

## RESEARCH ARTICLE OPEN ACCESS

# The Length–Weight Relationships of Eleven Fish Species From the Xinjiang River, China

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**Received:** 17 August 2025 | **Revised:** 20 November 2025 | **Accepted:** 22 November 2025

**Academic Editor:** Georgii Ruban

**Keywords:** Cyprinidae | length–weight relationship (LWR) | the Xinjiang River

## ABSTRACT

As a vital tributary of the Poyang Lake system, the Xinjiang River plays a crucial role in maintaining regional aquatic biodiversity and sustainable fisheries. However, anthropogenic pressures and climate change have led to significant degradation in fish community structure, including declining species diversity and population miniaturization. This study presents the first systematic evaluation of length–weight relationships (LWRs) for 11 native fish species in Xinjiang River, filling an important gap in fundamental biological data for this region. Fish samples were collected from 10 sampling sites between June and September 2022. LWR parameters ( $W = aL^b$ ) were determined using Le Cren's log-transformation method, with 95% confidence intervals and coefficients of determination ( $R^2$ ) calculated. Results showed that the allometric coefficient ( $b$ ) ranged from 2.24 to 3.28 among the 11 Cyprinidae species, with *Hemiculter bleekeri* and *Toxabramis swinhonis* exhibiting significant negative allometric growth ( $b < 3$ ). All species demonstrated high model fit ( $R^2 > 0.95$ ). This study reports the first LWR records for *Megalobrama skolkovii* and *T. swinhonis* in FishBase and reveals spatial variations in growth patterns compared with other Yangtze tributaries, likely reflecting ecological and anthropogenic influences. These findings provide essential data for evidence-based fisheries management and conservation strategies in the Xinjiang River basin.

## 1 | Introduction

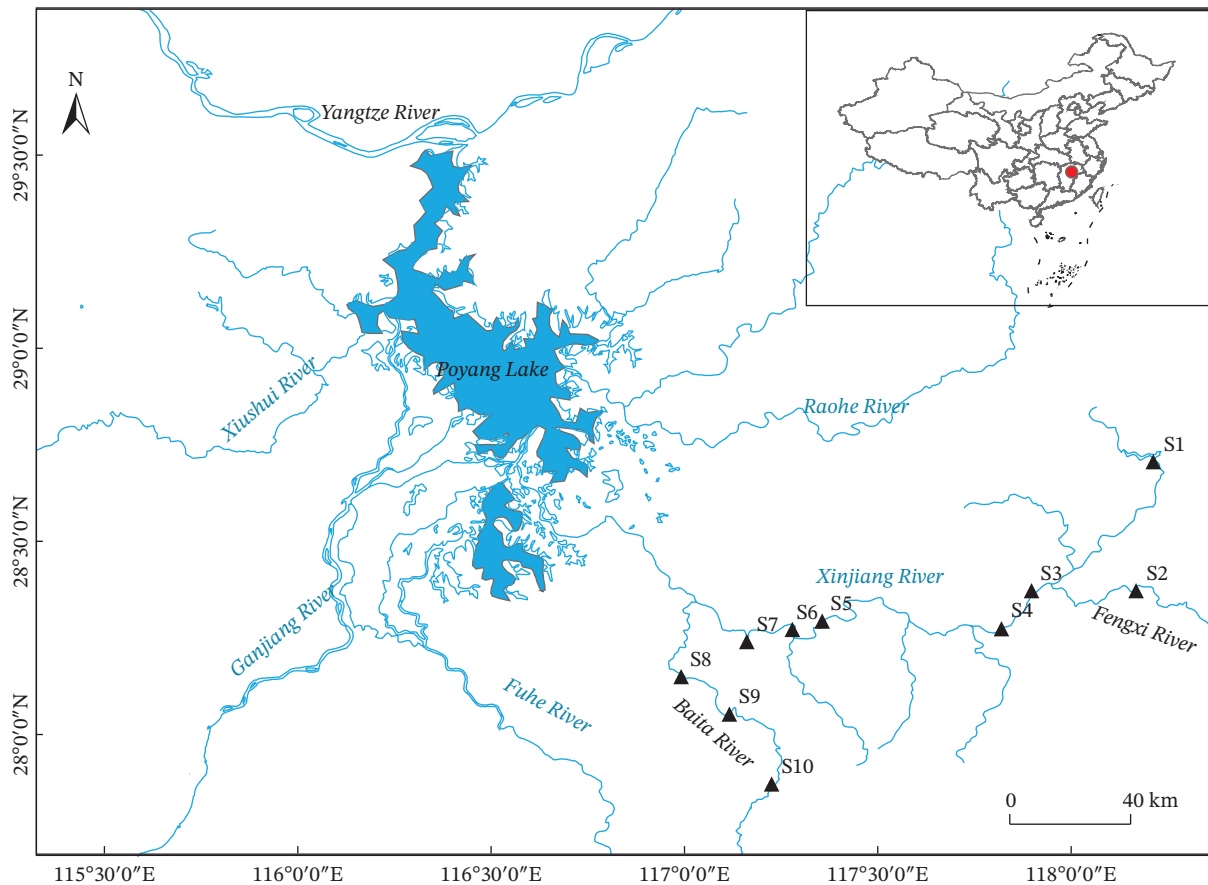
The Xinjiang River, a vital tributary of the Poyang Lake system, originates in the Wuyi Mountains and traverses 359 km through northeastern Jiangxi Province before discharging into Poyang Lake [1]. This subtropical river system, encompassing a drainage area of 17,599 km<sup>2</sup>, supports diverse fish populations including commercially valuable species (e.g., *Cyprinus carpio* and *Carassius auratus*) and endemic taxa (e.g., *Siniperca chuatsi* and *Pelteobagrus fulvidraco*) [2, 3]. As an ecological corridor connecting mountain and lake ecosystems, it maintains critical habitats that sustain regional aquatic biodiversity and fishery resources.

