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Article Type	Research Article
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Manuscript Files

Name	Type of File	Size
Manuscript_Azrita_Length.docx	Main Document - MS Word	861.2 KB
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Abstract

This study was conducted to investigate the length and weight relationship (LWR), condition factors, as well as morphometric and meristic characteristics of eleven freshwater fish species in Koto Panjang Reservoir ecotypes, Indonesia. Fresh specimens were collected during two sampling periods namely September-December (2023) and January-February (2024). The findings indicated that the b coefficient in the LWR of the fish species varied between 1.693 and 3.151. Among the studied fish species, only *Hemisilurus heterorhynchus* (b = 1.951), *Clarias teijsmanni* (b = 2.046), *Anabas testudineus* (b = 2.3750), *Labiobarbus festivus* (b = 2.305), and *Rasbora argyrotaenia* (b = 1.693) had values above the anticipated range of 2.5 < b < 3.5. One and seven fish species showed positive and negative allometric growth, while three demonstrated isometric growth respectively. The mean values of Fulton's condition factor (K*c*) ranged from 0.73 ± 0.15 to 4.96 ± 0.63, indicating variations in fish morphology. The range of allometric condition factor (K*a*) values observed, spanning from 0.87 ± 0.18 to 26.25 ± 4.05, suggested variations in resource availability and competitive pressures within aquatic environments. The mean relative weight condition factor (K*n*) between 1.00 ± 0.09 and 2.51 ± 0.55, suggested favorable growth for the eleven analyzed fish species. In conclusion, this study offered novel insights into the LWR, condition factor, and morphometric characteristics of freshwater species in the Koto Panjang Reservoir. The results have great potential for enhancing fish species stock assessment.

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The data that support the findings of this study are openly available in Figshare at https://figshare.com/articles/dataset/_b_Length_and_b_b_Weight_Relationship_Condition_Factor_b_b_and_b_b_Morphometric_Characteristics_b_b_of_b_b_Eleven_Freshwater_Fish_Species_b_b_b_b_i_b_b_n_Koto_Panjang_Reservoir_Indonesia_b_/25801219, reference number 10.6084/m9.figshare.25801219.

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Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia

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A B S T R A C T

This study was conducted to investigate the length and weight relationship (LWR), condition factors, as well as morphometric and meristic characteristics of eleven freshwater fish species in Koto Panjang Reservoir ecotypes, Indonesia. Fresh specimens were collected during two sampling periods namely September-December (2023) and January-February (2024). The findings indicated that the b coefficient in the LWR of the fish species varied between 1.693 and 3.151. Among the studied fish species, only *Hemisilurus heterorhynchus* (b = 1.951), *Clarias teijsmanni* (b = 2.046), *Anabas testudineus* (b = 2.3750), *Labiobarbus festivus* (b = 2.305), and *Rasbora argyrotaenia* (b = 1.693) had values above the anticipated range of 2.5 < b < 3.5. One and seven fish species showed positive and negative allometric growth, while three demonstrated isometric growth respectively. The mean values of Fulton's condition factor (K*c*) ranged from 0.73 ± 0.15 to 4.96 ± 0.63, indicating variations in fish morphology. The range of allometric condition factor (K*a*) values observed, spanning from 0.87 ± 0.18 to 26.25 ± 4.05, suggested variations in resource availability and competitive pressures within aquatic environments. The mean relative weight condition factor (K*n*) between 1.00 ± 0.09 and 2.51 ± 0.55, suggested favorable growth for the eleven analyzed fish species. In conclusion, this study offered novel insights into the LWR, condition factor, and morphometric characteristics of freshwater species in the Koto Panjang Reservoir. The results have great potential for enhancing fish species stock assessment.

Keywords: length-mass relationship; growth pattern; Fulton's condition index; allometric condition index; length-based weight; morphometric and meristic; Koto Panjang Reservoir

1. Introduction

Kampar Kanan is one of the largest rivers in Riau Province with a length of approximately 213.5 km and a width ranging from 125 to 143 meters. This river originates from the upper reaches of the Bukit Barisan mountains in Limapuluh Kota and Pasaman Regency, West Sumatra Province, Indonesia, flowing into the Siak River in the Bengkalis region, Riau Province, and finally into the Strait of Malacca [1].

Since 1996, the upper reaches of the Kampar Kanan River at a geographical position of 0°17'23.76"N and 100°52'53.39"E have been dammed into a reservoir called the Koto Panjang

Reservoir which is 96 meters high and located at an altitude of 85 meters above sea level. The area of the inundation formed is estimated at 12,400 hectares [2]. This reservoir has multiple functions, including being a hydroelectric power plant with a capacity of 114 MW, as well as irrigation, tourism, and fisheries. Due to the construction of the reservoir, the characteristics of the aquatic ecosystem in terms of abiotic and biotic are affected [3]. Similar to other rivers, dam construction can cause mortality and failure of fish migration [4, 5]. Changes in stream hydrological regimes from lotic to lentic can also affect water retention in reservoirs, leading to a decrease in native and an increase in exotic species [6, 7].

More than 44 types of fish live in the Koto Panjang Reservoir, including *Hemibagrus wyckii*, *Barbonymus schwanefeldii*, *Puntioplites bulu, Diplocheilichthys pleurotaenia, Ompok hypophthalmus, Wallago leerii, Channa lucius, Anabas testudineus,* and *Thyninichthy polylepis* [8]. To support local food security, exotic fish species such as tilapia (*Oreochromis niloticus)*, and carp (*Cyprnus carpio)*, can also be found through floating net cage farming [9].

The fish are caught by small-scale fishermen using non-selective fishing gear such as trap, cast, gill, and drag nets, then sold in traditional markets in the area [10]. However, the use of harmful fishing gear, habitat degradation, and the impact of invasive species can threaten the survival of native fish species in the Koto Panjang Reservoir [3, 11]. This underscores the need to manage fisheries resources that have substantial economic value in a sustainable and environmentally friendly manner.

Length-weight relationship (LWR) analysis plays an important role in fisheries development and conservation evaluation of endangered species. By using existing data, the LWR approach effectively considers fish biomass [12]. It also estimates the length of fish based on the weight in specific environments, ultimately producing estimates of biomass and population growth [13].

Apart from length-weight data, condition factor (K) data for each type of fish is also needed. This parameter indicates welfare based on the hypothesis that fish that weigh more at a certain length show better physiological conditions [14]. On the other hand, studies on differences and variability in morphometric and meristic characters in fish stocks play a crucial role in a phylogenetic context, providing the information needed for further investigations on the genetic improvement of stocks [15].

This study aimed to estimate the LWR, condition factors, and morphometrics of eleven economically important fish species caught in the Koto Panjang Reservoir, Riau Province, Indonesia. The results are expected to provide a deeper understanding of the growth process and contribute to future conservation efforts as well as fisheries management.

2. Materials and methods

2.1. Study area and fishing gear used.

This study was carried out in Kota Panjang Reservoir, located in the upper reaches of the Kampar Kanan River, Kampar Regency, Riau Province, Indonesia. The location is situated area at a geographical position of 0º20'12.30"N and 100º 44'27.26"E (Figure 1). Between September and December 2023, five fish species including *H. wyckii*, *C. lucius*, *A. testudineus, H. heterorhynchus,* and *C. teijsmanni* were caught using trap nets locally known as *bubu*. Trap nets were made from woven bamboo rattan and had a cylindrical front with a diameter of 80 cm, while the back was cone-shaped with a length of 2 meters. This tool was used at the bottom of the reservoir at a depth of 2 to 4 meters and operated between 18.00 and 06.00 to catch demersal fish including Bagridae, Siluridae, Claridae, Channidae, and Anabantidae using chicken intestines as bait. Furthermore, between January and February 2024, six species of fish namely *B. schwanefeldii*, *P. bulu*, *D. pleurotaenia, L. festivus, R. argyrotaenia,* and *T. polylepis* were caught using gill nets. The nets were rectangular in the shape of monofilament thread 60 meters long and 10 meters deep, with a mesh size of 1.25 and 2.5 inches. These nets were operated passively on the water surface from 6 pm to 6 am. The categories and IUCN Red List Status for eleven species as of 2019 and 2020 are presented in Table 1.

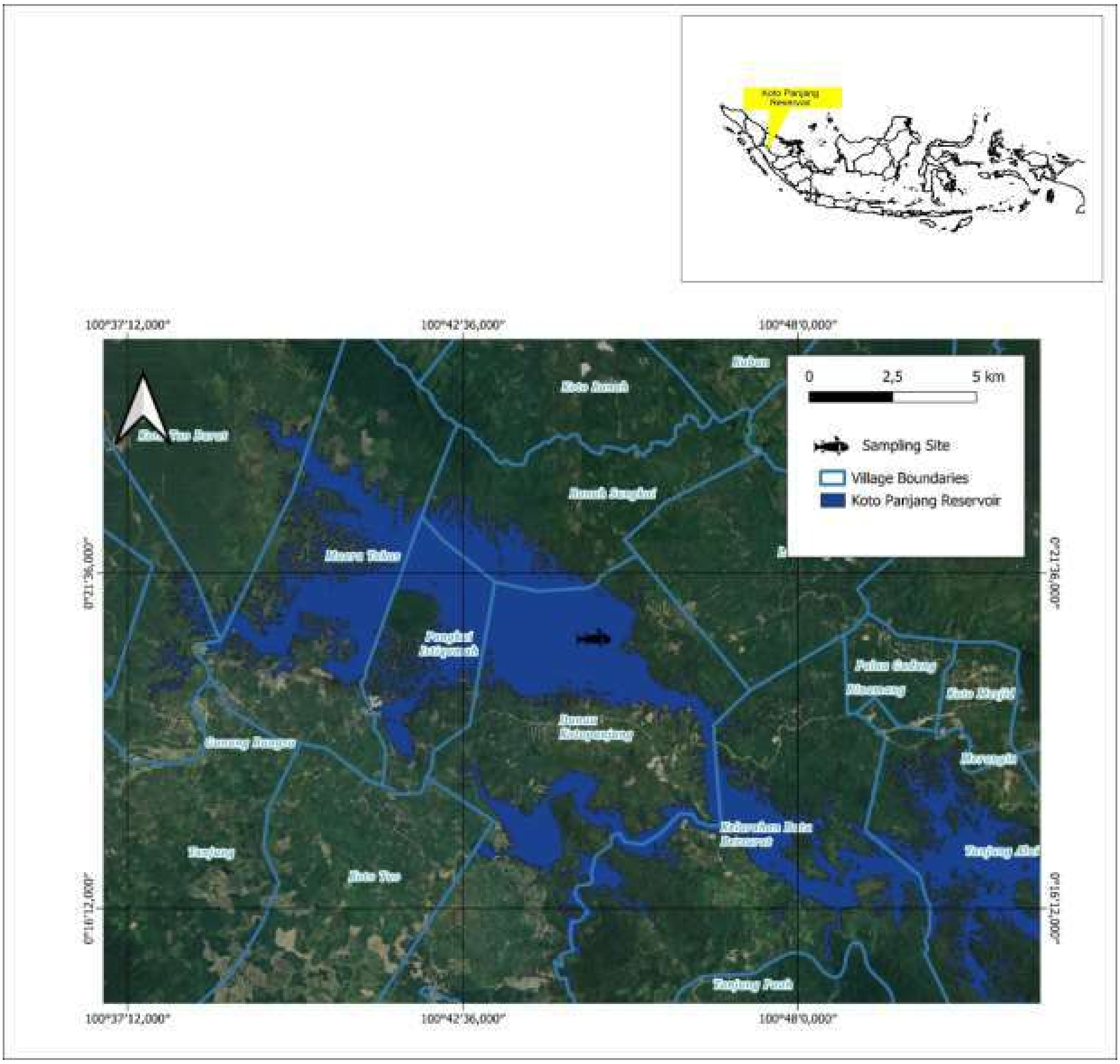

FIGURE 1: Location of sampling site in Koto Panjang Reservoir, Indonesia

2.2. Laboratory procedure

After harvest, the fish specimens were transported in a cold box with a temperature of about 10 °C to the Fish Biology Laboratory, Department of Aquaculture, Faculty of Fisheries and Marine Universitas Bung Hatta, Padang, Indonesia, to measure the length, weight, and morphometric characteristics. Classification and taxonomic identification of sample specimens were carried out using the standard keys [16, 17] Subsequently, the total length precision of each specimen was measured using a balance scale (OHAUS model CT 6000 USA) with an accuracy of 0.1 g, and the lengths were assessed through a meter ruler with 0.1 mm accuracy. The sex (male or female) of each fish sample collected with net traps and gillnets was recorded.

The morphometric characteristics of eleven fish species caught were measured using a 0.01 mm precision digital caliper (Made in China), focusing on parameters including total, standard, fork, and head length, body depth, body girth, peduncle depth, caudal peduncle length, pre-dorsal length, pre-pelvic length, and eye diameter. Meanwhile, meristic characteristics namely the number of hard and soft rays on the dorsal, caudal, anal, pectoral, and ventral fin were counted directly using a binocular magnifier equipped with two adjustable lenses, enabling three-dimensional imaging and detailed magnification for accurate calculation of fish fin radii. Morphometric characteristics were measured from ten randomly selected fish, while meristic traits were calculated from five fish also selected randomly.

2.3. Data analysis

Data analysis was performed using SPSS software version 16 after previously removing outlier data. Furthermore, the regression equation $W = a L^b$ was used to determine the LWR, where parameters ´a´ and 'b' were obtained by transforming the log-log equation, namely Log W = log (a) + b log (L). In this equation, ´W' represents the weight of fish in grams (g), ´L' denotes the total length (TL) of fish in centimeters (cm), 'a´ is a constant (intercept), and ´b´ is the slope (change in weight in weight per unit change in length) of the regression [13]. The 95% confidence interval (CI) of the total length and weight was also analyzed, while the toughness of the samples was assessed with the coefficient of determination (r^2).

The Fulton condition factor (*Kc*) was estimated using the [18] equation, formulated as $kc = 100*W/L^3$, where W is the total weight of the fish sample, and L is the standard length of the fish sample. The allometric condition factor (K*a*) was estimated using the formula from [12], namely $ka = 100*W/L^b$, where W is the total weight of the fish sample (g), L is the standard length of the fish sample (cm), and b is a constant in the length-weight. Meanwhile, the relative weight condition factor (K*n*) was determined using the [19] formula, K*n* = W/We, where W is the weight of the fish sample (g), and We is the theoretical weight calculated as $L^{b,}$ and a is a constant in the length-weight.

3. Results

3.1. Categories and IUCN red list status, and species composition

Eleven types of fish from the families Bagridae, Siluridae, Claridae, Channidae, Anabantidae, and Cyprinidae were collected from the Koto Panjang Reservoir in Indonesia. Information regarding the IUCN Red List categories and status in 2019 and 2020 is presented in Table 1.

TABLE 1: Categories and IUCN Red List Status for eleven species as of 2019 and 2020

Order/Family/Species	IUCN Categories for Species Conservation Status, 2019	The IUCN Red List Status	Occurrence
Siliruformes/Bagridae/*Hemibagrus wyckii* (Bleeker, 1858)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous spesies
Siliruformes/ Siluridae/ Hemisilurus heterorhynchus (Bleeker, 1854)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous spesies
Siluruformes/ Clariidae/ Clarias teijsmanni (Bleeker, 1857)	Not evaluated	No report from IUCN	Indigenous spesies
Anabantiformes/Channidae/ *Channa lucius* (Cuvier, 1831)	Least Concern (LC).	The IUCN Red List of Threatened Species in 2019	Indigenous spesies
Anabantiformes/ Anabantidae/*Anabas testudineus* (Bloch, 1792)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous spesies
Cypriniformas/Cyprinidae/ *Barbonymus schwanefeldii* (Bleeker, 1854)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous spesies
Cyprniformes/Cyprinidae/ *Puntioplites bulu* (Bleeker, 1851)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous spesies
Cyriniformas/Cyprinidae/*Diplocheilichthys pleurotaenia* (Bleeker, 1855)	Data Deficient (DD)	The IUCN Red List of Threatened Species in 2020	Indigenous spesies
Cypriniformes/Cyprinidae/ *Labiobarbus festivus* (Heckel, 1843)	Data Deficient (DD)	The IUCN Red List of Threatened Species in 2019	Indigenous spesies
Cypriniformes/Cyprinidae/ *Rasbora argyrotaenia (*Bleeker, 1849*)*	Least Concern (LC)	The IUCN Red List of Threatened Species in 2020	Indigenous spesies
Cypriniformes/Cyprinidae/ *Thynnichthys polylepis (*Bleeker, 1860*)*	Least Concern (LC)	The IUCN Red List of Threatened Species in 2020	Indigenous spesies

3.2. Species composition

The total samples collected were 485 specimens, with the percentage of each species being as follows: *H. wyckii* (3.09%), *H. heterorhynchus* (6.19%), *C. teijsmanni* (6.19%), *C. lucius* (12, 58%), *A. testudineus* (11.75%), *B. schwanefeldii* (15.26%), *P. feather* (8.25%), *D. pleurotaenia* (7.84%), *L. fetivus* (8.25%), *R. argyrotaenia* (10.31%), and *T. polylepis* (10.31%). Further information about fish species and the sex is presented in Table 2.

TABLE 2: Species composition, relative abundance, and percentage occurrence of eleven fish species

Family	Species	N	% by no	Sex (%)	
				F	M
Bagridae	*Hemibagrus wyckii*	15	3.09	33.33	66.66
Siluridae	*Hemisilurus heterorhynchus*	30	6.19	33.33	66.66
Clariidae	*Clarias teijsmanni*	30	6.19	66.66	33.33
Channidae	*Channa lucius*	61	12.58	65.67	34.43
Anabantidae	*Anabas testudineus*	57	11.75	29.82	70.17
Cyprinidae	*Barbonymus schwanefeldii*	74	15.25	41.89	58.10
Cyprinidae	*Puntioplites bulu*	40	8.25	62.5	37.5
Cyprinidae	*Diplocheilichthys pleurotaenia*	38	7.84	36.84	63.16
Cyprinidae	*Labiobarbus festivus*	40	8.25	50.0	50.0
Cyprinidae	*Rasbora argyrotaenia*	50	10.31	24.0	76.0
Cyprinidae	*Thynnichthys polylepis*	50	10.31	52.0	48.0
Total		485	100		

N: sample size; % = percentage; F: female; M: male; no = number

3.3. Length-weight relationship

Table 3 presents descriptive statistics for eleven fish species, including length and weight, used as parameters 'a' and 'b' in each LWR equation and the coefficient of determination (r^2). The range of 'a' values for each species was 0.010 to 0.259, while 'b' values ranged from 1.693 to 3.151. The range of r^2 values obtained was between 0.51 and 0.95, confirming the validity and reliability of the LWR measurement. Furthermore, the LWR relationship in each species consistently showed a significant correlation ($p<0.000$).

This study identified variations in the growth types of eleven fish species, with one species, namely *H. wyckii*, showing a positive allometric growth type, while the other three, including *C. lucius*, *B. schwanefeldii*, and *P. bulu*, demonstrated isometric growth. Seven other species, including *C. teijsmanni*, *A. testudineus*, *D. pleurotaenia*, *L. fetivus*, *R. argyrotaenia*, and *T. polylepis*, showed a negative allometric growth type (Table 3).

Based on the results, the least mean standard length and smaller weight were 9.77 ± 1.34 cm and 8.29 ± 4.27 g for *R. argyrotaenia*, while the maximum standard length and total weight were 39.47 ± 4.82 cm and 2,112.67 ± 889.88 g for *H. wyckii*. These include *H. wyckii* (41 cm vs. 71 cm), *H. heterorhynchus* (16.39 cm vs. 80 cm), *C. lucius* (30.68 cm vs. 53 cm), *A. testudineu*s (13.82 cm vs. 25 cm), *B. schwanefeldii* (18.63 cm vs. 35 cm), *P. bulu* (24.40 cm vs. 44.33 cm), *D. pleurotaenia* (18.13 cm vs. 22.5 cm), *L. festivus* (23.03 cm vs. 33.7 cm), and *R. argyrotaenia* (9.77 cm vs 14 cm). Meanwhile, *T. polylepis* (19.2 cm vs. 18 cm) and *C. teijsmanni* (23.77 cm vs. 22 cm) had a higher value than recorded in FishBase.

3.4. Condition factor

Table 4 shows the values of Fulton's (K*c*), allometric (K*a*), and relative weight condition factor (K*n*) of eleven fish species caught in the Koto Panjang reservoir. The mean value of K*c* for different species varied between 0.73 ± 0.15 and 4.96 ± 0.63 as summarized in Figure 2. *H. heterorhynchus*, *D. pleurotaenia*, *L. festivus* and *T. polylepis* had values < 1.0, while K*c* for *H. wyckii*, *C. teijsmanni*, *C. lucius*, *A. testudineus*, *B. schwanefeldii* and *P. bulu* was > 1.0. Furthermore, in Figuru 3, the mean value of Ka exceeds or equals 3 for six species namely *H. heterorhynchus* (14.70 ± 4.65), *C. teijsmanni* (26.25 ± 4.05), *A. testudineus* (15.07 ± 1.36), *D. pleurotaenia* (3.60 ± 0.34), *L.* f*estivus* (8.32 ± 0.36), and *R. argyrotaenia* (17.31 ± 0.38). While the mean value of K*n* for eleven species ranged from 1.00 ± 0.08 and 2.51 ± 0.55. *R. argyrotaenia* had the lowest value of 1.00 ± 0.08, while *C. lucius* recorded the highest value of 2.51 ± 0.55 (Figure 4).

TABLE 3: Descriptive Statistics and Parameters for LWR and Growth of Eleven Fish Species in Koto Panjang Reservoir, Riau.

Species	N	LWRs parameters							t-test	P value	Growth type
		Mean SL (cm)	CI 95% of SL (cm)	Mean Wt (g)	CI 95% of TW (g)	a	b	r^2			
Hemibagrus wyckii	15	39.79 ± 4.82	37.12 - 41.82	2,112.67 ± 889.88	1,527.67 - 2697.66	0.010	3.151	0.82	7.79	0.000	(+)
Hemisilurus heterorhynchus	30	16.39 ± 2.00	15.67 – 17.10	22.92 ± 10.76	22.90- 26.76	0.146	1.951	0.51	5..36	0.000	(-)
Clarias teijsmanni	30	23.77 ± 2.00	23.06 - 24.48	133.74 ± 41.37	118.97 – 148.51	0.259	2.046	0.77	9.60	0.000	(-)
Channa lucius	61	28.44 ± 2.24	26.20- 30.68	252.72 ± 63.03	189.69 – 315.75	0.012	2.956	0.83	17.10	0.000	(I)
Anabas testudineus	57	7.87 ± 1.15	6.72 – 9.02	24.91 ± 10.12	14.79 – 35.03	0.178	2.375	0.89	29.46	0.000	(-)
Barbonymus schwanefeldii	74	23.27 ± 2.60	22.67 – 23.88	149.49 ± 54.10	137.19 - 161.78	0.012	2.978	0.86	21.14	0.000	(I)
Puntioplites bulu	40	21.63 ± 2.46	20.36 – 23.39	243.69 ± 82.84	218.03 - 269.34	0.029	2.927	0.84	14.39	0.000	(I)
Diplocheilichthys pleurotaenia	38	22.40 ± 2.84	21.49 - 23.30	106.85 ± 30.37	97.20 - 116.49	0.037	2.555	0.94	23.87	0.000	(-)
Labiobarbus festivus	40	22.25 ± 2.61	21.43 - 23.06	108.18 ± 28.37	99.38 - 116.97	0.083	2.305	0.88	16.36	0.000	(-)
Rasbora argyrotaenia	50	7.74 ± 1.12	7.43 – 8.06	8.29 ± 4.27	7.10 – 9.40	0.172	1.693	0.95	31.13	0.000	(-)
Thynnichthys polylepis	50	14.72 ± 2.96	13.90 – 15.54	25.70 ± 13.31	22.01 – 29.39	0.008	2.932	0.91	22.20	0.000	(-)

N: sample size; SL: standard length; TW: total weight; Min; minimum; Max: maximum; SD: standard deviation; CI: confidence interval, (+) = positive allometric; (-) = negative allometric; (I) = isometric

TABLE 4: Condition Factors (Kc, Ka, Kn) for Eleven Fish Species in Koto Panjang Reservoir, Riau.

Species	N	Fulton's condition factor (*Kc* values)				The allometric condition factor (*Ka* values)				Relatif weight condition factor (*Kn* values)			
		Mean ± SD	SE	Range (*Kc* values)		Mean ± SD	SE	Range (*Ka*-values)		Mean ± SD	SE	Range (*Kn*-value*s*)	
				Min.	Max			Min.	Max.			Min.	Max.
Hemibagrus wyckii	15	3.24 ± 0.60	0.16	2.45	4.06	1.86 ± 0.06	0.09	1.39	2.67	1.03 ± 0.20	0.05	0.77	1.48
Hemisilurus heterorhynchus	30	0.89 ± 0.40	0.08	0.55	2.10	14.70 ± 4.65	0.21	9.47	25.30	1.01 ± 0.32	0.03	0.65	1.75
Clarias teijsmanni	30	1.57 ± 0.34	0.06	1.02	2.70	26.25 ± 4.05	0.74	17.31	37.12	1.01 ± 0.16	0.02	0.67	1.43
Channa lucius	61	1.08 ± 0.12	0.01	0.86	1.45	1.25 ± 0.13	0.02	0.79	1.51	2.51 ± 0.55	0.08	1.23	3.49
Anabas testudineus	57	4.96 ± 0.63	0.08	3.90	7.79	15.07 ± 1.36	0.11	12.06	19.7	1.00 ± 0.09	0.01	0.80	1.28
Barbonymus schwanefeldii	74	1.15 ± 0.20	0.02	0.80	1.53	2.91 ± 0.42	0.02	2.10	3.74	1.01 ± 0.14	0.02	0.71	1.35
Puntioplites bulu	40	2.33 ± 0.34	0.05	1.68	3.05	2.24 ± 0.33	0.05	1.62	2.94	1.02 ± 0.15	0.02	0.72	1.29
Diplocheilichthys pleurotaenia	38	0.93 ± 0.15	0.02	0.78	1.21	3.60 ± 0.34	0.05	3.11	4.46	1.00 ± 0.09	0.02	0.87	1.24
Labiobarbus festivus	40	0.96±0.16	0.02	0.80	1.63	8.32 ± 0.36	0.15	6.75	10.48	1.01 ± 0.12	0.02	0.82	1.28
Rasbora argyrotaenia	50	1.02 ± 0.31	0.04	0.60	1.76	17.31 ± 0.38	0.19	16.39	18.29	1.00 ± 0.08	0.01	0.95	1.06
Thynnichthys polylepis	50	0.73 ± 0.15	0.12	0.44	1.25	0.87 ± 0.18	0.03	0.52	1.47	1.02 ± 0.21	0.08	0.61	1.71

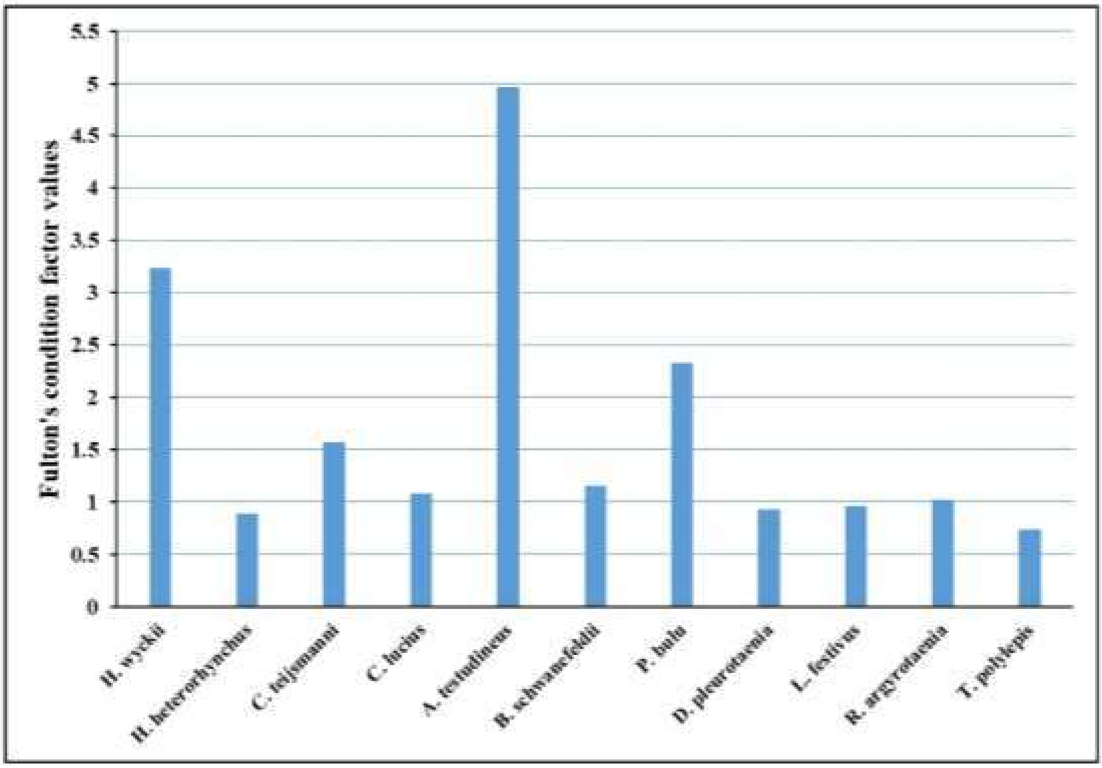

FIGURE 2: Fulton's condition factor (Kc) for eleven fish species in Koto Panjang Reservoir.

