



## Length-Weight Relationships of Ten Fish Species From Lake Eğirdir, Turkey

Meral APAYDIN YAĞCI\* Ahmet Alp<sup>2</sup> Abdulkadir YAĞCI<sup>1</sup> Rahmi Uysal<sup>3</sup> Fuat Bilgin<sup>4</sup> Mehmet Cesur<sup>5</sup> Vedat Yeğen<sup>4</sup>

<sup>1</sup>Sheep Breeding Research Institute, Republic of Turkey Ministry of Agriculture and Forestry, Bandırma, Balıkesir, Turkey

<sup>2</sup>Department of Fisheries, Faculty of Agriculture, University of Kahramanmaraş Sütçü İmam, 46100, Kahramanmaraş, Turkey

<sup>3</sup>Isparta Directorate of Provincial Agriculture and Forestry, Republic of Turkey Ministry of Agriculture and Forestry, Eğirdir, Isparta, Turkey

<sup>4</sup>Fisheries Research Institute, Republic of Turkey Ministry of Agriculture and Forestry, 32500, Eğirdir, Isparta, Turkey

<sup>5</sup>18<sup>th</sup> Regional Directorate of State Hydraulic Works, Isparta, Turkey

Geliş/Received: 16.08. 2021

Kabul/Accepted: 28.03. 2022

Yayın/Published: 30.06. 2022

How to cite: Apaydın Yağcı, M., Alp, A., Yağcı, A., Uysal, R., Bilgin, F., Cesur, M. & Yeğen V.. (2022). Length-Weight Relationships of Ten Fish Species From Lake Eğirdir, Turkey. *J. Anatolian Env. and Anim. Sciences*, 7(2), 105-109.

Atıf yapmak için: Apaydın Yağcı, M., Alp, A., Yağcı, A., Uysal, R., Bilgin, F., Cesur, M. & Yeğen V.. (2022). Eğirdir Gölü'nden 10 Balık Türünün Boy-Ağırlık İlişkisi. *Anadolu Çev. ve Hay. Dergisi*, 7(2), 105-109.

\*ID: <https://orcid.org/0000-0002-2108-1853>  
ID: <https://orcid.org/0000-0002-0416-3670>  
ID: <https://orcid.org/0000-0002-7897-1734>  
ID: <https://orcid.org/0000-0002-7342-9380>  
ID: <https://orcid.org/0000-0002-2307-3611>  
ID: <https://orcid.org/0000-0002-7482-6353>  
ID: <https://orcid.org/0000-0001-5349-1497>

### \*Corresponding author's:

Meral APAYDIN YAĞCI  
Sheep Breeding Research Institute, Republic of  
Turkey Ministry of Agriculture and Forestry,  
Bandırma, Balıkesir, Turkey  
✉: [meralyagci@gmail.com](mailto:meralyagci@gmail.com)

**Abstract:** In this study, length-weight relationship for 10 fish species (*Cyprinus carpio* (common and mirror carp), *Anatolichthys iconii*, *Atherina boyeri*, *Carassius gibelio*, *Pseudophoxinus egridiri*, *Pseudorasbora parva*, *Sander lucioperca*, *Seminemacheilus ispartensis* and *Vimba vimba*) in Lake Eğirdir were assessed. Samples were obtained monthly from January 2010 to June 2011 of Lake Eğirdir, in Turkey. Moreover, for 3 Anatolian endemics species (*A. iconii*, *S. ispartensis* and *P. egridiri*) determined for the first time new maximum lengths are recorded.

**Keywords:** Endangered fish, fishbase, growth type, lake Eğirdir, red list, Turkey.

## Eğirdir Gölü'nden 10 Balık Türünün Boy-Ağırlık İlişkisi

### \*Sorumlu yazar:

Meral APAYDIN YAĞCI  
Koyunculuk Araştırma Enstitüsü Müdürlüğü,  
T.C. Tarım ve Orman Bakanlığı, Bandırma,  
Balıkesir, Türkiye.  
✉: [meralyagci@gmail.com](mailto:meralyagci@gmail.com)