Recent ecological assessments reveal significant degradation throughout the Poyang Lake basin [4–10], with parallel impacts observed in the Xinjiang River. Anthropogenic pressures and climate change have altered fish community structure, manifesting as reduced species diversity, population miniaturization, and increased dominance of invasive species [2]. These changes threaten to disrupt fundamental ecosystem processes including nutrient cycling and genetic resource maintenance, potentially leading to fishery collapse without immediate conservation intervention.

Length–weight relationships (LWRs) serve as essential tools for fisheries management, enabling biomass estimation, growth

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**FIGURE 1** | Location of sampling sites in the Xinjiang River, China.

pattern analysis, and population monitoring [11]. Despite their importance, comprehensive LWR data remain unavailable for most Xinjiang River species. This study establishes the first LWR parameters for 11 native fish species, providing critical baseline data to support conservation planning and sustainable resource management in this ecologically significant watershed.

## 2 | Material and Methods

Fish samples of eleven fish species were collected from the Xinjiang River from June to September 2022. A total of 10 sampling points were distributed along the Xinjiang River (see Figure 1). Fish samples were collected using multimesh composite gill nets (100 m in length and 2 m in height, with mesh sizes of 20, 40, 60, 100, and 140 mm) and baited trap nets (20 m in length, with mesh  $2a = 8$  mm). Specifically, gill nets were suspended at the water surface for approximately 8 h of overnight fishing, whereas baited trap nets remained submerged for about 24 hours. Fish species were identified following Chen [12]. Total length (TL, measured from snout to caudal fin tip) and body weight (BW) were recorded in situ. TL was measured to the nearest 0.1 cm using a standard ruler, while BW was determined using an electronic balance with an accuracy of 0.01 g.

LWRs were determined using Le Cren's log-transformation approach [13]. The weight-length relationship for 11 fish species was described using the equation  $W = aL^b$ , where  $W$  is the body weight (g) and  $L$  is the total length (cm). Parameters  $a$  (intercept) and  $b$  (slope) were derived from the linear

regression of the log-transformed equation:  $\log(W) = \log(a) + b\log(L)$ . For each parameter ( $a$  and  $b$ ), 95% confidence limits (95% CLs) were calculated, along with coefficients of determination ( $R^2$ ).

The parameters and statistical tests were analyzed using *R* software (Version 4.4.3). Prior to regression analysis, outliers were identified and removed based on log-log plots. If  $R^2$  values were below 0.95, the regression analysis was repeated after outlier removal.

