Acta Aquatica Turcica

E-ISSN: 2651-5474

Home Page: https://dergipark.org.tr/actaquatr 20(4): 298-311, 2024 DOI: 10.22392/actaquatr.1451579

Research Article **Araştırma Makalesi**

Length-weight Relationships and Condition Factors of Çaltıcak (Taşkısığı) Lake (Sakarya, Türkiye) Fish Species

Çaltıcak (Taşkısığı) Gölü (Sakarya, Türkiye) Balık Türlerinin Boy-ağırlık İlişkileri ve Kondisyon Faktörleri

Erdinç Aydın[1], Nurgül Şen Özdemir[2,*], Teoman Özgür Sökmen[3]

[1]Sakarya Directorate of Provincial Agriculture and Forestry, Republic of Türkiye Ministry of Agriculture and Forestry, 54000, Sakarya-TÜRKİYE
[2]Department of Veterinary Medicine, Vocational School of Food, Agriculture and Livestock, Bingöl University, 12000, Bingöl-TÜRKİYE
[3]Department of Veterinary Medicine, Çayırlı Vocational School, Erzincan Binali Yıldırım University, 24500, Erzincan-TÜRKİYE

*Corresponding author: nsozdemir@bingol.edu.tr

Received: 12.03.2024 **Accepted:** 10.05.2024 **Published:** 01.12.2024

How to Cite: Aydın, E., Şen Özdemir, & Sökmen, T. Ö. (2024). Length-weight relationships and condition factors of Çaltıcak (Taşkısığı) lake (Sakarya, Türkiye) fish species. *Acta Aquatica Turcica, 20*(4), 298-311. https://doi.org/10.22392/actaquatr.1451579

Abstract: Length-weight relationships (LWRs) and Fulton condition factor (CF) of 8 fish species belonging to different families (*Bilicca bjoerkna*, *Scardinus erythrophthalmus* and *Carassius gibelio* from Cyprinidae, *Esox lucius* from Esocidae, *Silurus glanis* from Siluridae, *Perca fuliviatilis* from Percidae, *Abramis brama* from *Leuciscidae*) obtained from commercial fishermen in Çaltıcak (Taşkısığı) Lake (Sakarya/Türkiye) were examined. LWRs and CF of the fish species were analyzed between March 2021 and March 2022. *C. gibelio* and *E. lucius* show positive allometric growth, *B. bjoerkna*,*S. glanis* and *P. fuliviatilis* and *A. brama* showed negative allometric growth, while *S. erythrophthalmus* and *T. tinca* show isometric growth. The lowest CF values of the fish species were also determined in *S. glanis* (0.62) and *E. lucius* (0.69). It is thought that the information obtained in the study about the LWRs and CF values of the fish species in Çaltıcak Lake will be beneficial for commercial fishing and fisheries management in the region.

Keywords
- Çaltıcak Lake
- Fulton's condition factor
- LW

Özet: Çaltıcak (Taşkısığı) Gölü'nde (Sakarya/Türkiye) ticari balıkçılık yapan balıkçılardan elde edilen farklı familyalara ait 8 balık türünün (Cyprinidae'den *Bilicca bjoerkna, Scardinus erythrophthalmus* ve *Carassius gibelio*, Esocidae'den *Esox lucius*, Siluridae'den *Silurus glanis*, Percidae'den *Perca fuliviatilis*, Tincidae'den *Tinca tinca* ve Leuciscidae'den *Abramis brama*) boy-ağırlık ilişkileri (LWR) ve Fulton kondüsyon faktörü (KF) incelenmiştir. Balık türlerinin LWR'leri ve KF'leri Mart 2021-Mart 2022 tarihleri arasında analiz edilmiştir. *S. erythrophthalmus* ve *T. tinca* izometrik büyüme gösterirken, *C. gibelio* ve *E. lucius* pozitif allometrik, *B. bjoerkna*, *S. glanis* ve *P. fuliviatilis* ve *A. brama*'nın negatif allometrik büyüme gösterdiği tespit edilmiştir. Balık türlerinin en düşük KF değerleri *S. glanis*'de (0.62) ve *E. lucius*'a (0.69) da belirlenmiştir. Çalışmada, Çaltıcak Gölü'ndeki balık türlerinin LWR'leri ve KF değerleri hakkında elde edilen bilgilerin, bölgedeki ticari balıkçılık ve balıkçılık yönetimi açısından yarar sağlayacağı düşünülmektedir.

Anahtar kelimeler
- Çaltıcak Gölü
- Fulton kondüsyon faktörü
- LWR

1. INTRODUCTION

Çaltıcak (Taşkısığı) Lake spreads over an area of 90 hectares within the borders of Sakarya province in western Türkiye. It is mainly fed by groundwater coming from the bottom. Its maximum depth is 5-6 m. The northern shores of the lake, whose southern part is deeper, are reeds and swamps. It expands in winter and contracts in summer. The lake has freshwater characteristics. Çaltıcak (Taşkısığı) Lake is a pond where commercial fishing activities are intensely carried out.

Freshwater resources play an important role in supporting biodiversity and livelihoods of human

communities around the world, especially those in rural and poor communities. 56 million people are engaged in small-scale freshwater fisheries in the developing world (Béné et al., 2010).

Fishing activities address the economic, social and biological factors that affect fish stocks by adopting a strategy that meets the nutritional needs of communities without destroying fish stocks (FAO, 2003). In addressing this, the cornerstone tool for research and management includes biometric studies that provide information for an estimated assessment of the biomass of fish species (Zargar et al., 2012). In biometric studies, it is necessary to determine the growth characteristics of the fish in terms of weight and length, as well as the welfare status of the species, which is affected by different biological and environmental factors (Morato et al., 2001). Length-weight relationships (LWRs) are considered an important tool in fisheries sciences, especially in ecology, population dynamics and stock management (Froese, 2006; Abdoli et al., 2008; Epler et al., 2009). This relationship allows estimating the weight of a sample when its total length is known (Nadaf et al., 2013). Additionally, this relationship is used (i) to estimate the growth type (isometric and allometric) from the length and weight of the fish (Ricker, 1975), (ii) to determine the condition of the fish, and (iii) to compare the historical characteristics and living conditions of a fish species in different areas/regions (Petrakis and Stergiou, 1995; Goncalves et al., 1997; Hossain et al., 2015) (iv) also, these values are required for Yield per Recruit analysis in stock assessment studies (Alam et al., 2022). Comprehensive LWRs studies are needed to maintain a healthy commercial stock. Additionally, the condition factor (CF) is also useful for collecting stock composition, lifespan, growth, maturity and production information. LWRs and CF are very effective tools in fisheries biology to implement effective guidelines for sustainable fisheries management in natural water resources (Rajput et al., 2019).

