ACTA ZOOLOGICA BULGARICA

Acta Zool. Bulg., Supplement 20 (August 2024), 105-109
Proceedings, Fourth International Conference on One Health and Zoology
Hisar, Bulgaria, 27-29 September 2023
https://www.acta-zoologica-bulgarica.eu/2024/Suppl_20_13

Biodiversity, Ecology,
Conservation Zoology and Zoonozes

Length-Weight Relationships of Five Endemic Fish Species from Lake Prespa

Blagoja Trajchevski[1], Trajche Talevski[1] & Elizabeta Veljanoska-Sarafiloska[2]

[1]Department of Cyprinid Fauna, Hydrobiological Institute, Ohrid, R.N. Macedonia
[2]Department of Physical and Chemical Research of Water, Hydrobiological Institute, Ohrid, R.N. Macedonia

Abstract: The length-weight relationships (LWR) were estimated for five endemic fish species from Lake Prespa, including *Rutilus prespensis, Chondrostoma prespense, Barbus prespensis, Alburnus belvica* and *Squalius prespensis*. The *a* and *b* parameters and the condition factor were calculated using the measurements for length and weight. According to FishBase, this study provides the first LWRs for some of these species (no data is available for *R. prespensis*, *C. prespense* and *S. prespensis*). As for *B. prespensis* and *A. blevica,* only data for specimens from Small Prespa Lake are available.

Key words: LWR, fish growth, condition factor, Lake Prespa, FishBase

Introduction

Many studies have emphasised the significance of establishing length-weight relationships (LWRs) in fish. They offer details about the fish's physical traits and overall well-being, growth patterns, and environmental conditions. Because of this, the length-weight relationship and its parameters have important applications in fish biology, fish ecology, and fisheries management (Le Cren 1951, Froese 2006). LWRs can be used to determine the weight and estimate the biomass associated with a specific length (Froese 1998). Length-weight relationships can differ in various aspects regarding season (Le Cren 1951, Bobori et al. 2010, De Giosa 2014), region variations within the same species (Tsoumani et al. 2012), feeding regimes (Datta et al. 2012), physiological factors such as maturity and spawning, or changes in environmental conditions (Froese 2006). The relationship between length and weight also enables the calculation of condition indexes. Fulton's Condition Factor (K) is a means for comparing the weight and length in a particular fish sample and can indicate differences related to sex, season, or place of capture (Ricker 1975). The values for the condition factor have been interpreted from the point of various biological features, such as fish health, feeding intensity, or gonadal development. The expression of the length-weight relationship and the measurement of changes in condition are two rather different but interconnected aims in analysing length-weight data (Le Cren 1951).

Lake Prespa is a mesotrophic water body located on the Balkan peninsula and is shared by three countries: North Macedonia, Albania, and Greece. This lake belongs to the watershed of the river Crn Drim that flows into the Adriatic Sea (Popovska & Bonacci 2007). There are a total of 25 fish species identified in Lake Prespa, of which 13 are native, and 12 are introduced at different times in history (Ilik-Boeva et al. 2017). Out of the 13 native species, 8 are endemic and found only in this lake or its watershed (Spirkovski et al. 2012). The native and endemic fish species are under constant pres-

sure and competition with the alien fish species with well-established lake populations (Pietrock et al. 2022). However, regardless of the uniqueness of the Lake Prespa ecosystem, its high level of fish endemism, and all the challenges that the fish fauna has to endure, there are very few LWR studies.

This study aimed to investigate the length-weight relationships of five fish species from Lake Prespa, including *Rutilus prespensis* Karaman, 1924; *Chondrostoma prespense* Karaman, 1924; *Barbus prespensis* Karaman, 1924; *Alburnus belvica* Karaman, 1924 and *Squalius prespensis* Fowler, 1977. These species are members of the *Cyprinidae* family and are endemic to Lake Prespa and its watershed (Kottelat & Freyhof 2007). It is worth mentioning that none of the investigated species from Lake Prespa have encoded LWR data in FishBase (Froese & Pauly 2023).

