Uttar Pradesh Journal of Zoology

Volume 45, Issue 6, Page 184-190, 2024; Article no.UPJOZ.3337
ISSN: 0256-971X (P)

Length-Weight Relationship and Condition Factor of a Commercial Food Fish *Labeo rohita* (Hamilton, 1822) from Ghaghara River, Uttar Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. Authors AS and DR are contributed to the study conception, design, manuscript writing and data analysis. Authors AS and DR contributed equally to this work. All authors read and approved the final manuscript.

Article Information

DOI: 10.56557/UPJOZ/2024/v45i63965

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://prh.mbimph.com/review-history/3337

Original Research Article

Received: 12/01/2024
Accepted: 16/03/2024
Published: 21/03/2024

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Uttar Pradesh J. Zool., vol. 45, no. 6, pp. 184-190, 2024

ABSTRACT

The present study provides first-hand information about the length-weight relation of *Labeo rohita* (Hamilton) from Ghaghara River, Uttar Pradesh. We collected 107 specimens and took length and weight for better conservation techniques and proper management for rohu. A total of 107 specimens were examined for the study, which has ranging from 25.2-56.13 cm TL (Total length) and 183.3-2409.78 gm (weight) were used for the study of LWRs and condition factors. Our study represented that *L. rohita* exhibited a negative allometric growth (b < 3) indicating that the fish grows faster in length compared to their weight. The values of the correlation coefficient (r^2) and condition factor (K) are 0.8601 and 1.27 respectively. This research will be useful for fishery research, stock assessment, conservation, and estimation of the fish condition of this Himalayan River.

Keywords: Length-weight relationships; Ghaghara River; fisheries management; Labeo rohita; allometric growth.

1. INTRODUCTION

Labeo rohita (Hamilton), a member of the Indian major carps (IMC) group belonging to the cyprinidae family, which are naturally distributed in the rivers of Bangladesh, India, Pakistan and Myanmar [1,2]. Rohu, *Labeo rohita* is the most popular fish species because of their delicious and prestigious fish species among other Indian major carps. In 2020, *L. rohita* contributed approximately 5.1 % of the total aquaculture production which ranked 9th in the list of principal contributing species [3].

Biometric relationships play a crucial role in fisheries management and research. They help transform raw data collected from the field into meaningful indices and provide valuable insights into fish populations and their dynamics [4]. The length-weight relationship (LWR) of fishes is a fundamental concept in fisheries biology and ecology because it refers to the mathematical relationship between the length and weight of an individual fish or a population of fish [5,6]. The relationship helps researchers and fisheries managers estimate the weight of a fish based on its length or vice versa.

According to Nehemia et al. [7], fish can attain either isometric growth, negative allometric growth or positive allometric growth. Isometric growth is associated with no change on the dimensions of the body as an organism grows. Negative allometric growth implies that the fish becomes slenderer as it increases in weight while positive allometric growth refers to the fish becomes relatively stouter or deeper-bodied as it increases in length [8]. In fishes, the condition factor has been shown to reflect through its variations, information on the physiological state of the fish with its welfare [9]. It also gives information when comparing two populations living in certain feeding, density, climate, and other conditions; when determining the period of gonadal maturation and when following up the degree of feeding activity of a species to verify whether it is making good use of its feeding source [10]. According to Lizama et al. [11], the study of the condition factor is important to understanding the life cycle of fish species and contributes to adequate management of the species. Hence, maintaining the equilibrium in the ecosystem.

To study the condition of the commercially available food fish of Ghaghra River. In this study, we evaluated the length-weight relationship and condition factor of *L. rohita*. Studies on LWR of commercially important fish are highly significant for the management and conservation of populations in river. This study provides basic biological information in the form of a length-weight key for rohu from Ghaghara Basin as a valuable tool to assist fishery managers.

2. MATERIALS AND METHODS

2.1 Study Area

Ghaghara River, one of the major tributary of the Ganga river system in northern India has been selected for the present study. The river rises at an altitude of about 3,962 metres on the southern slope of the Himalayas in Tibet, in the glaciers of Mapchachungo. The major tributaries of Ghaghara are Rapti, Chhoti, Gandak, Sharda and Sarju.