CF is standard practice and is based on the analysis of length-weight data in fisheries ecology. It assumes that heavier fish of a given length fare better. In other words, CF allows quantitative comparison of the fitness of two or more populations from different regions (Neff and Cargnelli, 2004). Hence, the aim of this study was to 1) estimate LWRs for 8 the fish species (including three species from Cyprinidae and other species from the families Esocidae, Siluridae, Percidae, Tincidae, and Leuciscidae) obtained from Çaltıcak Lake, 2) evaluate CF and determine suitability. This information will contribute to the management and conservation of this water resource and will allow future comparisons between natural populations of these fish species' stocks which have economic importance.

2.MATERIALS AND METHODS

2.1.Sample collection

Sampling area, Çaltıcak (Taşkısığı) Lake is located within the borders of Sakarya province (40° 50' 25" N, 30° 27' 59" E) and 90 ha (Figure 1). In the study, a total of 11 hunting operations were carried out with plain (galsama) gillnets with 32-40-50-60 and 80 mm mesh size. A total of 11 samples were made in the selected locations within the fishing operation area in December 2021, January, February and March 2022 to represent the entire lake.

The fish samples were placed in 12-liter cold chain plastic containers filled with ice molds on a fishing boat and were immediately transferred to the research laboratory.

In this study, 8 fish species from different families (*Bilicca bjoerkna*, *Scardinus erythrophthalmus* and *Carassius gibelio* from Cyprinidae, *Esox lucius* from Esocidae, *Silurus glan*is from Siluridae, *Perca fuliviatilis* from Percidae, *Tinca* tinca from Tincidae Abramis brama from Leuciscidae) were obtained from commercial fishermen in Çaltıcak (Taşkısığı) Lake. The fish samples were placed in cold chain plastic containers filled with ice molds on a fishing boat and were immediately transferred to the research laboratory.

Figure 1. Sampling area, Çaltıcak (Taşkısığı) Lake.

2.2. Length-weight relationships (LWRs) and Condition factor (CF)

The samples were taxonomically identified in the laboratory according to Kuru, (2004); Kottelat & Freyhof, (2007); Geldiay & Balik, (2009).

Length and weight measurements of fish samples were carried out during field work. The total length of the fish samples was measured with a fish measuring board with an accuracy of 1 mm. Weightlab brand WL-3002L type precision scale with ± 0.01 g accuracy and 3000 g weighing capacity was used for weight measurement.

Student's t-test was used for comparison b value obtained in the linear regression with isometric value (Sokal and Rohlf, 1987): $ts = (b-3)\ Sb$, where ts is the t-test value, b the slope and *Sb* the standard error of the slope (*b*). To evaluate the type of isometric growth if $b=3.0$, negative allometric if $b<3.0$, and positive allometric if $b>3.0$, t-student test was used to determine significant differences from the estimated value of *b* and its 95% confidence interval (Cl) (Zar, 2010).

The statistical relationship between length and weight parameters of fish species was established using the equation $TW=a\times TL^b$. In this equation; TW is the total weight of the fish (g), TL is the total length (cm), a is the intercept and b is the slope of the relationship (Bagenal and Tesch, 1978).

Fulton's CF is used to reveal the condition of the length and weight of fish. It is based on the assumption that heavier fish of a given length are in better condition (Sheikh and Ahmed, 2018). Fulton's CF was calculated for all individuals by the following equation (Fulton, 1911):

$CF = 100TW/TL^3$

2.3. Statistical analysis

The Relationships among the variables were determined using regression analysis (Spearman Rank Correlation). Observed differences were evaluated statistically by t-test in MINITAB software,

independently by groups. Statistical differences in CF value among species were tested using one-way analysis of variance (ANOVA, $p<0.05$).

3. RESULTS and DISCUSSION

The length-weight relationships of different freshwater 8 fish species including *Bilicca bjoerkna*, *Scardinus erythrophthalmus* and *Carassius gibelio* from Cyrinidae, *Esox lucius* from Esocidae, *Silurus glanis* from Siluridae, *Perca fuliviatilis* from Percidae, *Tinca tinca* from Tincidae and *Abramis brama* from Leuciscidae were analyzed in Çaltıcak (Taşkısığı) Lake. The most commercial importance among these species are *P. fuliviatilis*, *S. glanis* and *E. lucius* in Çaltıcak Lake (Reis et al., 2019).

A total of 1041 specimens of about 282921.89 kg were collected during the period of study by the freshwater fish in the Çaltıcak (Taşkısığı) Lake, mean LWRs and CF parameters of the for each fish species are given in Table 1. As revealed by the results, the mean lowest total length of fish species was measured 20 cm for *P. fuliviatilis*, while the mean maximum total length was measured 59 cm for *S. glanis*. The mean least weights were measured for *B. bjoerkna* and *S. erythrophthalmus* (141 g), while the mean most weights was for *C. gibelio* (692 g), as shown in Table 1.

The LWRs of fish species can vary temporally or spatially according to size range, reproductive activities, or environmental conditions such as temperature and water quality, food quality, food availability, disease, and competition (Wootton, 2012). In this study, the LWR parameters (a, b), the coefficient of determination (R^2), the growth type and the CF values are shown in Table 1. The "*b*" value shows the shape of the fish according to its conditions, while the "a" value in the fish length-weight relationship equation shows the average condition of the individuals (Avşar, 1998). The "*b*" value gives the growth type. If $b=3$, it is defined as isometric growth (I), if $b>3$, positive allometric growth is defined as A(+), and if $b<3$, negative allometric growth is defined as A(-) (Wootton, 2012). The species used in this study are economically and ecologically important species and discussed in below.