**Öz:** Bu çalışmada; Eğirdir Gölü'nde 10 balık türünde (*Cyprinus carpio* (pullu ve aynalı sazan), *Anatolichthys iconii*, *Atherina boyeri*, *Carassius gibelio*, *Pseudophoxinus egridiri*, *Pseudorasbora parva*, *Sander lucioperca*, *Seminemacheilus ispartensis* ve *Vimba vimba*) boy-ağırlık ilişkisi değerlendirilmiştir. Türkiye'de Eğirdir Gölü'nden Ocak 2010'dan Haziran 2011'e kadar aylık olarak numuneler alınmıştır. Ayrıca ilk kez belirlenen 3 Anadolu endemik türü (*A. iconii*, *S. ispartensis* ve *P. egridiri*) için yeni maksimum uzunluklar kaydedilmiştir.

**Anahtar kelimeler:** Büyüme tipi, Eğirdir gölü, fishbase, kırmızı liste, nesli tükenmekte olan balık, Türkiye.

## INTRODUCTION

Eğirdir Lake, which is a tectonic lake, is located at about 924 m from sea level with a total surface area of 500 km<sup>2</sup> and the second largest freshwater in Turkey (Lahn, 1948; Numann, 1958). Information of length-weight relationships are principal in fisheries sustainability and population dynamics (Tarkan & Vilizzi, 2016). In addition, length-weight relationship with the expressed fish growth

is isometric or allometric (Le Cren, 1951; Ricker, 1975; Pe'rez-Bote & Roso, 2012).

Length-weight relationship parameters (a and b), gives the possibility to estimate the size of fish by weight, the calculation of the index condition, in different habitats populations of morphology and to compare their life cycle (Britton & Davies, 2007; Yılmaz et al., 2007; Yılmaz et al., 2010; Pe'rez-Bote & Roso, 2012; Giosa et al., 2014; Alagoz Erguden, 2015; Yoğurtçuoğlu & Ekmekçi, 2015;

Saç & Okgerman, 2016; Sungur Birecikligil et al., 2016; İlhan & İlhan, 2018). Up to now, several studies regarding the fish fauna in Eğirdir Lake were conducted (Küçük et al., 2009; Güçlü, 2012; Yerli et al., 2013; Yağcı et al., 2016). The present study describes the length-weight relationships for ten fish species (3 native, 4 introduced and 3 endemic) inhabiting the Lake Eğirdir. This research reports the new length-weight relationships for two endemic (*S.ispartensis* and *P.egridiri*) species for Lake Eğirdir in Turkey.

**MATERIAL AND METHOD**

Fish specimens were collected monthly from January 2010 to June 2011 in Lake Eğirdir. Fish measured for total length (TL) to the nearest centimeter and weighed (W) to the nearest gram. Fish were collected using different mesh size (10x10, 16x16, 20x20, 25x25, 30x30, 35x35, 40x40, 45x45, 50x50, 55x55, 60x60, 65x65, 70x70, 80x80, 100x100 mm) gillnets that one of them length (10x10 mm) were 25 meters, fifteen of them length were 100 meters and seine-net (mesh size: 0.9 mm). For each species, the length-weight relationship was calculated using the expression:  $\text{Log}W = \text{Log} a + b \text{Log} L$ , where “W” is the weight (g) and “L” the total length (cm), “a” is the intercept of the regression and “b” is the slope or regression coefficient (i.e., “a” is a coefficient related to body form and “b” is an exponent indicating isometric growth when equal to 3 and indicating allometric growth when significantly different

from 3) (Le Cren, 1951; Froese, 2006). Whether the b values obtained from the length-weight relationship of the samples were different from 3 was determined using the t-test. The t-test results of b values were taken into account while determining the growth types of the species. In addition, 95% confidence intervals (95%CI) of a and b values for species were also calculated (Zar, 1999). The ethics committee report of the project was obtained from the Süleyman Demirel University (SDU) Animal Experiments Local Ethics Committee and was approved by the SDU Animal Experiments Local Ethics Committee (Date 25.12.2018 and Decision No: 01).