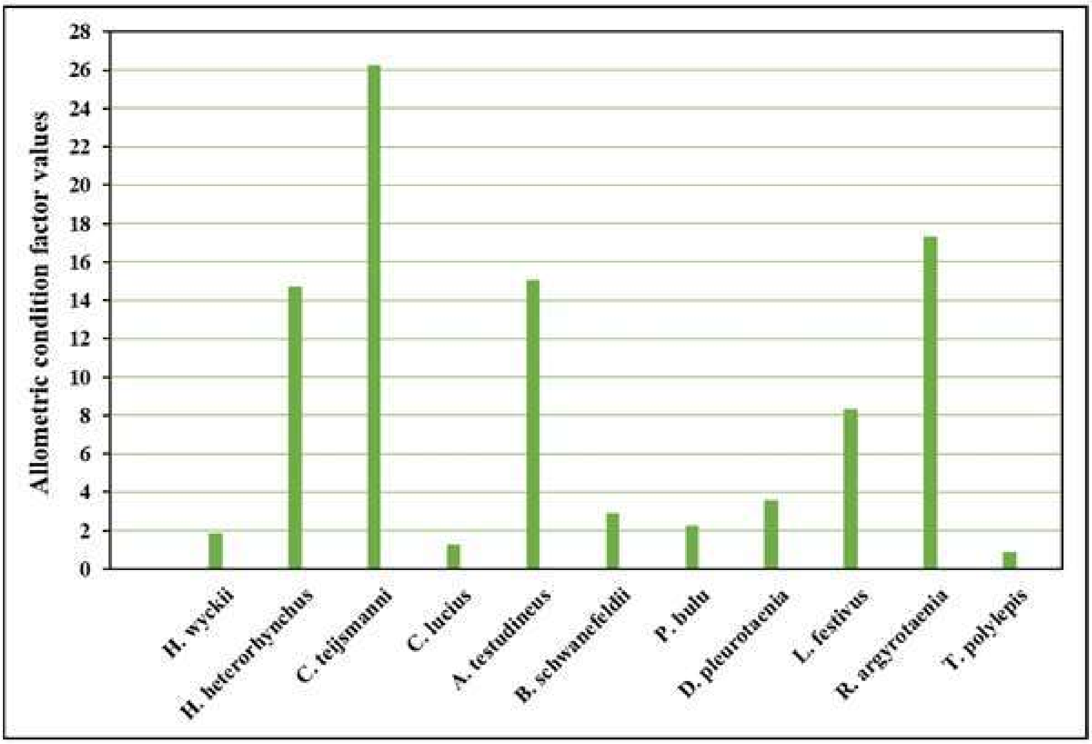

FIGURE 3: Allometric condition factor (Ka) for eleven fish species in Koto Panjang Reservoir

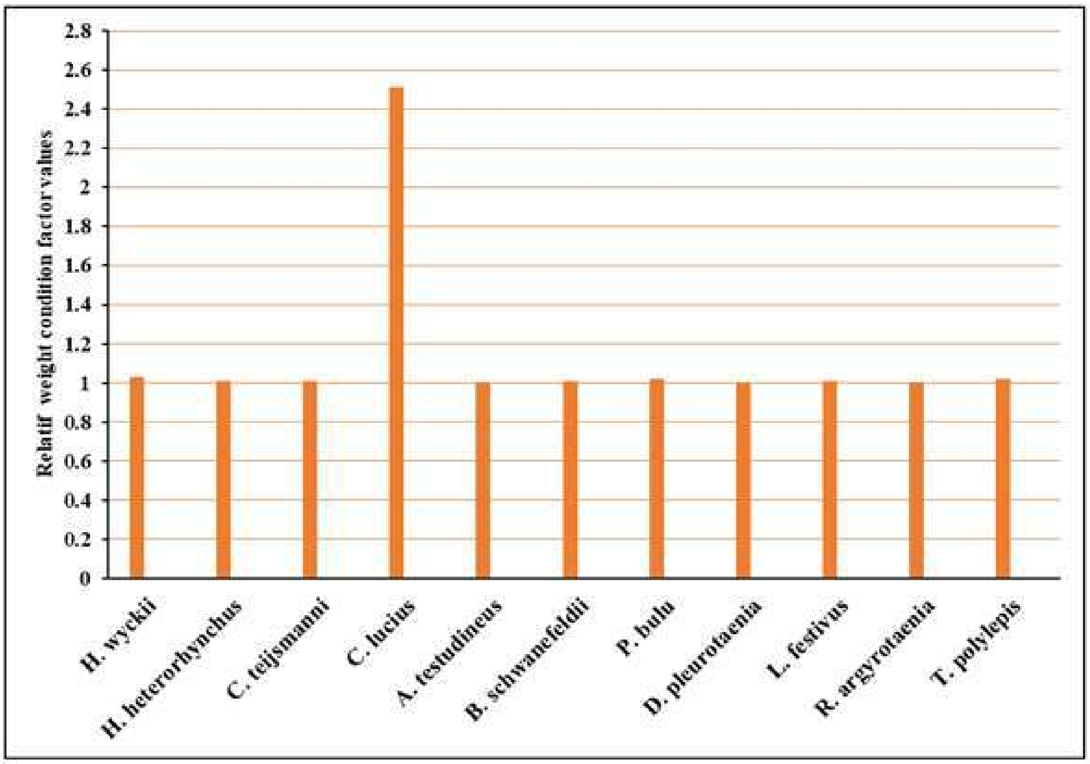

FIGURE 4: Relative condition factor (K*n*) for eleven fish species in Koto Panjang Reservoir

3.5. Morphometric and meristic characteristics

Table 5 summarizes the mean, minimum, and maximum range values of the morphometric characteristics of eleven fish species in Koto Panjang Reservoir. *H. wyckii* (Bleeker, 1858) showed the highest mean standard length (SL) value of 39.79 ± 4.82 cm and body weight (WT) value of 2,112.67 ± 889.88 g. Conversely, *R. Argyrotaenia* (Bleeker, 1849) had the lowest mean standard length and weight values of 7.74±1.12 cm and 8.29±4.27 g. The smallest mean body depth value was found in *R. argyrotaenia* at 1.66 ± 0.36 cm, accompanied by a mean body girth value of 3.33 ± 0.72 cm. The highest mean body depth (BD) was recorded in *P. bulu* (8.34±0.82 cm), equivalent to 15.72% of SL, which also had the highest mean body girth (BG) of 16.69 ± 1.63 cm.

Meristic character data from various types of fish are presented in Table 6. In this study, several data from dorsal fins, caudal fins, anal fins, ventral fins, and pelvic fins were found, showing differences and similarities in number when compared with previous research reports, which are represented by numbers in parentheses.

TABLE 5: Morphometric features of eleven species from Koto Panjang Reservoir, Riau

Species	No of fishes	TL (range, cm)	SL (range, cm)	HL (range, cm)	BD (range, cm)	BG (range, cm)	FL (range, cm)	PD (range, cm)	CPL (range, cm)	PDL (range, cm)	PPL (range, cm)	EY (range, cm)	Wt (range, g)
Hemibagrus wyckii	10	48.49 ± 6.48 (37.39-55.96)	39.79 ± 4.82 (30.4 – 45.0)	11.73 ± 1.50 (9.12-13.05)	7.43 ± 0.95 (5.78-8.05)	16.08 ± 2.18 (13.28-19.88)	44.61±5.96 (34.40-51.48)	3.13±0.40 (2.43-3.64)	6.65±0.85 (5.17-7.74)	16.42±2.10 (12.77-19.11)	21.11±2.70 (16.42-24.57)	1.17±0.15 (0.91=1.37)	1,979.70±716.05 (832-2,835)
Hemisilurus heterorhynchus	10	16.39±2.00 (13.2-20.9)	14.16±1.89 (10.08-18.2)	2.49±0.26 (2.32-3.06)	2.98±0.53 (3.05-4.22)	5.95±1.07 (4.78-8.44)	14.87±2.18 (11.4-20.0)	0.53±0.17 (0.62-0.77)	0.38±0.12 (0.36-0.6)	4.13±0.53 (3.06-5.37)	4.30±0.90 (3.50-6.50)	0.31±0.07 (0.21-0.46)	22.92±10.76 (14.33-51.10)
Clarias teijsmanni	10	23.77±2.00 (21.5-26.8)	20.82±1.83 (18.2-23.80)	5.16±0.53 (4.30-5.92)	3.47±0.40 (3.10-4.18)	6.94±0.79 (6.20-8.36)	21.21±2.09 (16.68-24.0)	1.24±0.16 (0.94-1.48)	0.76±0.37 (0.40-1.50)	5.99±0.63 (5.01-6.95)	8.80±1.22 (7.20-10.24)	0.27±0.09 (0.20-0.38)	133.74±41.37 (74.69-198.02)
Channa lucius	10	30.68±4.81 (29.36-38)	25.05±5.20 (17.1-32)	8.01±1.44 (6.06-10.10)	5.09±0.91 (3.72-6.21	8.07±1.98 (3.55-10.22)	28.60±4.92 (21.21-35.34)	2.54±0.43 (1.89-3.15)	1.74±0.36 (1.34.2.33)	11.65±3.46 (9.70-16.17)	12.73±2.45 (9.72-16.19)	1.02±0.32 (0.67-102)	328.43±134.65 (128.5-473.2)
Anabas testudineus	10	13.82±1.53 (11.5-17.0)	11.11±1.15 (9.0-13.5)	3.30±0.48 (2.24-4.14)	3.72±0.45 (3.10-4.74)	7.80±0.95 (6.51-9.95)	12.72±1.45 (10.37-16.0)	1.60±0.22 (1.31-2.10)	0.70±0.14 (0.51-0.82)	3.46±0.41 (2.74-4.20)	4.01±0.48 (3.09-4.50)	0.58±0.11 (0.50-0.77)	48.82±20.04 (36.20-103.35)
Barbonymus schwanefeldii	10	18.63±2.45 (15.10-23.0)	14.05±1.75 (11.5-17.22)	3.21±0.29 3.06-3.79)	6.14±0.76 (5.60-7.40)	12.90±1.59 (10.14-15.54)	15.32±1.65 (14.0-18.5)	2.10±0.24 (1.96-2.51)	4.47±2.98 (2.38-8.87)	6.91±0.79 (6.84-8.35)	6.60±0.85 (5.88-8.22)	1.21±0.21 (1.05-1.59)	85.96±21.18 (63.4-110.0)
Puntioplites bulu	10	24.40±2.27 (20.5-27.4)	18.85±1.69 (16.0-21.0)	5.05±0.58 (4.30-6.01)	8.34±0.82 (6.77-9.50)	16.69±1.63 (13.54-19.00)	21.21±2.06 (17.40-24.21)	2.58±0.27 (2.22-3.19)	3.44±0.24 (3.07-3.75)	9.62±0.99 (8.00-11.35)	8.84±0.98 (7.46-10.37)	1.51±0.20 (1.18-1.79)	209.49±43.04 (126.84-290.90)
Diplocheilichthys pleurotaenia	10	18.13±1.96 (14.5-20.3)	14.25±1.45 (11.5-16.0)	2.86±0.31 (2.25-3.30)	5.13±0.52 (4.10-5.710	10.27±1.04 (8.21-11.42)	16.00±1.62 (12.82-17.84)	1.87±0.20 (1.51-2.10)	1.64±0.26 (1.25-2.21)	5.45±0.60 (4.35-6.20)	6.49±0.69 (5.13-7.20)	0.79±0.07 (0.57-0.89)	65.30±20.85 (29.8-100.56)
Labiobarbus festivus	10	23.03±3.64 (17.55-30.25)	19.03±3.01 (14.5-25.0)	3.79±0.64 (2.74-4.20)	5.87±3.13 (4.26-7.15)	15.12±3.88 (9.36-15.73)	22.21±2.65 (17.71-26.52)	2.06±0.88 (1.45-4.48)	3.16±1.51 (2.09-7.33)	7.915±0.93 (6.32-9.39)	12.26±5.58 (8.48-27.49)	1.37±0.63 (0.94-3.09)	71.24±26.57 (40.6-132.3)
Rasbora argyrotaenia	10	9.77±1.34 (8.0-12.0)	7.74±1.12 (6.40-9.50)	1.52±0.22 (1.14-1.90)	1.66±0.36 (1.25-2.30)	3.33±0.72 (2.5-4.6)	8.50±1.34 (6.80.10.80)	0.68±0.14 (0.49-0.86)	1.04±0.25 (0.62-1.33)	3.88±0.64 (2.96-5.07)	3.57±0.57 (2.80-4.27)	0.42±0.16 (0.28-0.86)	8.29±4.27 (3.62-15.41)
Thynnichthys polylepis	10	19.92±1.55 (18.35-22.30	14.73±3.74 (14.00-18.60)	3.1±0.25 (2.80-3.56)	4.85±0.62 (4.0-5.92)	10.67±1.36 (8.80-13.02)	18.29±2.50 (15.2-22.72)	1.47±0.23 (1.16-1.86)	2.22±0.25 (1.9-2.68)	6.52±0.90 (5.4-8.11)	8.68±1.24 (7.2-10.88)	0.96±0.13 (0.8-1.2)	56.102±25.89 (26.9-95.46)

TL = Total length; SL = Standar length; HL = Head length; BD = Body depth; BG = Body girth; FL = Fork length; PD = Penduncle depth; CPL = Caudal penduncle length
PDL = Pre-dorsal length; PPL = Pre-pelvic length; EY = Eye diameter; WT = Weight; No = number; cm = centimeter

TABLE 6: Meristic characteristics of eleven species collected from the Koto Panjang Reservoir, Riau

Species	No. of fishes	Dorsal fin	Caudal fin	Anal fin	Pectoral fin	Ventral fin
Hemibagrus wyckii	5	i,7 (7)	ii,8 (1), ii,8, i (1), iii,8,i (1), iv,9 (3)	i,8 (8)	i,9,1 (1)	i,5 (5)
Hemisilurus heterorhynchus	5	iii,9 (9)	-	iii, 6 (6)	i,13-14 (12-13)	i.8 (8)
Clarias teijsmanni	5	i.71 (70)	ii.8 (7)	ii,57 (60)	i,8 (8)	i,5 (60)
Channa lucius	5	i, 39 (38)	12-14 (13)	i, 28-29 (28-30)	32 (32)	10 (9)
Anabas testudineus	5	xvii,7-9 (9)	16-20 (19)	xi, 9-10 (8-10)	13-15 (13-14)	vi.5 (6)
Barbonymus schwanefeldii	5	i,9 (8)	15.17 (17)	i,6-8 (6-8)	i,11-13 (12)	i.8 (7)
Puntioplites bulu	5	iv, 8 (8)	22 (22)	iii,5	i,17-18 (17)	i,9 (8)
Diplocheilichthys pleurotaenia	5	i,11-13 (12)	17 (16)	i,5 (5)	i,12-15 (12-14)	i.8 (8)
Labiobarbus festivus	5	i,23-26 (24-25)	20-22 (22)	i,7 (7)	i,11-14 (12-14)	vi.9 (9)
Rasbora argyrotaenia	5	ii,7 (7)	16 (15)	i,3-5 (3-5)	i,12-13 (13)	2.7 (7)
Thynnichthys polylepis	5	iii, 8 (9)	10.2.9 (10.2.9)	i,7-8 (7-8)	ii,17 (18)	2.8 (8)

Note: the numbers in parentheses represent the number of fin rays calculated; black numbers make no difference; red numbers show differences

4. Discussion

Correlation coefficients ($r^2 > 0.77$) in linear regression for ten fish species in the context of LWR indicated a high degree of correlation, indicating a strong relationship between increasing length and body weight. However, an exception occurred in *H. heterorhynchus*, where the correlation coefficient was only 0.51. This finding is consistent with prior research on fish from diverse aquatic environments [20, 21], with values "a" and "b" in the range that is in accordance with the findings in previous research reports [13]. Earlier studies also found variations in the 'b' value for LWR in different species [22-24]. This variation could be attributed to various factors, including the number of species analyzed, fishing season, sampling location, size and developmental stage of the specimen, feeding categories, environmental factors, as well as type of fishing gear used [14, 26]. The growth patterns of eleven fish species varied, comprising one species exhibiting positive allometry (9.09%), seven species displaying negative allometry (63.63%), and three species showing isometry (27.27%). The length and weight relationship of fish alongside the growth pattern depends on various factors, including stock and population size, body shape, feeding, swimming behavior, trophic level, sexual characteristics, gonad maturity level, as well as environmental conditions, namely low oxygen levels and temperature in highland waters [25-28]. Therefore, estimating length-weight relationship (LWR) and condition factor (K) is crucial in fisheries management due to the valuable insights into the species' health and growth patterns. These parameters assist in assessing the overall condition of fish populations, inform sustainable fishing practices and aid in monitoring ecosystem health.

In this study, the total length of nine fish species sampled was smaller than that recorded in FishBase, while two species had higher values than documented in FishBase [29]. The effect of changing the hydrological regime from lotic to lentic on the length-weight and growth types of the fish analyzed is not understood. One of the main threats to freshwater biodiversity is the loss of connectivity within river systems due to anthropogenic barriers such as dams, land use change, hydrological disturbance, and over-exploitation [30,31]. Artificial barriers, including dams, dikes, or fishing nets, can potentially affect critical environmental variables, namely water flow, temperature, and substrate composition. These variables potentially change ecological design and structure, while also decreasing species richness, freshwater community growth types, and fish body size [32-34].

The Kc values of the eleven fish species analyzed were not significantly different from research findings in other water areas [35,36], including for *C. punctata* which is the object of cultivation [37]. The use of allometric condition factor (Ka) is rare in cases where species exhibit allometric growth patterns or when the value of b is calculated with sufficient data to minimize errors [14]. Its application extends to assessing the feeding habits of different fish species [27, 38, 39] and serving in different feeding regimes in laboratory experiments [37]. When a species exhibits an allometric growth pattern or when "b" equals #3.00, the allometric condition factor (K*a*) is considered more appropriate. In such cases, variations in the condition factor are directly related to differences in body weight and food intake. In this study, the average Ka values exceeded or were equal to 3 for six species, ranged from 1.86 to 2.91 for three species, and were less than 1 for one species. Several studies have used the relative condition factor (K*n*) to evaluate the condition of fish species. K*n* values below 1.0 indicate limited prey availability or elevated predator density, while values above 1.00 suggest an abundance of prey or reduced predator density [24]. In this study, *C. lucius* showed the highest performance with a Kn value of 2.51 ± 0.55. This condition is related to a carnivorous diet, while other species had a Kn value ranging from 1.0 to 1.03. Although carnivorous fish species, including *C. lucius*, *C. striata*, *H. wyckii*, *H. nemurus*, *P. pangasius*, and *W. leerii* inhabit the Koto Panjang reservoir [10], the presence does not seem to diminish the food availability for herbivorous fish, as evidenced by relative condition factor values equal to or greater than 1.0.

The morphological characteristics of fish play a crucial role in identifying the taxonomic classification of a genus or species and discerning differences between geographically variant populations. This information serves as an initial step for studying ontogeny or evolutionary relationships of species [40, 41]. Although DNA sequencing has become a popular method for distinguishing evolutionary relationships among different taxonomic groups, this technique often entails high costs [42]. The analysis of morphological characteristics remains one of the oldest and most widely used methods for systematically studying fish [43]. The mean, minimum, and maximum ranges of morphometric characteristics, such as height and body girth, vary among the eleven species in Koto Panjang Reservoir. Morphometric characteristics of each fish species within an aquatic habitat depend on the order and family, type of fishing gear used, fishing area, food availability, sampling season, geographic influences [44], environmental conditions, and physiological state [13].

Based on the results, fish actively foraging during the day had larger eye diameters, ranging from 27.62 to 37.69% of the head length. This pattern was mainly observed in fish species from the families Cyprinidae, including *B. schwanefeldii*, *P. bulu*, *D. pleurotaenia*, *L. festivus*, R. *argyrotaenia*, and *T. polylepis*, as well as Channidae namely *C. lucius*. On the other hand, fish that rely on the sense of smell to find food, such as the Bagridae, Siluridae, Clariidae, and Anabantidae, tend to have smaller eye diameters, ranging from 3.37 to 17.58% of the head length. Vision dominates as the main modality in diurnal fish living in shallow water habitats, but eye diameter depends on feeding habits [45, 46]. Similar to other nocturnal fish, *A. annularis* [47] is a small planktivorous reef fish 7–10 cm in length, characterized by relatively large eyes up to 5 mm diameter, covering 47% of the head length and a relatively large mouth (8 mm). This fish shows strong selectivity towards larger prey [48, 49], including *C. lucius*.

5. Conclusion

In conclusion, knowledge about the analysis of length-weight relationship, condition factor, as well as morphometric and meristic data in this study contributed to understanding the population structure of species in the Koto Panjang Reservoir ecotype, located in West Sumatra and Riau Province, Indonesia. Among the eleven types of fish analyzed, *B. schwanefeldii* had the highest percentage (15.26%) with an mean weight of 149.49 ± 54.10 g, while the lowest percentage (3.09%) was found in *H. wyckii* with an mean weight of 2,112.67 ± 889.88 g. Based on the results, the eleven species caught from these waters had a consistent length-weight relationship for each species, indicating a significant correlation between these two morphological parameters and various growth patterns, including positive allometry, negative allometry, and isometry. Fulton (K*c*), allometric (K*a*), and relative weight condition factor (K*n*) values also varied between species, with some showing Kc values <1 and >1, as well as Ka values indicating variation in shape and size of fish body. In addition, the Kc value of all fish species exceeded 1, indicating sufficient prey availability and low predators, as well as a good range of environmental conditions. The results provide a significant contribution to future fisheries management by the Indonesian government with economic benefits to local communities. This study also offers insight into improving the evaluation of fish stocks and species selection for domestication. Further studies are recommended to examine aspects of biological reproduction while considering physicochemical parameters, the biochemical composition of water, and food habits.

Data Availability

The data that support the findings of this study are openly available in Figshare. https://doi.org/10.6084/m9.figshare.25801219.

Ethical Approval

The Animal Ethics Committee of the Institute for Research and Community Service at Bung Hatta University in Indonesia approved this study. Ethical permission was obtained to gather fish specimens from the Koto Panjang Reservoir and conduct measurements of length and weight at the Fish Biology Laboratory, located within the Department of Aquaculture at the Faculty of Fisheries and Marine.

Conflicts of Interest

The authors declare that there are no competing interests.

Authors' Contributions

Azrita Azrita, as Associate Professor, is responsible for data collection, analysis and preparation of the manuscript. Professor Hafrijal Syandri took part in designing the study as well as reviewing and editing the manuscript. Professor Netti Aryani took care of the research design, as well as reviewing and editing the manuscript thoroughly.

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Webmail Univ. Bung Hatta

azrita ubh <azrita31@bunghatta.ac.id>

9927705: Manuscript returned to draft

3 messages

International Journal of Zoology <ijz@hindawi.com> Sat, May 11, 2024 at 7:03 PM
Reply-To: Lakshmi Chandrasekar <lchandras@wiley.com>
To: Azrita Azrita <azrita31@bunghatta.ac.id>
Cc: Sindhuja Devadoss <sdevadoss@wiley.com>

WILEY

Dear Dr. Azrita Azrita,
Your manuscript "Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia" with ID 9927705 submitted to International Journal of Zoology has been returned to draft. We found the following issues which need to be resolved:

- **Relevance Check**
  - [1] The data availability statement is different between the manuscript file and the system. Please provide the final statement and update accordingly. -- [2] The edited certificate is included in the cover letter. Please remove and upload the updated cover letter on the system.

> *This paper has been returned to draft for the reasons listed above. Please could you log into your account and address these points as soon as possible? The changes should be made on this submission 9927705, please do not submit a new manuscript.*

In order to be considered further, follow the link below, and complete and submit with the required updates.

MANUSCRIPT DETAILS

Kind regards,
Lakshmi Chandrasekar
International Journal of Zoology

---

azrita ubh <azrita31@bunghatta.ac.id> Tue, May 14, 2024 at 12:40 PM
To: Lakshmi Chandrasekar <lchandras@wiley.com>

Dear Editor,

We have corrected the relevance check of the manuscript "Relationship of Length and Weight, Condition Factors, and Morphometric Characteristics of Eleven Types of Freshwater Fish in Koto Panjang Reservoir, Indonesia" (ID. 9927705), have completed and submitted the necessary updates. Thanks

Best regards,

Azrita

[Quoted text hidden]

Lakshmi Chandrasekar <lakshmi.chandrasekar@hindawi.com> Tue, May 14, 2024 at 3:31 PM
Reply-To: Lakshmi Chandrasekar <lakshmi.chandrasekar@hindawi.com>
To: azrita31@bunghatta.ac.id

Dear Dr. Azrita,

Many thanks for your response.

We will check the data given and shall get back to you in case of any queries.

Best regards,

Lakshmi

Lakshmi Chandrasekar
Editorial Screener

Hindawi

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[Quoted text hidden]
, azrita ubh <azrita31@bunghatta.ac.id> wrote:
[Quoted text hidden]

[Quoted text hidden]

May 14, 2024

Editor-in-Chief
International Journal of Zoology

Dear Editor-in-Chief

Herewith I send the manuscript for the international Journal of Zoology. The title of the manuscript is “Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia”.

We declare no financial and personal relationship with other people or organizations that could inappropriately influence the research.

We declare that this is an original and new research work and is not previously published or presented elsewhere in any language, and is also not considered in any other journal simultaneously.

We agree that the content of this manuscript will not be copyright, submitted, or published elsewhere (including the internet) and is also not plagiarized from any language.

The corresponding author is Azrita, from the Department of Aquaculture, Faculty of Fisheries and Marine Science Universitas Bung Hatta Padang Indonesia
25133; phone: +628116624222; e-mail address: azrita31@bunghatta.ac.id

Thank you very much for considering the manuscript in the Journal

Best Regards

Dr. Azrita

Webmail Univ. Bung Hatta

azrita ubh <azrita31@bunghatta.ac.id>

9927705: Manuscript returned to draft

azrita ubh <azrita31@bunghatta.ac.id> Tue, May 14, 2024 at 12:40 PM
To: Lakshmi Chandrasekar <lchandras@wiley.com>

Dear Editor,

We have corrected the relevance check of the manuscript "Relationship of Length and Weight, Condition Factors, and Morphometric Characteristics of Eleven Types of Freshwater Fish in Koto Panjang Reservoir, Indonesia" (ID. 9927705), have completed and submitted the necessary updates. Thanks

Best regards,

Azrita
[Quoted text hidden]

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azrita ubh <azrita31@bunghatta.ac.id>

9927705: Manuscript returned to draft

Lakshmi Chandrasekar <lakshmi.chandrasekar@hindawi.com>
Reply-To: Lakshmi Chandrasekar <lakshmi.chandrasekar@hindawi.com>
To: azrita31@bunghatta.ac.id

Tue, May 14, 2024 at 3:31 PM

Dear Dr. Azrita,

Many thanks for your response.

We will check the data given and shall get back to you in case of any queries.

Best regards,

Lakshmi

Lakshmi Chandrasekar
Editorial Screener

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[Quoted text hidden]
, azrita ubh <azrita31@bunghatta.ac.id> wrote:
[Quoted text hidden]

[Quoted text hidden]

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9927705: Revision requested

1 message

International Journal of Zoology <ijz@hindawi.com> Fri, May 31, 2024 at 7:16 PM
Reply-To: International Journal of Zoology <sdevadoss@wiley.com>
To: Azrita Azrita <azrita31@bunghatta.ac.id>

WILEY

Dear Dr. Azrita Azrita,

In order for your submission "Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia" to "International Journal of Zoology" to proceed further in the review process, you will need to revise your manuscript.

Reason & Details:

> “
>
> *Dear authors*
> *Your ms has been revised by three referees. Two of them ask for minor revisions a decision with which I do agree. Please submit a revised version with detailed answers to all the issues raised by the referees and a cover letter explaining your changes.*
> *Sincerely,*
> *JP Barreiros*

When you have finished revising, follow the link below to submit your revision:

MANUSCRIPT DETAILS

Kind regards,
Sindhuja Devadoss
International Journal of Zoology

Reviewer Comments:

> “
>
> ***Reviewer 1 Comments to the Author***
>
> > *The article is fit to be published, requiring only spelling corrections in table 1*
>
> ***Reviewer 2 Comments to the Author***
>
> > *This study appears to be within the journal's scope, scientifically valid, technically accurate enough in its methods and results (however, the authors must be clearer in some aspects), and ethically sound.*
> > *This study significantly contributes to understanding and knowledge of the population structure of fish species in the Koto Panjang Reservoir ecotype, located in West Sumatra and Riau Province, Indonesia. It is a region affected by an anthropogenic barrier, namely a dam, which can affect critical environmental variables of the river ecosystems and potentially change the ecological balance of the local ichthyofauna.*

However, there is some information and parts of the text that I recommend being changed or improved. The highlighted parts will

Title
- The title provides a clear indication of the focus of the manuscript.
• The title is concise.
Abstract
- The abstract is an accurate summary of the aims, methods, findings and conclusions.
- The abstract can be read and understood on its own, separately from the full text of the manuscript.

1. Introduction:
- The introduction clearly summarises the current state of the topic in question, the aim of the study and is consistent with the rest of the manuscript. Namely the contextualisation of the Koto Panjang Reservoir and the potential threat it represents to the indigenous fish species that exist in the local river systems.
- However, some paragraphs of the discussion should be moved to the introduction, as will be explained further ahead in the report.