The "*b*" value changed between 1.73 and 3.32 (*P. fuliviatilis*- *E. lucius*, respectively). *C. gibelio* (b=3.23) and *E. lucius* (b=3.32) had only positive allometric growth (b=3.23; 3.32, respectively), and *S. Erythrophthalmus (b= 2.99)* and *T. Tinca (b=2.97)* had isometric growth while the other fish species (*S. glanis, P. Fuliviatilis;* b=1.73, *B. bjoerkna;* b=2.77, *S. glanis*; b=2.81, *A. brama ;* b=2.94)) had negative allometric growth (Table 1, Figure 1). Many studies have emphasized that *B. bjoerkna* showed positive allometric growth (Tarkan et al., 2006; Yılmaz et. al, 2012;Yılmaz et. al, 2015; Okgerman et al., 2012; Reis et al., 2019; Jamali et al., 2015). Also, there were researches indicating that *B. bjoerkna* showed negative allometric growth (Şaşı and Berber, 2012; Litvinenko et al., 2021). It was emphasized that the *b* value of *B. bjoerkna* was lower in eutrophic and relatively shallow lakes and this species were found in shallow parts of warm lakes with vegetation by Sası and Berber (2012). It is possible for B. *bjoerkna* to show negative allometric growth since Çaltıcak Lake is a eutrophic lake with reeds and swamp areas (Yılmaz, 2016). Contrary to this study, Kahraman et al. (2014), found positive allometric growth for *S. glanis* (*b*= 3.22) and negative allometry for *E. lucius* (*b*=2.48) in Sakarya River. Similarly, *P. fuliviatilis* and *A. brama* generally showed to positive allometric growth in many researches. However, we found that *P. fuliviatilis* and *A. brama* had negative allometric growth. Reis at al. (2019) for *P. fuliviatilis* in Sakarya River and Yurchenko and Morozov (2020) for *A. brama* in Volga River found negative allometric growth. It has been reported that variations of "*b*" value in same species or different species might be due to several factors. Growth patterns of species may differ between different populations of the same species or in different years within the same population, depending on food availability (Ricker, 1975), water quality (Mommsen, 1998), biological, temporal and sampling factors (Mehanna and Farouk, 2021), the fish condition, seasonality (Haimovici and Velasco, 2000; Teixeira et al., 2017), diet, sex, health, habitat, gonad maturity, preservation techniques, stomach fullness and locality (Esmaeili, 2001; Sadeghi and Esmaeili, 2018; Al Jufaili et al., 2021). Therefore, differences may occur in the same species and region. The results of different studies investigating the LWRs (a, b, R^2) and CF of the same species of fish in inland waters of different locations are given in Table 2.

The investigation of condition factors of all the 8 fish species revealed that mean Fulton's condition factors (CF) values were between 0.62 (*S. glanis*) and 2.16 (*C. gibelio*) (2.16) (Table 1). Le Cren

(1951) indicated that CF values greater than 1 (CF>1) indicated the good condition of the fish whereas mean CF values lower than 1 (CF<1) is indicative of the reverse nature. The mean CF was above 1 in 8 species, except *E. lucius* (0.69) and *S. glanis* (0.62) from the 8 species used in present study. The best performance of these eight species *were C. gibelio* (2.16) and *B. Bjoerkna* (2.11). In contrast, the lowest performance were *L. lucius* (0.69) and *S. glanis* (0.62). A high value of CF indicates suitable environmental conditions (e.g. habitat and prey availability), while a low CF indicates less favorable environmental conditions (Blackwell et al., 2000). CF values are given in widely varying ranges. Variability in these values is seen even in the same species as can be seen in Table 2. Okgerman et al. (2012) stated that differences in CF result from responses to feeding regime, time of year, greater weight of the female ovary, organisms used, feeding behavior, biological factors, and environmental perturbations. Differences in CF may result from a combination of one or more of the factors mentioned (Al Jufaili et al., 2021). As a result, the value of CF indicates that Çaltıcak Lake has a rich food reserves and convenient environmental conditions for the fish species used in this study except for *E. lucius* and *S. glanis.* Statistically, there was a significant difference among the fish species in terms of CF values. The most significant difference in CF was between *C. gibelio* and *S. galanis,* and *C. gibelio* and *B. bjoerkna.* On the other hand, the CF differences between *E. lucius* and *S. galnis, T. tinca, P. fuliviatilis* and *S. erythrophthalmus* are not significant ($p<0.05$). Additionally, Datta et al. (2013) indicated that fish fed with different diets and much robust fish if CF is greater than 1. Therefore, we can say that *S. erythrophthalmus, C. gibelio, P. fuliviatilis, T. tinca* and *A. brama* were fed different and richer nutrient diets than *E. lucius* and *S. glanis* ve these six fish species were much more robust than from the other two fish species.

In the study, lowest R^2 *values* was in *P. fuliviatilis* (0.88) and *S. erythrophthalmus (0.90),* whereas the highest R^2 *values* were in *C. gibelio* (0.99) and *T. tinca* (0.98) (Table 1, Figure 2). The high value of the coefficient of determination R^2 suggested that the model used for the analysis fits the data, confirming the model's fitness. Knowledge of LWRs and the CF of introduced or invaded species are essential for assessing and appropriately managing alien and native species in an aquatic system (Aminisarteshnizi and Moyo, 2020). The regression analysis showed that *C. gibelio*'s and *T. tinca* length correlated higher with weight than the other species ($p<0.05$) in Çaltıcak Lake (Figure 2).

Table 1. Mean length-weight relationship parameters of the fish species in Çaltıcak Lake ($p<0.05$).

Species	Total Length (cm)		Total Weight (g)		Parameters			*b*(SE)	95 % Cl of *b*	Student t test of *b*	CF±SD	CF (Min-Max)	LWR equations	Growth type	p
	Mean TL±SD	Min-Max	Mean TW±SD	Min-Max	a	*b*	R^2								
B. bjoerkna	21.73±5.63	10.80-52.00	141.35±150.54	10.00-1650.00	0.023	2.77	0.93	2.12	14.21-22.55	7.24	2.11±0.28	0.23-2.11	$TW=0.023L^{2.77}$	A(-)	<0.05*
S.erythrophthalmus	22.02±2.30	16.10-30.00	141.43±47.51	42.00-326.40	0.013	2.99	0.90	12.50	18.70-68.20	3.22	1.49±0.18	0.12-1.59	$TW=0.013L^{2.99}$	I	<0.05*
C. gibelio	30.02±7.02	14.20-40.20	691.95±409.10	58.00-1420.00	0.010	3.23	0.99	83.60	-12.3-321.80	1.82	2.16±0.36	0.21-2.57	$TW=0.0098L^{3.23}$	A(+)	>0.05
E. lucius	54.82±9.43	31.10-73.00	1259.41±629.34	180.00-2480.00	0.002	3.32	0.96	33.20	-22.70-111.90	1.25	0.69±0.10	0.54-0.87	$TW=0.002L^{3.31}$	A(+)	>0.05
S. glanis	58.67±10.03	40.70-83.00	1341.60±625.00	422.00-3142.00	0.013	2.81	0.97	13.60	30.10-85.20	4.03	0.62±0.06	0.53-0.77	$TW=0.0134L^{2.81}$	A(-)	<0.05*
P. fuliviatilis	20.21±3.76	14.60-26.70	119.78±41.90	55.30-230.00	0.640	1.73	0.88	3.15	0.50-13.82	1.28	1.41±0.41	0.91-2.37	$TW=0.6403L^{1.73}$	A (-)	>0.05
T. tinca	33.79±3.62	26.20-37.70	628.58±184.21	289.60-878.00	0.018	2.97	0.98	7.85	39.85-74.04	6.88	1.25±0.06	1.47-1.68	$TW=0.0176L^{2.97}$	I	<0.05*
A.brama	35.58±5.96	26.60-46.50	529.70±276.21	172.00-1156.00	0.013	2.94	0.91	12.30	12.60-64.30	2.88	1.10±0.19	0.89-1.59	$TW=0.0133L^{2.94}$	A(-)	<0.05*