**RESULTS**

A total of 7670 specimens from ten fish species (Table 1), each belonging to a different family, were analyzed. *A. boyeri* was caught with the seine-net and gillnet, other fish species were caught with the gillnets. The parameters of the LWR of the ten fish species are presented. Also, according to the information in FishBase length-weight relationships and maximum total lengths for three endemic species are reported here for the first time (Table 1). The most abundant species included *Carassius gibelio* and *Atherina boyeri*. Length and weight data were plotted for each species (Figures 1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h, 1i, 1j).

**Table 1.** The length-weight relationship parameters for ten fish species from Lake Eğirdir, Turkey

Family/species	IUCN Category	N	Length (TL, cm)		Weight (g)		Parameters		aCL <sub>95%</sub>		bCL <sub>95%</sub>		r <sup>2</sup>	t <sub>th</sub>	Growth type
			Min	Max	Min	Max	a	b	Min	Max	Min	Max			
<b>Cyprinidae</b>															
<i>Cyprinus carpio</i> (Common carp/native)	VU	305	9.3	65.7	12.4	5622	0.0140	3.0834	0.0120	0.0160	3.0507	3.1173	.9907	3,02 <sup>a</sup>	A+
<i>Cyprinus carpio</i> (Mirror carp/ introduced)	VU	30	15	53	55.9	2633	0.0110	3.1580	0.0069	0.0151	3.0518	3.2642	.9924	4,85 <sup>b</sup>	A+
<i>Carassius gibelio</i> (Prussian carp/introduced)	LC	3987	6.9	38.2	3.7	1266	0.0108	3.1711	0.0110	0.0110	3.1573	3.1847	.9793	23,44 <sup>c</sup>	A+
<i>Pseudophoxinus egridiri</i> (Eğirdir minnow/endemic)	EN	551	4.7	<b>10</b>	2.4	17.4	0.0182	2.9425	0.0141	0.0219	2.8579	3.0421	.8808	1,24 <sup>d</sup>	A-
<i>Pseudorasbora parva</i> (Topmouth gudgeon/introduced)	LC	88	6.1	11.1	3.5	25.5	0.0080	3.3215	0.0060	0.0010	3.1652	3.4788	.9530	4,04 <sup>e</sup>	A+
<i>Vimba vimba</i> (Vimba bream/native)	LC	334	12.2	35.9	18.2	576.5	0.0057	3.2116	0.0060	0.0060	3.1748	3.2492	.9891	11,42 <sup>f</sup>	A+
<b>Atherinidae</b>															
<i>Atherina boyeri</i> (Big-scale sand smelt/ introduced)	LC	2098	2.7	10.4	0.12	9.42	0.0048	3.1729	0.0040	0.0040	3.1886	3.2474	.9663	14,47 <sup>g</sup>	A+
<b>Cyprinodontidae</b>															
<i>Anatolichthys iconii</i> (Icon toothcarp/endemic)	NE	47	4.3	<b>6.1</b>	2.25	3.2	0.2086	1.6168	0.0918	0.3262	1.2694	1.9646	.6630	8,05 <sup>h</sup>	A-
<b>Percidae</b>															
<i>Sander lucioperca</i> (Pike-perch/introduced)	LC	166	16.3	66.4	105	3091	0.0055	3.136	0.0051	0.0129	2.8871	3.0909	.9872	4,89 <sup>i</sup>	A+
<b>Balitoridae</b>															
<i>Seminemacheilus ispartensis</i> (Southern pond loach/endemic)	VU	64	6.7	<b>12.2</b>	4.43	17.3	0.0286	2.5398	0.2763	0.3037	2.3185	2.7615	.8900	4,06 <sup>j</sup>	A-

a, (t-test,  $t_{10} > t_{0.05, 30} = 1.70$ ); b, (t-test,  $t_{10} < t_{0.05, 30} = 1.65$ ); c, (t-test,  $t_{10} > t_{0.05, 3987} = 1.64$ ); d, (t-test,  $t_{10} > t_{0.05, 551} = 1.65$ ); e, (t-test,  $t_{10} < t_{0.05, 88} = 1.66$ ); f, (t-test,  $t_{10} > t_{0.05, 334} = 1.65$ ); g, (t-test,  $t_{10} > t_{0.05, 2098} = 1.65$ ); h, (t-test,  $t_{10} < t_{0.05, 47} = 1.68$ ); i, (t-test,  $t_{10} > t_{0.05, 166} = 1.65$ ); j, (t-test,  $t_{10} > t_{0.05, 64} = 1.67$ )  
 N, number of individuals; a, intercept of the relationship; b, slope of the relationship; r<sup>2</sup>, coefficient of determination; CL, confidence limits;  
 A+, allometric positive; A-, allometric negative. New maximum lengths data in bold