2. Materials and methods
2.1. Study area and fishing gear used.
- The authors need to clarify the distinction between the two sampling stations.
- Why was the second sampling season only half as long as the first one?
- Why was the sampling period considered two separate seasons if there is no interval period between them? Also, what distinguishes them?
- The authors need to clarify why they didn't use the same two fishing techniques in both seasons.
- It is necessary to standardise the presentation of sampling hours (e.g. 6 pm and 6 am)
- The last phrase "The categories and IUCN Red List Status for eleven species as of 2019 and 2020 are presented in Table 1." should be in the results.
- Figure 1.: The figure should be improved and better captioned, namely the map of Indonesia in the upper right corner and the respective location of the reservoir in the country, and the north arrow.
2.2. Laboratory procedure
- In the phrase: "Subsequently, the total length precision of each specimen was measured using a balance scale (…)", authors have to replace "length" with "weight".

3. Results
3.1. Categories and IUCN red list status, and species composition
- Table 1: Correct the word "species"
3.3. Length-weight relationship
- Authors should be clearer in the last paragraph. Are these measurements all mean/averages?

3.4. Condition factor

- Figures 2, 3 and 4 should include standard deviations in the bars.

3.5. Morphometric and meristic characteristics

- The first phrase "Table 5 summarizes the mean, minimum, and maximum range values of the morphometric characteristics of eleven fish species in Koto Panjang Reservoir." should go to the caption of table 5.

4. Discussion

- In the phrase "In this study, the total length of nine fish species sampled was smaller than that recorded in FishBase, while two species had higher values than those documented in FishBase [29].", authors should clarify if they are comparing the maximum total lengths.

- In the same paragraph, the authors should clarify whether they are assuming the possibility that most of the species caught are smaller due to loss of connectivity within rivers. If so, be clearer and more concise about that. Additionally, much of the information in this paragraph should be in the introduction.

- Some paragraphs do not make sense to be included in the discussion since they are broad subjects; it is more appropriate to do so in the introduction.

- The paragraph that starts with "The morphological characteristics of fish play a crucial role in identifying the taxonomic (…)" is irrelevant to discussing the results obtained in this study.

Reviewer 3 Comments to the Author

The present manuscript "Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia" seems an interesting and relevant subject to the overall stock assessment for the region and as a base for future studies and monitorization. In the body of the text, I suggest some modifications that could be used by the authors with the aim of improving the presentation of the work itself.

• Synthetise keywords: adjust to 5.

• In the introduction, add information on the importance of the river for local economies and development before the construction of the reservoir.

• In the introduction, it's not clear the magnitude of fisheries depending on the reservoir.

• In 2.1. there is no mention on the decision to use trap or gill nets. To recreate traditional fishing methods and better represent the fishing culture? Why not use other methods?

• Origin of Figure 1?

• In 2.2. why the decision to maintain a transport temperature of 10ºC? Based on which previous work? If yes, needs a reference, if not, I suggest justification.

• On the points 3.3 and 3.4, recommend adjusting the sequence of the tables and figures with the text in order to facilitate the reading.

• In the discussion, I suggest to the authors to better clarify what the results on the LWR suggest.

• Revise writing and grammar on the manuscript (Text and tables).

Webmail Univ. Bung Hatta

azrita ubh <azrita31@bunghatta.ac.id>

9927705: Revision reminder

azrita ubh <azrita31@bunghatta.ac.id> Sat, Jun 8, 2024 at 1:28 PM
To: International Journal of Zoology <sdevadoss@wiley.com>

Thank you, I will do that.

[Quoted text hidden]

Reviewer 1 Komentar untuk Penulis

Artikel ini layak untuk diterbitkan, hanya memerlukan koreksi ejaan pada tabel 1

Reviewer 2 Komentar untuk Penulis

- Studi ini tampaknya berada dalam cakupan jurnal, valid secara ilmiah, cukup akurat secara teknis dalam metode dan hasilnya (namun, penulis harus lebih jelas dalam beberapa aspek), dan secara etika baik.
- Studi ini memberikan kontribusi yang signifikan terhadap pemahaman dan pengetahuan tentang struktur populasi spesies ikan di ekotipe Waduk Koto Panjang, yang terletak di Sumatera Barat dan Provinsi Riau, Indonesia. Ini adalah wilayah yang dipengaruhi oleh penghalang antropogenik, yaitu bendungan, yang dapat memengaruhi variabel lingkungan kritis ekosistem sungai dan berpotensi mengubah keseimbangan ekologi ichthyofauna setempat.
- Namun, ada beberapa informasi dan bagian teks yang saya sarankan untuk diubah atau ditingkatkan. Bagian yang disorot akan

Judul

- Judul memberikan indikasi yang jelas tentang fokus naskah. • Judul ringkas.

Abstrak

- Abstrak adalah ringkasan akurat dari tujuan, metode, temuan, dan kesimpulan. - Abstrak dapat dibaca dan dipahami sendiri, terpisah dari teks lengkap naskah.

1. Pendahuluan:

- Pendahuluan merangkum dengan jelas keadaan terkini topik yang dimaksud, tujuan penelitian, dan konsisten dengan bagian naskah lainnya. Yaitu kontekstualisasi Waduk Koto Panjang dan potensi ancaman yang ditimbulkannya terhadap spesies ikan asli yang ada di sistem sungai setempat.
- Namun, beberapa paragraf pembahasan harus dipindahkan ke pendahuluan, seperti yang akan dijelaskan lebih lanjut dalam laporan.

2. Bahan dan metode

2.1. Area penelitian dan alat tangkap yang digunakan.

- Penulis perlu mengklarifikasi perbedaan antara dua stasiun pengambilan sampel.
- Mengapa musim pengambilan sampel kedua hanya setengah dari musim pertama?

- Mengapa periode pengambilan sampel dianggap sebagai dua musim yang terpisah jika tidak ada periode interval di antara keduanya? Selain itu, apa yang membedakannya?
- Penulis perlu mengklarifikasi mengapa mereka tidak menggunakan dua teknik penangkapan ikan yang sama di kedua musim.
- Perlu distandardisasi penyajian jam pengambilan sampel (misalnya pukul 18.00 dan 06.00)
- Frasa terakhir "Kategori dan Status Daftar Merah IUCN untuk sebelas spesies pada tahun 2019 dan 2020 disajikan dalam Tabel 1." harus ada dalam hasil.
- Gambar 1.: Gambar harus diperbaiki dan diberi judul yang lebih baik, yaitu peta Indonesia di sudut kanan atas dan lokasi masing-masing reservoir di negara tersebut, dan tanda panah utara.

2.2. Prosedur laboratorium

- Dalam frasa: "Selanjutnya, presisi panjang total setiap spesimen diukur menggunakan timbangan (...)", penulis harus mengganti "panjang" dengan "berat".

3. Hasil

3.1. Kategori dan status daftar merah IUCN, dan komposisi spesies

- Tabel 1: Perbaiki kata "spesies"

3.3. Hubungan panjang-berat

- Penulis harus lebih jelas dalam paragraf terakhir. Apakah semua pengukuran ini merupakan rata-rata?

3.4. Faktor kondisi

- Gambar 2, 3, dan 4 harus menyertakan simpangan baku pada batangan.

3.5. Karakteristik morfometrik dan meristik

- Frasa pertama "Tabel 5 merangkum nilai rata-rata, minimum, dan maksimum kisaran karakteristik morfometrik sebelas spesies ikan di Waduk Koto Panjang." harus ditambahkan pada judul tabel 5.

4. Pembahasan

- Dalam frasa "Dalam penelitian ini, panjang total sembilan spesies ikan yang diambil sampelnya lebih kecil daripada yang tercatat di FishBase, sementara dua spesies memiliki nilai lebih tinggi daripada yang didokumentasikan di FishBase [29].", penulis harus mengklarifikasi apakah mereka membandingkan panjang total maksimum.

- Dalam paragraf yang sama, penulis harus mengklarifikasi apakah mereka berasumsi bahwa sebagian besar spesies yang ditangkap lebih kecil karena hilangnya konektivitas di dalam sungai. Jika demikian, jelaskan dengan lebih jelas dan ringkas tentang hal itu. Selain itu, sebagian besar informasi dalam paragraf ini harus ada di bagian pendahuluan.
- Beberapa paragraf tidak masuk akal untuk dimasukkan dalam pembahasan karena merupakan subjek yang luas; lebih tepat untuk melakukannya di bagian pendahuluan.
- Paragraf yang dimulai dengan "Karakteristik morfologi ikan memainkan peran penting dalam mengidentifikasi taksonomi (...)" tidak relevan untuk membahas hasil yang diperoleh dalam penelitian ini.

Reviewer 3 Komentar untuk Penulis

Naskah saat ini "Hubungan Panjang dan Berat, Faktor Kondisi, dan Karakteristik Morfometrik Sebelas Spesies Ikan Air Tawar di Waduk Koto Panjang, Indonesia" tampaknya merupakan subjek yang menarik dan relevan untuk penilaian stok keseluruhan di wilayah tersebut dan sebagai dasar untuk studi dan pemantauan di masa mendatang. Dalam isi teks, saya menyarankan beberapa modifikasi yang dapat digunakan oleh penulis dengan tujuan meningkatkan penyajian karya itu sendiri.

• Sintesis kata kunci: sesuaikan dengan 5.

• Dalam pendahuluan, tambahkan informasi tentang pentingnya sungai bagi ekonomi dan pembangunan lokal sebelum pembangunan waduk.

• Dalam pendahuluan, tidak jelas besarnya perikanan tergantung pada waduk.

• Dalam 2.1. tidak disebutkan tentang keputusan untuk menggunakan perangkap atau jaring insang. Untuk menciptakan kembali metode penangkapan ikan tradisional dan lebih mewakili budaya penangkapan ikan? Mengapa tidak menggunakan metode lain?

• Asal Gambar 1?

• Dalam 2.2. mengapa keputusan untuk mempertahankan suhu pengangkutan 10°C? Berdasarkan pekerjaan sebelumnya yang mana? Jika ya, perlu referensi, jika tidak, saya sarankan justifikasi.

• Pada poin 3.3 dan 3.4, rekomendasikan untuk menyesuaikan urutan tabel dan gambar dengan teks agar memudahkan pembacaan.

• Dalam diskusi, saya sarankan kepada penulis untuk lebih memperjelas apa yang disarankan oleh hasil pada LWR.

• Merevisi penulisan dan tata bahasa pada naskah (Teks dan tabel).

Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia

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A B S T R A C T

This study was conducted to investigate the length and weight relationship (LWR), condition factors, as well as morphometric and meristic characteristics of eleven freshwater fish species in Koto Panjang Reservoir ecotypes, Indonesia. Fresh specimens were collected during September 2023 - February 2024. The findings indicated that the b coefficient in the LWR of the fish species varied between 1.693 and 3.151. Among the studied fish species, only *Hemisilurus heterorhynchus* (b = 1.951), *Clarias teijsmanni* (b = 2.046), *Anabas testudineus* (b = 2.3750), *Labiobarbus festivus* (b = 2.305), and *Rasbora argyrotaenia* (b = 1.693) had values above the anticipated range of 2.5 < b < 3.5. One and seven fish species showed positive and negative allometric growth, while three demonstrated isometric growth respectively. The mean values of Fulton's condition factor (K*c*) ranged from 0.73 ± 0.15 to 4.96 ± 0.63, indicating variations in fish morphology. The range of allometric condition factor (K*a*) values observed, spanning from 0.87 ± 0.18 to 26.25 ± 4.05, suggested variations in resource availability and competitive pressures within aquatic environments. The mean relative weight condition factor (K*n*) between 1.00 ± 0.09 and 2.51 ± 0.55, suggested favorable growth for the eleven analyzed fish species. In conclusion, this study offered novel insights into the LWR, condition factor, and morphometric characteristics of freshwater species in the Koto Panjang Reservoir. The results have great potential for enhancing fish species stock assessment.

Keywords: length-mass relationship; growth pattern; Fulton's condition index; morphometric and meristic; Koto Panjang Reservoir

1. Introduction

Kampar Kanan is one of the largest rivers in Riau Province with a length of approximately 213.5 km and a width ranging from 125 to 143 meters. This river originates from the upper reaches of the Bukit Barisan mountains in Limapuluh Kota and Pasaman Regency, West Sumatra Province, Indonesia, flowing into the Siak River in the Bengkalis region, Riau Province, and finally into the Strait of Malacca [1].

Since 1996, the upper reaches of the Kampar Kanan River at a geographical position of 0°17'23.76"N and 100°52'53.39"E have been dammed into a reservoir called the Koto Panjang

Reservoir which is 96 meters high and located at an altitude of 85 meters above sea level. The area of the inundation formed is estimated at 12,400 hectares [2]. Before the construction of the Koto Panjang Reservoir, the river played an essential role as a source of clean water for the community, supporting agriculture and fisheries as primary livelihoods. The river also served as a transportation route, connecting remote villages to trade centers. Additionally, it provided raw materials such as sand and stone for the construction industry and offered tourism potential with its natural beauty, contributing to the local economy.

This reservoir has multiple functions, including being a hydroelectric power plant with a capacity of 114 MW, as well as irrigation, tourism, and fisheries. Due to the construction of the reservoir, the characteristics of the aquatic ecosystem in terms of abiotic and biotic are affected [3]. Similar to other rivers, dam construction can cause mortality and failure of fish migration [4, 5]. Changes in stream hydrological regimes from lotic to lentic can also affect water retention in reservoirs, leading to a decrease in native and an increase in exotic species [6, 7].

More than 44 types of fish live in the Koto Panjang Reservoir, including *Hemibagrus wyckii*, *Barbonymus schwanefeldii*, *Puntioplites bulu, Diplocheilichthys pleurotaenia, Ompok hypophthalmus, Wallago leerii, Channa lucius, Anabas testudineus,* and *Thyninichthy polylepis* [8]. To support local food security, exotic fish species such as tilapia (*Oreochromis niloticus)*, and carp (*Cyprnus carpio)*, can also be found through floating net cage farming [9].

The fish are caught by small-scale fishermen using non-selective fishing gear such as trap, cast, gill, and drag nets, then sold in traditional markets in the area [10]. However, the use of harmful fishing gear, habitat degradation, and the impact of invasive species can threaten the survival of native fish species in the Koto Panjang Reservoir [3, 11]. This underscores the need to manage fisheries resources that have substantial economic value in a sustainable and environmentally friendly manner.

Length-weight relationship (LWR) analysis plays an important role in fisheries development and conservation evaluation of endangered species. By using existing data, the LWR approach effectively considers fish biomass [12]. It also estimates the length of fish based on the weight in specific environments, ultimately producing estimates of biomass and population growth [13].

Apart from length-weight data, condition factor (K) data for each type of fish is also needed. This parameter indicates welfare based on the hypothesis that fish that weigh more at a certain length show better physiological conditions [14]. On the other hand, studies on differences and variability in morphometric and meristic characters in fish stocks play a crucial role in a phylogenetic context, providing the information needed for further investigations on the genetic improvement of stocks [15].

This study aimed to estimate the LWR, condition factors, and morphometrics of eleven economically important fish species caught in the Koto Panjang Reservoir, Riau Province, Indonesia.

The results are expected to provide a deeper understanding of the growth process and contribute to future conservation efforts as well as fisheries management.

2. Materials and methods

2.1. Study area and fishing gear used.

This study was carried out in Kota Panjang Reservoir, located in the upper reaches of the Kampar Kanan River, Kampar Regency, Riau Province, Indonesia. The location is situated area at a geographical position of 0°20'12.30" N and 100°44'27.26" E (Figure 1). Fish were caught using trap nets known locally as ″bubu" and gill nets. Trap nets were made from woven bamboo rattan and had a cylindrical front with a diameter of 80 cm, while the back was cone-shaped with a length of 2 meters. The gill nets were rectangular in the shape of monofilament thread 60 meters long and 10 meters deep, with a mesh size of 1.25 and 2.5 inches. This tool was used at the bottom of the reservoir at a depth of 2 to 4 meters and operated between 6:00 PM and 6:00 AM to catch demersal fish including Bagridae, Siluridae, Claridae, Channidae, and Anabantidae using chicken intestines as bait. These nets were operated passively on the water surface. Five fish species caught including H. wyckii, C. lucius, A. testudineus, H. heterorhynchus, and C. teijsmanni were caught between September - December 2023 is the transition season from the dry season to the rainy season. This can affect sea conditions and fish behavior. Furthermore, between January - February 2024 are the peak of the rainy season. This can affect sea conditions such as increased water turbidity and stronger ocean currents, six species of fish were caught, namely B. schwanefeldii, P. bulu, D. pleurotaenia, L. festivus, R. argyrotaenia, and T. polylepis. The categories and IUCN Red List Status for eleven species as of 2019 and 2020 are presented in Table 1.

2.2. Laboratory procedure

After harvest, the fish specimens were transported in a cold box to the Fish Biology Laboratory, Department of Aquaculture, Faculty of Fisheries and Marine Universitas Bung Hatta, Padang, Indonesia, to measure the length, weight, and morphometric characteristics. Classification and taxonomic identification of sample specimens were carried out using the standard keys [16, 17] Subsequently, the weight precision of each specimen was measured using a balance scale (OHAUS model CT 6000 USA) with an accuracy of 0.1 g, and the lengths were assessed through a meter ruler with 0.1 mm accuracy. The sex (male or female) of each fish sample collected with net traps and gillnets was recorded.

The morphometric characteristics of eleven fish species caught were measured using a 0.01 mm precision digital caliper (Made in China), focusing on parameters including total, standard, fork, and head length, body depth, body girth, peduncle depth, caudal peduncle length, pre-dorsal length, pre-pelvic length, and eye diameter. Meanwhile, meristic characteristics namely the number of hard and soft rays on the dorsal, caudal, anal, pectoral, and ventral fin were counted directly using a binocular magnifier equipped with two adjustable lenses, enabling three-dimensional imaging and detailed magnification for accurate calculation of fish fin radii. Morphometric characteristics were measured from ten randomly selected fish, while meristic traits were calculated from five fish also selected randomly.

2.3. Data analysis

Data analysis was performed using SPSS software version 16 after previously removing outlier data. Furthermore, the regression equation W = a L^b was used to determine the LWR, where parameters ′a′ and 'b' were obtained by transforming the log-log equation, namely Log W = log (a) + b log (L). In this equation, ′W' represents the weight of fish in grams (g), ′L' denotes the total length (TL) of fish in centimeters (cm), 'a′ is a constant (intercept), and ′b′ is the slope (change in weight in weight per unit change in length) of the regression [13]. The 95% confidence interval (CI) of the total length and weight was also analyzed, while the toughness of the samples was assessed with the coefficient of determination (r^2).

The Fulton condition factor (*Kc*) was estimated using the [18] equation, formulated as *kc* = $100*W/L^3$, where W is the total weight of the fish sample, and L is the standard length of the fish sample. The allometric condition factor (K*a*) was estimated using the formula from [12], namely *ka* = $100*W/L^b$, where W is the total weight of the fish sample (g), L is the standard length of the fish sample (cm), and b is a constant in the length-weight. Meanwhile, the relative weight condition factor (K*n*) was determined using the [19] formula, K*n* = W/We, where W is the weight of the fish sample (g), and We is the theoretical weight calculated as $L^{b,}$ and a is a constant in the length-weight.

3. Results

3.1.Categories and IUCN red list status, and species composition

Eleven types of fish from the families Bagridae, Siluridae, Claridae, Channidae, Anabantidae, and Cyprinidae were collected from the Koto Panjang Reservoir in Indonesia. Information regarding the IUCN Red List categories and status in 2019 and 2020 is presented in Table 1.

3.2. Length-weight relationship

Table 3 presents descriptive statistics for eleven fish species, including length and weight, used as parameters 'a' and 'b' in each LWR equation and the coefficient of determination (r^2). The range of 'a' values for each species was 0.010 to 0.259, while 'b' values ranged from 1.693 to 3.151. The range of r^2 values obtained was between 0.51 and 0.95, confirming the validity and reliability of the LWR measurement. Furthermore, the LWR relationship in each species consistently showed a significant correlation ($p<0.000$).

This study identified variations in the growth types of eleven fish species, with one species, namely *H. wyckii*, showing a positive allometric growth type, while the other three, including *C. lucius*, *B. schwanefeldii*, and *P. bulu*, demonstrated isometric growth. Seven other species, including *C. teijsmanni*, *A. testudineus*, *D. pleurotaenia*, *L. fetivus*, *R. argyrotaenia*, and *T. polylepis*, showed a negative allometric growth type (Table 3).

Based on the results, the least mean standard length and smaller weight were 7.74 ± 1.12 cm and 8.29 ± 4.27 g for *R. argyrotaenia*, while the maximum standard length and total weight were 39.79 ± 4.82 cm and 2.112.67 ± 889.88 g for *H. wyckii*. These include *H. wyckii* (41 cm vs. 71 cm), *H. heterorhynchus* (16.39 cm vs. 80 cm), *C. lucius* (30.68 cm vs. 53 cm), *A. testudineu*s (13.82 cm vs. 25 cm), *B. schwanefeldii* (18.63 cm vs. 35 cm), *P. bulu* (24.40 cm vs. 44.33 cm), *D. pleurotaenia* (18.13 cm vs. 22.5 cm), *L. festivus* (23.03 cm vs. 33.7 cm), and *R. argyrotaenia* (9.77 cm vs 14 cm). Meanwhile, *T. polylepis* (19.2 cm vs. 18 cm) and *C. teijsmanni* (23.77 cm vs. 22 cm) had a higher value than recorded in FishBase.

3.3. Condition factor

Table 4 shows the values of Fulton's (K*c*), allometric (K*a*), and relative weight condition factor (K*n*) of eleven fish species caught in the Koto Panjang reservoir. The mean value of K*c* for different species varied between 0.73 ± 0.15 and 4.96 ± 0.63 as summarized in Figure 2. *H. heterorhynchus*, *D. pleurotaenia*, *L. festivus* and *T. polylepis* had values < 1.0, while K*c* for *H. wyckii*, *C. teijsmanni*, *C. lucius*, *A. testudineus*, *B. schwanefeldii* and *P. bulu* was > 1.0. Furthermore, in Figuru 3, the mean value of Ka exceeds or equals 3 for six species namely *H. heterorhynchus* (14.70 ± 4.65), *C. teijsmanni* (26.25 ± 4.05), *A. testudineus* (15.07 ± 1.36), *D. pleurotaenia* (3.60 ± 0.34), *L. festivus* (8.32 ± 0.36), and *R. argyrotaenia* (17.31 ± 0.38). While the mean value of K*n* for eleven species ranged from 1.00 ± 0.08 and 2.51 ± 0.55. *R. argyrotaenia* had the lowest value of 1.00 ± 0.08, while *C. lucius* recorded the highest value of 2.51 ± 0.55 (Figure 4).

3.4. Morphometric and meristic characteristics

Table 5 summarizes the mean, minimum, and maximum range values of the morphometric characteristics of eleven fish species in Koto Panjang Reservoir. *H. wyckii* (Bleeker, 1858) showed the highest mean standard length (SL) value of 39.79 ± 4.82 cm and body weight (WT) value of 2,112.67 ± 889.88 g. Conversely, *R. Argyrotaenia* (Bleeker, 1849) had the lowest mean standard length and weight values of 7.74±1.12 cm and 8.29±4.27 g. The smallest mean body depth value was found in *R. argyrotaenia* at 1.66 ± 0.36 cm, accompanied by a mean body girth value of 3.33 ± 0.72 cm. The highest mean body depth (BD) was recorded in *P. bulu* (8.34±0.82 cm), equivalent to 15.72% of SL, which also had the highest mean body girth (BG) of 16.69 ± 1.63 cm.

Meristic character data from various types of fish are presented in Table 6. In this study, several data from dorsal fins, caudal fins, anal fins, ventral fins, and pelvic fins were found, showing differences and similarities in number when compared with previous research reports, which are represented by numbers in parentheses.

4. Discussion

Correlation coefficients ($r^2 > 0.77$) in linear regression for ten fish species in the context of LWR indicated a high degree of correlation, indicating a strong relationship between increasing length and body weight. However, an exception occurred in *H. heterorhynchus*, where the correlation coefficient was only 0.51. This finding is consistent with prior research on fish from diverse aquatic environments [20, 21], with values "a" and "b" in the range that is in accordance with the findings in previous research reports [13]. Earlier studies also found variations in the 'b' value for LWR in different species [22-24]. This variation could be attributed to various factors, including the number of species analyzed, fishing season, sampling location, size and developmental stage of the specimen, feeding categories, environmental factors, as well as type of fishing gear used [14, 26]. The growth patterns of eleven fish species varied, comprising one species exhibiting positive allometry (9.09%), seven species displaying negative allometry (63.63%), and three species showing isometry (27.27%). The length and weight relationship of fish alongside the growth pattern depends on various factors, including stock and population size, body shape, feeding, swimming behavior, trophic level, sexual characteristics, gonad maturity level, as well as environmental conditions, namely low oxygen levels and temperature in highland waters [25-28]. Therefore, estimating length-weight relationship (LWR) and condition factor (K) is crucial in fisheries management due to the valuable insights into the species' health and growth patterns. These parameters assist in assessing the overall condition of fish populations, inform sustainable fishing practices and aid in monitoring ecosystem health.

In this study, the total length of nine fish species sampled was smaller than that recorded in FishBase, while two species had higher values than documented in FishBase [29]. The effect of changing the hydrological regime from lotic to lentic on the length-weight and growth types of the fish analyzed is not understood. One of the main threats to freshwater biodiversity is the loss of connectivity within river systems due to anthropogenic barriers such as dams, land use change, hydrological disturbance, and over-exploitation [30,31]. Artificial barriers, including dams, dikes, or fishing nets, can potentially affect critical environmental variables, namely water flow, temperature, and substrate composition. These variables potentially change ecological design and structure, while also decreasing species richness, freshwater community growth types, and fish body size [32-34].

The Kc values of the eleven fish species analyzed were not significantly different from research findings in other water areas [35,36], including for *C. punctata* which is the object of cultivation [37]. The use of allometric condition factor (Ka) is rare in cases where species exhibit allometric growth patterns or when the value of b is calculated with sufficient data to minimize errors [14]. Its application extends to assessing the feeding habits of different fish species [27, 38, 39] and serving in different feeding regimes in laboratory experiments [37]. When a species exhibits an allometric growth pattern or when "b" equals #3.00, the allometric condition factor (K*a*) is considered more appropriate. In such cases, variations in the condition factor are directly related to differences in body weight and food intake. In this study, the average Ka values exceeded or were equal to 3 for six species, ranged from 1.86 to 2.91 for three species, and were less than 1 for one species. Several studies have used the relative condition factor (K*n*) to evaluate the condition of fish species. K*n* values below 1.0 indicate limited prey availability or elevated predator density, while values above 1.00 suggest an abundance of prey or reduced predator density [24]. In this study, *C. lucius* showed the highest performance with a Kn value of 2.51 ± 0.55. This condition is related to a carnivorous diet, while other species had a Kn value ranging from 1.0 to 1.03. Although carnivorous fish species, including *C. lucius*, *C. striata*, *H. wyckii*, *H. nemurus*, *P. pangasius*, and *W. leerii* inhabit the Koto Panjang reservoir [10], the presence does not seem to diminish the food availability for herbivorous fish, as evidenced by relative condition factor values equal to or greater than 1.0.

The morphological characteristics of fish play a crucial role in identifying the taxonomic classification of a genus or species and discerning differences between geographically variant populations. The analysis of morphological characteristics remains one of the oldest and most widely used methods for systematically studying fish [40]. The mean, minimum, and maximum ranges of morphometric characteristics, such as height and body girth, vary among the eleven species in Koto Panjang Reservoir. Morphometric characteristics of each fish species within an aquatic habitat depend on the order and family, type of fishing gear used, fishing area, food availability, sampling season, geographic influences [41], environmental conditions, and physiological state [13].

Based on the results, fish actively foraging during the day had larger eye diameters, ranging from 27.62 to 37.69% of the head length. This pattern was mainly observed in fish species from the families Cyprinidae, including *B. schwanefeldii*, *P. bulu*, *D. pleurotaenia*, *L. festivus*, R. *argyrotaenia*, and *T. polylepis*, as well as Channidae namely *C. lucius*. On the other hand, fish that rely on the sense of smell to find food, such as the Bagridae, Siluridae, Clariidae, and Anabantidae, tend to have smaller eye diameters, ranging from 3.37 to 17.58% of the head length. Vision dominates as the main modality in diurnal fish living in shallow water habitats, but eye diameter depends on feeding habits [42, 43]. Similar to other nocturnal fish, *A. annularis* [44] is a small planktivorous reef fish 7–10 cm in length, characterized by relatively large eyes up to 5 mm diameter, covering 47% of the head length and a relatively large mouth (8 mm). This fish shows strong selectivity towards larger prey [45, 46], including *C. lucius*.

5. Conclusion

In conclusion, knowledge about the analysis of length-weight relationship, condition factor, as well as morphometric and meristic data in this study contributed to understanding the population structure of species in the Koto Panjang Reservoir ecotype, located in West Sumatra and Riau

Province, Indonesia. Among the eleven types of fish analyzed, *B. schwanefeldii* had the highest percentage (15.26%) with an mean weight of 149.49 ± 54.10 g, while the lowest percentage (3.09%) was found in *H. wyckii* with an mean weight of 2,112.67 ± 889.88 g. Based on the results, the eleven species caught from these waters had a consistent length-weight relationship for each species, indicating a significant correlation between these two morphological parameters and various growth patterns, including positive allometry, negative allometry, and isometry. Fulton (K*c*), allometric (K*a*), and relative weight condition factor (K*n*) values also varied between species, with some showing Kc values <1 and >1, as well as Ka values indicating variation in shape and size of fish body. In addition, the Kc value of all fish species exceeded 1, indicating sufficient prey availability and low predators, as well as a good range of environmental conditions. The results provide a significant contribution to future fisheries management by the Indonesian government with economic benefits to local communities. This study also offers insight into improving the evaluation of fish stocks and species selection for domestication. Further studies are recommended to examine aspects of biological reproduction while considering physicochemical parameters, the biochemical composition of water, and food habits.

Data Availability

The data that support the findings of this study are openly available in Figshare. https://doi.org/10.6084/m9.figshare.25801219.