Materials and Methods

Specimens of the mentioned fish species were collected in Lake Prespa at four sampling locations designated in Figure 1. The sampling occurred during campaigns in different months throughout 2020-2022. A total of 3094 specimens were sampled using gillnets with mesh sizes of 16, 18, 22, 24, and 26 mm knot to knot. At dusk, the nets were placed in the lake's littoral zone and remained in the water for approximately 12 hours. Following the lifting and cleaning the nets, the fish were immediately identified and divided by species. The taxonomy of the fish species was applied according to Kottelat & Freyhof (2007). Total length (to the nearest 1 mm), measured from the tip of the snout to the end of the caudal fin, and body weight (to the nearest 0.1 g) were measured using a ruler and laboratory scale, respectively. The function $W=aL^b$ was applied for the estimation of the LWR (Ricker 1975), where W indicates the total body weight in grams(g), L is the total body length in centimetres (cm), a and b are the coefficient and the exponent of the arithmetic form of the length-weight relationship, and the intercept and slope of the regression line of the logarithmic form of that relationship (Froese 2006). Linear regression of the logarithmic form of the LWR was used to estimate the values for a and b (logw = log$a$ + b(logl)), 95% confidence intervals of the parameters, and the statistical significance of the regression relationship (r^2). The parameter b serves as an indicator of the type of growth of the fish. When b=3, it indicates isometric growth, in which weight increases as the cube of length. When b>3, the fish grows in weight at a greater rate than required to maintain constant body proportions, and vice versa when b<3 (Ricker 1979). To determine whether the b value differed significantly from 3, a t-test at the significance level of 0,05 was used. From the values for weight and length, Fulton's condition factor was calculated for every fish using the standard formula $K = (W / L^3) \times 100$ (Ricker 1975).

Results

For each of the examined species, the sample size, minimum and maximum lengths, weights, values for the a and b parameters with their 95% confidence limits, and the coefficient of determination r^2 are all listed in Table 1. Figure 2 shows the LW plot for each of the fish species.

The parameters a and b values fell between 0.0083 and 0.0231, and 2.6979 and 3.31374, respectively. *Barbus prespensis* showed negative allometric growth (b<3, p=0.05), *Rutilus prespensis* showed positive allometric growth (b>3, p=0.05), while *Alburnus belvica, Chondrostoma prespense*, and *Squalius prespensis* showed isometric growth (b=3). Only *A. belvica,* with 0.7581, had a lower r^2 value than the other studied species (above 0.9). The condition factor was also determined, ranging from 0.95 for *C. prespense* to 1.23 for *R. prespensis* (Table 2).

Discussion

LWR data for Lake Prespa fish are scarce, and there is a gap in knowledge regarding this topic. No data was available in FishBase for the fish species from Lake Prespa (Froese & Pauly 2023). We presented the first LWR description for *B. prespensis* from Lake Prespa, with previous data only available for specimens from Small Prespa Lake (Crivelli et al. 1996). There are available data for *A. belvica*, *C. prespense, R. prespensis* and *S. prespensis* from Lake Prespa (Tsoumani et al. 2012, Milosevic & Talevski 2016) and Small Prespa Lake (Bobori et al. 2010), but they are not presented on FishBase.

According to Froese (2006), the parameter b values for teleost fish should fall in the $2.5 < b < 3.5$ range, and our findings match that estimate. Using the LWR data for 1773 species, Froese (2006) showed that 90% of the values for parameter a fell between 0.001 and 0.05. All fish species in our investigation displayed values that fell within this range. The regression models for *R. prespensis* and *C. prespense* are in line with the data presented for these fish species from Small Prespa Lake (Bobori et al. 2010) with positive allometric and isometric growth, but not with the available data from Lake