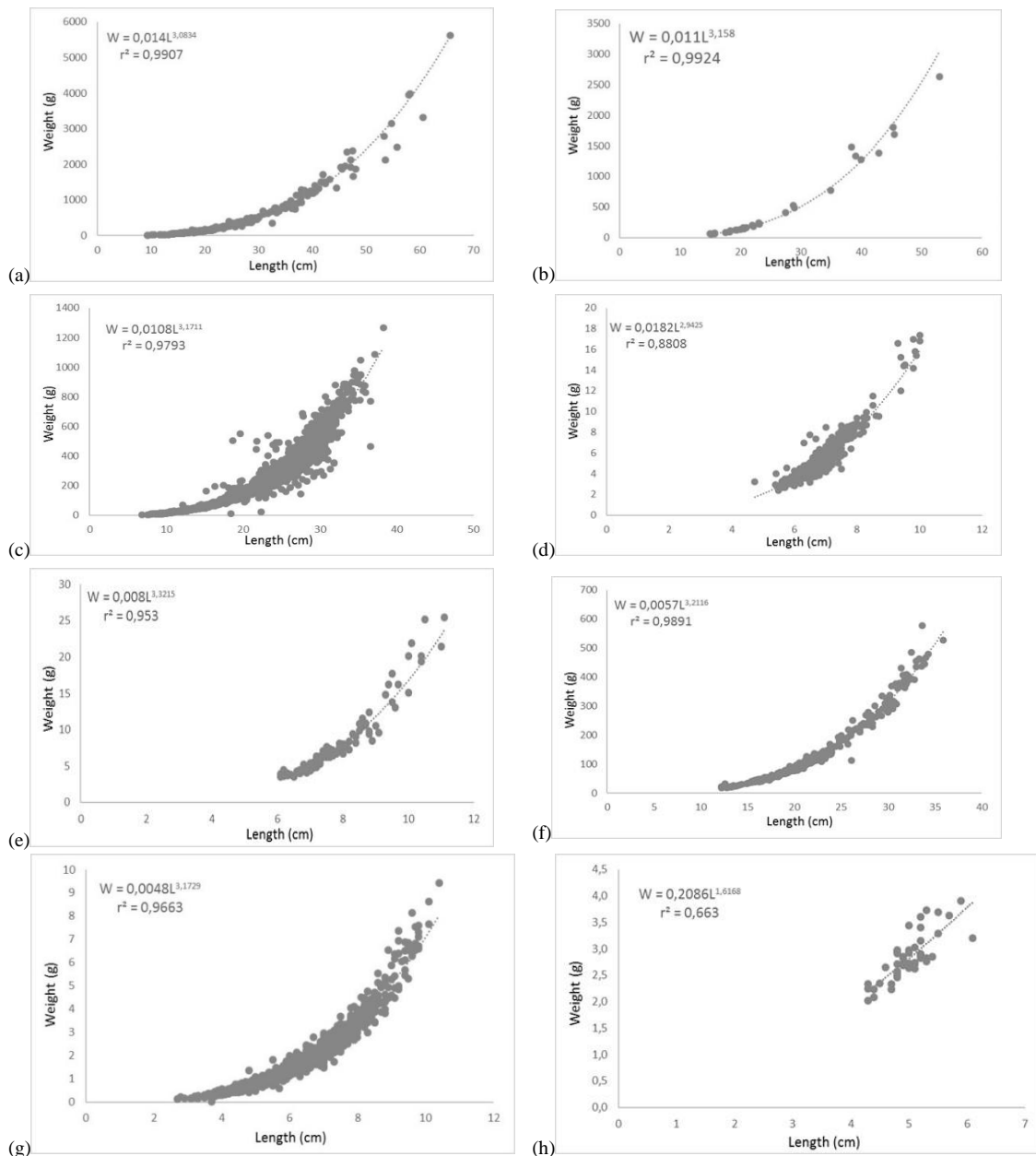
**DISCUSSION AND CONCLUSION**

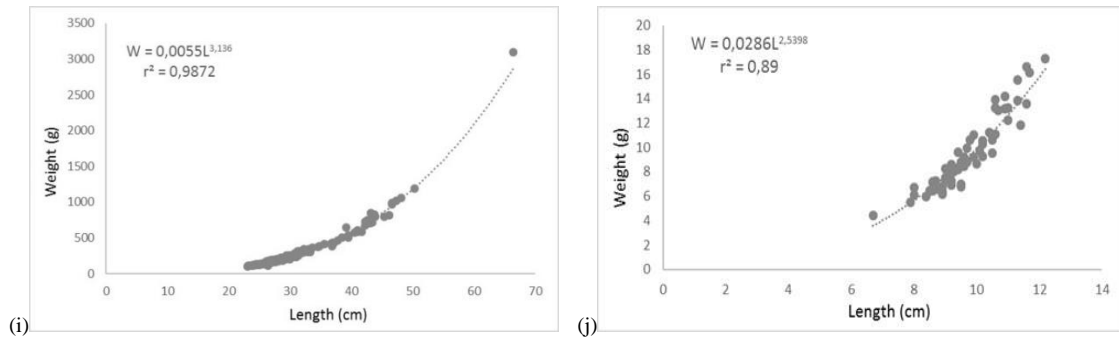
The “a” value in the length-weight relationship equation in fish shows the average condition of the individuals, while the “b” value shows the shape of the fish according to the conditions it is in (Avşar, 2005). In general, for all species estimated “b” values, fell within expected range of 2.7-3.4 (Froese, 2006). It has been

reported that the length-weight relationship was strong (r<sup>2</sup>=0.988) in *Carassius gibelio* samples captured from Lake Ladik, and the calculated b value was different from 3 (b>3) and the result was positive allometric (Yazıcıoğlu et al., 2013). In the present study, the correlation coefficient (r<sup>2</sup>) was found to be 0.990 while for *Cyprinus carpio* (common carp), Zencir Tanır (2020) recorded a correlation coefficient 0.972 in Tercan Dam Lake

(Turkey). The value of growth coefficient (b) was estimated as 3.083 which not differed significantly from value of 3, indicating a positive allometric growth for the *C. carpio*. Saylar & Şanlı Benzer, (2014) have informed negative allometric growth for *C. carpio* in Mogan Lake, with b values 2.8. However, positive allometric growth for *C. carpio* has been reported by Karataş et al., (2007) who reported