018 to March 2019 were 1.431; 1.068; 1.074; 1.006; 1.019; 1.054 and 0.794, where this shows that the condition of *M. cyprinoides* in Lake Siombak morphologically can be said to have a good plumpness.

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