## 3 | Results

This study sampled 11 Cyprinidae species from 9 genera in the Xinjiang River. The sample size for each species varied according to relative abundance, ranging from 70 (*Megalobrama skolkovii*) to 653 (*Chanodichthys dabryi*) individuals (Table 1). All measured and calculated parameters, including TL, BW, LWR coefficients ( $a$  and  $b$ ), their 95% confidence intervals (CIs), and  $R^2$ , are comprehensively presented in Table 1. The allometric coefficient  $b$  in the LWRs of these 11 fish species ranged from 2.24 to 3.28. In the present study, only the value  $b$  of *Hemiculter bleekeri*, *Toxabramis hoffmanni*, and *Culter Alburnus* is less than 3.

In the regression analysis of LWRs,  $R^2$  was employed to evaluate the goodness of fit of the model. The results demonstrated that the  $R^2$  values ranged from 0.9515 to 0.9921, indicating strong linear relationships between body length and weight across all 11 species.

**TABLE 1** | Descriptive statistics and estimated parameters of length–weight relationships for eleven fish species sampled in the Xinjiang River from July to September 2022.

| Genus                 | Species                           | N   | Standard length (cm) |      |               | Weight (g) |     |               | Regression parameters |               |      |               | R <sup>2</sup> (LWR) |
|-----------------------|-----------------------------------|-----|----------------------|------|---------------|------------|-----|---------------|-----------------------|---------------|------|---------------|----------------------|
|                       |                                   |     | Min                  | Max  | Average value | Min        | Max | Average value | a                     | 95% CL of a   | b    | 95% CL of b   |                      |
| <i>Hemiculter</i>     | <i>Hemiculter bleekeri</i>        | 271 | 5.3                  | 15.8 | 12            | 19.3       | 1   | 10.4          | 0.0394                | 0.0339~0.0458 | 2.24 | 2.1763~2.2976 | 0.9515               |
|                       | <i>Hemiculter leucisculus</i>     | 367 | 5.2                  | 17.6 | 10.9          | 42.7       | 1.1 | 10            | 0.0061                | 0.0055~0.0069 | 3.03 | 2.9815~3.0733 | 0.9788               |
| <i>Hemiculterella</i> | <i>Hemiculterella wui</i>         | 324 | 4.1                  | 25   | 13.8          | 103.5      | 0.5 | 25            | 0.0066                | 0.0062~0.0071 | 3.01 | 2.9779~3.0371 | 0.992                |
| <i>Parabramis</i>     | <i>Parabramis pekinensis</i>      | 101 | 8.6                  | 32.5 | 22.5          | 331.5      | 5   | 109           | 0.0081                | 0.0065~0.0101 | 3.03 | 2.9562~3.1010 | 0.9858               |
| <i>Sinibrama</i>      | <i>Sinibrama macrops</i>          | 546 | 4.7                  | 22.7 | 10.7          | 113.8      | 0.9 | 16            | 0.0072                | 0.0067~0.0077 | 3.11 | 3.0771~3.1343 | 0.9882               |
| <i>Megalobrama</i>    | <i>Megalobrama skolkovii</i>      | 70  | 8.2                  | 51.5 | 22.4          | 1905       | 4.8 | 202.1         | 0.0047                | 0.0037~0.0059 | 3.26 | 3.1791~3.3337 | 0.9905               |
| <i>Cultrichthys</i>   | <i>Cultrichthys erythropterus</i> | 179 | 6.8                  | 27.8 | 15.2          | 174.8      | 2.1 | 37.6          | 0.0034                | 0.0031~0.0039 | 3.28 | 3.2333~3.3199 | 0.9921               |
| <i>Chanodichthys</i>  | <i>Chanodichthys dabryi</i>       | 653 | 4.6                  | 44   | 14.9          | 782.7      | 0.2 | 43.5          | 0.0034                | 0.0031~0.0037 | 3.24 | 3.2120~3.2760 | 0.9838               |
|                       | <i>Chanodichthys mongolicus</i>   | 81  | 11.9                 | 36.5 | 20.5          | 380.6      | 8.4 | 80.1          | 0.0045                | 0.0037~0.0055 | 3.14 | 3.0664~3.2014 | 0.9908               |
| <i>Culter</i>         | <i>Culter alburnus</i>            | 318 | 4.7                  | 58.6 | 15.5          | 1285       | 0.9 | 40.7          | 0.0064                | 0.0054~0.0076 | 2.96 | 2.8986~3.0258 | 0.9638               |
| <i>Toxabramis</i>     | <i>Toxabramis hoffmanni</i>       | 165 | 5.1                  | 12.5 | 8.6           | 10.6       | 1.4 | 4.7           | 0.0336                | 0.0292~0.0387 | 2.26 | 2.1924~2.3246 | 0.9654               |