b value 3.31 in Almus Dam Lake. The exponent of the length-weight relationship for *Sander lucioperca* indicate positive allometric growth (b=3,13) in this study. While *S. lucioperca* showed positive allometric growth in 2004 (b= 3,14 ; Balık et al., 2004) in Lake Eğirdir in Turkey, it showed negative allometric growth in another study conducted in 2006 (İzci & Kuşat, 2006). Length-weight relationship in Turkey (Ablak & Yılmaz, 2004) (b=3,07), in Tunisia (M'Hetli et al., 2011) (b=3,06) indicate

isometric growth. *Atherina boyeri* is found in freshwater, lagoon and marine environments. With the b value obtained in this study, *A. boyeri* showed positive allometric (b=3.17) growth. With previous studies in the lake (b=3.25, Bostancı et al., 2014; b=2.78, İnnal & Engin, 2020) and studies conducted in different ecosystems in Turkey (b=3.29, Gençoğlu and Ekmekçi 2016; b= 3.20, Özeren 2009; b=2.90, İlhan & Sarı, 2015; b=2.94, İnnal & Engin, 2020) showed similar growth. The b value of *Pseudorasbora parva* fish was determined as 3.32 in this study (positive allometric). It was reported as 3.03-2.97 in Hirfanlı dam lake (Benzer & Benzer, 2020), 2.83-2.94 in Mogan lake (Benzer et al., 2016) 3.1 in Tajan River (Aazami et al., 2015) and 3.047 in Island ecosystem (Gökçecada) (Ağdamar and Gaygusuz, 2021).