n=sample size, W=total weight (g), a=intercept, *b*=slope, Cl=confidence intervals, R^2=coefficient of determination, CF= Fulton's condition factor, GT=growth type, I):isometric growth, A (+):positive allometric growth, and A(-):negative allometric growth, *<0.05= Regression analysis results are significant

Table 2. Mean length-weight relationship parameters of the fish species in different locations ($p<0.05$).

Species	n	L(cm) (Min-Max	W (g) (Min-Max)	Lenght-Weight Parameters			Growth (t test)	Location	CF	References
				a	b	R^2				
B. bjoerkna	196	12.00-21.20	-	0.007	3.18	0.90	**A(+)**	Sapanca Lake	-	Tarkan et al., 2006
	434	13.20-27.80	22.80-259.00	0.004	3.36	0.97	**A(+)**	Ladik Lake	1.59	Yılmaz et. al, 2012
	434	13.87-18.72	42.90-112.30	0.007	3.32	0.97	**A(+)**	Ladik Lake	1.49-1.78	Yılmaz et. al, 2015
	1250	8.00-30.00	-	0.033	2.93	0.97	**A(-)**	Kyiv Reservoir	2.68	Litvinenko et al., 2021
	350	6.60-24.30	-	0.004	3.39	0.97	**A(+)**	Sapanca Lake	1.12	Okgerman et al., 2012
	183	7.40-18.50	6.78-124.16	0.115	2.58	0.81	**A(-)**	Uluabat Lake	1.27-2.87*****	Sasi and Berber, 2012
	547	6.20-30.40	3.15-311.15	0.015	3.12	0.96	**A(+)**	Sakarya River	-	Reis et al., 2019
	392	13.70-27.80	26.00-289.00		3.44	1E-06	**A(+)**	Aras Dam Lake	-	Jamali et al., 2015
S. erythrophthalmus	19	7.80-22.90	-	0.008	3.21	0.99	**A(+)**	Sapanca Lake	-	Tarkan et al., 2006
	305	6.90-27.00	-	0.008	3.17	0.98	**A(+)**	Büyükçekmece Lake	1.38	Saç and Okgerman, 2016
	270	9.40-17.90	11.98-98.50	0.006	3.29	0.96	**A(+)**	Anzali Lagoon	1.58-2.30*****	Aminisarteshnizi&Moyo, 2022
	43	10.20-30.20	13.46-364.67	0.009	3.15	0.99	**A(+)**	Sakarya River	-	Reis et al., 2019
	317	6.80-29.00	3.40-392.70	0.007	3.24	0.99	**A(+)**	Ömerli Reservoir	0.88-1.86*	Gaygusuz, 2018
	141	6.40-17.70	-	0.006	3.36	0.96	**A(+)**	Anzali Wetlands	1.40	Moradinasab et al., 2012
C. gibelio	363	5.20-30.20	-	0.008	3.25	0.99	**A(+)**	İznik Lake	-	Tarkan et al., 2006
	395	9.90-34.50	16.17-774.40	0.012	3.11	0.99	**A(+)**	Büyükçekmece Lake	1.72	Saç and Okgerman, 2016
	95	11.30-35.50	-	0.022	2.88	0.90	**A(-)**	Anzali Wetlands	1.55	Moradinasab et al., 2012
	179	9.30-32.40	13.76-592.75	0.026	2.87	0.97	**A(-)**	Sakarya River	-	Reis et al., 2019
	3987	6.90-38.20	3.70-1266.00	0.011	3.17	0.98	**A(+)**	Eğirdir Lake	-	Apaydın Yağcı et al., 2022
	46	1.90-36.50	113.00-984.00	0.019	3.04	0.88	**A(+)**	Asartepe Dam Lake	2.03	Saylar et al., 2019
E. lucius	13	26.3-57.6	-	0.003	3.21	0.97	**A(+)**	Sapanca Lake	-	Tarkan et al., 2006
	48	40.20-76.30	689.40-3421.50	0.066	2.48	0.94	**A(-)**	Sakarya River	-	Kahraman et al., 2014
	311	22.50-33.39	101.50-319.81	0.023	2.72	0.95	**A(-)**	Çapalı Lake	0.88	Küçük and Güçlü, 2004
	313	22.80-66.00	92.90-3342.00	0.003	3.21	0.98	**A(+)**	Işıklı Dam Lake	0.87	Uysal et al., 2008
	100	16.5-53.4	260.00-1870.00	0.036	2.69	0.998	**A(-)**	Kesikköprü Dam Lake	0.86-1.04*****	Altındağ et al., 1999
	44	27.20-259.80	153.16-1353.12	0.0097	2.91	0.93	**A(-)**	Sakarya River	-	Reis et al., 2019
S. glanis	64	22.50-86.70	66.10-5987.60	0.003	3.22	0.99	**A(+)**	Sakarya River	-	Kahraman et al. 2014
	21	20.5-250.0	-	0.032	2.57	0.96	**A(-)**	Seyhan Dam Lake	-	Erguden and Goksu, 2009
	257	92.7-101.8	6578.2-9041.10	0.010	2.91	0.97	**A(-)**	Menzelet Reservoir	-	Alp et al. 2011
	66	48.50-68.32	704.00-6560.00	0.004	3.06	0.96	**A(+)**	Çelik Lake	0.58	Yüngül et al., 2014
	108	24.80-67.90	92.40-2066.50	0.005	3.02	0.99	**A(+)**	İznik Lake	0.60	Uysal et al., 2009
	128	33.80-103.00	165.00-7600.00	0.007	2.99	0.99	**I**	Altınkaya Dam Lake	0.63	Yılmaz et. al., 2007