## 4 | Discussion

The biological characteristics of fish in Poyang Lake basin remain poorly documented, particularly for species inhabiting its main tributaries. To our knowledge, this study provides the first report on the LWRs of these fish species in the Xinjiang River. The LWRs of eleven fish species were determined and all the  $p$  values were extremely significant ( $p < 0.001$ ).  $R^2$  values demonstrated the goodness of fit of the growth models [14]. In this study, all eleven fish species exhibited  $R^2$  values greater than 0.95, indicating excellent model fitting performance for each species-specific growth model.

The LWR coefficients ( $b$ ) for most of the 11 studied species in the present study fell within the theoretical isometric range of 2.5–3.5 [11]. However, *H. bleekeri* ( $b = 2.24$ ) and *Toxabramis swinhonis* ( $b = 2.26$ ) demonstrated significant negative allometric growth, as indicated by their  $b$ -values being substantially below 3 [15]. According to established principles, a  $b$ -value less than 3 signifies negative allometric growth, where length increases at a faster rate than weight. The observed deviations of the allometric coefficients in these two species from the normal range ( $b < 2.5$ ) may be attributed to the restricted size range of specimens sampled [16].

Our study revealed both conserved and divergent LWRs among fish populations across Chinese river systems. Specifically, *Hemiculterella wui* exhibited similar allometric coefficients between our study ( $b = 3.01$ ) and the Guijiang River population ( $b = 2.97$ ) [17], while *C. dabryi* showed comparable growth patterns ( $b = 3.24$ ) to those in the Wujiang River ( $b = 3.03$ ) [18]. Furthermore, both *Chanodichthys mongolicus* and *Culter alburnus* demonstrated  $b$ -values consistent with upper Yangtze tributary reports [19, 20]. However, significant spatial differences were observed for other species: *H. bleekeri* displayed lower coefficients ( $b = 2.24$ ) than reference populations in the Chishui ( $b = 3.14$ ) [19] and Yiluo Rivers ( $b = 3.16$ ) [21], whereas *Hemiculter leucisculus* values exceeded reports from the Chishui ( $b = 2.98$ ) [19], Wujiang ( $b = 2.98$ ) [18], and Xiangjiang Rivers ( $b = 2.87$ ) [22] but were lower than the Yiluo River data ( $b = 3.25$ ) [21]. Similarly, *Parabramis pekinensis* exhibited intermediate  $b$ -values (3.24) between the Xiangjiang (3.29) [22] and Wujiang Rivers (2.89) [18], while *Cultrichthys erythropterus* displayed consistently higher coefficients (3.28) than the populations in the Chishui (3.17) [19], Wujiang (2.98) [18], and Yiluo Rivers (3.08) [21]. The observed growth patterns likely reflect interactions among population traits (size/age structure, sex ratios, and maturity), ecological factors (resource availability and fishing pressure), and methodological differences (sampling design and protocols) [11, 23–25]. Interspecific variation in spatial consistency suggests complex bio-environmental interactions.

This study provides the first published LWRs for *Megalobrama skolkovii* and *T. swinhonis*, according to FishBase records [26]. It can provide some reference value for the subsequent research and management of these two species. Comprehensively, this research provides the foundational LWR data for eleven indigenous fish species in the Xinjiang River, filling a key knowledge gap that will facilitate evidence-based conservation planning and fishery resource management.

## Acknowledgments

We are sincerely grateful to Yingtan Agricultural Technology Extension Center, Shangrao Academy of Agricultural Sciences, and Fuzhou Academy of Agricultural Sciences for their invaluable assistance provided in all aspects of this study.

## Funding

This study was supported by Earmarked Funds Project for Jiangxi Province's Aquatic Biological Resources Survey and Monitoring System (JXSSJC-2022), an important habitat survey project of *Coilia nasus* in the Key Water Areas of Jiangxi Province (NY2022-C0901).

## Conflicts of Interest

The authors declare no conflicts of interest.

## Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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