**Figure 1.** Total length and weight plotted for: *Cyprinus carpio* (common carp) (1a); *Cyprinus carpio* (mirror carp) (1b); *Carassius gibelio* (1c); *Pseudophoxinus egridiri* (1d); *Pseudorasbora parva* (1e); *Vimba vimba* (1f); *Atherina boyeri* (1g); *Anatolichthys iconii* (1h); *Sander lucioperca* (1i); *Seminemacheilus ispartensis* (1j)

The lowest “b” value found for the species *Anatolichthys iconii* could be attributed, among others, to the narrow length range of captured specimens (4.3-6.1 cm). All regressions were strong relationship (with  $r^2 \geq 0.890$ , only except *A.iconii* (with  $r^2 \geq 0.663$ ). According to one way t-test of specimens, *P. egridiri*, isometric; *A.iconii*, and *S.ispartensis*, negative allometric; other species showed positive allometric growth type (Table 1). *A.iconii*, *S.ispartensis* and *P. egridiri* were listed in the Turkey species Red list in 2014 categorized as an Near Threatened, Vulnerable and Endangered in Fishbase. In conclusion, this research provides new information on the biology of freshwater fish belonging to Anatolian endemics on this Red list species in Turkey and information on the length-weight relationships of 10 fish species from the Lake Eğirdir. Finally, our study will be contribute for endemic species, especially *S.ispartensis* and *P. egridiri*, *A.iconii*, awareness, management and conservation.

#### ACKNOWLEDGEMENTS

This study was funded by the General Directorate of Agricultural Research and Policies, Republic of Turkey Ministry of Agriculture and Forestry (TAGEM/HAYSÜD/2010-09-01-01 Project No).

#### REFERENCES

- Aazami, J., Esmaili -Sari, A., Abdoli, A., Sohrabi, H. & Van Den Brink, P.J. (2015). Length-weight relationships of 14 fish species from Tajan River, Southern Caspian Sea basin, Iran. *Iranian Journal of Ichthyology*, 2( 4), 299 -301.
- Ablak, Ö. & Yılmaz, M. (2004). Growth properties of Pikeperch (*Sander lucioperca* (L., 1758)) living in Hirfanlı Dam Lake. *Turkish Journal of Veterinary and Animal Sciences*, 28, 455-463.
- Ağdamar, S. & Gaygusuz, Ö. (2021). Condition, length-length and length-weight relationship for four introduced freshwater fish species from an island ecosystem (Gökçeada, Turkey). *Journal of Anatolian Environmental and Animal Sciences*, 6(3), 403-408. DOI: 10.35229/jaes.923425
- Alagoz Erguden, S. (2015). Determination of condition factor and length-weight relationship of the Prucian carp, *Carassius gibelio* (Bloch, 1782) inhabiting Seyhan Dam Lake. *International Journal of Scientific and Technological Research*, 1(1), 157-166.
- Avşar, D. (2005). Balıkçılık biyolojisi ve populasyon dinamiği. Nobel Kitabevi, 332p. Adana.
- Balık, İ., Çubuk, H., Özkök, R. & Uysal, R. (2004). Size composition, growth characteristics and stock analysis of the Pikeperch, *Sander lucioperca* (L. 1758), population in Lake Eğirdir. *Turkish Journal of Veterinary and Animal Sciences*, 28, 715-722.
- Benzer, S. & Benzer, R. (2016). Evaluation of growth in pike (*Esox lucius* L., 1758) using traditional methods and artificial neural networks. *Applied Ecology and Environmental Research*, 14(2), 543-554. DOI: 10.15666/aer/1402\_543554
- Benzer, S. & Benzer, R., 2020. Growth and length-weight relationships of *Pseudorasbora parva* (Temminck & Schlegel, 1846) in Hirfanlı Dam Lake: Comparison with traditional and artificial neural networks approaches. *Iranian Journal of Fisheries Sciences*, 19(3)1098-1110. DOI: 10.22092/ijfs.2018.119889
- Bostancı, D., Apaydın Yağcı, M., Konaş, S., Kurucu, G. & Polat, N. (2014). İstilacı Bir Tür *Atherina boyeri* Risso, 1810 'nın Eğirdir Gölü Popülasyonunda Morfometrikve Bazı Kemiksi Yapıların Biyometrik Özellikleri, *Eğirdir Su Ürünleri Fakültesi Dergisi*, 10, 1-11.
- Britton, J.R. & Davies, G.D. (2007). Length–weight relationships of the invasive topmouth gudgeon (*Pseudorasbora parva*) in ten lakes in the UK. *Journal of Applied Ichthyology*, 23, 624-626.
- Freyhof, J. & Yagurcuoglu, B. (2020). A proposal for a new generic structure of the killifish family Aphaniidae, with the description of *Aphaniops teimorii* (Teleostei: Cyprinodontiformes). *Zootaxa*, 4810(3), 421-451.
- Froese, R. (2006). Cube law, condition factor and weight-length relationship: History, meta-analysis and recommendations. *Journal of Applied Ichthyology*, 22(4), 241-253.
- Gençoğlu, L. & Ekmekçi, F. G. (2016). Growth and reproduction of a marine fish, *Atherina boyeri* Risso 1810, in a freshwater ecosystem, *Turkish Journal of Zoology*, 40, 534-542. DOI: 10.3906/zoo-1406-42