P. fuliviatilis	11	7.20-21.20	-	0.008	3.20	0.98	**A(+)**	Büyükçekmece Lake	-	Tarkan et al., 2006
	128	10.50-26.20	20.00-615.00	0.0096	3.24	0.989	**A(+)**	Volga River	1.72-2.25*	Yurchenko & Morozov, 2020
	689	5.90-29.30	1.37-449.00	0.006	3.26	0.99	**A(+)**	Büyükçekmece Lake	1.24	Saç and Okgerman, 2016
	858	8.20-27.50	7.16-365.20	0.005	3.36	0.98	**A(+)**	Ladik Lake	1.28	Saygin et al., 2016
	107	11.40-28.70	20.45-370.51	0.015	2.94	0.93	**A(-)**	Sakarya River	-	Reis et al., 2019
T. tinca	68	13.1-35.00	-	0.007	3.45	0.999	**A(+)**	Sapanca Lake	-	Tarkan et al., 2006
	131	19.00-42.90	103.00-1302.00	-	3.05	0.97	**A(+)**	Asartepe Reservoir	1.68	Saylar et al., 2018
	102	5.90-38.60	2.40-783.24	0.008	3.16	0.997	**A(-)**	Sıddıklı Dam Lake	1.30	Yazıcıoğlu and Yazıcı, 2023
	3360	9.00-37.00	13.00-815.00	0.015	2.99	0.99	**I**	Beyşehir Lake	1.51	Balık et al., 2009
	46	15.00-26.50	-	0.06	2.53	0.90	**A(-)**	Anzali Wetlands	1.60	Moradinasab et al., 2012
	1284	12.00-29.00	27.00-403.30	0.06	2.51		**A(-)**	Seyhan Dam Lake	1.58	Erguden and Goksu, 2010
A. brama	21	20.9-39.70	-	0.005	3.35	0.99	**A(+)**	Terkos Dam Lake	-	Tarkan et al., 2006
	184	21.50-45.00	228.00-2044.00	0.028	2.91	0.97	**A(-)**	Volga River	2.01-2.15*****	Yurchenko & Morozov, 2020
	143	14.30-53.70	33.35-1977.48	0.007	3.12	0.97	**A(+)**	Sakarya River	-	Reis et al., 2019
	1420	14.00-56.00	50.00-5600.00	0.010	3.21	0.98	**A(+)**	Middle Dnieper	2.21	Khristenko and Kotovska, 2017
	722	8.10-44.60	8.00-1790.00	0.009	3.18	0.99	**A(+)**	Ladik Lake	1.59	Yilmaz et al., 2015

*gives the minumum and maximum CF values for the fish species if the mean of CF values are not given in the reference paper . Other CF values are given as mean CF values.

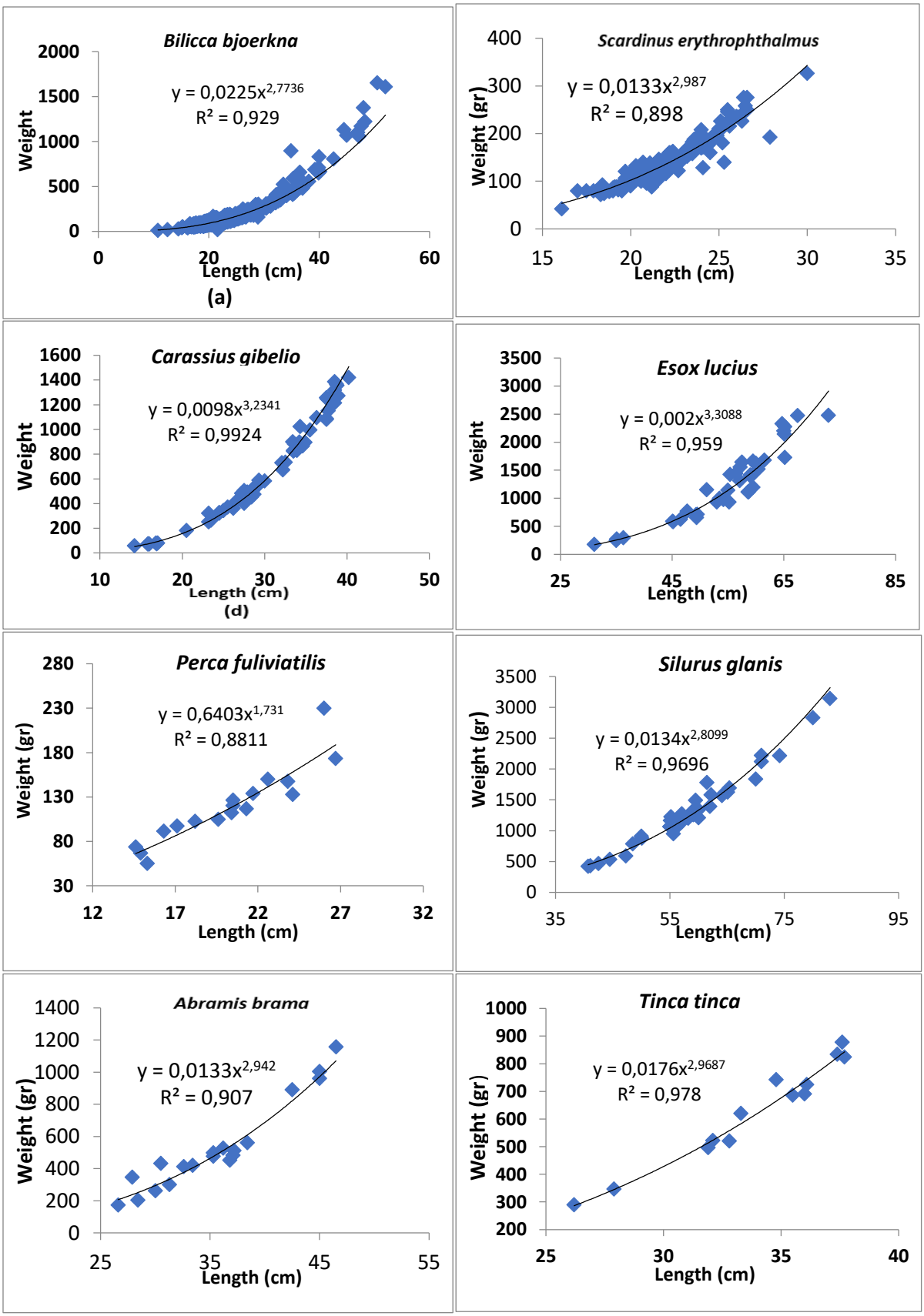

Figure 2. Length–weight relationships of the eight economical fish species from the Çaltıcak (Taşkısığı) Lake.