Table 1. Estimated parameters of length-weight relationships for five endemic fish species from Lake Prespa

species	n	Length (cm)		Weight (g)		Regression parameters				
		min	max	min	max	b	95% CL of b	a	95% CL of a	r^2
Rutilus prespensis	2235	11.1	21.1	21.1	120.3	3.1374*	3.0961-3.1787	0.0083	0.0074-0.0093	0.9087
Chondrostoma prespense	717	14.3	27.6	22.7	200	3.0215	2.9712-3.0717	0.0089	0.0077-0.0103	0.9512
Barbus prespensis	82	14.6	31.6	35.5	325	2.8454*	2.7145-2.9693	0.0174	0.0120-0.0251	0.9631
Alburnus belvica	40	14.4	21.3	27.3	95.5	2.6979	2.1974-2.9693	0.0174	0.0120-0.0251	0.9631
Squalius prespensis	20	16.4	27	55.9	254.6	2.9146	2.6051-3.1983	0.0231	0.0056-0.0960	0.7581

*Significant difference of the value for parameter b from 3 (t-test; p<0,05)

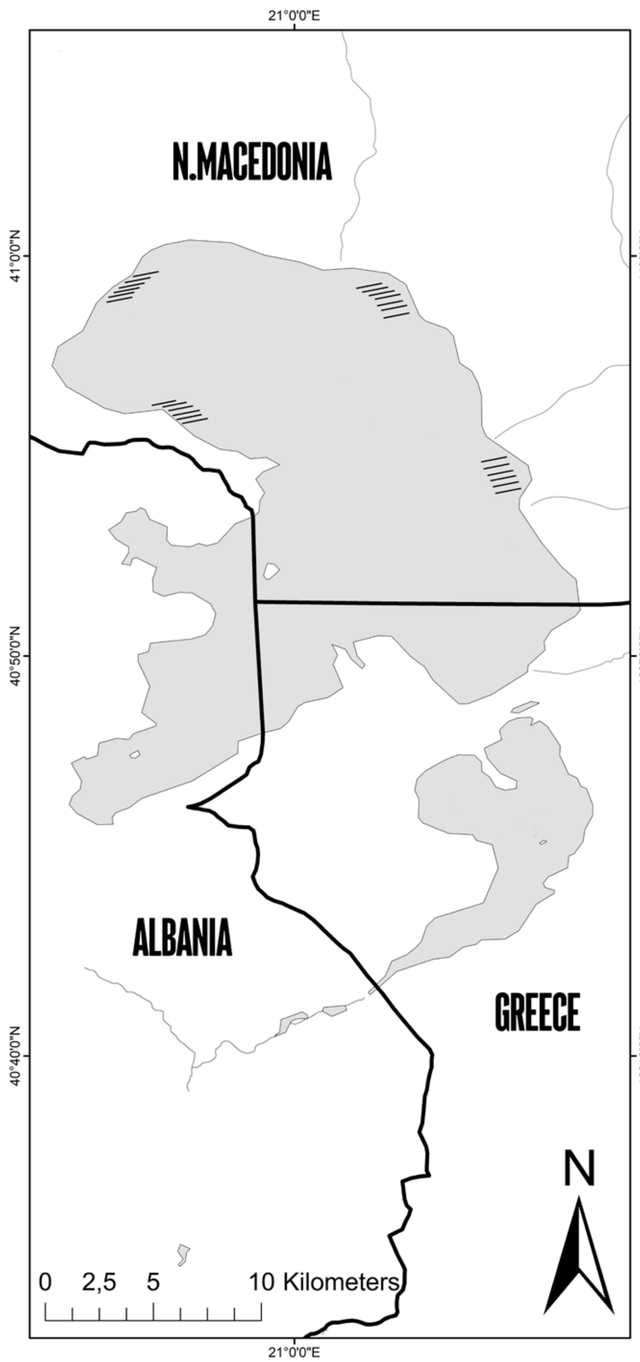

Fig. 1. Map of Lake Prespa and the location of the sampling sites

Prespa, where Milosevic & Talevski (2016) presented negative and positive allometric growth for these species, respectively. Our results for parameter *b* showed that *A. belvica* has isometric growth, which is in agreement with previous data from Lake Prespa (Milosevic & Talevski 2016) but not with the data from Small Prespa Lake presented by Bobori et al. (2010), which showed positive allometric growth. Depending on the season, the population, or annual