- Giosa, M.D., 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*, 7p.
- Güçlü, S.S. (2012).** Population structure of killifish, *Aphanius anatoliae* (Cyprinodontidae) endemic to Anatolia in Lake Eğirdir-Isparta (Turkey). *Iranian Journal of Fisheries Sciences*, 11(4), 786-795.
- İlhan, A. & Sarı, H.M. (2015).** Length-weight relationships of fish species in Marmara Lake, West Anatolia, Turkey. *Croatian Journal of Fisheries*, 73, 30-32. DOI: 10.14798/73.1.784
- İlhan, A. & İlhan, D. (2018).** Length-weight relationship and condition of big-scale sand smelt (*Atherina boyeri* Risso, 1810) from Marmara Lake (Manisa) and Homa Lagoon (İzmir). *The Black Sea Journal of Sciences*, 8(1), 25-34.
- İnnal, D. & Engin, S. (2020).** Length-weight relationships of *Atherina boyeri* Risso, 1810 and *A. hepsetus* Linnaeus, 1758 (Teleostei: Atherinidae) from some inland, brackish water and marine systems of Turkey. *Indian Journal of Geo Marine Sciences*, 49(06), 1099-1104.
- İzci, L. & Kuşat, M. (2006).** Some population parameters of Pikeperch (*Sander lucioperca* (L.,1758)) in Lake Eğirdir. *Süleyman Demirel Üniversitesi Fen Bilimleri Enstitüsü Dergisi*, 10, 167-172.
- Karataş, M., Çiçek, E., Başusta, A. & Başusta, N. (2007).** Age, growth and mortality of common carp (*Cyprinus carpio* Linnaeus, 1758) population in Almus Dam Lake (Tokat/Turkey). *Journal of Applied Biological Sciences*, 1, 81-85.
- Küçük, F., Sarı, H.M., Demir, O. & Gülle, İ. (2009).** Review of the ichthyofaunal changes in lake Eğirdir between 1915 and 2007. *Turkish Journal of Zoology*, 33(3), 277-286.
- 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(2), 201-219.
- Lahn, E. (1948).** Türkiye göllerinin jeolojisi ve jeomorfolojisi hakkında bir etüd. *Maden Tetkik ve Arama Enstitüsü Yayınları*, B(12), 87p.
- M'hetli, M., Ben Khemis, I., Hamza, N., Turku, B. & Turku, O. (2011).** Allometric growth and reproductive biology traits of pikeperch *Sander lucioperca* at the southern edge of its range. *Journal of Fish Biology*, 78, 567-579. DOI: 10.1111/j.1095-8649.2010.02878.x
- Numann, W. (1958).** Anadolunun muhtelif göllerinde limnolojik ve balıkçılık ilmi bakımından araştırmalar ve bu göllerde yaşayan sazınlara hakkında özel bir etüd. *İstanbul Üniversitesi Fen Fakültesi Hidrobiyoloji Araştırma Enstitüsü Yayınları*, 7, 112.
- Özeren, S. C. (2009).** Age, growth and reproductive biology of the sand smelt *Atherina boyeri*, Risso 1810 (Pisces: Atherinidae) in Lake Iznik, Turkey. *Journal of Fisheries International*, 4, 34-39.
- Pe'rez-Bote, J.L. & Roso, R. (2012).** Growth and length-weight relationships of *Sander lucioperca* (Linnaeus, 1758) in the Alcántara Reservoir, south-western Spain: comparison with other water bodies in Eurasia. *Journal of Applied Ichthyology*, 28, 264-268.