Ethical Approval

The Animal Ethics Committee of the Institute for Research and Community Service at Bung Hatta University in Indonesia approved this study. Ethical permission was obtained to gather fish specimens from the Koto Panjang Reservoir and conduct measurements of length and weight at the Fish Biology Laboratory, located within the Department of Aquaculture at the Faculty of Fisheries and Marine.

Conflicts of Interest

The authors declare that there are no competing interests.

Authors' Contributions

Azrita Azrita, as Associate Professor, is responsible for data collection, analysis and preparation of the manuscript. Professor Hafrijal Syandri took part in designing the study as well as reviewing and editing the manuscript. Professor Netti Aryani took care of the research design, as well as reviewing and editing the manuscript thoroughly.

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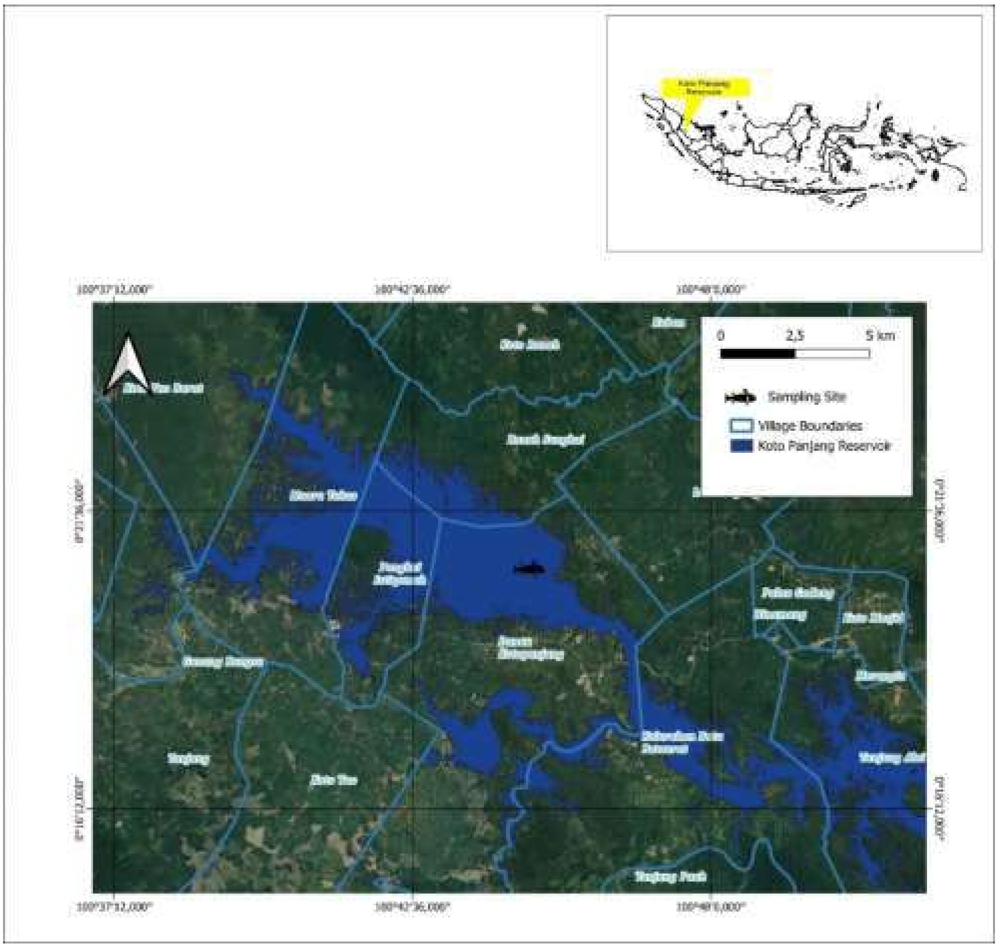

FIGURE 1: Indonesia map and location of sampling site in Koto Panjang Reservoir Kampar Kanan River, Kampar Regency, Riau Province

TABLE 1: Categories and IUCN Red List Status for eleven species in 2019 and 2020

Order/Family/Species	IUCN Categories for Species Conservation Status, 2019	The IUCN Red List Status	Occurrence
Siliruformes/Bagridae/*Hemibagrus wyckii* (Bleeker, 1858)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous species
Siliruformes/ Siluridae/ Hemisilurus heterorhynchus (Bleeker, 1854)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous species
Siluruformes/ Clariidae/ Clarias teijsmanni (Bleeker, 1857)	Not evaluated	No report from IUCN	Indigenous species
Anabantiformes/Channidae/ *Channa lucius* (Cuvier, 1831)	Least Concern (LC).	The IUCN Red List of Threatened Species in 2019	Indigenous species
Anabantiformes/ Anabantidae/*Anabas testudineus* (Bloch, 1792)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous species
Cypriniformas/Cyprinidae/ *Barbonymus schwanefeldii* (Bleeker, 1854)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous species
Cyprniformes/Cyprinidae/ *Puntioplites bulu* (Bleeker, 1851)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous species
Cyriniformas/Cyprinidae/*Diplocheilichthys pleurotaenia* (Bleeker, 1855)	Data Deficient (DD)	The IUCN Red List of Threatened Species in 2020	Indigenous species
Cypriniformes/Cyprinidae/ *Labiobarbus festivus* (Heckel, 1843)	Data Deficient (DD)	The IUCN Red List of Threatened Species in 2019	Indigenous species
Cypriniformes/Cyprinidae/ *Rasbora argyrotaenia (*Bleeker, 1849*)*	Least Concern (LC)	The IUCN Red List of Threatened Species in 2020	Indigenous species
Cypriniformes/Cyprinidae/ *Thynnichthys polylepis (*Bleeker, 1860*)*	Least Concern (LC)	The IUCN Red List of Threatened Species in 2020	Indigenous species

TABLE 2: Species composition, relative abundance, and percentage occurrence of eleven fish species

Family	Species	N	% by no	Sex (%) F	Sex (%) M
Bagridae	*Hemibagrus wyckii*	15	3.09	33.33	66.66
Siluridae	*Hemisilurus heterorhynchus*	30	6.19	33.33	66.66
Clariidae	*Clarias teijsmanni*	30	6.19	66.66	33.33
Channidae	*Channa lucius*	61	12.58	65.67	34.43
Anabantidae	*Anabas testudineus*	57	11.75	29.82	70.17
Cyprinidae	*Barbonymus schwanefeldii*	74	15.25	41.89	58.10
Cyprinidae	*Puntioplites bulu*	40	8.25	62.5	37.5
Cyprinidae	*Diplocheilichthys pleurotaenia*	38	7.84	36.84	63.16
Cyprinidae	*Labiobarbus festivus*	40	8.25	50.0	50.0
Cyprinidae	*Rasbora argyrotaenia*	50	10.31	24.0	76.0
Cyprinidae	*Thynnichthys polylepis*	50	10.31	52.0	48.0
Total		485	100		

N: sample size; % = percentage; F: female; M: male; no = number

TABLE 3: Descriptive Statistics and Parameters for LWR and Growth of Eleven Fish Species in Koto Panjang Reservoir, Riau.

Species	N	LWRs parameters							t-test	P value	Growth type
		Mean SL (cm)	CI 95% of SL (cm)	Mean Wt (g)	CI 95% of TW (g)	a	b	r^2			
Hemibagrus wyckii	15	39.79 ± 4.82	37.12 - 41.82	2,112.67 ± 889.88	1,527.67 - 2697.66	0.010	3.151	0.82	7.79	0.000	(+)
Hemisilurus heterorhynchus	30	16.39 ± 2.00	15.67 – 17.10	22.92 ± 10.76	22.90- 26.76	0.146	1.951	0.51	5..36	0.000	(-)
Clarias teijsmanni	30	23.77 ± 2.00	23.06 - 24.48	133.74 ± 41.37	118.97 – 148.51	0.259	2.046	0.77	9.60	0.000	(-)
Channa lucius	61	28.44 ± 2.24	26.20- 30.68	252.72 ± 63.03	189.69 – 315.75	0.012	2.956	0.83	17.10	0.000	(I)
Anabas testudineus	57	7.87 ± 1.15	6.72 – 9.02	24.91 ± 10.12	14.79 – 35.03	0.178	2.375	0.89	29.46	0.000	(-)
Barbonymus schwanefeldii	74	23.27 ± 2.60	22.67 – 23.88	149.49 ± 54.10	137.19 - 161.78	0.012	2.978	0.86	21.14	0.000	(I)
Puntioplites bulu	40	21.63 ± 2.46	20.36 – 23.39	243.69 ± 82.84	218.03 - 269.34	0.029	2.927	0.84	14.39	0.000	(I)
Diplocheilichthys pleurotaenia	38	22.40 ± 2.84	21.49 - 23.30	106.85 ± 30.37	97.20 - 116.49	0.037	2.555	0.94	23.87	0.000	(-)
Labiobarbus festivus	40	22.25 ± 2.61	21.43 - 23.06	108.18 ± 28.37	99.38 - 116.97	0.083	2.305	0.88	16.36	0.000	(-)
Rasbora argyrotaenia	50	7.74 ± 1.12	7.43 – 8.06	8.29 ± 4.27	7.10 – 9.40	0.172	1.693	0.95	31.13	0.000	(-)
Thynnichthys polylepis	50	14.72 ± 2.96	13.90 – 15.54	25.70 ± 13.31	22.01 – 29.39	0.008	2.932	0.91	22.20	0.000	(-)

N: sample size; SL: standard length; TW: total weight; Min; minimum; Max: maximum; SD: standard deviation; CI: confidence interval, (+) = positive allometric; (-) = negative allometric; (I) = isometric

TABLE 4: Condition Factors (Kc, Ka, Kn) for Eleven Fish Species in Koto Panjang Reservoir, Riau.

Species	N	Fulton's condition factor (*Kc* values)				The allometric condition factor (*Ka* values)				Relatif weight condition factor (*Kn* values)			
		Mean ± SD	SE	Range (*Kc* values)		Mean ± SD	SE	Range (*Ka*-values)		Mean ± SD	SE	Range (*Kn*-value*s*)	
				Min.	Max			Min.	Max.			Min.	Max.
Hemibagrus wyckii	15	3.24 ± 0.60	0.16	2.45	4.06	1.86 ± 0.06	0.09	1.39	2.67	1.03 ± 0.20	0.05	0.77	1.48
Hemisilurus heterorhynchus	30	0.89 ± 0.40	0.08	0.55	2.10	14.70 ± 4.65	0.21	9.47	25.30	1.01 ± 0.32	0.03	0.65	1.75
Clarias teijsmanni	30	1.57 ± 0.34	0.06	1.02	2.70	26.25 ± 4.05	0.74	17.31	37.12	1.01 ± 0.16	0.02	0.67	1.43
Channa lucius	61	1.08 ± 0.12	0.01	0.86	1.45	1.25 ± 0.13	0.02	0.79	1.51	2.51 ± 0.55	0.08	1.23	3.49
Anabas testudineus	57	4.96 ± 0.63	0.08	3.90	7.79	15.07 ± 1.36	0.11	12.06	19.7	1.00 ± 0.09	0.01	0.80	1.28
Barbonymus schwanefeldii	74	1.15 ± 0.20	0.02	0.80	1.53	2.91 ± 0.42	0.02	2.10	3.74	1.01 ± 0.14	0.02	0.71	1.35
Puntioplites bulu	40	2.33 ± 0.34	0.05	1.68	3.05	2.24 ± 0.33	0.05	1.62	2.94	1.02 ± 0.15	0.02	0.72	1.29
Diplocheilichthys pleurotaenia	38	0.93 ± 0.15	0.02	0.78	1.21	3.60 ± 0.34	0.05	3.11	4.46	1.00 ± 0.09	0.02	0.87	1.24
Labiobarbus festivus	40	0.96±0.16	0.02	0.80	1.63	8.32 ± 0.36	0.15	6.75	10.48	1.01 ± 0.12	0.02	0.82	1.28
Rasbora argyrotaenia	50	1.02 ± 0.31	0.04	0.60	1.76	17.31 ± 0.38	0.19	16.39	18.29	1.00 ± 0.08	0.01	0.95	1.06
Thynnichthys polylepis	50	0.73 ± 0.15	0.12	0.44	1.25	0.87 ± 0.18	0.03	0.52	1.47	1.02 ± 0.21	0.08	0.61	1.71

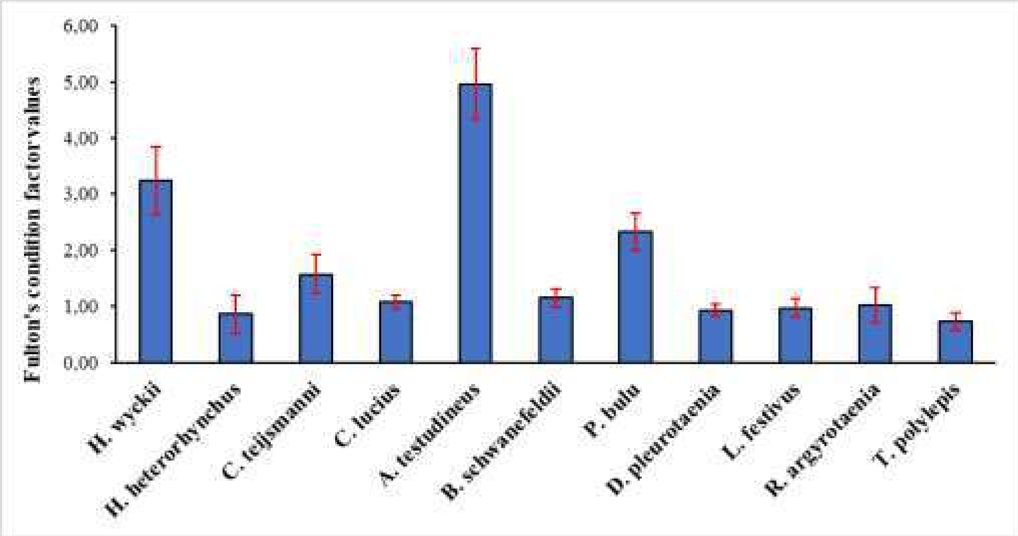

FIGURE 2: Fulton's condition factor (Kc) for eleven fish species in Koto Panjang Reservoir.

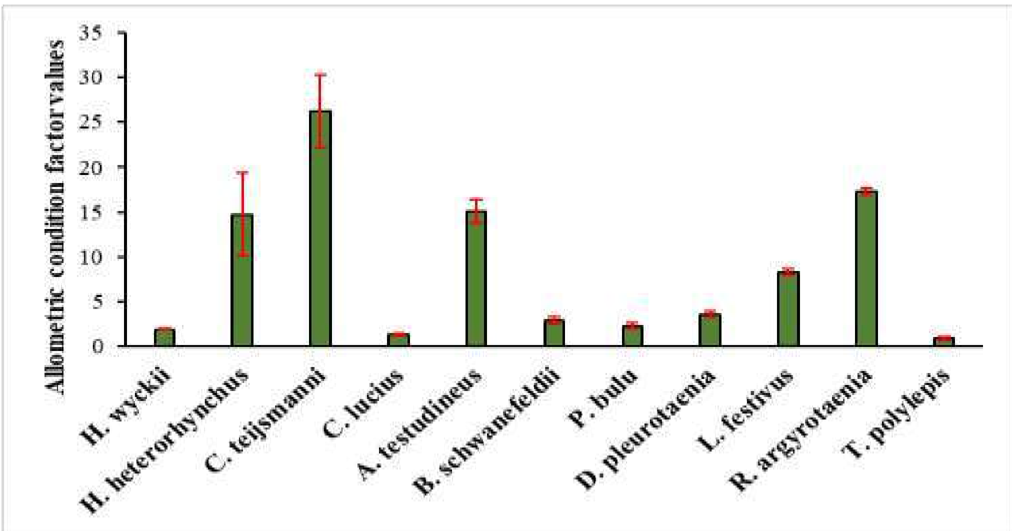

FIGURE 3: Allometric condition factor (Ka) for eleven fish species in Koto Panjang Reservoir

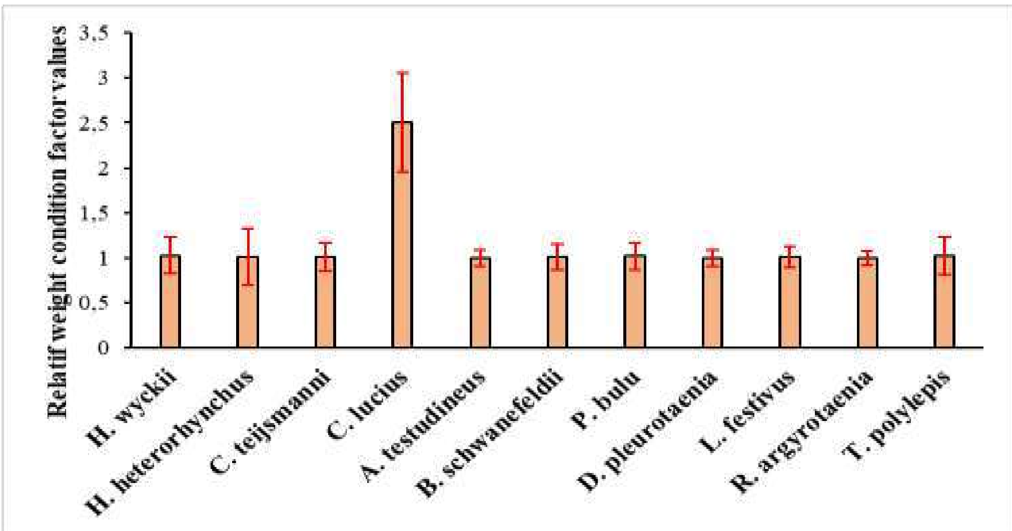

FIGURE 4: Relative condition factor (K*n*) for eleven fish species in Koto Panjang Reservoir

TABLE 5: The mean, minimum, and maximum range values of the morphometric characteristics of eleven fish species in Koto Panjang Reservoir

Species	No of fishes	TL (range, cm)	SL (range, cm)	HL (range, cm)	BD (range, cm)	BG (range, cm)	FL (range, cm)	PD (range, cm)	CPL (range, cm)	PDL (range, cm)	PPL (range, cm)	EY (range, cm)	Wt (range, g)
Hemibagrus wyckii	10	48.49 ± 6.48 (37.39-55.96)	39.79 ± 4.82 (30.4 – 45.0)	11.73 ± 1.50 (9.12-13.05)	7.43 ± 0.95 (5.78-8.05)	16.08 ± 2.18 (13.28-19.88)	44.61±5.96 (34.40-51.48)	3.13±0.40 (2.43-3.64)	6.65±0.85 (5.17-7.74)	16.42±2.10 (12.77-19.11)	21.11±2.70 (16.42-24.57)	1.17±0.15 (0.91=1.37)	1,979.70±716.05 (832-2,835)
Hemisilurus heterorhynchus	10	16.39±2.00 (13.2-20.9)	14.16±1.89 (10.08-18.2)	2.49±0.26 (2.32-3.06)	2.98±0.53 (3.05-4.22)	5.95±1.07 (4.78-8.44)	14.87±2.18 (11.4-20.0)	0.53±0.17 (0.62-0.77)	0.38±0.12 (0.36-0.6)	4.13±0.53 (3.06-5.37)	4.30±0.90 (3.50-6.50)	0.31±0.07 (0.21-0.46)	22.92±10.76 (14.33-51.10)
Clarias teijsmanni	10	23.77±2.00 (21.5-26.8)	20.82±1.83 (18.2-23.80)	5.16±0.53 (4.30-5.92)	3.47±0.40 (3.10-4.18)	6.94±0.79 (6.20-8.36)	21.21±2.09 (16.68-24.0)	1.24±0.16 (0.94-1.48)	0.76±0.37 (0.40-1.50)	5.99±0.63 (5.01-6.95)	8.80±1.22 (7.20-10.24)	0.27±0.09 (0.20-0.38)	133.74±41.37 (74.69-198.02)
Channa lucius	10	30.68±4.81 (29.36-38)	25.05±5.20 (17.1-32)	8.01±1.44 (6.06-10.10)	5.09±0.91 (3.72-6.21	8.07±1.98 (3.55-10.22)	28.60±4.92 (21.21-35.34)	2.54±0.43 (1.89-3.15)	1.74±0.36 (1.34.2.33)	11.65±3.46 (9.70-16.17)	12.73±2.45 (9.72-16.19)	1.02±0.32 (0.67-102)	328.43±134.65 (128.5-473.2)
Anabas testudineus	10	13.82±1.53 (11.5-17.0)	11.11±1.15 (9.0-13.5)	3.30±0.48 (2.24-4.14)	3.72±0.45 (3.10-4.74)	7.80±0.95 (6.51-9.95)	12.72±1.45 (10.37-16.0)	1.60±0.22 (1.31-2.10)	0.70±0.14 (0.51-0.82)	3.46±0.41 (2.74-4.20)	4.01±0.48 (3.09-4.50)	0.58±0.11 (0.50-0.77)	48.82±20.04 (36.20-103.35)
Barbonymus schwanefeldii	10	18.63±2.45 (15.10-23.0)	14.05±1.75 (11.5-17.22)	3.21±0.29 3.06-3.79)	6.14±0.76 (5.60-7.40)	12.90±1.59 (10.14-15.54)	15.32±1.65 (14.0-18.5)	2.10±0.24 (1.96-2.51)	4.47±2.98 (2.38-8.87)	6.91±0.79 (6.84-8.35)	6.60±0.85 (5.88-8.22)	1.21±0.21 (1.05-1.59)	85.96±21.18 (63.4-110.0)
Puntioplites bulu	10	24.40±2.27 (20.5-27.4)	18.85±1.69 (16.0-21.0)	5.05±0.58 (4.30-6.01)	8.34±0.82 (6.77-9.50)	16.69±1.63 (13.54-19.00)	21.21±2.06 (17.40-24.21)	2.58±0.27 (2.22-3.19)	3.44±0.24 (3.07-3.75)	9.62±0.99 (8.00-11.35)	8.84±0.98 (7.46-10.37)	1.51±0.20 (1.18-1.79)	209.49±43.04 (126.84-290.90)
Diplocheilichthys pleurotaenia	10	18.13±1.96 (14.5-20.3)	14.25±1.45 (11.5-16.0)	2.86±0.31 (2.25-3.30)	5.13±0.52 (4.10-5.710	10.27±1.04 (8.21-11.42)	16.00±1.62 (12.82-17.84)	1.87±0.20 (1.51-2.10)	1.64±0.26 (1.25-2.21)	5.45±0.60 (4.35-6.20)	6.49±0.69 (5.13-7.20)	0.79±0.07 (0.57-0.89)	65.30±20.85 (29.8-100.56)
Labiobarbus festivus	10	23.03±3.64 (17.55-30.25)	19.03±3.01 (14.5-25.0)	3.79±0.64 (2.74-4.20)	5.87±3.13 (4.26-7.15)	15.12±3.88 (9.36-15.73)	22.21±2.65 (17.71-26.52)	2.06±0.88 (1.45-4.48)	3.16±1.51 (2.09-7.33)	7.915±0.93 (6.32-9.39)	12.26±5.58 (8.48-27.49)	1.37±0.63 (0.94-3.09)	71.24±26.57 (40.6-132.3)
Rasbora argyrotaenia	10	9.77±1.34 (8.0-12.0)	7.74±1.12 (6.40-9.50)	1.52±0.22 (1.14-1.90)	1.66±0.36 (1.25-2.30)	3.33±0.72 (2.5-4.6)	8.50±1.34 (6.80.10.80)	0.68±0.14 (0.49-0.86)	1.04±0.25 (0.62-1.33)	3.88±0.64 (2.96-5.07)	3.57±0.57 (2.80-4.27)	0.42±0.16 (0.28-0.86)	8.29±4.27 (3.62-15.41)
Thynnichthys polylepis	10	19.92±1.55 (18.35-22.30	14.73±3.74 (14.00-18.60)	3.1±0.25 (2.80-3.56)	4.85±0.62 (4.0-5.92)	10.67±1.36 (8.80-13.02)	18.29±2.50 (15.2-22.72)	1.47±0.23 (1.16-1.86)	2.22±0.25 (1.9-2.68)	6.52±0.90 (5.4-8.11)	8.68±1.24 (7.2-10.88)	0.96±0.13 (0.8-1.2)	56.102±25.89 (26.9-95.46)

TL = Total length; SL = Standar length; HL = Head length; BD = Body depth; BG = Body girth; FL = Fork length; PD = Penduce depth; CPL = Caudal penduce length
PDL = Pre-dorsal length; PPL = Pre-pelvic length; EY = Eye diameter; WT = Weight; No = number; cm = centimeter

TABLE 6: Meristic characteristics of eleven species collected from the Koto Panjang Reservoir, Riau

Species	No. of fishes	Dorsal fin	Caudal fin	Anal fin	Pectoral fin	Ventral fin
Hemibagrus wyckii	5	i,7 (7)	ii,8 (1), ii,8, i (1), iii,8,i (1), iv,9 (3)	i,8 (8)	i,9,1 (1)	i,5 (5)
Hemisilurus heterorhynchus	5	iii,9 (9)	-	iii, 6 (6)	i,13-14 (12-13)	i.8 (8)
Clarias teijsmanni	5	i.71 (70)	ii.8 (7)	ii,57 (60)	i,8 (8)	i,5 (60)
Channa lucius	5	i, 39 (38)	12-14 (13)	i, 28-29 (28-30)	32 (32)	10 (9)
Anabas testudineus	5	xvii,7-9 (9)	16-20 (19)	xi, 9-10 (8-10)	13-15 (13-14)	vi.5 (6)
Barbonymus schwanefeldii	5	i,9 (8)	15.17 (17)	i,6-8 (6-8)	i,11-13 (12)	i.8 (7)
Puntioplites bulu	5	iv, 8 (8)	22 (22)	iii,5	i,17-18 (17)	i,9 (8)
Diplocheilichthys pleurotaenia	5	i,11-13 (12)	17 (16)	i,5 (5)	i,12-15 (12-14)	i.8 (8)
Labiobarbus festivus	5	i,23-26 (24-25)	20-22 (22)	i,7 (7)	i,11-14 (12-14)	vi.9 (9)
Rasbora argyrotaenia	5	ii,7 (7)	16 (15)	i,3-5 (3-5)	i,12-13 (13)	2.7 (7)
Thynnichthys polylepis	5	iii, 8 (9)	10.2.9 (10.2.9)	i,7-8 (7-8)	ii,17 (18)	2.8 (8)

Note: the numbers in parentheses represent the number of fin rays calculated; black numbers make no difference; red numbers show differences

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Sindhuja Devadoss <sdevadoss@wiley.com> Mon, Jul 8, 2024 at 11:52 AM
Reply-To: Sindhuja Devadoss <sdevadoss@wiley.com>
To: azrita31@bunghatta.ac.id
Cc: syandri_1960@bunghatta.ac.id, netti.aryani@lecturer.unri.ac.id

Dear Dr. Azrita,

Many thanks for your email. If you have any other concerns, please do not hesitate to contact us.

Best regards,
Sindhuja

Sindhuja Devadoss
Editorial Assistant

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, azrita ubh <azrita31@bunghatta.ac.id> wrote:
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azrita ubh <azrita31@bunghatta.ac.id> Sun, Jul 14, 2024 at 3:45 PM
To: International Journal of Zoology <sdevadoss@wiley.com>

Dear Sindhuja Devadoss,

I have submitted my revised manuscript 9927705 titled "Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia" to the International Journal of Zoology system. Thanks

Best Regards,
Azrita

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Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia

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A B S T R A C T

This study was conducted to investigate the length and weight relationship (LWR), condition factors, as well as morphometric and meristic characteristics of eleven freshwater fish species in Koto Panjang Reservoir ecotypes, Indonesia. Fresh specimens were collected during September 2023 - February 2024. The findings indicated that the b coefficient in the LWR of the fish species varied between 1.693 and 3.151. Among the studied fish species, only *Hemisilurus heterorhynchus* (b = 1.951), *Clarias teijsmanni* (b = 2.046), *Anabas testudineus* (b = 2.3750), *Labiobarbus festivus* (b = 2.305), and *Rasbora argyrotaenia* (b = 1.693) had values above the anticipated range of $2.5 < b < 3.5$. One and seven fish species showed positive and negative allometric growth, while three demonstrated isometric growth respectively. The mean values of Fulton's condition factor (K*c*) ranged from 0.73 ± 0.15 to 4.96 ± 0.63, indicating variations in fish morphology. The range of allometric condition factor (K*a*) values observed, spanning from 0.87 ± 0.18 to 26.25 ± 4.05, suggested variations in resource availability and competitive pressures within aquatic environments. The mean relative weight condition factor (K*n*) between 1.00 ± 0.09 and 2.51 ± 0.55, suggested favorable growth for the eleven analyzed fish species. In conclusion, this study offered novel insights into the LWR, condition factor, and morphometric characteristics of freshwater species in the Koto Panjang Reservoir. The results have great potential for enhancing fish species stock assessment.

Keywords: Length-weight relationship; growth pattern; Fulton's condition index; morphometric and meristic; Koto Panjang Reservoir

1. Introduction

Kampar Kanan is one of the largest rivers in Riau Province with a length of approximately 213.5 km and a width ranging from 125 to 143 meters. This river originates from the upper reaches of the Bukit Barisan mountains in Lima Puluh Kota and Pasaman Regency, West Sumatra Province, Indonesia, flowing into the Siak River in the Bengkalis region, Riau Province, and finally into the Strait of Malacca [1].