CONCLUSIONS

This study includes the main information on the length-weight relationships and condition factor of freshwater fish species (*Bilicca bjoerkna*, *Scardinus erythrophthalmus* and *Carassius gibelio*, *Esox lucius*, *Silurus glanis*, *Perca fuliviatilis*, *Tinca tinca* and *Abramis brama*) catching from the Çaltıcak Lake, (Sakarya,Türkiye). There is no study on LWRs and CF in Çaltıcak Lake. Therefore, this study are first research. In this regard, we evaluated that our results will make a positive contribution to the management of freshwater fisheries and related studies to be conducted in the future.

ACKNOWLEDGEMENT

We would like to thank the Sakarya the Ministry of Agriculture and Forestry of the Republic of Türkiye and the fisheries branch directorate staff for their support in technical matters and in the preparation and use of the infrastructure during the study.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

AUTHOR CONTRIBUTIONS

Experimenting: EA, TÖS; Data analysis: NŞÖ, Manuscript writing: NŞÖ, EA. All authors approved the final draft.

ETHICAL APPROVAL

Ethical approval is not required as this study does not involve clinical research or experimental procedures and the fish samples were obtained from fishermen engaged in commercial fishing activities. No treatment/experimentation was performed on live animals during the study. All samplings and laboratory studies regarding the fish used in the study were carried out in accordance with the Animal Welfare Laws of the Ministry of Agriculture and Forestry of the Republic of Türkiye.

DATA AVAILABILITY

Data supporting the results are available in the manuscript.

REFERENCES

Abdoli, A., Rasooli, P., Mostafavi, H. 2008. Length–weight relationships of *Capoeta capoeta capoeta* (Gueldenstaedt, 1772) in the Gorganrud River, south Caspian Basin. *Journal of Applied Ichthyology, 24*(1), 96-98. https://doi.org/10.1111/j.1439-0426.2007.01045.xç

Alam, M. S., Liu, Q., Schneider, P., Mozumder, M. M. H., Chowdhury, M. Z. R., Uddin, M. M., Barua, S. 2022. Length-Based Stock Assessment for the Data-Poor Bombay Duck Fishery from the Northern Bay of Bengal Coast, Bangladesh. *Journal of Marine Science and Engineering, 10*(2), 213. https://doi.org/10.3390/jmse10020213

Al Jufaili, S. M., Sayyadzadeh, G., Jawad, L., Esmaeili, H. R. 2021. Length-weight relationships of five fish species from the inland waters of Oman. *Iranian Journal of Ichthyology, 8*(1), 62-66. https://doi.org/10.22034/iji.v8i1.607

Alp, A., Kara, C., Üçkardeş, F., Carol, J., & García-Berthou, E. 2011. Age and growth of the European catfish (*Silurus glanis*) in a Turkish Reservoir and comparison with introduced populations. *Reviews in Fish Biology and Fisheries, 21*, 283-294. https://doi.org/10.1007/s11160-010-9168-4

Altındağ, A., Yiğit, S., Ahıska, S., Özkurt, Ş. 1999. The Growth Features of Pike *(Esox lucius* L., 1758) in Dam Lake Kesikköprü. Turkish Journal of Zoology, 23(3), 901-910.

Aminisarteshnizi, M., Moyo, N. A. 2022. Condition Factor and Length-Weight Relationship of *Scardinius erythrophthalmus* (Linnaeus, 1758) in Anzali Lagoon. *Pakistan Journal of Biological Sciences: PJBS, 25*(10), 899-904. https://doi.org/10.3923/pjbs.2022.899.904

Apaydın Yağcı, M. A., Alp, A., Yağcı, A., Uysal, R., Bilgin, F., Cesur, M., Yeğen, V. 2022. Length-weight relationships of ten fish species from Lake Eğirdir, Turkey. *Journal of Anatolian Environmental and Animal Sciences, 7*(2), 105-109. https://doi.org/10.35229/jaes.982459

Avşar D, 1998. Balıkçılık Biyolojisi ve Populasyon Dinamiği. Baki Kitap ve Yayınevi, Yayın No. 20, Adana, 303 p.

Balık, İ., Çubuk, H., Çınar, Ş., Özkök, R. 2009. Population structure, growth, mortality and estimated stock size of the introduced tench, *Tinca tinca* (L.), population in Lake Beyşehir, Turkey. *Journal of Applied Ichthyology, 25*(2), 206-210.

Bagenal, T. B., Tesch, F. W. 1978. Age and growth. pp101-136. Methods for Assessment of Fish Production in Freshwaters. IBP Handbook, 3.

Béné, C., Lawton, R. and Allison, E.H. 2010. 'Trade matters in the fight against poverty': Narratives, perceptions, and (lack of) evidence in the case of fish trade in Africa. *World Development, 38,* 933-954. https://doi.org/10.1016/j. worlddev.2009.12.010

Blackwell, B. G., Brown, M. L., Willis, D. W. 2000. Relative weight (Wr) status and current use in fisheries assessment and management. *Reviews in fisheries Science, 8*(1), 1-44. https://doi.org/10.1080/10641260091129161

Datta, S. N., Kaur, V. I., Dhawan, A., Jassal, G. 2013. Estimation of length-weight relationship and condition factor of spotted snakehead *Channa punctata* (Bloch) under different feeding regimes. *SpringerPlus, 2,* 436. https://doi.org/10.1186/2193-1801-2-436

Erguden, S. A., Goksu, M. Z. L. 2009. Length–weight relationships for 12 fish species caught in Seyhan Dam Lake in southern Anatolia, Adana, Turkey. *Journal of Applied Ichthyology, 25*(4), 501-502. https://doi.org/10.1111/j.1439-0426.2009.01231.x

Erguden, S. A., Goksu, M. Z. L. 2010. Age, growth and sex ratio of tench Tinca tinca (L., 1758) in Seyhan Dam Lake, Turkey. *Journal of Applied Ichthyology*, *26*(4), 546-549. https://doi.org/10.1111/j.1439-0426.2010.01476.x

Epler, P., Nowak, M., Popek, W. 2009. Growth rate of the chub (*Squalius cephalus*) and the nase (*Chondrostoma nasus*) from Raba, Dunajec, and Poprad River. *Aquaculture, Aquarium, Conservation & Legislation, 2*(1), 1-8.

Esmaeili, H. R. 2001. Biology of an exotic fish silver carp *Hypophthalmichthys molitrix* valenciennes from Gobindsagar reservoir Himachal Pradesh India. PhD thesis. Panjab University, Chandigarh, India.

FAO, 2003. Fisheries management.The ecosystem approach to fisheries. *FAO Technical Guidelines for Responsible Fisheries. No.*4, Suppl.2.Rome,112p.