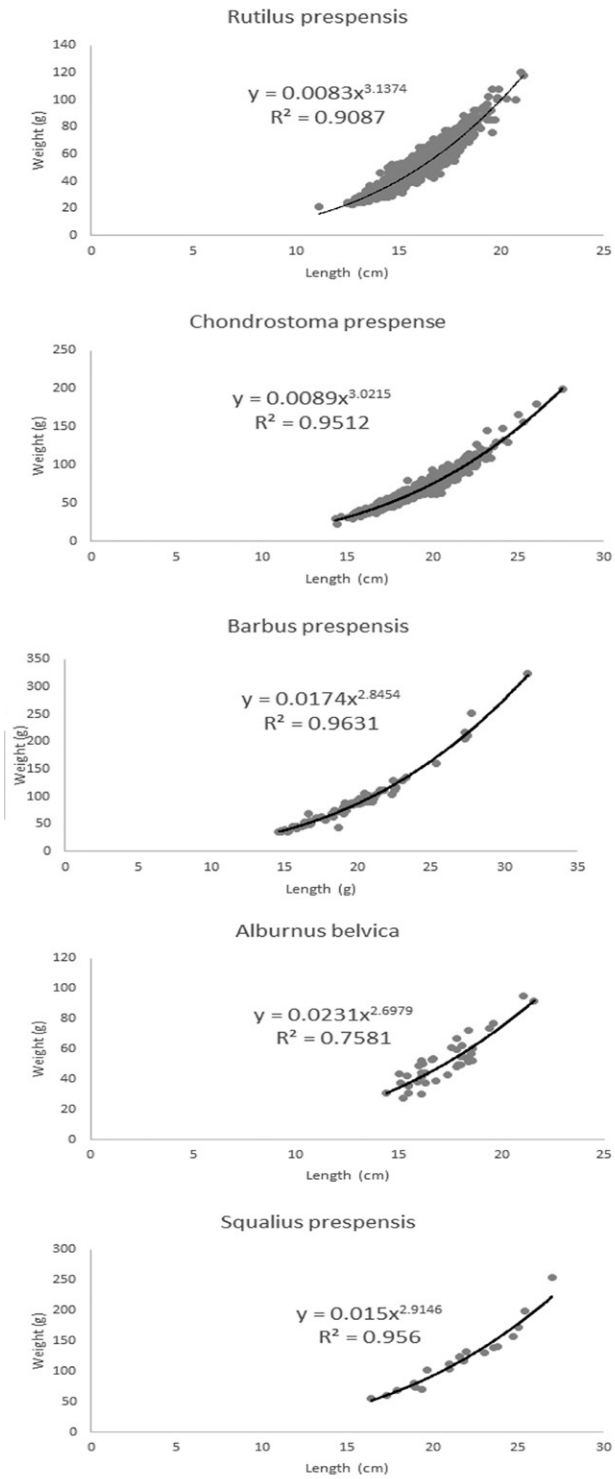

Fig. 2. Plot representation of the LW relationships, with the function $W=aL^b$ and r^2

environmental variations, there can be significant within-species variations in length-weight relationships (Froese 2006). We found isometric growth for *S. prespensis, a* result also presented in the available data for this fish species from Lake Prespa and Small Prespa Lake (Milosevic & Talevski 2016, Bobori et al. 2010). Fish LWR variations may be caused by several factors, including sample size and length range, fish age and sex, gonad maturity, feeding intensity, season, and environmental conditions (Froese 2006). However, not all of these variables were considered in the current study.

Table 2. Fulton's condition factor for five endemic fish species from Lake Prespa

	Condition Factor
species	**avg±st.dev.**
Rutilus prespensis	1.23±0.09
Chondrostoma prespense	0.95±0.06
Barbus prespensis	1.10±0.09
Alburnus belvica	1.10±0.09
Squalius prespensis	0.99±0.14

The results for the condition factor showed values around 1 (Table 2). A good fitness for fish species is assumed when condition factor values are equal or close to 1 (Jisr et al. 2018). We couldn't find any previously published data regarding the condition factor for the species in question. The Fulton condition factor assumes that the investigated fish is growing without any change of form (b=3) (Le Cren 1951, Froese 2006), but it is the most popular and widely used condition factor in ichthyological research.