Since 1996, the upper reaches of the Kampar Kanan River at a geographical position of 0°17'23.76"N and 100°52'53.39"E have been dammed into a reservoir called the Koto Panjang Reservoir which is 96 meters high and located at an altitude of 85 meters above sea level. The area of the inundation formed is estimated at 12,400 hectares [2]. Before the construction of the Koto Panjang Reservoir, the river played an essential role as a source of clean water for the community, supporting agriculture and fisheries as primary livelihoods. The river also served as a transportation route, connecting remote villages to trade centers. Additionally, it provided raw materials such as sand and stone for the construction industry and offered tourism potential with its natural beauty, contributing to the local economy.

This reservoir has multiple functions, including being a hydroelectric power plant with a capacity of 114 MW, as well as irrigation, tourism, and fisheries. Due to the construction of the reservoir, the characteristics of the aquatic ecosystem in terms of abiotic and biotic are affected [3]. Similar to other rivers, dam construction can cause mortality and failure of fish migration [4, 5]. Changes in stream hydrological regimes from lotic to lentic can also affect water retention in reservoirs, leading to a decrease in native and an increase in exotic species [6, 7].

More than 44 types of fish live in the Koto Panjang Reservoir, including *Hemibagrus wyckii*, *Barbonymus schwanefeldii*, *Puntioplites bulu, Diplocheilichthys pleurotaenia, Ompok hypophthalmus, Wallago leerii, Channa lucius, Anabas testudineus,* and *Thyninichthy polylepis* [8]. To support local food security, exotic fish species such as tilapia (*Oreochromis niloticus)*, and carp (*Cyprnus carpio)*, can also be found through floating net cage farming [9].

The fish are caught by small-scale fishermen using non-selective fishing gear such as trap, cast, gill, and drag nets, then sold in traditional markets in the area [10]. However, the use of harmful fishing gear, habitat degradation, and the impact of invasive species can threaten the survival of native fish species in the Koto Panjang Reservoir [3, 11]. This underscores the need to manage fisheries resources that have substantial economic value in a sustainable and environmentally friendly manner.

Length-weight relationship (LWR) analysis plays an important role in fisheries development and conservation evaluation of endangered species. By using existing data, the LWR approach effectively considers fish biomass [12]. It also estimates the length of fish based on the weight in specific environments, ultimately producing estimates of biomass and population growth [13].

Apart from length-weight data, condition factor (K) data for each type of fish is also needed. This parameter indicates welfare based on the hypothesis that fish that weigh more at a certain length show better physiological conditions [14]. On the other hand, the morphological characteristics of fish play a crucial role in identifying the taxonomic classification of a genus or species and discerning differences between geographically variant populations. This information serves as an initial step for studying ontogeny or evolutionary relationships of species has been change to introduction in an effort to improve genetic stock [15].

This study aimed to estimate the species composition, relative abundance, percentage occurrence, LWR, condition factors, and morphometric and meristic characteristics of eleven economically important fish species caught in the Koto Panjang Reservoir, Riau Province, Indonesia. The results are expected to enhance understanding of the growth process and contribute to future conservation efforts and fisheries management.

2. Materials and methods

2.1. Study area and fishing gear used.

This study was carried out in Kota Panjang Reservoir, located in the upper reaches of the Kampar Kanan River, Kampar Regency, Riau Province, Indonesia. The location is situated area at a geographical position of 0°20'12.30" N and 100°44'27.26" E (Figure 1). Fish were caught using trap nets known locally as ″bubu" and gill nets. Trap nets were made from woven bamboo rattan and had a cylindrical front with a diameter of 80 cm, while the back was cone-shaped with a length of 2 meters. The gill nets were rectangular in the shape of monofilament thread 60 meters long and 10 meters deep, with a mesh size of 1.25 and 2.5 inches. This tool was used at the bottom of the reservoir at a depth of 2 to 4 meters and operated between 6:00 PM and 6:00 AM to catch demersal fish including Bagridae, Siluridae, Claridae, Channidae, and Anabantidae using chicken intestines as bait. These nets were operated passively on the water surface. Five fish species caught including *H. wyckii*, *C. lucius*, *A. testudineus, H. heterorhynchus*, and *C. teijsmanni* were caught between September - December 2023 is the transition season from the dry season to the rainy season. This can affect sea conditions and fish behavior. Furthermore, between January - February 2024 are the peak of the rainy season. This can affect sea conditions such as increased water turbidity and stronger ocean currents, six species of fish were caught, namely *B. schwanefeldii*, *P. bulu*, *D. pleurotaenia*, *L. festivus*, *R. argyrotaenia*, and *T. polylepis*. The categories and IUCN Red List Status for eleven species as of 2019 and 2020 are presented in Table 1.

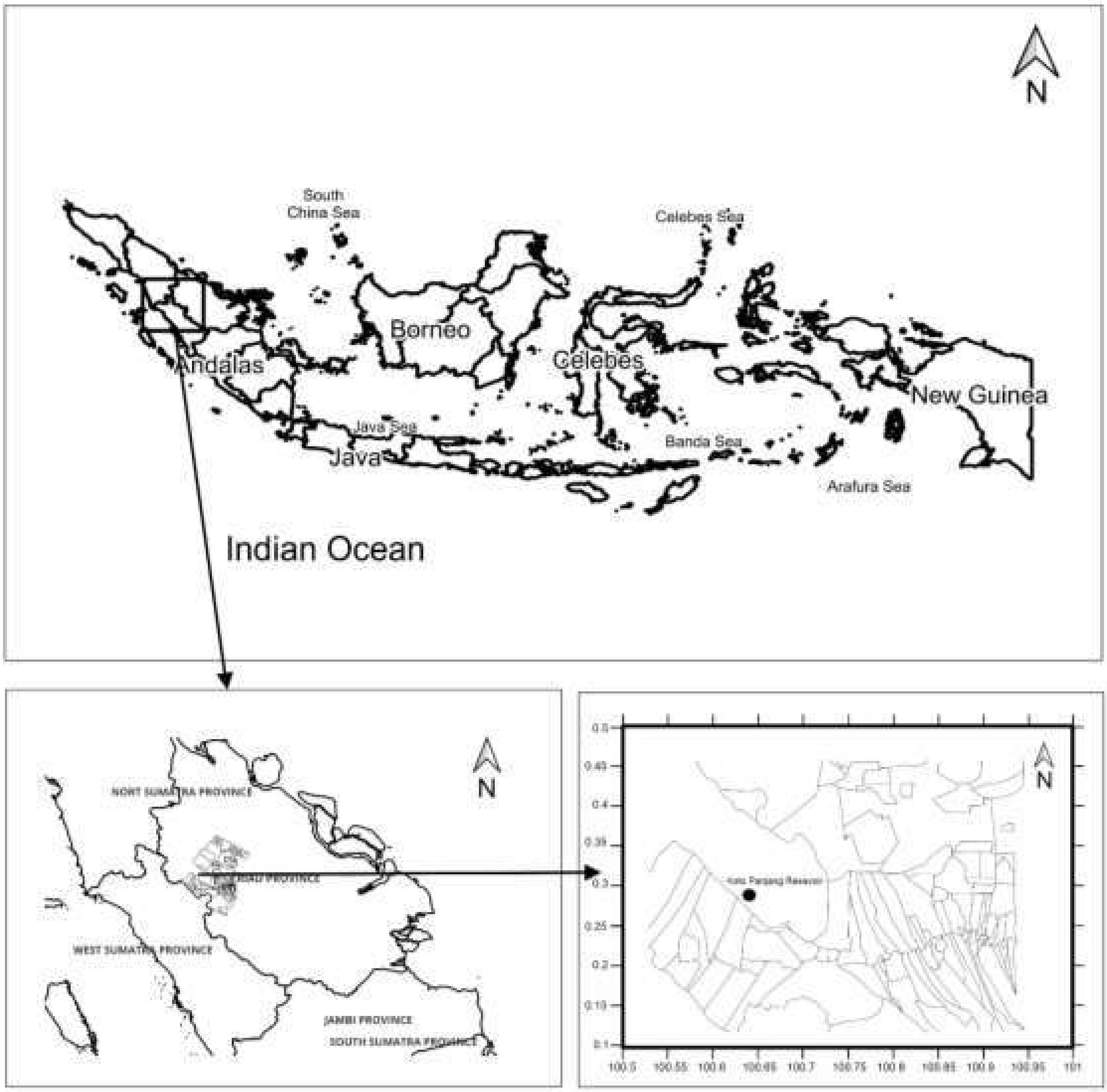

FIGURE 1: Study site map in Koto Panjang Reservoir Kampar Kanan River, Kampar Regency, Riau Province

2.2. Laboratory procedure

After harvest, the fish specimens were transported in a cold box with a temperature of about 10 °C to the Fish Biology Laboratory, Department of Aquaculture, Faculty of Fisheries and Marine Universitas Bung Hatta, Padang, Indonesia, to measure the length, weight, and morphometric characteristics. Classification and taxonomic identification of sample specimens were carried out using the standard keys [16, 17] Subsequently, the weight precision of each specimen was measured using a balance scale (OHAUS model CT 6000 USA) with an accuracy of 0.1 g, and the lengths were assessed through a meter ruler with 0.1 mm accuracy. The sex (male or female) of each fish sample collected with net traps and gillnets was recorded.

The morphometric characteristics of eleven fish species caught were measured using a 0.01 mm precision digital caliper (Made in China), focusing on parameters including total, standard, fork, and head length, body depth, body girth, peduncle depth, caudal peduncle length, pre-dorsal length, pre-pelvic length, and eye diameter. Meanwhile, meristic characteristics namely the number of hard and soft rays on the dorsal, caudal, anal, pectoral, and ventral fin were counted directly using a binocular magnifier equipped with two adjustable lenses, enabling three-dimensional imaging and detailed magnification for accurate calculation of fish fin radii. Morphometric characteristics were measured from ten randomly selected fish, while meristic traits were calculated from five fish also selected randomly.

2.3. Data analysis

Data analysis was performed using SPSS software version 16 after previously removing outlier data. Furthermore, the regression equation $W = a L^b$ was used to determine the LWR, where parameters ´a´ and 'b' were obtained by transforming the log-log equation, namely $\text{Log } W = \log (a) + b \log (L)$. In this equation, ´W' represents the weight of fish in grams (g), ´L' denotes the total length (TL) of fish in centimeters (cm), 'a´ is a constant (intercept), and ´b´ is the slope (change in weight in weight per unit change in length) of the regression [13]. The 95% confidence interval (CI) of the total length and weight was also analyzed, while the toughness of the samples was assessed with the coefficient of determination (r^2).

The Fulton condition factor (K*c*) was estimated using the [18] equation, formulated as $kc = 100*W/L^3$, where W is the total weight of the fish sample, and L is the standard length of the fish sample. The allometric condition factor (K*a*) was estimated using the formula from [12], namely $ka = 100*W/L^b$, where W is the total weight of the fish sample (g), L is the standard length of the fish sample (cm), and b is a constant in the length-weight. Meanwhile, the relative weight condition factor (K*n*) was determined using the [19] formula, $Kn = W/We$, where W is the weight of the fish sample (g), and We is the theoretical weight calculated as $L^{b,}$ and a is a constant in the length-weight.

3. Results

3.1.Categories and IUCN red list status, and species composition

Eleven types of fish from the families Bagridae, Siluridae, Claridae, Channidae, Anabantidae, and Cyprinidae were collected from the Koto Panjang Reservoir in Indonesia. Information regarding the IUCN Red List categories and status in 2019 and 2020 is presented in Table 1.

TABLE 1: Categories and IUCN Red List Status for Eleven Species in 2019 and 2020 in Koto Panjang Reservoir

Order/Family/Species	IUCN Categories for Species Conservation Status, 2019	The IUCN Red List Status	Occurrence
Siliruformes/Bagridae/*Hemibagrus wyckii* (Bleeker, 1858)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous species
Siliruformes/ Siluridae/ Hemisilurus heterorhynchus (Bleeker, 1854)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous species
Siluruformes/ Clariidae/ Clarias teijsmanni (Bleeker, 1857)	Not evaluated	No report from IUCN	Indigenous species
Anabantiformes/Channidae/ *Channa lucius* (Cuvier, 1831)	Least Concern (LC).	The IUCN Red List of Threatened Species in 2019	Indigenous species
Anabantiformes/ Anabantidae/*Anabas testudineus* (Bloch, 1792)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous species
Cypriniformas/Cyprinidae/ *Barbonymus schwanefeldii* (Bleeker, 1854)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous species
Cyprniformes/Cyprinidae/ *Puntioplites bulu* (Bleeker, 1851)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous species
Cyriniformas/Cyprinidae/*Diplocheilichthys pleurotaenia* (Bleeker, 1855)	Data Deficient (DD)	The IUCN Red List of Threatened Species in 2020	Indigenous species
Cypriniformes/Cyprinidae/ *Labiobarbus festivus* (Heckel, 1843)	Data Deficient (DD)	The IUCN Red List of Threatened Species in 2019	Indigenous species
Cypriniformes/Cyprinidae/ *Rasbora argyrotaenia (*Bleeker, 1849*)*	Least Concern (LC)	The IUCN Red List of Threatened Species in 2020	Indigenous species
Cypriniformes/Cyprinidae/ *Thynnichthys polylepis (*Bleeker, 1860*)*	Least Concern (LC)	The IUCN Red List of Threatened Species in 2020	Indigenous species

3.2. Species composition

The total samples collected were 485 specimens, with the percentage of each species being as follows: *H. wyckii* (3.09%), *H. heterorhynchus* (6.19%), *C. teijsmanni* (6.19%), *C. lucius* (12, 58%), *A. testudineus* (11.75%), *B. schwanefeldii* (15.26%), *P. feather* (8.25%), *D. pleurotaenia* (7.84%), *L. fetivus* (8.25%), *R. argyrotaenia* (10.31%), and *T. polylepis* (10.31%). Further information about fish species and the sex is presented in Table 2.

TABLE 2: Species Composition, Relative Abundance, and Percentage Occurrence of Eleven Fish Species in Koto Panjang Reservoir

Family	Species	N	% by no	Sex (%)	
				F	M
Bagridae	*Hemibagrus wyckii*	15	3.09	33.33	66.66
Siluridae	*Hemisilurus heterorhynchus*	30	6.19	33.33	66.66
Clariidae	*Clarias teijsmanni*	30	6.19	66.66	33.33
Channidae	*Channa lucius*	61	12.58	65.67	34.43
Anabantidae	*Anabas testudineus*	57	11.75	29.82	70.17
Cyprinidae	*Barbonymus schwanefeldii*	74	15.25	41.89	58.10
Cyprinidae	*Puntioplites bulu*	40	8.25	62.5	37.5
Cyprinidae	*Diplocheilichthys pleurotaenia*	38	7.84	36.84	63.16
Cyprinidae	*Labiobarbus festivus*	40	8.25	50.0	50.0
Cyprinidae	*Rasbora argyrotaenia*	50	10.31	24.0	76.0
Cyprinidae	*Thynnichthys polylepis*	50	10.31	52.0	48.0

Total	485	100	
N: sample size; % = percentage; F: female; M: male; no = number			

3.3. Length-weight relationship

Table 3 presents descriptive statistics for eleven fish species, including length and weight, used as parameters 'a' and 'b' in each LWR equation and the coefficient of determination (r^2). The range of 'a' values for each species was 0.010 to 0.259, while 'b' values ranged from 1.693 to 3.151. The range of r^2 values obtained was between 0.51 and 0.95, confirming the validity and reliability of the LWR measurement. Furthermore, the LWR relationship in each species consistently showed a significant correlation ($p<0.000$).

This study identified variations in the growth types of eleven fish species, with one species, namely *H. wyckii*, showing a positive allometric growth type, while the other three, including *C. lucius*, *B. schwanefeldii*, and *P. bulu*, demonstrated isometric growth. Seven other species, including *C. teijsmanni*, *A. testudineus*, *D. pleurotaenia*, *L. fetivus*, *R. argyrotaenia*, and *T. polylepis*, showed a negative allometric growth type (Table 3).

Based on the results, the least mean standard length and smaller weight were 7.74 ± 1.12 cm and 8.29 ± 4.27 g for *R. argyrotaenia*, while the maximum standard length and total weight were 39.79 ± 4.82 cm and 2.112.67 ± 889.88 g for *H. wyckii*. These include *H. wyckii* (41 cm vs. 71 cm), *H. heterorhynchus* (16.39 cm vs. 80 cm), *C. lucius* (30.68 cm vs. 53 cm), *A. testudineu*s (13.82 cm vs. 25 cm), *B. schwanefeldii* (18.63 cm vs. 35 cm), *P. bulu* (24.40 cm vs. 44.33 cm), *D. pleurotaenia* (18.13 cm vs. 22.5 cm), *L. festivus* (23.03 cm vs. 33.7 cm), and *R. argyrotaenia* (9.77 cm vs 14 cm). Meanwhile, *T. polylepis* (19.2 cm vs. 18 cm) and *C. teijsmanni* (23.77 cm vs. 22 cm) had a higher value than recorded in FishBase.

3.4. Condition factor

Table 4 shows the values of Fulton's (K*c*), allometric (K*a*), and relative weight condition factor (K*n*) of eleven fish species caught in the Koto Panjang reservoir. The mean value of K*c* for different species varied between 0.73 ± 0.15 and 4.96 ± 0.63 as summarized in Figure 2. *H. heterorhynchus*, *D. pleurotaenia*, *L. festivus* and *T. polylepis* had values < 1.0, while K*c* for *H. wyckii*, *C. teijsmanni*, *C. lucius*, *A. testudineus*, *B. schwanefeldii* and *P. bulu* was > 1.0. Furthermore, in Figuru 3, the mean value of Ka exceeds or equals 3 for six species namely *H. heterorhynchus* (14.70 ± 4.65), *C. teijsmanni* (26.25 ± 4.05), *A. testudineus* (15.07 ± 1.36), *D. pleurotaenia* (3.60 ± 0.34), *L.* f*estivus* (8.32 ± 0.36), and *R. argyrotaenia* (17.31 ± 0.38). While the mean value of K*n* for eleven species ranged from 1.00 ± 0.08 and 2.51 ± 0.55. *R. argyrotaenia* had the lowest value of 1.00 ± 0.08, while *C. lucius* recorded the highest value of 2.51 ± 0.55 (Figure 4).

TABLE 3: Descriptive Statistics and Parameters for LWR and Growth of Eleven Fish Species in Koto Panjang Reservoir.

Species	N	LWRs parameters							t-test	P value	Growth type
		Mean SL (cm)	CI 95% of SL (cm)	Mean Wt (g)	CI 95% of TW (g)	a	b	r^2			
Hemibagrus wyckii	15	39.79 ± 4.82	37.12 - 41.82	2,112.67 ± 889.88	1,527.67 - 2697.66	0.010	3.151	0.82	7.79	0.000	(+)
Hemisilurus heterorhynchus	30	16.39 ± 2.00	15.67 – 17.10	22.92 ± 10.76	22.90- 26.76	0.146	1.951	0.51	5..36	0.000	(-)
Clarias teijsmanni	30	23.77 ± 2.00	23.06 - 24.48	133.74 ± 41.37	118.97 – 148.51	0.259	2.046	0.77	9.60	0.000	(-)
Channa lucius	61	28.44 ± 2.24	26.20- 30.68	252.72 ± 63.03	189.69 – 315.75	0.012	2.956	0.83	17.10	0.000	(I)
Anabas testudineus	57	7.87 ± 1.15	6.72 – 9.02	24.91 ± 10.12	14.79 – 35.03	0.178	2.375	0.89	29.46	0.000	(-)
Barbonymus schwanefeldii	74	23.27 ± 2.60	22.67 – 23.88	149.49 ± 54.10	137.19 - 161.78	0.012	2.978	0.86	21.14	0.000	(I)
Puntioplites bulu	40	21.63 ± 2.46	20.36 – 23.39	243.69 ± 82.84	218.03 - 269.34	0.029	2.927	0.84	14.39	0.000	(I)
Diplocheilichthys pleurotaenia	38	22.40 ± 2.84	21.49 - 23.30	106.85 ± 30.37	97.20 - 116.49	0.037	2.555	0.94	23.87	0.000	(-)
Labiobarbus festivus	40	22.25 ± 2.61	21.43 - 23.06	108.18 ± 28.37	99.38 - 116.97	0.083	2.305	0.88	16.36	0.000	(-)
Rasbora argyrotaenia	50	7.74 ± 1.12	7.43 – 8.06	8.29 ± 4.27	7.10 – 9.40	0.172	1.693	0.95	31.13	0.000	(-)
Thynnichthys polylepis	50	14.72 ± 2.96	13.90 – 15.54	25.70 ± 13.31	22.01 – 29.39	0.008	2.932	0.91	22.20	0.000	(-)

N: sample size; SL: standard length; TW: total weight; Min; minimum; Max: maximum; SD: standard deviation; CI: confidence interval, (+) = positive allometric; (-) = negative allometric; (I) = isometric

TABLE 4: Condition Factors (K*c*, K*a*, K*n*) for Eleven Fish Species in Koto Panjang Reservoir.

Species	N	Fulton's condition factor (K*c* values)				The allometric condition factor (K*a* values)				Relative weight condition factor (K*n* values)			
		Mean ± SD	SE	Range (K*c* values)		Mean ± SD	SE	Range (K*a*-values)		Mean ± SD	SE	Range (K*n*-value*s*)	
				Min.	Max			Min.	Max.			Min.	Max.
Hemibagrus wyckii	15	3.24 ± 0.60	0.16	2.45	4.06	1.86 ± 0.06	0.09	1.39	2.67	1.03 ± 0.20	0.05	0.77	1.48
Hemisilurus heterorhynchus	30	0.89 ± 0.40	0.08	0.55	2.10	14.70 ± 4.65	0.21	9.47	25.30	1.01 ± 0.32	0.03	0.65	1.75
Clarias teijsmanni	30	1.57 ± 0.34	0.06	1.02	2.70	26.25 ± 4.05	0.74	17.31	37.12	1.01 ± 0.16	0.02	0.67	1.43
Channa lucius	61	1.08 ± 0.12	0.01	0.86	1.45	1.25 ± 0.13	0.02	0.79	1.51	2.51 ± 0.55	0.08	1.23	3.49
Anabas testudineus	57	4.96 ± 0.63	0.08	3.90	7.79	15.07 ± 1.36	0.11	12.06	19.7	1.00 ± 0.09	0.01	0.80	1.28
Barbonymus schwanefeldii	74	1.15 ± 0.20	0.02	0.80	1.53	2.91 ± 0.42	0.02	2.10	3.74	1.01 ± 0.14	0.02	0.71	1.35
Puntioplites bulu	40	2.33 ± 0.34	0.05	1.68	3.05	2.24 ± 0.33	0.05	1.62	2.94	1.02 ± 0.15	0.02	0.72	1.29
Diplocheilichthys pleurotaenia	38	0.93 ± 0.15	0.02	0.78	1.21	3.60 ± 0.34	0.05	3.11	4.46	1.00 ± 0.09	0.02	0.87	1.24
Labiobarbus festivus	40	0.96±0.16	0.02	0.80	1.63	8.32 ± 0.36	0.15	6.75	10.48	1.01 ± 0.12	0.02	0.82	1.28
Rasbora argyrotaenia	50	1.02 ± 0.31	0.04	0.60	1.76	17.31 ± 0.38	0.19	16.39	18.29	1.00 ± 0.08	0.01	0.95	1.06
Thynnichthys polylepis	50	0.73 ± 0.15	0.12	0.44	1.25	0.87 ± 0.18	0.03	0.52	1.47	1.02 ± 0.21	0.08	0.61	1.71

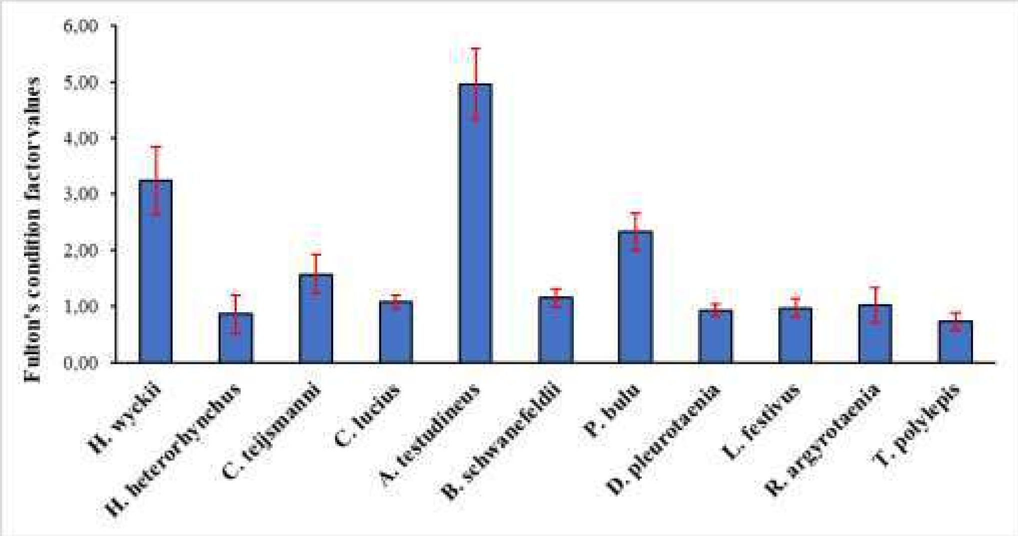

FIGURE 2: Fulton's condition factor (K*c*) for eleven fish species in Koto Panjang Reservoir.

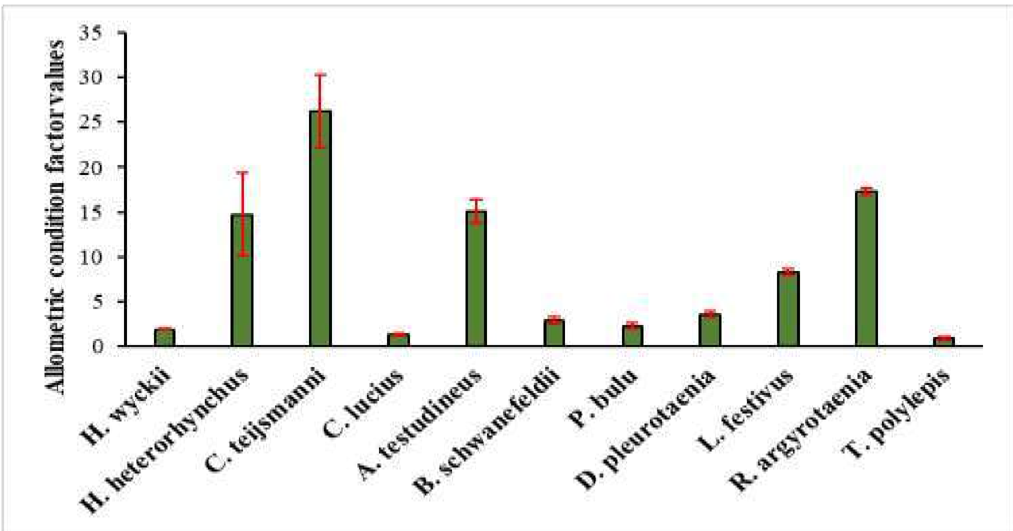

FIGURE 3: Allometric condition factor (K*a*) for eleven fish species in Koto Panjang Reservoir

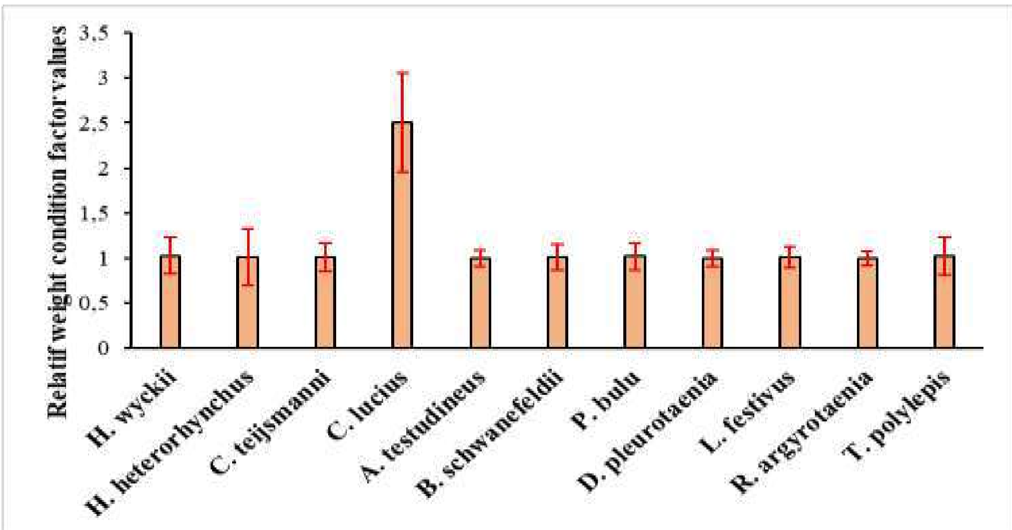

FIGURE 4: Relative condition factor (K*n*) for eleven fish species in Koto Panjang Reservoir

3.5. Morphometric and meristic characteristics

Table 5 summarizes the mean, minimum, and maximum range values of the morphometric characteristics of eleven fish species in Koto Panjang Reservoir. *H. wyckii* (Bleeker, 1858) showed the highest mean standard length (SL) value of 39.79 ± 4.82 cm and body weight (WT) value of 2,112.67 ± 889.88 g. Conversely, *R. Argyrotaenia* (Bleeker, 1849) had the lowest mean standard length and weight values of 7.74±1.12 cm and 8.29±4.27 g. The smallest mean body depth value was found in *R. argyrotaenia* at 1.66 ± 0.36 cm, accompanied by a mean body girth value of 3.33 ± 0.72 cm. The highest mean body depth (BD) was recorded in *P. bulu* (8.34±0.82 cm), equivalent to 15.72% of SL, which also had the highest mean body girth (BG) of 16.69 ± 1.63 cm.