Froese, R. 2006. Length-weight relationships for 18 less-studied fish species. *Journal of Applied Ichthyology, 14*(1-2), 117-118. https://doi.org/10.1111/j.1439-0426.1998.tb00626.x

Fulton, T. W. 1911. In: The sovereignty of the sea: an historical account of the claims of England to the dominion of the British seas, and of the evolution of the territorial waters. W. Blackwood (Ed.), Edinburgh, London. 799 pp.

Gaygusuz, Ç. G. 2018. Age and Growth of Rudd, Scardinius erythophthalmus (Linnaeus, 1758), in Ömerli Reservoir (İstanbul, Turkey). *Aquatic Sciences and Engineering, 33*(1), 25-31.

Geldiay, R., Balık, S. 2009. Türkiye Tatlısu Balıkları. [Freshwater fish in Turkey.] Ege University, Faculty of Fisheries Textbook, Series:46, VI. Press, Izmir, pp 648.

Gonçalves, J. M. S., Bentes, L., Lino, P. G., Ribeiro, J., Canário, A. V., Erzini, K. 1997. Weight-length relationships for selected fish species of the small-scale demersal fisheries of the south and south-west coast of Portugal. *Fisheries research, 30*(3), 253-

256. https://doi.org/10.1016/S0165-7836(96)00569-3

Jamali, H., Paydarb, M., Radmehrc, B., Salmah, I., Dadrasniaa, A. 2015. Prevalence and antimicrobial resistance of *Staphylococcus aureus* isolated from raw milk and dairy products. *Food Control, 18*(1), 1-12. https://doi.org/10.1016%2Fj.foodcont.2015.02.013

Haimovici, M., Velasco, G. 2000. Length weight relationship of marine fishes from southern Brazil. Naga, The ICLARM Quarterly, *23*(1), 1-5.

Hossain, M. S., Hein, L., Rip, F. I., Dearing, J. A. 2015. Integrating ecosystem services and climate change responses in coastal wetlands development plans for Bangladesh. *Mitigation and Adaptation strategies for global Change, 20*, 241-261. https://doi.org/10.1007/s11027-013-9489-4

Kahraman, A. E., Göktürk, D., Aydin, E. 2014. Length-weight relationships of five fish species from the Sakarya River, Turkey. *Annual Research & Review in Biology*, 2476-2483. https://doi.org/10.9734/ARRB/2014/7513

Khristenko, D. S., Kotovska, G. O. 2017. Length-weight relationship and condition factors of freshwater bream *Abramis brama* (Linnaeus, 1758) from the Kremenchug Reservoir, Middle Dnieper. *Turkish Journal of Fisheries and Aquatic Sciences, 17*(1), 71-77. https://doi.org/10.4194/1303-2712-v17_1_09

Kottelat, M., Freyhof, J. 2007. Handbook of European Freshwater Fishes. Switzerlan" d. Imprimerie du Démocrate SA, Delémont.

Kuru, M. 2004. Türkiye İçsu Balıklarının Son Sistematik Durumu,(Recent Systematic Status of Inland Water Fishes of Turkey), Gazi Üniversitesi, Eğitim Fak.

Küçük, F., Güçlü, S. 2004. Growth and Food of Pike (*Esox luc*ius L., 1758) Population in Lake Çapalı. *SDÜ Eğirdir Su Ürünleri Fakültesi Dergisi*, *2*, 32-38.

Le Cren, E. D. 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). *The Journal of Animal Ecology*, 201-219. https://doi.org/10.2307/1540

Litvinenko, V., Kotovska, G., Buzevitch, O., Khrystenko, D. 2021. Length-weight relationship and condition factors of white bream (*Blicca bjoerkna* (Linnaeus, 1758)) from the Kyiv Reservoir. *Aquaculture, Aquarium, Conservation & Legislation, 14*(6), 3283-3290.

Mehanna,S.F., Farouk,A.E. 2021.Length-Weight Relation ship of 60 Fish Species From the Eastern Mediterranean Sea, Egypt (GFCM-GSA26). *Frontiers in Marine Science, 49*(3), 361-367. https://doi.org/10.3389/fmars.2021.625422625422

Mommsen, T. P. 1998. Growth and metabolism. The physiology of fishes, 2, 65-97.

Moradinasab, Gh., Daliri, M., Ghorbani, R., Paighambari, S.Y., Davoodi, R. 2012. Length-weight and length-length relationships, Relative condition factor and Fulton? s condition factor of Five Cyprinid species in Anzali wetland, southwest of the Caspian Sea. *Caspian Journal of Environmental Sciences, 10*(1), 25-31.

Morato, T., Afonso, P., Lourinho, P., Barreiros, J. P., Santos, R. S., Nash, R. D. M. 2001. Length–weight relationships for 21 coastal fish species of the Azores, north-eastern Atlantic. *Fisheries Research, 50*(3), 297-302.

Nadaf, S. B., Bhilave, M. P., Bhosale, S. V. 2013. Length-weight relationship (LWR) in freshwater fishes fed on formulated feed. *Bionano Frontier, 6*(2), 232-236.

Neff, B.D., Cargnelli, L.M. 2004. Relationships Between Condition Factors, Parasite Load and Paternity in Bluegill Sunfish, Lepomis macrochirus. *Environmental Biology of Fishes, 71*, 297–304.

Okgerman, H. C., Elp, M., Atasağun, S. 2012. The growth and reproduction of white bream (*Blicca bjoerkna* L. 1758) in an oligo-mesotrophic lake in northwest Anatolia (Sapanca, Turkey). *Turkish Journal of Biology, 36*(1), 125-134.

Rajput, V., Dipanshu, Gaur, R. 2019. Length-weight relationship and condition factor of fresh water fish from Himalayan state. *Octa Journal of Biosciences, 7*(2), 74-78.

Petrakis, G., Stergiou, K. I. 1995. Weight-length relationships for 33 fish species in Greek waters. *Fisheries research, 21*(3-4), 465-469. https://doi.org/10.1016/0165-7836(94)00294-7

Reis, İ., Cerim, H., Ateş, C. 2019. Length-weight relationship of 13 fish species from the Lower Sakarya River, Turkey. *Aquatic Sciences and Engineering, 34*(3), 86-89.

Ricker,W.E. 1975.Computation and interpretation of biological statistics for fish populations. Bull.Fish.Res.BoardCan., 191,382.