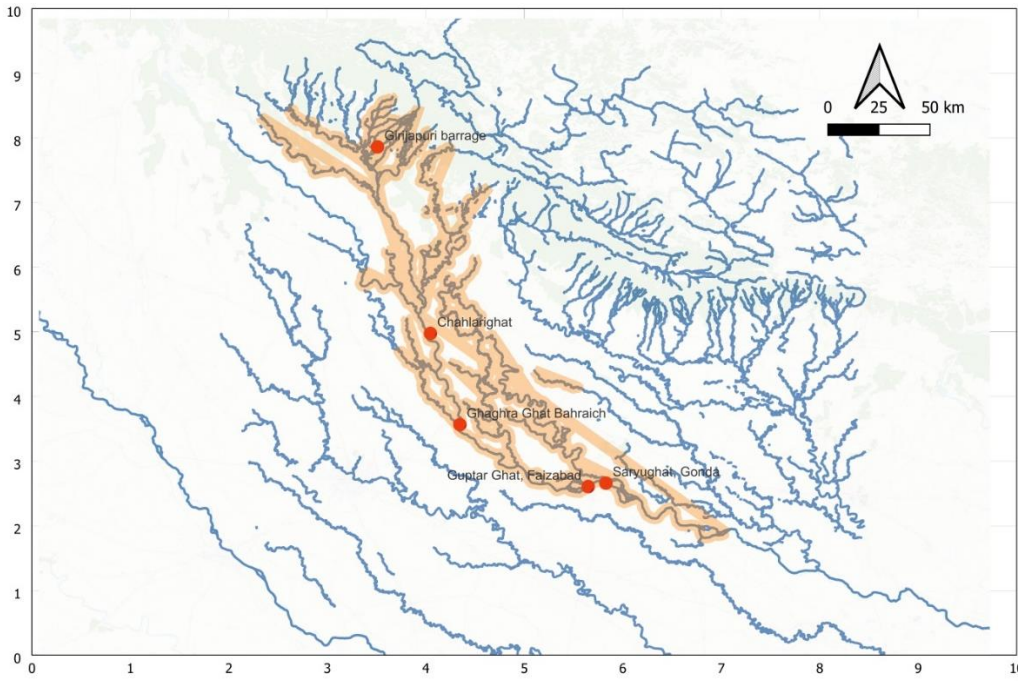

Fig. 1. Map showing the location of the study area

2.2 Sample Collection

Our study estimates LWRs of an indigenous commercial fish *L. rohita* belonging to the cyprinidae family from the Ghaghra River Basin. Altogether 110 samples were collected using various fishing gears such as drag nets, cast nets and gillnets. After collection, the total length (TL) of each individual was taken from the tip of the snout to the extended tip of the caudal fin nearest 0.1 mm by a digital caliper (Mitutiyo) and weighed to the nearest 0.01 g (total weight) by the digital weighing machine.

2.3 Length-Weight Relationship

The LWR of rohu was analysed by using the parabolic equation by Froese, [12].

$$W=aL^b$$

Where, W: weight of fish (g), L: length of fish (cm), a: constant and b: an exponential expressing relationship between length-weight.

The equation was log-transformed to estimate the parameters 'a' and 'b'. The relationship ($W = aL^b$) when converted into the logarithmic form gives a straight-line relationship graphically;

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

Where, b represents the slope of the line, Log a is a constant

When b is equal to three (3), isometric pattern of growth occurs but when b is not equal to 3, allometric pattern of growth occurs, which may be positive if >3 or negative if <3 [7].

Where "a" and "b" are intercept and regression coefficients respectively. The determination coefficient (R^2) was used as an indicator of the quality of the linear regressions. Additionally, 95% confidence limits of the parameters "a" and "b" and the statistical significance level of R^2 were estimated. In order to confirm whether b values obtained in the linear regressions were significantly different from the isometric value of ±95% was applied. All the statistical analyses were considered significance level of 5% ((P<0.05).

2.4 Condition Factor (K)

The condition factor is used for comparing the condition, fatness, and degree of well-being of the fish in their habitat was determined by using the equation (Fulton, 1904);

$$K=100*W/L^3$$

Where, W: weight (g), L: length (cm), b: the value obtained from the length-weight equation

and 100 is a factor to bring the value of K near unity.

2.5 Data Analysis

All the above statistical calculations were done using the MS-Windows Excel 2010.