Meristic character data from various types of fish are presented in Table 6. In this study, several data from dorsal fins, caudal fins, anal fins, ventral fins, and pelvic fins were found, showing differences and similarities in number when compared with previous research reports, which are represented by numbers in parentheses.

TABLE 5: The Mean, Minimum, and Maximum Range Values of the Morphometric Characteristics of Eleven Fish Species in Koto Panjang Reservoir

Species	No of fishes	TL (range, cm)	SL (range, cm)	HL (range, cm)	BD (range, cm)	BG (range, cm)	FL (range, cm)	PD (range, cm)	CPL (range, cm)	PDL (range, cm)	PPL (range, cm)	EY (range, cm)	Wt (range, g)
Hemibagrus wyckii	10	48.49 ± 6.48 (37.39-55.96)	39.79 ± 4.82 (30.4 – 45.0)	11.73 ± 1.50 (9.12-13.05)	7.43 ± 0.95 (5.78-8.05)	16.08 ± 2.18 (13.28-19.88)	44.61±5.96 (34.40-51.48)	3.13±0.40 (2.43-3.64)	6.65±0.85 (5.17-7.74)	16.42±2.10 (12.77-19.11)	21.11±2.70 (16.42-24.57)	1.17±0.15 (0.91=1.37)	1,979.70±716.05 (832-2,835)
Hemisilurus heterorhynchus	10	16.39±2.00 (13.2-20.9)	14.16±1.89 (10.08-18.2)	2.49±0.26 (2.32-3.06)	2.98±0.53 (3.05-4.22)	5.95±1.07 (4.78-8.44)	14.87±2.18 (11.4-20.0)	0.53±0.17 (0.62-0.77)	0.38±0.12 (0.36-0.6)	4.13±0.53 (3.06-5.37)	4.30±0.90 (3.50-6.50)	0.31±0.07 (0.21-0.46)	22.92±10.76 (14.33-51.10)
Clarias teijsmanni	10	23.77±2.00 (21.5-26.8)	20.82±1.83 (18.2-23.80)	5.16±0.53 (4.30-5.92)	3.47±0.40 (3.10-4.18)	6.94±0.79 (6.20-8.36)	21.21±2.09 (16.68-24.0)	1.24±0.16 (0.94-1.48)	0.76±0.37 (0.40-1.50)	5.99±0.63 (5.01-6.95)	8.80±1.22 (7.20-10.24)	0.27±0.09 (0.20-0.38)	133.74±41.37 (74.69-198.02)
Channa lucius	10	30.68±4.81 (29.36-38)	25.05±5.20 (17.1-32)	8.01±1.44 (6.06-10.10)	5.09±0.91 (3.72-6.21	8.07±1.98 (3.55-10.22)	28.60±4.92 (21.21-35.34)	2.54±0.43 (1.89-3.15)	1.74±0.36 (1.34.2.33)	11.65±3.46 (9.70-16.17)	12.73±2.45 (9.72-16.19)	1.02±0.32 (0.67-102)	328.43±134.65 (128.5-473.2)
Anabas testudineus	10	13.82±1.53 (11.5-17.0)	11.11±1.15 (9.0-13.5)	3.30±0.48 (2.24-4.14)	3.72±0.45 (3.10-4.74)	7.80±0.95 (6.51-9.95)	12.72±1.45 (10.37-16.0)	1.60±0.22 (1.31-2.10)	0.70±0.14 (0.51-0.82)	3.46±0.41 (2.74-4.20)	4.01±0.48 (3.09-4.50)	0.58±0.11 (0.50-0.77)	48.82±20.04 (36.20-103.35)
Barbonymus schwanefeldii	10	18.63±2.45 (15.10-23.0)	14.05±1.75 (11.5-17.22)	3.21±0.29 3.06-3.79)	6.14±0.76 (5.60-7.40)	12.90±1.59 (10.14-15.54)	15.32±1.65 (14.0-18.5)	2.10±0.24 (1.96-2.51)	4.47±2.98 (2.38-8.87)	6.91±0.79 (6.84-8.35)	6.60±0.85 (5.88-8.22)	1.21±0.21 (1.05-1.59)	85.96±21.18 (63.4-110.0)
Puntioplites bulu	10	24.40±2.27 (20.5-27.4)	18.85±1.69 (16.0-21.0)	5.05±0.58 (4.30-6.01)	8.34±0.82 (6.77-9.50)	16.69±1.63 (13.54-19.00)	21.21±2.06 (17.40-24.21)	2.58±0.27 (2.22-3.19)	3.44±0.24 (3.07-3.75)	9.62±0.99 (8.00-11.35)	8.84±0.98 (7.46-10.37)	1.51±0.20 (1.18-1.79)	209.49±43.04 (126.84-290.90)
Diplocheilichthys pleurotaenia	10	18.13±1.96 (14.5-20.3)	14.25±1.45 (11.5-16.0)	2.86±0.31 (2.25-3.30)	5.13±0.52 (4.10-5.710	10.27±1.04 (8.21-11.42)	16.00±1.62 (12.82-17.84)	1.87±0.20 (1.51-2.10)	1.64±0.26 (1.25-2.21)	5.45±0.60 (4.35-6.20)	6.49±0.69 (5.13-7.20)	0.79±0.07 (0.57-0.89)	65.30±20.85 (29.8-100.56)
Labiobarbus festivus	10	23.03±3.64 (17.55-30.25)	19.03±3.01 (14.5-25.0)	3.79±0.64 (2.74-4.20)	5.87±3.13 (4.26-7.15)	15.12±3.88 (9.36-15.73)	22.21±2.65 (17.71-26.52)	2.06±0.88 (1.45-4.48)	3.16±1.51 (2.09-7.33)	7.915±0.93 (6.32-9.39)	12.26±5.58 (8.48-27.49)	1.37±0.63 (0.94-3.09)	71.24±26.57 (40.6-132.3)
Rasbora argyrotaenia	10	9.77±1.34 (8.0-12.0)	7.74±1.12 (6.40-9.50)	1.52±0.22 (1.14-1.90)	1.66±0.36 (1.25-2.30)	3.33±0.72 (2.5-4.6)	8.50±1.34 (6.80.10.80)	0.68±0.14 (0.49-0.86)	1.04±0.25 (0.62-1.33)	3.88±0.64 (2.96-5.07)	3.57±0.57 (2.80-4.27)	0.42±0.16 (0.28-0.86)	8.29±4.27 (3.62-15.41)
Thynnichthys polylepis	10	19.92±1.55 (18.35-22.30	14.73±3.74 (14.00-18.60)	3.1±0.25 (2.80-3.56)	4.85±0.62 (4.0-5.92)	10.67±1.36 (8.80-13.02)	18.29±2.50 (15.2-22.72)	1.47±0.23 (1.16-1.86)	2.22±0.25 (1.9-2.68)	6.52±0.90 (5.4-8.11)	8.68±1.24 (7.2-10.88)	0.96±0.13 (0.8-1.2)	56.102±25.89 (26.9-95.46)

TL = Total length; SL = Standard length; HL = Head length; BD = Body depth; BG = Body girth; FL = Fork length; PD = Peduncle depth; CPL = Caudal peduncle length
PDL = Pre-dorsal length; PPL = Pre-pelvic length; EY = Eye diameter; WT = Weight; No = number; cm = centimeter

TABLE 6: Meristic Characteristics of Eleven Species Collected From the Koto Panjang Reservoir

Species	No. of fishes	Dorsal fin	Caudal fin	Anal fin	Pectoral fin	Ventral fin
Hemibagrus wyckii	5	i,7 (7)	ii,8 (1), ii,8, i (1), iii,8,i (1), iv,9 (3)	i,8 (8)	i,9,1 (1)	i,5 (5)
Hemisilurus heterorhynchus	5	iii,9 (9)	-	iii, 6 (6)	i,13-14 (12-13)	i.8 (8)
Clarias teijsmanni	5	i.71 (70)	ii.8 (7)	ii,57 (60)	i,8 (8)	i,5 (60)
Channa lucius	5	i, 39 (38)	12-14 (13)	i, 28-29 (28-30)	32 (32)	10 (9)
Anabas testudineus	5	xvii,7-9 (9)	16-20 (19)	xi, 9-10 (8-10)	13-15 (13-14)	vi.5 (6)
Barbonymus schwanefeldii	5	i,9 (8)	15.17 (17)	i,6-8 (6-8)	i,11-13 (12)	i.8 (7)
Puntioplites bulu	5	iv, 8 (8)	22 (22)	iii,5	i,17-18 (17)	i,9 (8)
Diplocheilichthys pleurotaenia	5	i,11-13 (12)	17 (16)	i,5 (5)	i,12-15 (12-14)	i.8 (8)
Labiobarbus festivus	5	i,23-26 (24-25)	20-22 (22)	i,7 (7)	i,11-14 (12-14)	vi.9 (9)
Rasbora argyrotaenia	5	ii,7 (7)	16 (15)	i,3-5 (3-5)	i,12-13 (13)	2.7 (7)
Thynnichthys polylepis	5	iii, 8 (9)	10.2.9 (10.2.9)	i,7-8 (7-8)	ii,17 (18)	2.8 (8)

Note: the numbers in parentheses represent the number of fin rays calculated; black numbers make no difference; red numbers show differences

4. Discussion

Correlation coefficients ($r^2 > 0.77$) in linear regression for ten fish species in the context of LWR indicated a high degree of correlation, indicating a strong relationship between increasing length and body weight. However, an exception occurred in *H. heterorhynchus*, where the correlation coefficient was only 0.51. This finding is consistent with prior research on fish from diverse aquatic environments [20, 21], with values "a" and "b" in the range that is in accordance with the findings in previous research reports [13]. Earlier studies also found variations in the 'b' value for LWR in different species [22-24]. This variation could be attributed to various factors, including the number of species analyzed, fishing season, sampling location, size and developmental stage of the specimen, feeding categories, environmental factors, as well as type of fishing gear used [14, 26]. The growth patterns of eleven fish species varied, comprising one species exhibiting positive allometry (9.09%), seven species displaying negative allometry (63.63%), and three species showing isometry (27.27%). The length and weight relationship of fish alongside the growth pattern depends on various factors, including stock and population size, body shape, feeding, swimming behavior, trophic level, sexual characteristics, gonad maturity level, as well as environmental conditions, namely low oxygen levels and temperature in highland waters [25-28]. Therefore, estimating length-weight relationship (LWR) and condition factor (K) is crucial in fisheries management due to the valuable insights into the species' health and growth patterns. These parameters assist in assessing the overall condition of fish populations, inform sustainable fishing practices and aid in monitoring ecosystem health of the ecosystem in the waters of the Koto Panjang reservoir, Kampar Regency, Riau Province, Indonesia.

In this study, the total length of nine sampled fish species is smaller compared to the total length of fish species recorded in FishBase, while two other species have a total length higher than those recorded in FishBase [29]. The effect of changing the hydrological regime from lotic to lentic on the length-weight and growth types of the fish analyzed is not understood. One of the main threats to freshwater biodiversity is the loss of connectivity within river systems due to anthropogenic barriers such as dams, land use change, hydrological disturbance, and over-exploitation [30,31]. Artificial barriers, including dams, dikes, or fishing nets, can potentially affect critical environmental variables, namely water flow, temperature, and substrate composition. These variables potentially change ecological design and structure, while also decreasing species richness, freshwater community growth types, and fish body size [32-34].

The Kc values of the eleven fish species analyzed were not significantly different from research findings in other water areas [35,36], including for *C. punctata* which is the object of cultivation [37]. The use of allometric condition factor (Ka) is rare in cases where species exhibit allometric growth patterns or when the value of b is calculated with sufficient data to minimize errors [14]. Its application extends to assessing the feeding habits of different fish species [27, 38, 39] and serving in different feeding regimes in laboratory experiments [37]. When a species exhibits an allometric growth pattern or when "b" equals #3.00, the allometric condition factor (K*a*) is considered more appropriate. In such cases, variations in the condition factor are directly related to differences in body weight and food intake. In this study, the average Ka values exceeded or were equal to 3 for six species, ranged from 1.86 to 2.91 for three species, and were less than 1 for one species. Several studies have used the relative condition factor (K*n*) to evaluate the condition of fish species. K*n* values below 1.0 indicate limited prey availability or elevated predator density, while values above 1.00 suggest an abundance of prey or reduced predator density [24]. In this study, *C. lucius* showed the highest performance with a Kn value of 2.51 ± 0.55. This condition is related to a carnivorous diet, while other species had a Kn value ranging from 1.0 to 1.03. Although carnivorous fish species, including *C. lucius*, *C. striata*, *H. wyckii*, *H. nemurus*, *P. pangasius*, and *W. leerii* inhabit the Koto Panjang reservoir [10], the presence does not seem to diminish the food availability for herbivorous fish, as evidenced by relative condition factor values equal to or greater than 1.0.

The morphological characteristics of fish play a crucial role in identifying the taxonomic classification of a genus or species and discerning differences between geographically variant populations. The analysis of morphological characteristics remains one of the oldest and most widely used methods for systematically studying fish [40]. The mean, minimum, and maximum ranges of morphometric characteristics, such as height and body girth, vary among the eleven species in Koto Panjang Reservoir. Morphometric characteristics of each fish species within an aquatic habitat depend on the order and family, type of fishing gear used, fishing area, food availability, sampling season, geographic influences [41], environmental conditions, and physiological state [13].

Based on the results, fish actively foraging during the day had larger eye diameters, ranging from 27.62 to 37.69% of the head length. This pattern was mainly observed in fish species from the families Cyprinidae, including *B. schwanefeldii*, *P. bulu*, *D. pleurotaenia*, *L. festivus*, R. *argyrotaenia*, and *T. polylepis*, as well as Channidae namely *C. lucius*. On the other hand, fish that rely on the sense of smell to find food, such as the Bagridae, Siluridae, Clariidae, and Anabantidae, tend to have smaller eye diameters, ranging from 3.37 to 17.58% of the head length. Vision dominates as the main modality in diurnal fish living in shallow water habitats, but eye diameter depends on feeding habits [42, 43]. Similar to other nocturnal fish, *A. annularis* [44] is a small planktivorous reef fish 7–10 cm in length, characterized by relatively large eyes up to 5 mm diameter, covering 47% of the head length and a relatively large mouth (8 mm). This fish shows strong selectivity towards larger prey [45, 46], including *C. lucius*.

5. Conclusion

In conclusion, knowledge about the analysis of length-weight relationship, condition factor, as well as morphometric and meristic data in this study contributed to understanding the population structure of species in the Koto Panjang Reservoir ecotype, located in West Sumatra and Riau Province, Indonesia. Among the eleven types of fish analyzed, *B. schwanefeldii* had the highest percentage (15.26%) with an mean weight of 149.49 ± 54.10 g, while the lowest percentage (3.09%) was found in *H. wyckii* with an mean weight of 2,112.67 ± 889.88 g. Based on the results, the eleven species caught from these waters had a consistent length-weight relationship for each species, indicating a significant correlation between these two morphological parameters and various growth patterns, including positive allometry, negative allometry, and isometry. Fulton (K*c*), allometric (K*a*), and relative weight condition factor (K*n*) values also varied between species, with some showing Kc values <1 and >1, as well as K*a* values indicating variation in shape and size of fish body. In addition, the Kc value of all fish species exceeded 1, indicating sufficient prey availability and low predators, as well as a good range of environmental conditions. The results provide a significant contribution to future fisheries management by the Indonesian government with economic benefits to local communities. This study also offers insight into improving the evaluation of fish stocks and species selection for domestication. Further studies are recommended to examine aspects of biological reproduction while considering physicochemical parameters, the biochemical composition of water, and food habits.

Data Availability

The data that support the findings of this study are openly available in Figshare. https://doi.org/10.6084/m9.figshare.25801219.

Ethical Approval

The Animal Ethics Committee of the Institute for Research and Community Service at Bung Hatta University in Indonesia approved this study. Ethical permission was obtained to gather fish specimens from the Koto Panjang Reservoir and conduct measurements of length and weight at the Fish Biology Laboratory, located within the Department of Aquaculture at the Faculty of Fisheries and Marine.

Conflicts of Interest

The authors declare that there are no competing interests.

Authors' Contributions

Azrita Azrita, as Associate Professor, is responsible for data collection, analysis and preparation of the manuscript. Professor Hafrijal Syandri took part in designing the study as well as reviewing and editing the manuscript. Professor Netti Aryani took care of the research design, as well as reviewing and editing the manuscript thoroughly.

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Webmail Univ. Bung Hatta

azrita ubh <azrita31@bunghatta.ac.id>

9927705: Overdue revised manuscript

Sindhuja Devadoss <sdevadoss@wiley.com> Mon, Jul 15, 2024 at 8:56 AM
Reply-To: Sindhuja Devadoss <sdevadoss@wiley.com>
To: azrita31@bunghatta.ac.id

Dear Dr. Azrita,

Many thanks for your email. Hopefully, we will get back to you soon with a positive response.

If you need any further information, please let me know.

Best regards,
Sindhuja

Sindhuja Devadoss
Editorial Assistant

WILEY

On Sun, 14 Jul at 9:46 AM , azrita ubh <azrita31@bunghatta.ac.id> wrote:
Dear Sindhuja Devadoss,

I have submitted my revised manuscript 9927705 titled "Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia" to the International Journal of Zoology system. Thanks

Best Regards,
Azrita

On Sun, Jul 7, 2024 at 7:16 PM International Journal of Zoology <ijz@hindawi.com> wrote:

WILEY

Dear Dr.Azrita Azrita,

This is to inform you that the revised version of your manuscript 9927705 titled "Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia" to International Journal of Zoology is overdue, as it has been over 1 month since you received your decision email.

To submit the revised manuscript, please follow the link below.

Submit your revised files

If you require additional time or assistance submitting your revised manuscript, please let me know as soon as possible. If we do not hear from you or receive your revised manuscript within 2 weeks, we will withdraw your manuscript.

I look forward to receiving your response.

Kind regards,
Sindhuja Devadoss
International Journal of Zoology

Webmail
Univ. Bung Hatta

azrita ubh <azrita31@bunghatta.ac.id>

9927705: Overdue revised manuscript

azrita ubh <azrita31@bunghatta.ac.id> Tue, Jul 16, 2024 at 10:41 AM
To: Sindhuja Devadoss <sdevadoss@wiley.com>

Any updates?
[Quoted text hidden]

Webmail Univ. Bung Hatta

azrita ubh <azrita31@bunghatta.ac.id>

9927705: Update on manuscript

International Journal of Zoology <ijz.office@wiley.com> Wed, Jul 24, 2024 at 1:35 PM
Reply-To: International Journal of Zoology <sdevadoss@wiley.com>
To: Azrita Azrita <azrita31@bunghatta.ac.id>

WILEY

Dear Dr. Azrita Azrita,

I am writing regarding your manuscript 9927705, entitled Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia. It is taking us longer than expected to send you an editorial decision for your manuscript.

As standard practice, we perform rigorous peer review integrity checks as part of the editorial process. These checks can sometimes incur delays.

We wanted to inform you that we are still working to send you an editorial decision as soon as possible. You can track the status of your manuscript at the link below:

MANUSCRIPT DETAILS

Please accept our apologies for any inconvenience.

Kind regards,
Devadoss Sindhuja
International Journal of Zoology

Webmail Univ. Bung Hatta

azrita ubh <azrita31@bunghatta.ac.id>

9927705: Revision requested

3 messages

International Journal of Zoology <ijz.office@wiley.com> Sun, Sep 15, 2024 at 5:43 AM
Reply-To: International Journal of Zoology <sdevadoss@wiley.com>
To: Azrita Azrita <azrita31@bunghatta.ac.id>

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azrita ubh <azrita31@bunghatta.ac.id>

9927705: Revision requested

azrita ubh <azrita31@bunghatta.ac.id> Thu, Sep 19, 2024 at 6:24 PM
To: International Journal of Zoology <sdevadoss@wiley.com>

Dear
Sindhuja Devadoss
International Journal of Zoology

Thank you for your email dated September 15, 2024. The author has completed the revision of manuscript ID No. 9927705. The manuscript and author response were submitted on September 19, 2024. We look forward to hearing from the International Journal of Zoology.

Best Regards

Azrita
[Quoted text hidden]

Dear Dr. Azrita Azrita,

In order for your submission "Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia" to "International Journal of Zoology" to proceed further in the review process, you will need to revise your manuscript.

Reason & Details:

> *Dear authors*
> *Your ms has been revised and the referee suggested minor revisions a decision with which I do agree. Please upload a revised version and a new cover latter responding to all the referee's comments.*
> *Sincerely,*
> *JP Barreiros*

When you have finished revising, follow the link below to submit your revision:

MANUSCRIPT DETAILS

Kind regards,
Sindhuja Devadoss
International Journal of Zoology

Reviewer Comments:

> ***Reviewer 1 Comments to the Author***
>
> *PEER REVIEWER ASSESSMENTS:*
>
> *OBJECTIVE - Full research articles: is there a clear objective that addresses a testable research question(s) (brief or other article types: is there a clear objective)?*
> *Yes - there is a clear objective*
>
> *DESIGN - Is the current approach (including controls and analysis protocols) appropriate for the objective?*
> *No - there are minor issues*
>
> *EXECUTION - Are the experiments and analyses performed with technical rigor to allow confidence in the results?*
> *Yes - experiments and analyses were performed appropriately*
>
> *STATISTICS - Is the use of statistics in the manuscript appropriate?*
> *Yes - appropriate statistical analyses have been used in the study*

INTERPRETATION - Is the current interpretation/discussion of the results reasonable and not overstated?
Yes - the author's interpretation is reasonable

OVERALL MANUSCRIPT POTENTIAL - Is the current version of this work technically sound? If not, can revisions be made to make the work technically sound?
Probably - with minor revisions

PEER REVIEWER COMMENTS:

GENERAL COMMENTS: The study investigated the length and weight relationship (LWR), condition factor, morphometric and meristic characteristics of eleven freshwater fish species in the Koto Panjang Reservoir, Indonesia. The document is well written, and the analyses are mostly correct. However, the number of specimens per species is relatively low, the temporal span short (one single year), and the study area restricted to a single site. So, even if, in my opinion, basic science should be promoted, the conclusions remain quite speculative as there is no possible comparison between e.g. impacted-non impacted or any analysis on the temporal trends etc. I'm afraid the study will have little further interest for the scientific community.

REQUESTED REVISIONS:
Abstract:
In the first sentence, I would use "condition factor", without the S.
Before length and weight relationship (LWR) indicate which kind of function is being adjusted, so the reader will understand the meaning of the 'b' parameter.
In the sentence ") had values above the anticipated range of $2.5 < b < 3.5$. " should it be 'below'?
This hypothesis (they should be above/below $2.5 < b < 3.5$) is not described in the introduction.
IN ", suggested variations in resource availability and competitive pressures within aquatic environments ." There is only one reservoir, not multiple environments. I would rephrase.
I would check the structure/grammar of several sentences.

Introduction:
"a width ranging from 125 to 143 meters" Where? Across this province? Before and after the reservoir?
"Reservoir which is 96 meters high and located at an altitude " The 96 meters is the maximum depth or the dam height? Please, clarify.
"construction industry and offered tourism potential with" the word "potential" make me wonder if there were or there were not tourism along the river? Please, rephrase the sentence to clarify this point.
"This information serves as an initial step for studying ontogeny or evolutionary relationships of species has been change to introduction in an effort to improve genetic stock." this sentence is

introduction in an effort to improve genetic stock " this sentence is unclear, especially: "has been change". Pease check this sentence. "This study aimed to estimate the species composition, relative abundance, percentage occurrence, " there is no mention to species composition, relative abundance, percentage occurrence in the introduction it only describes the benefits of studying the length and weight relationships, condition factor, and morphometric characteristics. Besides, the sampling effort seems unplanned/random and only 11 out of 44 fish species were caught. The reasons for this low number are not indicated, but it seems caused by a low/misguided sampling effort because it is indicated they currently inhabit the reservoir.

Materials and methods
Study area and fishing gear used.
"The location is situated area at a " Please, reprhase.
"This can affect sea conditions and fish behavior . " Sea? What the authors meant by sea? Is this reservoir connected to the sea? I am sorry I have been unable to find this reservoir in Google Maps.

Laboratory procedure
"The sex (male or female) of each fish sample collected with net traps and gillnets was recorded." I would simply write: The sex (male or female) of each collected fish was recorded.

Data analysis
"while the toughness of the samples was assessed" "toughness " seems odd I would use Robustness o Accuracy instead.
"was estimated using the [18] equation, " Add the name of the author(s).
"using the formula from [12] ," Add the name of the author(s).
"was determined using the [19] formula," Add the name of the author(s) or something that can be read.

Results
Categories and IUCN red list status, and species composition
It does not seem a great percentage compared with the total number of species present in this reservoir ...

Length-weight relationship
"(p < 0.000)" As far as I know P cannot be negative use "P < 0.001".
"Based on the results, " This paragraph described the captures, and they do not seem conditioned by the regressions described above.

Morphometric and meristic characteristics
Check the document for double spaces.

Discussion
"Correlation coefficients " Please, use "the coefficient of determination".
"indicated a strong relationship" Please remove: "high degree of correlation , indicating a"
Sample size also condition the variability in the "b" parameters.

"Therefore, estimating length-weight relationship (LWR) [...]" I guess when they are compared from multiple sites/years. They do not seem to be that informative when they are calculated from isolated years.
When Fishbase total lengths are reported, I assume the authors meant the maximum total length. In this case, the lower lengths are irrelevant. There must be smaller fish.
"The effect of changing the hydrological regime from lotic to lentic [...]" This is quite theoretical and conclusions cannot be drowned from the study as there is no comparison with the results from a flowing river segment.

Conclusions (Please add the S)
"contributed to understanding the population structure of species in the Koto Panjang Reservoir ecotype" I dont think the population strcture has been studied. The authors have not analysed the cohorts. I don't think the authors have data to do so.

Figures and tables
Table1: Separate the species from order and family into different columns.

Table 3: in the figure caption, indicate the meaning of LWR (lenght-weight relationships)

Table 4: If possible, move this to supplementary material. These values are shown in subsequent figures.

Table 5: remove the "The" before "Mean, Minimum"
ADDITIONAL REQUESTS/SUGGESTIONS:
I don't think the study will be of interest for a "restricted-broader" audience even for local managers.

---

azrita ubh <azrita31@bunghatta.ac.id> Thu, Sep 19, 2024 at 6:24 PM
To: International Journal of Zoology <sdevadoss@wiley.com>

Dear
Sindhuja Devadoss
International Journal of Zoology

Thank you for your email dated September 15, 2024. The author has completed the revision of manuscript ID No. 9927705. The manuscript and author response were submitted on September 19, 2024. We look forward to hearing from the International Journal of Zoology.

Best Regards

Azrita

[Quoted text hidden]

Sindhuja Devadoss <sdevadoss@wiley.com>
Reply-To: Sindhuja Devadoss <sdevadoss@wiley.com>
To: azrita31@bunghatta.ac.id

Thu, Sep 19, 2024 at 8:46 PM

Dear Dr. Azrita,

Many thanks for your submission to International Journal of Zoology. Hopefully, we will get back to you soon with a positive response. If you need any further information, please let me know.

Best regards,
Sindhuja

Sindhuja Devadoss
Editorial Assistant

WILEY

[Quoted text hidden]
, azrita ubh <azrita31@bunghatta.ac.id> wrote:
[Quoted text hidden]

Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia

Azrita Azrita[a*] Hafrijal Syandri[a], Netti Aryani[b]

[a] *Faculty of Fisheries and Marine Science Universitas Bung Hatta, 25131, Padang-West Sumatra Province, Indonesia*
[b] *Faculty of Fisheries and Marine Science Universitas Riau, 28293, Pekanbaru-Riau Province, Indonesia*

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A B S T R A C T

This study analyzes the species composition, length-weight relationship (LWR), condition factor, and morphometric and meristic characteristics of eleven freshwater fish species in Kota Panjang Reservoir, Indonesia. Fresh specimens were collected from September 2023 to February 2024. Results show that among the sampled species, two belong to Order Anabantiformes, three to Order Siluriformes, and six to Order Cypriniformes. The Order Siluriformes has the lowest species composition, with Hemibagrus wyckii at 3.09%, while the Order Cypriniformes has the highest, with Barbonymus schwanefeldii at 15.25%. The LWR coefficient b ranges from 1.693 to 3.151. Of the species studied, only Hemisilurus heterorhynchus (b = 2.174), Clarias teijsmanni (b = 2.046), Anabas testudineus (b = 2.375), Labiobarbus festivus (b = 2.305), and Rasbora argyrotaenia (b = 1.693) fall outside the expected range of 2.5 < b less than < 3.5. One species exhibits positive allometric growth (+), seven show negative allometric growth (-), and three display isometric growth (I). Fulton's condition factor (Kc) averages between 0.73 ± 0.15 and 4.96 ± 0.63, indicating morphological variation. The allometric condition factor (Ka) ranges from 0.87 ± 0.18 to 26.25 ± 4.05, reflecting differences in resource availability and competition. Relative condition factor (Kn) values range from 1.00 ± 0.09 to 2.51 ± 0.55, indicating good growth. Morphometric analysis shows Rasbora argyrotaenia has the smallest average total length, head length, and body depth, while *Hemibagrus wyckii* has the largest. The results provide new data on the length-weight relationship, condition factor, and morphometric characteristics of eleven selected freshwater fish species in Kota Panjang Reservoir, Indonesia, and offer up-to-date information on the remaining species in the study area. These findings could have a significant impact on species stock assessments and help identify priority species for domestication.