Our study gave the first LWR description for *Barbus prespensis* from Lake Prespa and offered an update on the previous LWR data for the remaining fish species. Nevertheless, despite the scientific and commercial importance of the Lake Prespa fish, we can say that LWR investigations regarding these species are lacking. Lake Prespa fish species have multiple challenges to face, such as loss of habitat and spawning grounds because of the water level decrease in the lake, water pollution from the surrounding agricultural areas, and competition with the growing alien fish species that have well-established populations in the lake. This kind of research and data is of great importance and will contribute to fishery research and management and species conservation. Moreover, our study can provide valuable data for FishBase, in which none of the investigated species from Lake Prespa have an LWR description presented.

References

Bobori D.C., Moutopoulos D.K., Bekri M., Salvarina I. & Munoz A.I.P. 2010. Length-weight relationships of freshwater fish species in three Greek lakes. Journal of Biological Research – Thessaloniki 14: 219-224.

Crivelli A. J., Malakou M., Castadorakkis G. & Rosecchi E. 1996. The prespa barbell, Barbus prespensis, a fish species endemic to the Prespa Lakes (North-Western Greece). Folia zoological 45(1): 21-32.

Datta S. N., Kaur V. I., Dhawan A. & Jassal G. 2013. Estimation of length-weight relationship and condition factor of spotted snakehead Channa punctate (Bloch) under different feeding regimes. SpringerPlus 2: 436.

De Giosa M., Czerniejewski P. & Rybczyk A. 2014. Seasonal changes in condition factor and weight-length relationship of invasive Carassius gibelio (Bloch, 1782) from Leszczynskie Lakeland, Poland. Advances in Zoology, 1-7.

Froese R. 1998. Length-weight relationships for 18 less-studied fish species. Journal of Applied Ichtiology 14:117-118.

Froese R. 2006. Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. Journal of Applied Ichthyology 22: 241-253.

Froese R. & Pauly D. (Eds.) 2014. FishBase. World Wide Web electronic publication. Available at: http://www. Fishbase. org (accessed on 09.2023)

Ilik-Boeva D., Shumka S., Spirkovski Z., Talevski T., Trajchevski B., Pietrock M., Ritterbusch D., Bramick U. & Peveling R. 2017. Fish and Fisheries Prespa Lake – Implementing the EU Water Framework Directive in South-Eastern Europe. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Bonn, Eschborn. Pegi Sh.p.k., Tirana.

Jisr N., Younes G., Sukhn C. & El-Dakdouki M.H. 2018. Length-weight relationships and relative condition factor of fish inhabiting the marine area of the Eastern Mediterranean city, Tripoli-Lebanon. Egyptian Journal of Aquatic Research 44(4): 299-305.

Kottelat M. & Freyhof J. 2007. Handbook of Europen Freshwater Fishes. Kottelat, Cornol, Switzerland and Freyhof, Berlin, Germany.

Le Cren E.D. 1951. The length–weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal of Animal Ecology 20: 201-219.

Milosevic D. & Talevski T. 2016. Length-Weight Relationship of 11 Fish Species from Three Natural and Two Artificical Lakes in the Former Yugoslav Republic of Macedonia (FYROM). Acta Zoologica Bulgarica 68(3): 391-394.

Pietrock M., Ritterbusch D., Lewin W.C., Shumka S., Spirkovski Z., Ilik-Boeva D., Bramick U. & Peveling R. 2022. The fish community of the ancient Prespa Lake (Southeast Europe): Non-indigenous species take over. Fisheries & Aquatic Life 30: 112-124.

Ricker W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada 191: 1-382.

Ricker. W.E. 1979 Growth rates and models. In: Hoar W. S., Randall D. J. &. Brett J. R. (Eds.): Fish Physiology Vol. VIII Bioenergetics and Growth. London: Academic Press., 677-743.

Tsoumani M., Apostolidis A.P. & Leonardos I.D. 2012. Length-weight relationships of Rutilus species from fifteen Greek lakes. Journal of Applied Ichthyology 29: 297-298.