3. RESULTS AND DISCUSSION

3.1 Length-Weight Relationship of *L. rohita*

Table 1 represents the length-weight parameters of *L. rohita* of the Ghghra River. A total of 107 specimens were examined for the study, which has ranging from 25.2-56.13 cm TL (Total length) and 183.3-2409.78 gm (weight) were used for the study of length-weight relationship and condition factor.

In terms of growth type, the length-weight relationship in this study showed that *L. rohita* exhibited a negative allometric growth ($b < 3$) indicating that the fish grows faster in length compared to their weight and fish become lighter (negative allometric) for a particular length. The value of the correlation coefficient (r^2) is on the very high side 0.8601.

According to Allen, [13], the value of b usually remains constant at 3.0 for an ideal fish. According to Le Cren [14], fishes may not remain the same shape or body outline throughout their life span. The value of 'b' gives information about the growth and well-being of fish. The b values in fish are species-specific and vary with sex, age, seasons, physiological conditions, growth increment and nutritional status of fish [15]. Generally, differences in b values in the LWRs can be attributed to several factors such as sample size, length range covered, type of habitat, ontogenetic development, gonadal development of fishes, area/season, habitat, population, sex, gonad maturity, degree of stomach fullness, diet, health, disease and parasite loads of the fish, preservation technique [12]. Furthermore, the precision of b values may be affected due to sampling bias i.e. when the sample size is relatively small, the size range covered is not fully species representative, and no independent and standardized sampling protocol is followed. The length-weight relationship studies of fish prove to be an important tool for studying the growth, [14]. The length-weight relationship is the most important aspect in biological studies of fishes. Several researchers have found similar results to our study the value of "b such as Kaur et al. [16] for *L. rohita*, Jumawan and Seronay, [17] for *Channa striata* also.

All the observed values are plotted on a graph with length on the X-axis and weight on the Y-axis. It has also been observed that when the observed values of total length and the weight are plotted on the X and Y axes respectively, a linear relationship has been obtained which is very much evident in the graph (Fig.2). To calculate the length-weight relationship, these values have been converted into logarithmic values to obtain a straight line relationship (Fig.3). Therefore all the calculations of the length-weight relationship are based on log values, not on the original values.

3.2 Condition Factor (K) of *L. rohita*

The Fulton's condition factor (K) for this fish ranged from 0.77506 to 2.45703 with an average value of 1.27. The Fulton's condition factor is an index of well-being or condition of fish measured by the unit called condition factor (K). In the present study, the condition factor analysis has resulted in a K value of more than 1 in each length group. Hence, it can be concluded that the fitness of the candidate fish species is good in the ecosystem. This also indicates a sign of good health status of fish as well as its habitat. The factors affecting the K value include sex, size, season and degree of gonadal development in fish [18]. Ecological factors, food supply and parasitism, have a significant influence on the well-being of the fish [14]. The samples

Table 1. Correlation coefficient "r^2", value of constant "a" and "b" Conditional factor and Growth pattern of *Labeo rohita* (Hamilton)

Total Length (cm)	Weight (gm)	N	r^2	"a" value	"b" value	Conditional factor (K)	Growth pattern
25-56	183.3-2409.78	107	0.8601	0.019847234	2.875	1.27	Negative Allometric Growth