Keywords: Length-weight relationship; growth pattern; Fulton's condition index; morphometric and meristic; Koto Panjang Reservoir

1. Introduction

Kampar Kanan is one of the largest rivers in Riau Province with a length of approximately 213.5 km and a width ranging from 125 to 143 meters in some parts. Geographically, this part of the river is located after the Koto Panjang Reservoir. This river originates from the upper reaches of the Bukit Barisan mountains in Lima Puluh Kota and Pasaman Regency, West Sumatra Province, Indonesia, flowing into the Siak River in the Bengkalis region, Riau Province, and finally into the Strait of Malacca [1].

Since 1996, the upper reaches of the Kampar Kanan River at a geographical position of 0°17'23.76"N and 100°52'53.39"E have been dammed into a reservoir called the Koto Panjang Reservoir. The height of the dam-reservoir is 96 meters, and it is situated at an elevation of 85 meters above sea level. The estimated inundated area covers around 12,400 hectares, with water depths ranging from 9.8 to 28.6 meters [2]. Before the construction of the Koto Panjang Reservoir, the river played an essential role as a source of clean water for the community, supporting agriculture and fisheries as primary livelihoods. In addition, this area provides raw materials such as sand and stone for the construction industry. Furthermore, the region offers interesting tourism opportunities, especially along the riverbanks, with its stunning natural beauty.

This reservoir has multiple functions, including being a hydroelectric power plant with a capacity of 114 MW, as well as irrigation, tourism, and fisheries. Due to the construction of the reservoir, the characteristics of the aquatic ecosystem in terms of abiotic and biotic are affected [3]. Similar to other rivers, dam construction can cause mortality and failure of fish migration [4, 5]. Changes in stream hydrological regimes from lotic to lentic can also affect water retention in reservoirs, leading to a decrease in native and an increase in exotic species [6, 7].

More than 44 species of fish live in the Koto Panjang Reservoir, including *Hemibagrus wyckii*, *Barbonymus schwanefeldii*, *Puntioplites bulu, Diplocheilichthys pleurotaenia, Ompok hypophthalmus, Wallago leerii, Channa lucius, Anabas testudineus,* and *Thyninichthy polylepis* [8]. To support local food security, exotic fish species such as tilapia (*Oreochromis niloticus)*, and carp (*Cyprnus carpio)*, can also be found through floating net cage farming [9].

The fish are caught by small-scale fishermen using non-selective fishing gear such as trap, cast, gill, and drag nets, then sold in traditional markets in the area [10]. However, the use of harmful fishing gear, habitat degradation, and the impact of invasive species can threaten the survival of native fish species in the Koto Panjang Reservoir [3, 11]. This underscores the need to manage fisheries resources that have substantial economic value in a sustainable and environmentally friendly manner.

Length-weight relationship (LWR) analysis plays an important role in fisheries development and conservation evaluation of endangered species. Using available data, the LWR approach effectively considers fish biomass [12]. It also estimates fish length based on weight in a given environment, which ultimately results in estimates of biomass and population growth [13]. Furthermore, species composition, relative abundance, and frequency of occurrence have long been considered as key indicators in assessing biological communities. According to Thomson [14], fish abundance is a key parameter in monitoring fish populations. Various methods are available to estimate fish abundance and species composition, with traditional approaches usually involving the selection of sites or sampling units in a water body, followed by counting the number of fish caught at those sites. Species composition and abundance are influenced by a variety of factors, including overfishing, dam construction, habitat destruction, and biological pollution [15,16]. Occurrence frequency is used to measure various parameters that provide an overview of fish populations and their ecosystem dynamics, such as length-weight distribution and fishing frequency [17].

In addition to length-weight data, species composition, and relative abundance, condition factor (K) data for each fish species are also needed. This parameter indicates welfare based on the hypothesis that fish that weigh more at a certain length indicate better physiological conditions [18]. Additionally, the expected value of b ranges between 2.5 < less < 3.5 [13]. On the other hand, morphological characteristics of fish play an important role in identifying the taxonomic classification of a genus or species and distinguishing differences between geographically diverse populations. This information serves as an initial step to study ontogeny and evolution and can be used to manage genetic stocks sustainably and prevent possible declines in genetic diversity during the domestication process [19]. This study aims to estimate the species composition, relative abundance, occurrence percentage, LWR, condition factor, and morphometric and meristic characteristics of eleven economically important fish species caught in the Koto Panjang Reservoir, Riau Province, Indonesia. The results of this study are expected to improve understanding of the growth process and contribute to future fisheries conservation and management efforts.

Apart from length-weight data, condition factor (K) data for each type of fish is also needed. This parameter indicates welfare based on the hypothesis that fish that weigh more at a certain length show better physiological conditions [18] On the other hand, the morphological characteristics of fish play a crucial role in identifying the taxonomic classification of a genus or species and discerning differences between geographically variant populations. This information serves as an initial step for studying ontogeny and evolution and could be used to manage genetic stocks sustainably and prevent the decline in genetic diversity that may occur during the domestication process. [19].

This study aimed to estimate the species composition, relative abundance, percentage occurrence, LWR, condition factors, and morphometric and meristic characteristics of eleven economically important fish species caught in the Koto Panjang Reservoir, Riau Province, Indonesia. The results are expected to enhance understanding of the growth process and contribute to future conservation efforts and fisheries management.

2. Materials and methods

2.1. Study area and fishing gear used.

This study was conducted in Koto Panjang Reservoir, located in the upstream area of the Kampar Kanan River, Kampar Regency, Riau Province, Indonesia. The reservoir is situated at the geographical coordinates of 0°20'12.30" N and 100°44'27.26" E on the island of Sumatra. Water released from the Koto Panjang Reservoir flows downstream into the Kampar Kanan River, merges with the Siak River, and eventually empties into the Strait of Malacca (Figure 1).

Fishing is done using traps and gill net fishing gear. Traps is made of woven bamboo rattan; the front part is cylindrical with a diameter of 80 cm, while the back part is cone-shaped with a length of 2 meters. The gill net is rectangular with a monofilament thread length of 60 meters and a depth of 10 meters, with a mesh size of 1.25 and 2.5 inches. The traps fishing gear is used at the bottom of the reservoir at a depth of 2 to 4 meters and is operated between 18.00 and 06.00 to catch demersal fish including Bagridae, Siluridae, Claridae, Channidae, and Anabantidae using chicken intestine bait. The gill net fishing gear is operated passively on the water surface. Five types of fish caught, namely *H. wyckii*, *C. lucius*, *A. testudineus*, *H. heterorhynchus*, and *C. teijsmanni* were caught in September to December 2023 which is the transition season from the dry season to the rainy season. This can affect the condition of the reservoir and fish behavior. Furthermore, in January to February 2024 is the peak of the rainy season. This can affect the condition of the reservoir such as increasing water turbidity and increasing reservoir water level elevation, there are six types of fish caught, namely *B. schwanefeldii*, *P. bulu*, *D. pleurotaenia*, *L. festivus*, R. *argyrotaenia*, and *T. polylepis*. Furthermore, eleven fish species were sampled because during the fishing period, only eleven species were predominantly caught using fishing gear in the form of traps and gill nets. The IUCN Red List Categories and Status for eleven fish species per year 2019 and 2020 are presented in Table 1.

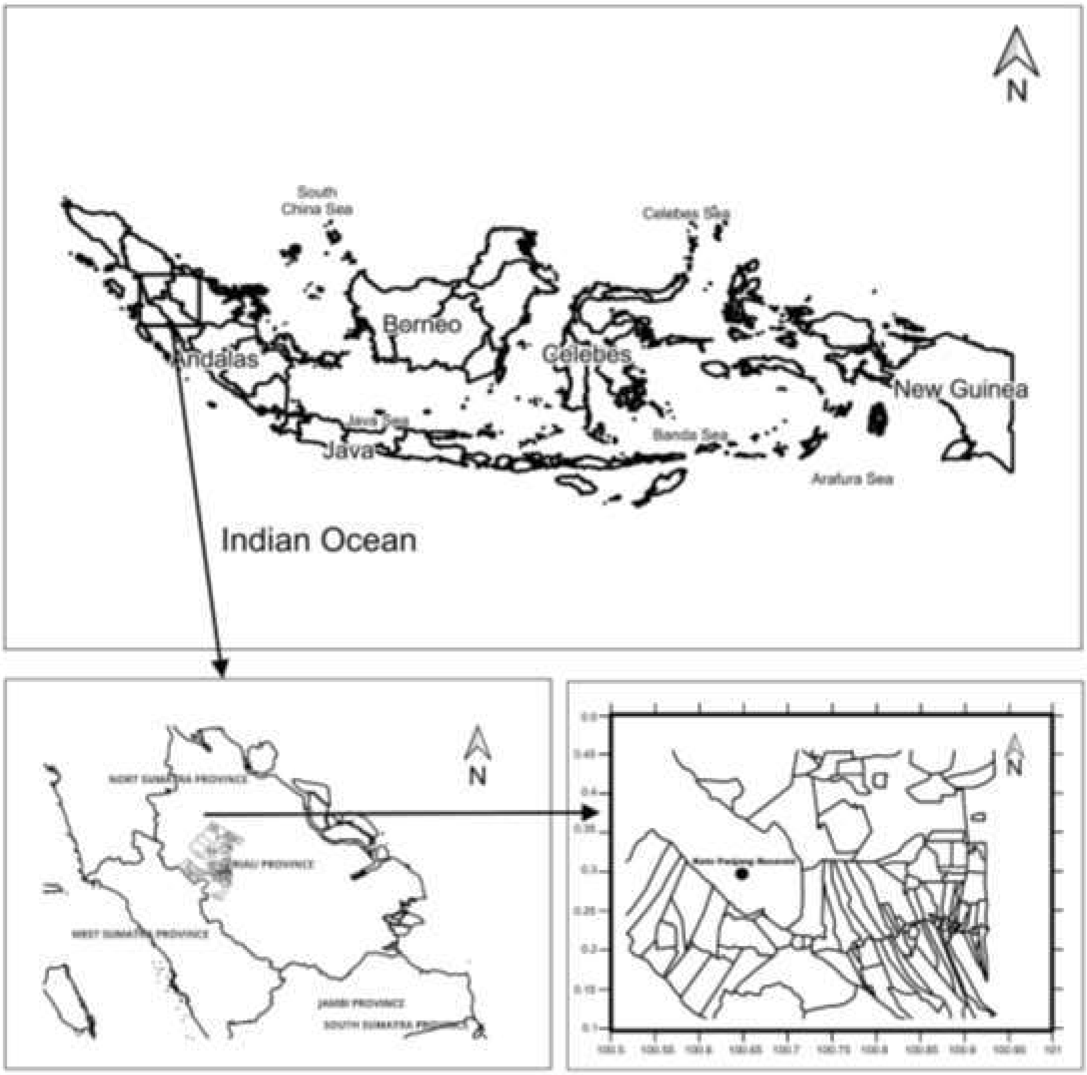

FIGURE 1: Study site map in Koto Panjang Reservoir Kampar Kanan River, Kampar Regency, Riau Province

2.2. Laboratory procedure

After harvest, the fish specimens were transported in a cold box with a temperature of about 10 °C to the Fish Biology Laboratory, Department of Aquaculture, Faculty of Fisheries and Marine Universitas Bung Hatta, Padang, Indonesia, to measure the length, weight, and morphometric characteristics. Classification and taxonomic identification of sample specimens were carried out using the standard keys [20,21] Subsequently, the weight precision of each specimen was measured using a balance scale (OHAUS model CT 6000 USA) with an accuracy of 0.1 g, and the lengths were assessed through a meter ruler with 0.1 mm accuracy. The sex (male or female) of each fish collected was recorded.

The morphometric characteristics of eleven fish species caught were measured using a 0.01 mm precision digital caliper (Made in China), focusing on parameters including total, standard, fork, and head length, body depth, body girth, peduncle depth, caudal peduncle length, pre-dorsal length, pre-pelvic length, and eye diameter. Meanwhile, meristic characteristics namely the number of hard and soft rays on the dorsal, caudal, anal, pectoral, and ventral fin were counted directly using a binocular magnifier equipped with two adjustable lenses, enabling three-dimensional imaging and detailed magnification for accurate calculation of fish fin radii. Morphometric characteristics were measured from ten randomly selected fish, while meristic traits were calculated from five fish also selected randomly.

2.3. Data analysis

Data analysis was performed using SPSS software version 16 after previously removing outlier data. Furthermore, the regression equation W = a L^b was used to determine the LWR, where parameters ´a´ and 'b' were obtained by transforming the log-log equation, namely Log W = log (a) + b log (L). In this equation, ´W' represents the weight of fish in grams (g), ´L' denotes the total length (TL) of fish in centimeters (cm), 'a´ is a constant (intercept), and ´b´ is the slope (change in weight in weight per unit change in length) of the regression by Froese [13]. The 95% confidence interval (CI) of the total length and weight was also analyzed, while the accuracy of the samples was assessed with the coefficient of determination (r^2).

The Fulton condition factor (K*c*) was estimated using the Fulton formula [22], formulated as $kc = 100*W/L^3$, where W is the total weight of the fish sample, and L is the standard length of the fish sample. The allometric condition factor (K*a*) was estimated using the formula from Bagenal and Tesch [18], namely $ka = 100*W/L^b$, where W is the total weight of the fish sample (g), L is the standard length of the fish sample (cm), and b is a constant in the length-weight. Meanwhile, the relative weight condition factor (K*n*) was determined using the Le Cren formula [23], K*n* = W/We, where W is the weight of the fish sample (g), and We is the theoretical weight calculated as $L^{b,}$ and a is a constant in the length-weight.

3. Results

3.1. Categories and IUCN red list status, and species composition

Eleven types of fish from the families Bagridae, Siluridae, Claridae, Channidae, Anabantidae, and Cyprinidae were collected from the Koto Panjang Reservoir in Indonesia. Information regarding the IUCN Red List categories and status in 2019 and 2020 is presented in Table 1.

TABLE 1: Categories and IUCN Red List Status for Eleven Species in 2019 and 2020 in Koto Panjang Reservoir

Ordo	Family	Species	IUCN Categories for Species Conservation Status, 2019	The IUCN Red List Status	Occurrence
Siluriformes	Bagridae	*Hemibagrus wyckii* (Bleeker, 1858)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous species
	Siluridae	*Hemisilurus heterorhynchus* (Bleeker, 1854)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous species
	Clariidae	*Clarias teijsmanni* (Bleeker, 1857)	Not evaluated	No report from IUCN	Indigenous species
Anabantiformes	Channidae	*Channa lucius* (Cuvier, 1831)	Least Concern (LC).	The IUCN Red List of Threatened Species in 2019	Indigenous species
	Anabantidae	*Anabas testudineus* (Bloch, 1792)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous species
Cypriniformes	Cyprinidae	*Barbonymus schwanefeldii* (Bleeker, 1854)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous species
		Puntioplites bulu (Bleeker, 1851)	Least Concern (LC)	The IUCN Red List of Threatened Species in 2019	Indigenous species
		Diplocheilichthys pleurotaenia (Bleeker, 1855)	Data Deficient (DD)	The IUCN Red List of Threatened Species in 2020	Indigenous species
		Labiobarbus festivus (Heckel, 1843)	Data Deficient (DD)	The IUCN Red List of Threatened Species in 2019	Indigenous species
		*Rasbora argyrotaenia (*Bleeker, 1849*)*	Least Concern (LC)	The IUCN Red List of Threatened Species in 2020	Indigenous species
		*Thynnichthys polylepis (*Bleeker, 1860*)*	Least Concern (LC)	The IUCN Red List of Threatened Species in 2020	Indigenous species

3.2. Species composition

The total samples collected were 485 specimens, with the percentage of each species being as follows: *H. wyckii* (3.09%), *H. heterorhynchus* (6.19%), *C. teijsmanni* (6.19%), *C. lucius* (12, 58%), *A. testudineus* (11.75%), *B. schwanefeldii* (15.26%), *P. feather* (8.25%), *D. pleurotaenia* (7.84%), *L. fetivus* (8.25%), *R. argyrotaenia* (10.31%), and *T. polylepis* (10.31%). Further information about fish species and the sex is presented in Table 2.

TABLE 2: Species Composition, Relative Abundance, and Percentage Occurrence of Eleven Fish Species in Koto Panjang Reservoir

Family	Species	N	% by no	Sex (%)	
				F	M
Bagridae	*Hemibagrus wyckii*	15	3.09	33.33	66.66
Siluridae	*Hemisilurus heterorhynchus*	30	6.19	33.33	66.66
Clariidae	*Clarias teijsmanni*	30	6.19	66.66	33.33
Channidae	*Channa lucius*	61	12.58	65.67	34.43
Anabantidae	*Anabas testudineus*	57	11.75	29.82	70.17
Cyprinidae	*Barbonymus schwanefeldii*	74	15.25	41.89	58.10
Cyprinidae	*Puntioplites bulu*	40	8.25	62.5	37.5
Cyprinidae	*Diplocheilichthys pleurotaenia*	38	7.84	36.84	63.16
Cyprinidae	*Labiobarbus festivus*	40	8.25	50.0	50.0
Cyprinidae	*Rasbora argyrotaenia*	50	10.31	24.0	76.0
Cyprinidae	*Thynnichthys polylepis*	50	10.31	52.0	48.0
Total		485	100		

N: sample size; % = percentage; F: female; M: male; no = number

3.3. Length-weight relationship

Table 3 presents descriptive statistics for eleven fish species, including length and weight, used as parameters 'a' and 'b' in each LWR equation and the coefficient of determination (r^2). The range of 'a' values for each species was 0.010 to 0.259, while 'b' values ranged from 1.693 to 3.151. The range of r^2 values obtained was between 0.61 and 0.95, confirming the validity and reliability of the LWR measurement. Furthermore, the LWR relationship in each species consistently showed a significant correlation ($p < 0.001$).

This study identified variations in the growth types of eleven fish species, with one species, namely *H. wyckii*, showing a positive allometric growth type, while the other three, including *C. lucius*, *B. schwanefeldii*, and *P. bulu*, demonstrated isometric growth. Seven other species, including *C. teijsmanni*, *A. testudineus*, *D. pleurotaenia*, *L. fetivus*, *R. argyrotaenia*, and *T. polylepis*, showed a negative allometric growth type (Table 3).

Based on the research results, the average smallest standard length and smallest weight were 7.74 ± 1.12 cm and 8.29 ± 4.27 g in *R. argyrotaenia*, with a moderate degree of correlation (r = 0.77), while the average largest standard length and total weight were 39.79 ± 4.82 cm and 2,112.67 ± 889.88 g in *H. wyckii* with a high degree of correlation (r = 0.90). In addition, species that had smaller standard lengths (95% confidence interval) compared to the data recorded in FishBase were *H. wyckii* (41.82 cm vs. 71 cm), *H. heterorhynchus* (17.10 cm vs. 80 cm), *C. lucius* (30.68 cm vs. 53 cm), *A. testudineus* (9.02 cm vs. 25 cm), *B. schwanefeldii* (23.88 cm vs. 35 cm), *P. bulu* (23.39 cm vs. 44.33 cm), *L. festivus* (23.06 cm vs. 33.7 cm), *R. argyrotaenia* (8.06 cm vs. 14 cm) and *T. polylepis* (15.54 cm vs. 18 cm). Meanwhile, *D. pleurotaenia* (23.30 cm vs. 22.5 cm), and *C. teijsmanni* (23.77 cm vs. 22 cm) had higher values than those recorded in FishBase.

3.4. Condition factor

Table 4 shows the values of Fulton's (K*c*), allometric (K*a*), and relative weight condition factor (K*n*) of eleven fish species caught in the Koto Panjang reservoir. The mean value of K*c* for different species varied between 0.73 ± 0.15 and 4.96 ± 0.63 as summarized in Figure 2. *H. heterorhynchus*, *D. pleurotaenia*, *L. festivus* and *T. polylepis* had values < 1.0, while K*c* for *H. wyckii*, *C. teijsmanni*, *C. lucius*, *A. testudineus*, *B*. *schwanefeldii* and *P*. *bulu* was > 1.0. Furthermore, in Figuru 3, the mean value of Ka exceeds or equals 3 for six species namely *H*. *heterorhynchus* (14.70 ± 4.65), *C. teijsmanni* (26.25 ± 4.05), *A*. *testudineus* (15.07 ± 1.36), *D*. *pleurotaenia* (3.60 ± 0.34), *L*. f*estivus* (8.32 ± 0.36), and *R*. *argyrotaenia* (17.31 ± 0.38). While the mean value of K*n* for eleven species ranged from 1.00 ± 0.08 and 2.51 ± 0.55. *R*. *argyrotaenia* had the lowest value of 1.00 ± 0.08, while *C*. *lucius* recorded the highest value of 2.51 ± 0.55 (Figure 4).

TABLE 3: Descriptive Statistics and Parameters for LWR and Growth of Eleven Fish Species in Koto Panjang Reservoir.

Species	N	LWRs parameters Mean SL (cm)	CI 95% of SL (cm)	Mean Wt (g)	CI 95% of TW (g)	a	b	r	r^2	t-test	P value	Growth type
Hemibagrus wyckii	15	39.79 ± 4.82	37.12 - 41.82	2,112.67 ± 889.88	1,527.67 - 2697.66	0.010	3.151	0.90	0.82	7.79	0.001	(+)
Hemisilurus heterorhynchus	30	16.39 ± 2.00	15.67 - 17.10	22.92 ± 10.76	22.90 - 26.76	0.076	2.174	0.77	0.61	6.48	0.001	(-)
Clarias teijsmanni	30	23.77 ± 2.00	23.06 - 24.48	133.74 ± 41.37	118.97 - 148.51	0.259	2.046	0.87	0.77	9.60	0.001	(-)
Channa lucius	61	28.44 ± 2.24	26.20 - 30.68	252.72 ± 63.03	189.69 - 315.75	0.012	2.956	0.91	0.83	17.10	0.001	(I)
Anabas testudineus	57	7.87 ± 1.15	6.72 - 9.02	24.91 ± 10.12	14.79 - 35.03	0.178	2.375	0.93	0.89	29.46	0.001	(-)
Barbonymus schwanefeldii	74	23.27 ± 2.60	22.67 - 23.88	149.49 ± 4.10	137.19 - 161.78	0.012	2.978	0.92	0.86	21.14	0.001	(I)
Puntioplites bulu	40	21.63 ± 2.46	20.36 - 23.39	243.69 ± 82.84	218.03 - 269.34	0.029	2.927	0.91	0.84	14.39	0.001	(I)
Diplocheilichthys pleurotaenia	38	22.40 ± 2.84	21.49 - 23.30	106.85 ± 30.37	97.20 - 116.49	0.037	2.555	0.97	0.94	23.87	0.001	(-)
Labiobarbus festivus	40	22.25 ± 2.61	21.43 - 23.06	108.18 ± 28.37	99.38 - 116.97	0.083	2.305	0.93	0.88	16.36	0.001	(-)
Rasbora argyrotaenia	50	7.74 ± 1.12	7.43 - 8.06	8.29 ± 4.27	7.10 - 9.40	0.172	1.693	0.97	0.95	31.13	0.001	(-)
Thynnichthys polylepis	50	14.72 ± 2.96	13.90 - 15.54	25.70 ± 13.31	22.01 - 29.39	0.008	2.932	0.95	0.91	22.20	0.001	(-)

N: sample size; SL: standard length; TW: total weight; Min; minimum; Max: maximum; SD: standard deviation; CI: confidence interval, (+) = positive allometric; (-) = negative allometric; (I) = isometric

TABLE 4: Condition Factors (K*c*, K*a*, K*n*) for Eleven Fish Species in Koto Panjang Reservoir.

Species	N	Fulton's condition factor (K*c* values)				The allometric condition factor (K*a* values)				Relative weight condition factor (K*n* values)			
		Mean ± SD	SE	Range (K*c* values)		Mean ± SD	SE	Range (K*a*-values)		Mean ± SD	SE	Range (K*n*-value*s*)	
				Min.	Max			Min.	Max.			Min.	Max.
Hemibagrus wyckii	15	3.24 ± 0.60	0.16	2.45	4.06	1.86 ± 0.06	0.09	1.39	2.67	1.03 ± 0.20	0.05	0.77	1.48
Hemisilurus heterorhynchus	30	0.89 ± 0.40	0.08	0.55	2.10	14.70 ± 4.65	0.21	9.47	25.30	1.01 ± 0.32	0.03	0.65	1.75
Clarias teijsmanni	30	1.57 ± 0.34	0.06	1.02	2.70	26.25 ± 4.05	0.74	17.31	37.12	1.01 ± 0.16	0.02	0.67	1.43
Channa lucius	61	1.08 ± 0.12	0.01	0.86	1.45	1.25 ± 0.13	0.02	0.79	1.51	2.51 ± 0.55	0.08	1.23	3.49
Anabas testudineus	57	4.96 ± 0.63	0.08	3.90	7.79	15.07 ± 1.36	0.11	12.06	19.7	1.00 ± 0.09	0.01	0.80	1.28
Barbonymus schwanefeldii	74	1.15 ± 0.20	0.02	0.80	1.53	2.91 ± 0.42	0.02	2.10	3.74	1.01 ± 0.14	0.02	0.71	1.35
Puntioplites bulu	40	2.33 ± 0.34	0.05	1.68	3.05	2.24 ± 0.33	0.05	1.62	2.94	1.02 ± 0.15	0.02	0.72	1.29
Diplocheilichthys pleurotaenia	38	0.93 ± 0.15	0.02	0.78	1.21	3.60 ± 0.34	0.05	3.11	4.46	1.00 ± 0.09	0.02	0.87	1.24
Labiobarbus festivus	40	0.96 ± 0.16	0.02	0.80	1.63	8.32 ± 0.36	0.15	6.75	10.48	1.01 ± 0.12	0.02	0.82	1.28
Rasbora argyrotaenia	50	1.02 ± 0.31	0.04	0.60	1.76	17.31 ± 0.38	0.19	16.39	18.29	1.00 ± 0.08	0.01	0.95	1.06
Thynnichthys polylepis	50	0.73 ± 0.15	0.12	0.44	1.25	0.87 ± 0.18	0.03	0.52	1.47	1.02 ± 0.21	0.08	0.61	1.71

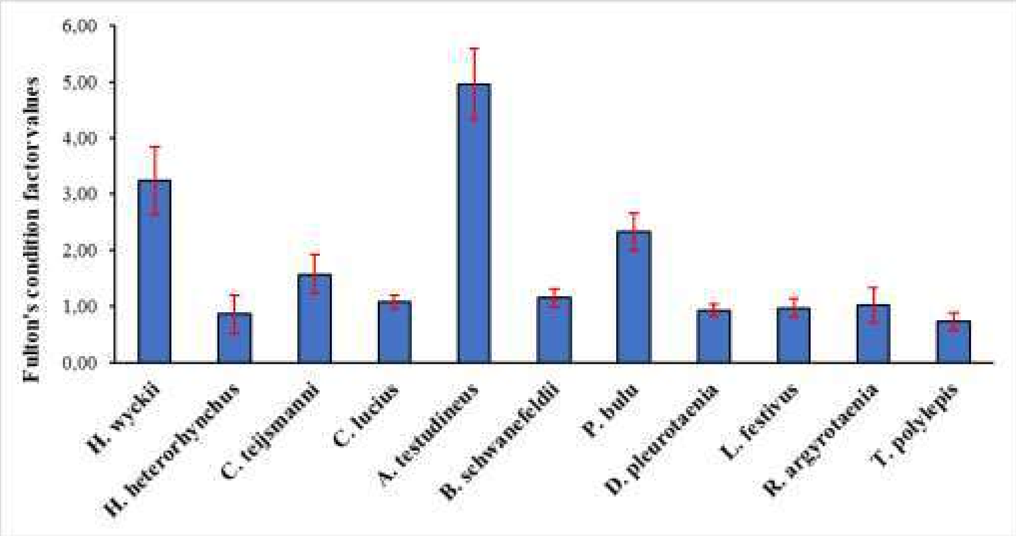

FIGURE 2: Fulton's condition factor (K*c*) for eleven fish species in Koto Panjang Reservoir.

