Hindawi
Journal of Applied Ichthyology
Volume 2023, Article ID 6651843, 4 pages
https://doi.org/10.1155/2023/6651843

Research Article

Length-Weight Relationships and Condition Factor of Four Threatened Riverine Catfish Species in the Meghna River Estuary, Bangladesh

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Received 6 July 2023; Revised 16 September 2023; Accepted 3 October 2023; Published 14 October 2023

Academic Editor: Hamed Ghafarifarsani

The current study examined the length-weight relationships (LWRs), length-length relationships (LLRs), and condition factor (K) of four threatened riverine catfish species (*Pangasius pangasius*, *Rita rita*, *Sperata aor*, and *Bagarius bagarius*) sampled from the Meghna River Estuary (MRE), Bangladesh. A total of 578 individuals were collected from contracted fishermen between January and October 2022. The length and weight of each species exhibited a highly positive correlation. The regression coefficient was 2.24 for *P. pangasius*, 2.90 for *R. rita*, 2.91 for *S. aor*, and 3.25 for *B. bagarius*. Furthermore, all species demonstrated a highly positive correlation between total length and standard length ($r > 0.90$). The calculated condition factor (K) values were 0.87 for *P. pangasius*, 1.18 for *R. rita*, 0.66 for *S. aor*, and 0.99 for *B. bagarius* indicating variations among the species. This study provides the first comprehensive documentation of all four major catfish species found in the MRE.

1. Introduction

Catfish, which belong to the order Siluriformes, are a popular and species-rich group of fish in Bangladesh, ranking third in terms of species diversity [1]. Among 55 catfish species found in Bangladesh, the riverine catfish species, including yellowtail catfish (*Pangasius pangasius*), rita (*Rita rita*), long-whiskered catfish (*Sperata aor*), and Goonch catfish (*Bagarius bagarius*), are highly prized in the country's table fish market due to their large size, taste, and low number of intramuscular bones. These species are also rich in nutritional values, with good quality protein and high fat content [2, 3], and contribute to the second-highest riverine fish production in volume (29%) after hilsa in the Meghna River Estuary (MRE) [4]. However, the natural populations of these catfish species have drastically declined in recent years due to various anthropogenic and natural factors, and they are currently facing different levels of threats. *S. aor* is classified as vulnerable, *R. rita* and *P. pangasius* is classified as endangered, and *B. bagarius* is classified as critically endangered in Bangladesh [5]. Urgent conservation efforts are required to prevent their extinction. Two primary conservation strategies, safeguarding the fish species in their native habitat and/or incorporating them into aquaculture practices, could be employed to bring them back to their previous state. Efforts to include these species within the realm of aquaculture have not yielded success so far, and sustainable management practice is supposed to be the only viable approach to rejuvenate the natural populations of these species. However, before effective conservation strategies can be developed, the biology of the species needs to be thoroughly studied. Estimating the length-length relationships (LLRs), length-weight relationships (LWRs), and condition factor (K) of fish is essential in fisheries' management, as it provides insights into the well-being and growth patterns of the species [6, 7], aid in the development

Table 1: Descriptive statistics and estimated parameters of length-weight relationships (LWRs), length-length relationships (LLRs, total length against standard length), and condition factors for *Pangasius pangasius, Rita rita*, *Sperata aor*, and *Bagarius bagharius* in the Meghna River Estuary (MRE), Bangladesh.

Species	n	TL (cm)		W (g)		LWRs			95% CI of a		95% CI of b		LLRs			K		
		Max	Min	Max	Min	a	b	R^2	L_{CI}	U_{CI}	L_{CI}	U_{CI}	p	q	R^2	Max	Min	Avg
P. pangasius	244	20.2	10.6	62.8	10.5	−1.22	2.24	0.72	−1.42	−1.01	2.06	2.41	0.13	0.97	0.93	1.88	0.32	0.87
R. rita	201	24.7	10.5	150	14	−1.81	2.90	0.88	−1.99	−1.63	2.75	3.05	0.60	1.15	0.90	1.90	0.34	1.18
S. aor	102	29.9	16.3	209	21	−2.06	2.91	0.88	−2.34	−1.77	2.70	3.11	0.46	1.16	0.97	1.13	0.45	0.66
B. bagarius	31	77.47	26.67	6200	200	−2.45	3.25	0.96	−2.87	−2.02	3.00	3.50	−2.32	1.31	0.98	1.36	0.49	0.99

"n", number of examined individuals; "TL", total length; "W", body weight; "max", maximum value; "min", minimum value; "a" and "b" are intercept and slope of LWRs; "p" and "q" are intercept and slope of LLRs; "R^2", coefficient of determination; "CI", confidence interval; "L_{CI}", lower bound of CI; "U_{CI}", upper bound of CI; "K", condition factor; "Avg", average.

of single-species stock assessment models [8], and play a pivotal role in estimating the biomass of fish populations [9]. However, limited research is available [10, 11] on these four species, particularly in their largest habitat, the MRE. Therefore, the present study aims to estimate the LLRs, LWRs, and condition factor of the four riverine catfish species in the MRE.