TL: Total length; N: Number of individuals; r^2: Correlation Coefficient

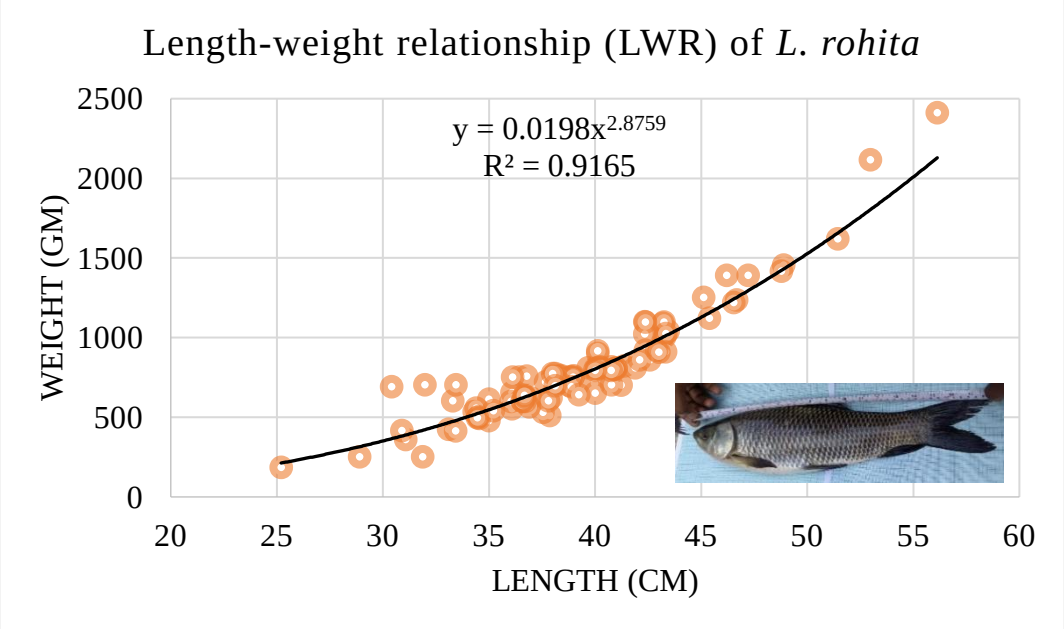

Fig. 2. Linear Relationship between Total Length (cm) and Total Weight (gm) of *Labeo rohita* (Hamilton)

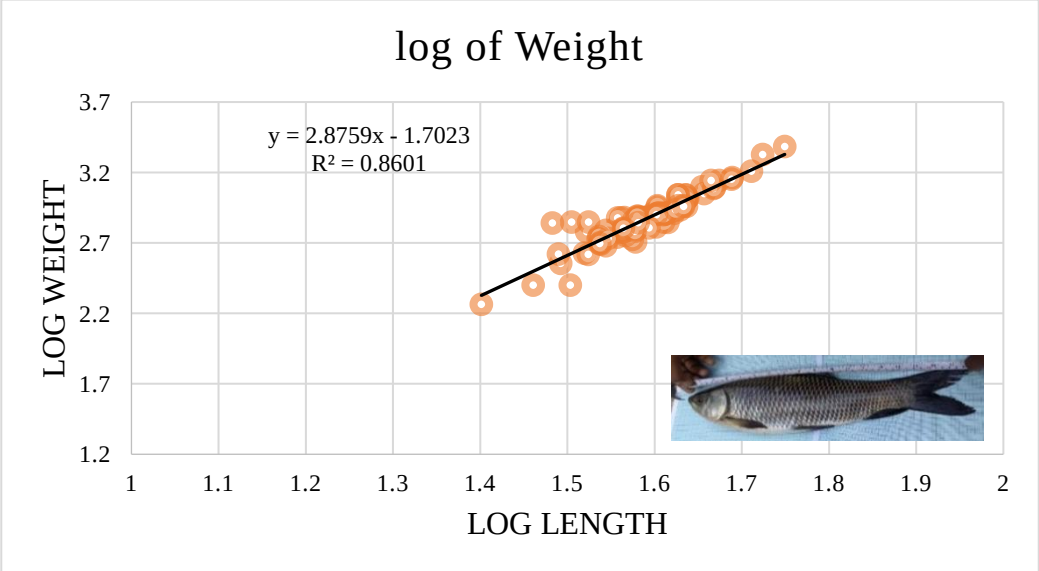

Fig. 3. Graph between Log TL and Log TW of *Labeo rohita* (Hamilton)

were observed to be healthy, as indicated by the length-weight relationship. Further studies are needed to assess the abundance of other fish stock available in relation to their environment to maintain the preferred habitat.

4. CONCLUSION

In the present study, the length-weight relationship of *L. rohita* found that fish growth is faster in length compared to their weight. The correlation was found to be higher than 0.8, showing the length-weight relationship. This study provides the first basic information on LWR and the condition of this commercial food fish from the Ghaghara River Basin. This study could be beneficial to fishery biologists and conversationalists to impose adequate regulation for sustainable fishery management, conservation and production methods of this fish species.

ACKNOWLEDGEMENTS

The authors are thankful to the local fishermen for help during the data collection.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
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