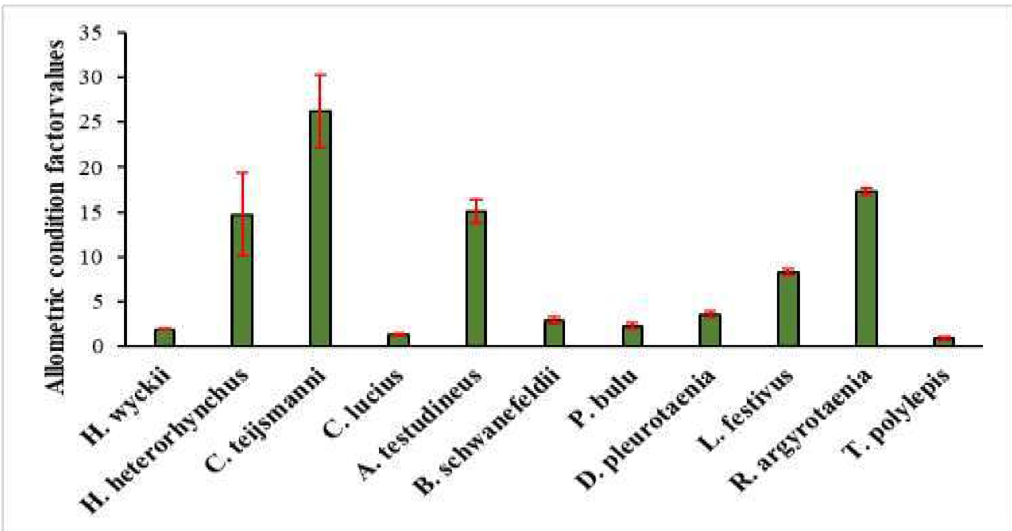

FIGURE 3: Allometric condition factor (K*a*) for eleven fish species in Koto Panjang Reservoir

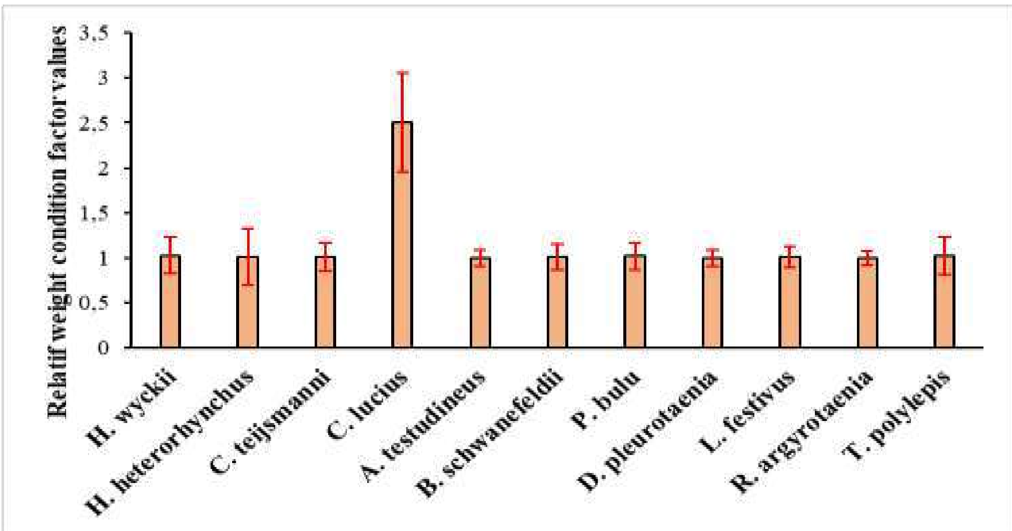

FIGURE 4: Relative condition factor (K*n*) for eleven fish species in Koto Panjang Reservoir

3.5. Morphometric and meristic characteristics

Table 5 summarizes the mean, minimum, and maximum range values of the morphometric characteristics of eleven fish species in Koto Panjang Reservoir. *H. wyckii* (Bleeker, 1858) showed the highest mean standard length (SL) value of 39.79 ± 4.82 cm and body weight (WT) value of 2,112.67 ± 889.88 g. Conversely, *R. Argyrotaenia* (Bleeker, 1849) had the lowest mean standard length and weight values of 7.74 ± 1.12 cm and 8.29 ± 4.27 g. The smallest mean body depth value was found in *R. argyrotaenia* at 1.66 ± 0.36 cm, accompanied by a mean body girth value of 3.33 ± 0.72 cm. The highest mean body depth (BD) was recorded in *P. bulu* (8.34 ± 0.82 cm), equivalent to 15.72% of SL, which also had the highest mean body girth (BG) of 16.69 ± 1.63 cm.

Meristic character data from various types of fish are presented in Table 6. In this study, several data from dorsal fins, caudal fins, anal fins, ventral fins, and pelvic fins were found, showing differences and similarities in number when compared with previous research reports, which are represented by numbers in parentheses.

TABLE 5: Mean, Minimum, and Maximum Range Values of the Morphometric Characteristics of Eleven Fish Species in Koto Panjang Reservoir

Species	No of fishes	TL (range, cm)	SL (range, cm)	HL (range, cm)	BD (range, cm)	BG (range, cm)	FL (range, cm)	PD (range, cm)	CPL (range, cm)	PDL (range, cm)	PPL (range, cm)	EY (range, cm)	Wt (range, g)
Hemibagrus wyckii	10	48.49 ± 6.48	39.79 ± 4.82	11.73 ± 1.50	7.43 ± 0.95	16.08 ± 2.18	44.61 ± 5.96	3.13 ± 0.40	6.65 ± 0.85	16.42 ± 2.10	21.11 ± 2.70	1.17 ± 0.15	1,979.70 ± 716.05
		(37.39 - 55.96)	(30.4 – 45.0)	(9.12 -13.05)	(5.78 - 8.05)	(13.28 - 19.88)	(34.4 - 1.48)	(2.43 - 3.64)	(5.17 - 7.74)	(12.77 - 19.1)	(16.42 - 24.57)	(0.91 - 1.37)	(832 - 2,835)
Hemisilurus	10	16.39 ± 2.00	14.16 ± 1.89	2.49 ± 0.26	2.98 ± 0.53	5.95 ± 1.07	14.87 ± 2.18	0.53 ± 0.17	0.38 ± 0.12	4.13 ± 0.53	4.30 ± 0.90	0.31 ± 0.07	22.92 ± 10.76
heterorhynchus		(13.2 - 20.9)	(10.08 - 18.2)	(2.32 - 3.06)	(3.05 - 4.22)	(4.78 - 8.44)	(11.4 - 20)	(0.62 - 0.77)	(0.36 - 0.6)	(3.06 - 5.37)	(3.50 - 6.50)	(0.21 - 0.46)	(14.33 - 51.10)
Clarias teijsmanni	10	23.77 ± 2.00	20.82 ± 1.83	5.16 ± 0.53	3.47 ± 0.40	6.94 ± 0.79	21.21 ± 2.09	1.24 ± 0.16	0.76 ± 0.37	5.99 ± 0.63	8.80 ± 1.22	0.27 ± 0.09	133.74 ± 41.37
		(21.5 - 26.8)	(18.2 - 23.80)	(4.30 - 5.92)	(3.10 - 4.18)	(6.20 - 8.36)	(16.68 - 24.0)	(0.94 - 1.48)	(0.40 - 1.50)	(5.01 - 6.95)	(7.20 - 10.24)	(0.20 - 0.38)	(74.69 - 198.02)
Channa lucius	10	30.68 ± 4.81	25.05 ± 5.20	8.01 ± 1.44	5.09 ± 0.91	8.07 ± 1.98	28.60 ± 4.92	2.54 ± 0.43	1.74 ± 0.36	11.65 ± 3.46	12.73 ± 2.45	1.02 ± 0.32	328.43 ± 134.65
		(29.36 - 38)	(17.1 - 32)	(6.06 - 10.10)	(3.72 - 6.21	(3.55 - 10.22)	(21.21 - 35.34)	(1.89 - 3.15)	(1.34 - 2.33)	(9.70 - 16.17)	(9.72 - 16.19)	(0.67 - 1.02)	(128.5 - 473.2)
Anabas testudineus	10	13.82 ± 1.53	11.11 ± 1.15	3.30 ± 0.48	3.72 ± 0.45	7.80 ± 0.95	12.72 ± 1.45	1.60 ± 0.22	0.70 ± 0.14	3.46 ± 0.41	4.01 ± 0.48	0.58 ± 0.11	48.82 ± 20.04
		(11.5 - 17.0)	(9.0 - 13.5)	(2.24 - 4.14)	(3.10 - 4.74)	(6.51 - 9.95)	(10.37 - 16.0)	(1.31 - 2.10)	(0.51 - 0.82)	(2.74 - 4.20)	(3.09 - 4.50)	(0.50 - 0.77)	(36.20 - 103.35)
Barbonymus	10	18.63 ± 2.45	14.05 ± 1.75	3.21 ± 0.29	6.14 ± 0.76	12.90 ± 1.59	15.32 ± 1.65	2.10 ± 0.24	4.47 ± 2.98	6.91 ± 0.79	6.60 ± 0.85	1.21 ± 0.21	85.96 ± 21.18
schwanefeldii		(15.10 - 23.0)	(11.5 - 17.22)	3.06 - 3.79)	(5.60 - 7.40)	(10.14 - 15.54)	(14.0 - 18.5)	(1.96 - 2.51)	(2.38 - 8.87)	(6.84 - 8.35)	(5.88 - 8.22)	(1.05 - 1.59)	(63.4 - 110.0)
Puntioplites bulu	10	24.40 ± 2.27	18.85 ± 1.69	5.05 ± 0.58	8.34 ± 0.82	16.69 ± 1.63	21.21 ± 2.06	2.58 ± 0.27	3.44 ± 0.24	9.62 ± 0.99	8.84 ± 0.98	1.51 ± 0.20	209.49 ± 43.04
		(20.5 - 27.4)	(16.0 - 21.0)	(4.30 - 6.01)	(6.77 - 9.50)	(13.54 - 19.0)	(17.40 - 24.21)	(2.22 - 3.19)	(3.07 - 3.75)	(8.00 - 11.35)	(7.46 - 10.37)	(1.18 - 1.79)	(126.84 - 290.90)
Diplocheilichthys	10	18.13 ± 1.96	14.25 ± 1.45	2.86 ± 0.31	5.13 ± 0.52	10.27 ± 1.04	16.00 ± 1.62	1.87 ± 0.20	1.64 ± 0.26	5.45 ± 0.60	6.49 ± 0.69	0.79 ± 0.07	65.30 ± 20.85
pleurotaenia		(14.5 - 20.3)	(11.5 - 16.0)	(2.25- 3.30)	(4.10 - 5.71)	(8.21 - 11.42)	(12.82 - 17.84)	(1.51 - 2.10)	(1.25 - 2.21)	(4.35 - 6.20)	(5.13 - 7.20)	(0.57 - 0.89)	(29.8 - 100.56)
Labiobarbus festivus	10	23.03 ± 3.64	19.03 ± 3.01	3.79 ± 0.64	5.87 ± 3.13	15.12 ± 3.88	22.21 ± 2.65	2.06 ± 0.88	3.16 ± 1.51	7.915 ± 0.93	12.26 ± 5.58	1.37 ± 0.63	71.24 ±2 6.57
		(17.55 - 30.25)	(14.5 - 25.0)	(2.74 - 4.20)	(4.26 - 7.15)	(9.36 - 15.73)	(17.71 - 26.52)	(1.45 - 4.48)	(2.09 - 7.33)	(6.32 - 9.39)	(8.48 - 27.49)	(0.94 - 3.09)	(40.6 - 132.3)
Rasbora argyrotaenia	10	9.77 ± 1.34	7.74 ± 1.12	1.52 ± 0.22	1.66 ± 0.36	3.33 ± 0.72	8.50 ± 1.34	0.68 ± 0.14	1.04 ± 0.25	3.88 ± 0.64	3.57 ± 0.57	0.42 ± 0.16	8.29 ± 4.27
		(8.0 - 12.0)	(6.40 - 9.50)	(1.14 - 1.90)	(1.25-2.30)	(2.50 - 4.60)	(6.80 - 10.80)	(0.49 - 0.86)	(0.62 - 1.33)	(2.96 - 5.07)	(2.80 - 4.27)	(0.28 - 0.86)	(3.62 - 15.41)
Thynnichthys polylepis	10	19.92 ± 1.55	14.73 ± 3.74	3.1 ± 0.25	4.85 ± 0.62	10.67 ± 1.36	18.29 ± 2.50	1.47 ± 0.23	2.22 ± 0.25	6.52 ± 0.90	8.68 ± 1.24	0.96 ± 0.13	56.102 ± 25.89
		(18.35 - 22.30	(14.00 -18.6)	(2.80 - 3.56)	(4.0 - 5.92)	(8.80 - 13.02)	(15.2 - 22.72)	(1.16 - 1.86)	(1.9 - 2.68)	(5.4 - 8.11)	(7.2 - 10.88)	(0.8 - 1.2)	(26.9 - 95.46)

TL = Total length; SL = Standard length; HL = Head length; BD = Body depth; BG = Body girth; FL = Fork length; PD = Peduncle depth; CPL = Caudal peduncle length
PDL = Pre-dorsal length; PPL = Pre-pelvic length; EY = Eye diameter; WT = Weight; No = number; cm = centimeter

TABLE 6: Meristic Characteristics of Eleven Species Collected from the Koto Panjang Reservoir

Species	No. of fishes	Dorsal fin	Caudal fin	Anal fin	Pectoral fin	Ventral fin
Hemibagrus wyckii	5	i, 7 (7)	ii, 8 (1), ii, 8, i (1), iii, 8, i (1), iv, 9 (3)	i, 8 (8)	i, 9, 1 (1)	i, 5 (5)
Hemisilurus heterorhynchus	5	iii, 9 (9)	-	iii, 6 (6)	i, 13-14 (12-13)	i. 8 (8)
Clarias teijsmanni	5	i.71 (70)	Ii, 8 (7)	ii, 57 (60)	i, 8 (8)	i, 5 (60)
Channa lucius	5	i, 39 (38)	12-14 (13)	i, 28-29 (28-30)	32 (32)	10 (9)
Anabas testudineus	5	xvii,7-9 (9)	16-20 (19)	xi, 9-10 (8-10)	13-15 (13-14)	vi. 5 (6)
Barbonymus schwanefeldii	5	i,9 (8)	15-17 (17)	i, 6-8 (6-8)	i, 11-13 (12)	i. 8 (7)
Puntioplites bulu	5	iv, 8 (8)	22 (22)	iii, 5	i, 17-18 (17)	i, 9 (8)
Diplocheilichthys pleurotaenia	5	i,11-13 (12)	17 (16)	i,5 (5)	i, 12-15 (12-14)	i. 8 (8)
Labiobarbus festivus	5	i,23-26 (24-25)	20-22 (22)	i,7 (7)	i, 11-14 (12-14)	vi. 9 (9)
Rasbora argyrotaenia	5	ii,7 (7)	16 (15)	i, 3-5 (3-5)	i, 12-13 (13)	2.7 (7)
Thynnichthys polylepis	5	iii, 8 (9)	10.2.9 (10.2.9)	i,7-8 (7-8)	ii, 17 (18)	2.8 (8)

Note: the numbers in parentheses represent the number of fin rays calculated; black numbers make no difference; red numbers show differences

4. Discussion

Coefficient of determination ($r^2 > 0.77$) in linear regression for ten fish species in the context of LWR indicated a high degree of correlation between increasing length and body weight. However, an exception occurred in *H. heterorhynchus*, where the correlation coefficient was only 0.61. This finding is consistent with prior research on fish from diverse aquatic environments [24,25], with values "a" and "b" in the range that is in accordance with the findings in previous research reports [13]. Earlier studies also found variations in the 'b' value for LWR in different species [26-28]. This variation could be attributed to various factors, including the number of species analyzed, fishing season, sampling location, size and developmental stage of the specimen, feeding categories, environmental factors, as well as type of fishing gear used [18, 29]. The growth patterns of eleven fish species varied, comprising one species exhibiting positive allometry (9.09%), seven species displaying negative allometry (63.63%), and three species showing isometry (27.27%). The length and weight relationship of fish alongside the growth pattern depends on various factors, including stock and population size, body shape, feeding, swimming behavior, trophic level, sexual characteristics, gonad maturity level, as well as environmental conditions, namely low oxygen levels and temperature in highland waters [30-33]. Therefore, estimation of length-weight relationship (LWR) and condition factor (K) is essential in fisheries management as it provides valuable insights into the health and growth patterns of species. These parameters help in assessing the overall condition of fish populations, informing sustainable fishing practices, and monitoring ecosystem health, especially when long-term data or comparisons between sites are not available. Future research should seek to incorporate comparative analyses across multiple years or sites to deepen understanding of these dynamics.

In this study, the results of the analysis of the confidence interval (CI 95%) of the standard length (cm). Nine fish species sampled were smaller than the maximum total length of fish species recorded in FishBase, while two other species had a total length higher than that recorded in FishBase [34]. Nevertheless, it can be ensured that there are fish with lengths smaller than the fish samples in this study [34]. The impact of the hydrological regime shift from lotic (flowing water) to lentic (standing water) systems on the length-weight relationship and growth patterns of fish has not been fully understood. This transition can influence various environmental factors, such as food availability, water quality, and habitat, all of which play crucial roles in determining fish growth and condition. In lotic systems, the continuous flow of water can provide different oxygen levels and food sources compared to lentic systems, which typically have calmer waters and more stable environmental conditions but may experience greater fluctuations in temperature and water quality. Therefore, in-depth studies are needed to understand how this change from lotic to lentic systems affects the growth dynamics and health of fish populations. One of the main threats to freshwater biodiversity is the loss of connectivity within river systems due to anthropogenic barriers such as dams, land use change, hydrological disturbance, and over-exploitation [35,36]. Artificial barriers, including dams, dikes, or fishing nets, can potentially affect critical environmental variables, namely water flow, temperature, and substrate composition. These variables potentially change ecological design and structure, while also decreasing species richness, freshwater community growth types, and fish body size [37,38,39].

The K*c* values of the eleven fish species analyzed were not significantly different from research findings in other water areas [40,41], including for *C. punctata* which is the object of cultivation [42] [37]. The use of allometric condition factor (K*a*) is rare in cases where species exhibit allometric growth patterns or when the value of b is calculated with sufficient data to minimize errors [18]. Its application extends to assessing the feeding habits of different fish species [33, 43,44] and serving in different feeding regimes in laboratory experiments [42]. When a species exhibits an allometric growth pattern or when "b" equals #3.00, the allometric condition factor (K*a*) is considered more appropriate. In such cases, variations in the condition factor are directly related to differences in body weight and food intake. In this study, the average Ka values exceeded or were equal to 3 for six species, ranged from 1.86 to 2.91 for three species, and were less than 1 for one species. Several studies have used the relative condition factor (K*n*) to evaluate the condition of fish species. K*n* values below 1.0 indicate limited prey availability or elevated predator density, while values above 1.00 suggest an abundance of prey or reduced predator density [28]. In this study, *C. lucius* showed the highest performance with a Kn value of 2.51 ± 0.55. This condition is related to a carnivorous diet, while other species had a Kn value ranging from 1.0 to 1.03. Although carnivorous fish species, including *C. lucius*, *C. striata*, *H. wyckii*, *H. nemurus*, *P. pangasius*, and *W. leerii* inhabit the Koto Panjang reservoir [10], the presence does not seem to diminish the food availability for herbivorous fish, as evidenced by relative condition factor values equal to or greater than 1.0.

The morphological characteristics of fish play a crucial role in identifying the taxonomic classification of a genus or species and discerning differences between geographically variant populations. The analysis of morphological characteristics remains one of the oldest and most widely used methods for systematically studying fish [45]. The mean, minimum, and maximum ranges of morphometric characteristics, such as height and body girth, vary among the eleven species in Koto Panjang Reservoir. Morphometric characteristics of each fish species within an aquatic habitat depend on the order and family, type of fishing gear used, fishing area, food availability, sampling season, geographic influences [46], environmental conditions, and physiological state [13].

Based on the results, fish actively foraging during the day had larger eye diameters, ranging from 27.62 to 37.69% of the head length. This pattern was mainly observed in fish species from the families Cyprinidae, including *B. schwanefeldii*, *P. bulu*, *D. pleurotaenia*, *L. festivus*, R. *argyrotaenia*, and *T.*

polylepis, as well as Channidae namely *C. lucius*. On the other hand, fish that rely on the sense of smell to find food, such as the Bagridae, Siluridae, Clariidae, and Anabantidae, tend to have smaller eye diameters, ranging from 3.37 to 17.58% of the head length. Vision dominates as the main modality in diurnal fish living in shallow water habitats, but eye diameter depends on feeding habits [47,48]. Similar to other nocturnal fish, *A. annularis* [49] is a small planktivorous reef fish 7–10 cm in length, characterized by relatively large eyes up to 5 mm diameter, covering 47% of the head length and a relatively large mouth (8 mm). This fish shows strong selectivity towards larger prey [50,51], including *C. lucius*.

5. Conclusion

In conclusion, the analysis of fish species composition, length-weight relationships, condition factors, and morphometric and meristic data in Koto Panjang Reservoir provides significant contributions to the understanding of fish growth, accurate species identification, biodiversity, and reservoir ecosystem health. Among the eleven fish species analyzed, *B. schwanefeldii* had the highest percentage composition, while the lowest percentage was found in *H. wyckii*. The eleven fish species caught from these waters had consistent length-weight relationships for each species, indicating a significant correlation between the two morphological parameters with various growth patterns, including positive allometry, negative allometry, and isometry. Fulton's condition factor (K*c*), allometric (K*a*), and relative weight (K*n*) also varied between species, with some showing Kc values <1 and >1, and the Ka value showed variations in fish body shape and size. In addition, the Kc values of all fish species exceeded 1, indicating sufficient prey availability and low predators, as well as various good environmental conditions. This information provides a scientific basis for further research in analyzing aspects of biological reproduction by considering physicochemical parameters and food habits. The results of this study are also useful for policy makers in designing effective regulations for the conservation and management of fishery resources in the reservoir.

Data Availability

The data that support the findings of this study are openly available in Figshare. https://doi.org/10.6084/m9.figshare.25801219.

Ethical Approval

The Animal Ethics Committee of the Institute for Research and Community Service at Bung Hatta University in Indonesia approved this study. Ethical permission was obtained to gather fish specimens from the Koto Panjang Reservoir and conduct measurements of length and weight at the Fish Biology Laboratory, located within the Department of Aquaculture at the Faculty of Fisheries and Marine.

Conflicts of Interest

The authors declare that there are no competing interests.

Authors' Contributions

Azrita Azrita, as Associate Professor, is responsible for data collection, analysis and preparation of the manuscript. Professor Hafrijal Syandri took part in designing the study as well as reviewing and editing the manuscript. Professor Netti Aryani took care of the research design, as well as reviewing and editing the manuscript thoroughly.

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Webmail Univ. Bung Hatta

azrita ubh <azrita31@bunghatta.ac.id>

9927705: Revision requested

Sindhuja Devadoss <sdevadoss@wiley.com> Thu, Sep 19, 2024 at 8:46 PM
Reply-To: Sindhuja Devadoss <sdevadoss@wiley.com>
To: azrita31@bunghatta.ac.id

Dear Dr. Azrita,

Many thanks for your submission to International Journal of Zoology. Hopefully, we will get back to you soon with a positive response. If you need any further information, please let me know.

Best regards,
Sindhuja

Sindhuja Devadoss
Editorial Assistant

WILEY

[Quoted text hidden]
, azrita ubh <azrita31@bunghatta.ac.id> wrote:
[Quoted text hidden]

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azrita ubh <azrita31@bunghatta.ac.id>

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2 messages

International Journal of Zoology <ijz.office@wiley.com> Tue, Sep 24, 2024 at 5:48 PM
Reply-To: Sindhuja Devadoss <sdevadoss@wiley.com>
To: Azrita Azrita <azrita31@bunghatta.ac.id>
Cc: isivakumar@wiley.com

WILEY

Dear Dr. Azrita Azrita,

Regarding your manuscript Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia 9927705, we would be grateful if you could please address the following:

- An update is required regarding the data availability statement for this submission.
- An update is required regarding the conflict of interest statement for this submission.

Additional Comments:

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azrita ubh <azrita31@bunghatta.ac.id>

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2 messages

International Journal of Zoology <ijz.office@wiley.com> Mon, Sep 23, 2024 at 5:07 PM
Reply-To: Sindhuja Devadoss <sdevadoss@wiley.com>
To: Azrita Azrita <azrita31@bunghatta.ac.id>
Cc: ssathianar@wiley.com

WILEY

Dear Dr. Azrita Azrita,

Regarding your manuscript Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia 9927705, we would be grateful if you could please address the following:

- An update is required regarding the figures/tables for this submission.

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azrita ubh <azrita31@bunghatta.ac.id> Fri, Oct 4, 2024 at 11:23 AM
To: Sindhuja Devadoss <sdevadoss@wiley.com>
Cc: ssathianar@wiley.com

Thank you, I will do that.
[Quoted text hidden]

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azrita ubh <azrita31@bunghatta.ac.id>

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2 messages

International Journal of Zoology <ijz.office@wiley.com> Mon, Sep 23, 2024 at 5:07 PM
Reply-To: Sindhuja Devadoss <sdevadoss@wiley.com>
To: Azrita Azrita <azrita31@bunghatta.ac.id>
Cc: ssathianar@wiley.com

WILEY

Dear Dr. Azrita Azrita,

Regarding your manuscript Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia 9927705, we would be grateful if you could please address the following:

- An update is required regarding the figures/tables for this submission.

Additional Comments:

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To: Sindhuja Devadoss <sdevadoss@wiley.com>
Cc: ssathianar@wiley.com

Thank you, I will do that.
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azrita ubh <azrita31@bunghatta.ac.id>

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azrita ubh <azrita31@bunghatta.ac.id> Fri, Oct 4, 2024 at 11:23 AM
To: Sindhuja Devadoss <sdevadoss@wiley.com>
Cc: ssathianar@wiley.com

Thank you, I will do that.
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1 message

International Journal of Zoology <ijz.office@wiley.com> Mon, Sep 23, 2024 at 5:06 PM
Reply-To: International Journal of Zoology <sdevadoss@wiley.com>
To: Azrita Azrita <azrita31@bunghatta.ac.id>

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Dear Dr. Azrita Azrita,

I am delighted to inform you that the review of your manuscript 9927705 titled "Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia" has been completed and your article has been accepted for publication in International Journal of Zoology.

If you have deposited your manuscript on a preprint server, now would be a good time to update it with the accepted version. If you have not deposited your manuscript on a preprint server, you are free to do so.

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The following reviewer comments were taken into consideration during the peer review process:

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> > *Dear authors*
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> > *Thanks for choosing IJZ.*
> > *Sincerely,*
> > *JP Barreiros*

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azrita ubh <azrita31@bunghatta.ac.id>

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azrita ubh <azrita31@bunghatta.ac.id> Thu, Oct 3, 2024 at 12:34 PM
To: Sindhuja Devadoss <sdevadoss@wiley.com>

Dear
Quality Checking Team
International Journal of Zoology

Regarding our manuscript, Length-Weight Relationship, Condition Factors, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia, with ID No. 9927705, the author would like to ask when this article will be published. This information is important for the author team to report the research results to Bung Hatta University as the funder.
We look forward to hearing from you.

Best Regards

Azrita
[Quoted text hidden]

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azrita ubh <azrita31@bunghatta.ac.id>

9927705: Your manuscript is moving into production

5 messages

International Journal of Zoology <ijz.office@wiley.com> Thu, Oct 10, 2024 at 12:18 PM
Reply-To: International Journal of Zoology <araghu@wiley.com>
To: Azrita Azrita <azrita31@bunghatta.ac.id>

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Dear Dr. Azrita Azrita,

Now that all the checks of your files have been completed, we are pleased to inform you that your manuscript “Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia” is moving into production to ready it for publication online.

Once ready, our Production team will email you proofs of the final manuscript version for your review and comments.

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azrita ubh <azrita31@bunghatta.ac.id> Thu, Oct 10, 2024 at 4:25 PM
To: International Journal of Zoology <araghu@wiley.com>

Thank you so much for the great news!
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azrita ubh <azrita31@bunghatta.ac.id> Thu, Oct 17, 2024 at 5:09 PM
To: International Journal of Zoology <araghu@wiley.com>

Request for Acceleration of Final Manuscript Proof Submission ID. No. 9927705

Dear Publish team

With respect,
With great hope, we request that the proof of the final manuscript version with ID No. 9927705 can be expedited and immediately sent to us for review and comments. This article is urgently needed as a requirement for the proposal of the position from Associate Professor to Professor on behalf of Azrita, a lecturer at Bung Hatta University, with a proposal deadline of October 24, 2024.

We greatly appreciate the attention and cooperation given, and hope that our request can be realized.

Thank you once again.

Sincerely,

Azrita
[Quoted text hidden]

Kowsalya Velliangiri <kvelliangi@wiley.com> Fri, Oct 18, 2024 at 6:36 PM
Reply-To: Kowsalya Velliangiri <kvelliangi@wiley.com>
To: azrita31@bunghatta.ac.id

Dear Dr. Ubh,

Thank you for your message regarding your article "IJZ/9927705". Your request has been noted and we will work to accelerate the production of your article where possible.

Best regards,
Kowsalya

Kowsalya Velliangiri
Production Editor

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azrita ubh <azrita31@bunghatta.ac.id> Sat, Oct 19, 2024 at 4:26 PM
To: Kowsalya Velliangiri <kvelliangi@wiley.com>

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azrita ubh <azrita31@bunghatta.ac.id>

9927705: Galley Proofs

3 messages

International Journal of Zoology <production.b@hindawi.com> Sun, Oct 20, 2024 at 5:59 PM
To: azrita31@bunghatta.ac.id
Cc: syandri_1960@bunghatta.ac.id, netti.aryani@lecturer.unri.ac.id, kvelliangi@wiley.com, production.b@hindawi.com

Dear Dr. Azrita,

I am pleased to let you know that the first set of galley proofs of your Research Article 9927705 titled "Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia," is ready. You can apply your corrections directly to the manuscript with the Author Proofing System (APS).

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International Journal of Zoology

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To: International Journal of Zoology <production.b@hindawi.com>
Cc: syandri_1960@bunghatta.ac.id, netti.aryani@lecturer.unri.ac.id, kvelliangi@wiley.com, production.b@hindawi.com

Thank you so much for the great news!
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azrita ubh <azrita31@bunghatta.ac.id> Mon, Oct 21, 2024 at 12:20 PM
To: International Journal of Zoology <production.b@hindawi.com>

Dear,
International Journal of Zoology

Thank you for the galley proof of the manuscript with ID number 9927705. The authors have reviewed the five key points related to the manuscript, and all have been agreed upon. We hereby confirm that all authors approve the publication of this manuscript. We look forward to the publication of this article with great anticipation.

Best regards,
Azrita

Webmail
Univ. Bung Hatta

azrita ubh <azrita31@bunghatta.ac.id>

9927705: Your article has been published

1 message

Agalya Raghu <araghu@wiley.com> Wed, Oct 23, 2024 at 5:16 PM
To: azrita31@bunghatta.ac.id

Dear Dr. Azrita,

I am pleased to let you know that your article has been published in its final form in "International Journal of Zoology."

Azrita Azrita, "Length and Weight Relationship, Condition Factor, and Morphometric Characteristics of Eleven Freshwater Fish Species in Koto Panjang Reservoir, Indonesia," International Journal of Zoology, vol. 2024, Article ID 9927705, 14 pages, 2024. https://doi.org/10.1155/2024/9927705.

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Best regards,

Agalya Raghu
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