- Ricker, W.E. (1975).** Computation and Interpretation of Biological Statistics of Fish Populations. *Bulletin of the Fisheries Research Board of Canada*, 191, 1-382.
- Saç, G., Okgerman, H. (2016).** Length-Weight Relationship, Length-Length Relationship and Condition Factor of Some Fish Populations in Büyükçekmece Reservoir (İstanbul, Turkey). *Journal of Limnology and Freshwater Research*, 2(1), 43-48.
- Saylar, Ö. & Şanlı Benzer, S. (2014).** Age and growth characteristics of Carp (*Cyprinus carpio* L., 1758) in Mogan Lake, Ankara, Turkey. *Pakistan Journal of Zoology*, 46(5), 1447-1453.
- Sungur Birecikligil, S., Çiçek, E., Öztürk, S., Seçer, B. & Celepoğlu, Y. (2016).** Length-length, length-weight relationship and condition factor of fishes in Nevşehir Province, Kızılırmak River Basin (Turkey). *Acta Biologica Turcica*, 29(3), 72-77.
- Tarkan, A.S. & Vilizzi, L., A. (2016).** Re-assessment of the growth index for quantifying growth in length of fish with application to Roach, *Rutilus rutilus* (L., 1758). *Journal of Limnology and Freshwater Research*, 2(1), 49-58.
- Yağcı, A., Apaydın Yağcı, M., Bilgin, F. & Erbatır, İ. (2016).** The effects of physicochemical parameters on fish distribution in Eğirdir Lake, Turkey. *Iranian Journal of Fisheries Sciences*, 15(2), 846-857.
- Yazıcıoğlu, O., Yılmaz, S., Yazıcı, R., Polat, N. (2013).** Condition factor, length-weight and length-length relationships of prussian carp, *Carassius gibelio* (Bloch, 1782) inhabiting Lake Ladik, Samsun, Turkey. *The Black Sea Journal of Sciences*, 3(9), 72-80.
- Yerli, S.V., Alp, A., Yeğen, V., Uysal, R., Apaydın Yağcı, M. & Balık, İ. (2013).** Evaluation of the ecological and economical results of the introduced alien fish species in Lake Eğirdir, Turkey. *Turkish Journal of Fisheries and Aquatic Sciences*, 13, 795-809.
- Yılmaz, M., Gül, A. & Saylar, Ö. (2007).** The growth features of *Cyprinus carpio* L., 1758 Living in Hirfanlı Dam Lake Kırşehir. *GÜ, Gazi Eğitim Fakültesi Dergisi*, 27(1), 37-57.
- Yılmaz, S., Polat, N. & Yazıcıoğlu, O. (2010).** Length-weight and length-length relationships of common carp (*Cyprinus carpio* L., 1758) inhabiting inland waters of Samsun province. *The Black Sea Journal of Sciences*, 1(2), 39-47.
- Yoğurtçuoğlu, B. & Ekmekçi, F.G. (2015).** Length-weight and length-length relationships of eight endemic *Aphanius* species from Turkey. *Journal of Applied Ichthyology*, 31, 811-813.
- Zar, J.H. (1999).** Biostatistical Analysis, 4<sup>th</sup> edn. Upper Saddle River, New Jersey: Prentice Hall, 663p.