Saç, G., Okgerman, H. 2016. Büyükçekmece Rezervuarı (İstanbul, Türkiye)'ndaki bazı balık türlerinin boy-ağırlık ve boy-boy ilişkileri ile kondisyon faktörleri. *Journal of Limnology and Freshwater Fisheries Research, 2*(1), 43-48. https://doi.org/10.17216/limnofish.205786

Sadeghi, R., Esmaeili, H. R. 2018. Length-weight relationships of three gobiid species (Perciformes: Gobiidae) along the Iranian intertidal coast of the Persian Gulf and Makran Sea. *Journal of Applied Ichthyology, 34*(5), 1233-1234. https://doi.org/10.1111/jai.13765

Sasi, H., Berber, S. 2012. Age, growth and some biological characteristics of white bream (*Blicca bjoerkna* L., 1758) in Uluabat Lake, in northwestern of Anatolia. *Asian Journal of Animal and Veterinary Advances, 7*(3), 262-267. https://doi.org/10.3923/ajava.2012.262.267

Saygin, S., Yilmaz, S., Yazicioglu, O., Polat, N. 2016. Biological characteristics of European perch (*Perca fluviatilis* L., 1758) inhabiting Lake Ladik (Samsun, Turkey). *Croatian Journal of Fisheries, 74*(4), 141-148. https://doi.org/10.1515/cjf-2016-0017

Saylar, Ö., Gül, G., Yılmaz, M., Gül, A. 2018. Some Biological Features of Tinca tinca Population inAsartepe Reservoir (Ankara). *Journal of Agricultural Science and Technology B, 8*(7). https://doi.org/10.17265/2161-6264/2018.07.006

Saylar, Ö., Gül, G., Yılmaz, M., Gül, A. 2019. Some Biological Characteristics of *Carassius gibelio* (Bloch, 1782) Living in Ankara Asartepe Dam Lake. *Nevşehir Bilim ve Teknoloji Dergisi, 8*(1) 14-25. https://doi.org/10.17100/nevbiltek.565112

Sheikh, Z. A., Ahmed, I. 2018. Length-weight relationship and condition factor of Schizothorax plagiostomus found in River Jhelum from Kashmir valley. *Journal of Ecophysiology and Occupational Health, 18*(3&4), 66-72. https://doi.org/10.18311/jeoh/2018/v18i3&4/19991

Sokal, R. R., Rohlf, F. J. 1987. Introduction to Biostatistics, 2 nd Edition. Freeman, New York, 363 p.

Tarkan, A. S., Gaygusuz, Ö., Acıpınar, H., Gürsoy, Ç., Özuluğ, M. 2006. Length–weight relationship of fishes from the Marmara region (NW-Turkey). *Journal of Applied Ichthyology, 22*(4), 271-273.

Teixeira, E. C., Silva, V. E. L., Fabré, N. N., Batista, V. S. 2017. Length–weight relationships for four stingray species from the tropical Atlantic Ocean. *Journal of Applied Ichthyology, 33*(3), 594-596.

Uysal, R., Yağcı, M. A., Yeğen, V., Alp, A., Yağcı, A. 2008. The growth features of Pike (*Esox lucius* L., 1758) Population in Lake Işıklı (Çivril-Denizli). *Ege Journal of Fisheries and Aquatic Sciences, 25*(4). https://doi.org/10.12714/egejfas.2008.25.4.5000156606

Uysal, R., Apaydın Yağci, M., Yeğen, V., Cesur, M., Yağci, A., Çetinkaya, S., Bostan, H. (2009). Growth Properties of European Catfish (Silurus glanis L., 1758) Population in İznik Lake (Bursa-Turkey*). Journal of Natural and Applied Sciences, 13*(3), 221-228.

Wootton, R. J. 2012. *Ecology of teleost fishes* (Vol. 1). Springer Science & Business Media.

Yazıcıoğlu, O., Yazıcı, R. 2023. Some Biological Features of Tench (*Tinca tinca*, L., 1758) Inhabiting Sıddıklı Dam. *Black Sea Journal of Agriculture*, *6*(2), 204-209. https://doi.org/10.47115/bsagriculture.1249974

Yılmaz, S., Yılmaz, M., PolaT, N. 2007. A research on Age-Length, Age-Weight and Length-Weight Relationships of *Silurus glanis* L., 1758 Population in Altınkaya Dam Lake (Samsun). *Süleyman Demirel Üniversitesi Fen Edebiyat Fakültesi Fen Dergisi, 2*(1), 18-26.

Yılmaz, S., Yazıcıoğlu, O., Erbaşaran, M., Esen, S., Zengin, M., Polat, N. 2012. Length-weight relationship and relative condition factor of white bream, *Blicca bjoerkna* (L., 1758), from Lake Ladik, Turkey. *Journal of Black Sea/Mediterranean Environment, 18*(3), 380-387.

Yılmaz, S., Yazıcıoğlu, O., Yazıcı, R., Polat, N. 2015. Age, growth and reproductive period of white bream, *Blicca bjoerkna* (L., 1758) in Lake Ladik, Turkey. *Journal of Limnology and Freshwater Fisheries Research, 1*(1), 9-18.

Yılmaz, S., Erbaşaran, M., Yazıcıoğlu, O., Polat, N. 2015. Age, growth and reproductive season of freshwater bream, *Abramis brama* (L., 1758) in Lake Ladik (Samsun, Türkiye). *Süleyman Demirel University Faculty of Arts and Science Journal of Science, 10*(1), 1-22.

Yılmaz, F. 2016. Bioecology and Determination of Distribution Maps of Anatidae Species in Some Lakes (Sapanca, Poyrazlar, Taşkısığı and Küçük Akgöl) in The Eastern Marmara Region. Phd Thesis-Sakarya University Institute of Science, 210 pp.

Yurchenko, V. V., Morozov, A. A. 2020. Data on length-weight relationships and mean condition factor for *Abramis brama* and *Perca fluviatilis*. *Data in brief, 29*, 105204. https://doi.org/10.1016/j.dib.2020.105204

Yüngül, M., Karaman, Z., Dörücü, M. 2014. Çelik Gölü'nde Yaşayan Yayın Balığı (*Silurus glanis* Linnaeus, 1758)'nın Yaş ve Bazı Büyüme Özellikleri. Aquaculture Studies, 2014(4).

Zar, J. H. 2010. BiostatisticalAnalysis, Prentice Hall, NewJersey, NJ, USA.

Zargar, U. R., Yousuf, A. R., Mushtaq, B., Dilafroza, J. A. N. 2012. Length-weight relationship of the *crucian carp*, *Carassius carassius* in relation to water quality, sex and season in some lentic water bodies of Kashmir Himalayas. *Turkish Journal of Fisheries and Aquatic Sciences, 12*(3), 683-689. https://doi.org/10.4194/1303-2712-v12_3_17