2. Materials and Methods

A total of 578 individuals (Table 1) from four riverine catfish species were collected by directly purchasing from contracted fishermen in Chandpur (23°14′38″ N; 90°38′09″ E), Lakshmipur (22°57′17″ N; 90°37′43″ E), and Bhola (22°20′38″ N; 90°59′12″ E) districts between January and October 2022. The fishermen employed different types of seine nets (referred to locally as "lasa jal" and "doom jal") with mesh size ranging from 2.2 to 6.5 cm for capturing *S. aor*, *R. rita*, and *B. bagarius*, whereas "chai" (a large cylindrical fish trap having an average length 1.52–2.45 m, tapering little at both ends and locally made with bamboo splits; mesh size 1.2 cm) was used to catch juvenile *P. pangasius*. The length and weight of the specimens were measured using a digital slide caliper with ±0.01 mm accuracy and a digital balance with ±1.0 g accuracy (BH-124), respectively.

The LWRs were calculated using formula $W = aL^b$, where W = weight of fish (g), L = total length (cm), a = intercept of the regression, and b = regression coefficient. The parameters "a" and "b" were obtained from the log-transformed equation as Log W = Log a + b Log L [12]. The LLRs was calculated using a simple linear regression model ($Y = p + qX$), where Y = total length (cm), X = standard length (cm), p = proportionality constant, and q = regression coefficient [13]. The condition factor (K) was calculated using formula $K = 100 \times (W/L^3)$, where K = condition factor, W = weight of fish (g), and L = total length of fish (cm). Statistical analyses were performed using SPSS version 20.0 statistical software package (IBM®) at a 0.05 significant level.

3. Results

The LWRs, LLRs, and condition factor of the four catfish species were examined separately. The mean length and weight of the collected samples were 14.67 cm and 25.77 g for *P. pangasius*, 24.79 cm and 106.70 g for *S. aor*, 16.47 cm and 56.48 g for *R. rita*, and 55.78 cm and 2,147 g for *B. bagarius*, respectively. The length and weight of each species exhibited a highly positive correlation (r = 0.85, 0.94, 0.94, and 0.98 for *P. pangasius*, *R. rita*, *S. aor*, and *B. bagarius*, respectively). The values of intercept (a), regression coefficient (b), coefficient of determination (R^2), and condition factor (K) of LWRs and LLRs are presented in Table 1.

4. Discussion

The LWRs parameter "b" of a fish depends on several factors, including species, seasonality, habitat, feeding intensity, age, sex, and geographic region [14]. The value of the regression coefficient "b" in LWRs remains constant at 3 for an ideal fish living in ideal conditions [15]. However, it is common to observe variations in the "b" parameter under natural conditions. A "b" value less than 3.0 indicates a negative allometric growth pattern of a fish species, where the fish becomes slenderer as it grows and value greater than 3.0 indicates positive allometric growth, with the fish becoming heavier [15]. In the present study, negative allometric growth patterns were observed in all species (except *B. bagarius*) which might be attributed to the age of the collected samples. The collected samples except *B. bagarius* were in their juvenile stage, which is defined as having a total length of less than 30 cm. It was reported that *P. pangasius*, *S. aor*, and *R. rita* reach maturity at sizes of 54 cm, 57.3 cm, and 29.5 cm, respectively [16–18]. During the early stages of life, fish tend to develop more in length than in weight [19]. The result of the present study is comparable with the findings of Yusof et al. [20]. Besides, several authors have demonstrated differences in "b" values at different life stages of fish, showing that "b" values increase gradually with age [10, 21]. The importance of LLRs in fisheries' management also becomes evident when conducting comparative growth studies [22]. The relationship between TL and SL of *P. pangasius*, *R. rita*, *S. aor*, *and B. bagarius* fish in all sexes showed that TL-SL are highly correlated ($r > 0.9$) to each other. The condition factor (K) is an important quantitative parameter for determining the relative degree of nourishment and habitat condition in fish [23]. The observed "K" values were found to be less than 1 for all three species except *R. rita* (1.18). The lower "K" value could be attributed to the age of the specimens, given that all of them were in the juvenile stage. The "K" value of a population does not only depend only on environmental elements such as temperature, rainfall, salinity, and food availability [24] but also the age and maturity stage of fish, which can significantly affect the value [25].

The vital role played by these species in providing nutrition, livelihoods to local fishers, coupled with their vulnerable states, makes it imperative to adopt a comprehensive sustainable management practice. The foundational data on LWRs and LLRs for the four riverine catfish species documented in this work might facilitate fish biologists and policymakers in evaluating population parameters and guiding the implementation of appropriate conservation measures aimed at restoring these species in the MRE.

Data Availability

The data used to support the findings of this study will be made available on request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

The authors are grateful to the "Research cell, Noakhali Science and Technology University" and USAID Funded Enhanced Coastal Fisheries in Bangladesh II (ECOFISH II project) for funding this research work.

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