

# An investigation on length-weight relationships, condition and reproduction of the bleak, *Alburnus alburnus* (L.) population in Çaygören Dam Lake (Balıkesir), Turkey

Zeliha ERDOĞAN, Hatice TORCU KOÇ\*

University of Balıkesir, Faculty of Science and Arts, Department of Biology, Çağış Campus, 10145, Balıkesir, Turkey

Geliş Tarihi (Received Date): 27.07.2016  
Kabul Tarihi (Accepted Date): 20.12.2016

## Abstract

*In this study, length-weight relationships, condition, and reproduction characteristics of 713 bleak (Alburnus alburnus L.) caught from the Çaygören Dam Lake were investigated monthly in the years of 2010-2012. Sex ratio was found as 1:1.04, corresponding to 49% males and 51% females. b values were estimated as 3.26 and 3.22 for females and males (b>3.0) Values of monthly conditions were found to be shown a similar pattern for both sexes. The values of hepatosomatic index were pointed out to be parallel with the values of condition factor. Spawning period of this species was determined to occur between April and August.*

**Keywords:** *Alburnus alburnus*, growth, condition, spawning

Balıkesir, Çaygören Baraj Gölü'ndeki *Alburnus alburnus* (L.) inci balığı populasyonunun boy-ağırlık ilişkileri, kondisyon ve üremesi üzerine bir araştırma

## Özet

*Bu çalışmada, Çaygören Barajından yakalanan 713 adet inci balığının boy-ağırlık ilişkisi, kondisyonu ve üreme özellikleri 2010-2012 yılları arasında aylık olarak incelenmiştir. Eşey oranı %49'u erkek ve %51 dişi olmak üzere, 1: 1,04 olarak bulunmuştur. b değerleri dişi ve erkek için sırasıyla 3.26 ve 3.22 olarak hesaplanmıştır.*

\* Hatice TORCU KOÇ, htorcukoc@hotmail.com, <http://orcid.org/0000-0003-0678-1509>  
Zeliha ERDOĞAN, zaka@balikesir.edu.tr, <http://orcid.org/0000-0002-5725-4402>

( $b > 3.0$ ). Aylık kondisyon değerleri her iki eşey için benzerlik gösterdiği bulunmuştur. Hepato-somatik indeks değerlerinin kondisyon faktörü değerleriyle paralellik gösterdiği ortaya konmuştur. Bu türün yumurtlama periyodunun Nisan-Ağustos ayları arasında gerçekleştiği tespit edilmiştir.

**Anahtar kelimeler:** *Alburnus alburnus*, büyüme, kondisyon, yumurtlama

## 1. Introduction

The genus *Alburnus* Rafinesque, 1820 (Bleaks and Shemayas) belongs to the largest teleost family, Cyprinidae, and comprises 38 recognized species distributed from Europe to northern parts of Southwest Asia [1]. The genus *Alburnus* is an excellent example for high diversity and endemism in the western Palaearctic freshwater fishes. Kottelat and Freyhof [2] reviewed the European species of *Alburnus* in a part of Palaearctic region. Turkey, with 20 recorded species including *Alburnus alburnus* is center of diversity of the genus [3-5]. Despite their wide distribution, taxonomy, systematic and actual distribution of bleaks of *Alburnus* species are still not well known [6]. Besides, the bleak is of little interest to commercial or sport fisheries in its native range because of its small size [7, 8].

However, the reason to study *Alburnus alburnus* is due to being a ring of the food chain and its bright scales are used as pearl essence in the cosmetic industry [2, 9]. Despite their wide distribution, taxonomy, systematic and actual distribution of bleaks of *Alburnus* species are still not well known [6]. Although there are papers on the growth, morphology, feeding and spreading of bleak in various water bodies across Europe [10, 11], there are a few of published data referring to the growth, metric and meristic characters, reproduction and parasite fauna of the bleak in Turkish waters [12, 13]

This paper was aimed at determination of some growth aspects and spawning period of bleak in Çaygören Dam Lake which was constructed on Simav Stream and its branches.

## 2. Materials and methods

Çaygören Dam Lake which is located in province of Balıkesir, Turkey (28°14'51" E and 39°15'23"N), has major economic importance to the area for both fisheries and irrigating water. The largest water supply to the lake is from Simav Stream which in turn is connected to other streams, namely, the Nilüfer, the Mustafakemalpaşa and the Kocacay. It was constructed in the years of 1965-1968 for the purposes of irrigation and flood prevention by DSI (XXV. General Directorate of State Hydraulic Works). The reservoir has a surface area of 7.25 km<sup>2</sup> with a maximum depth of 52.5 m, an annual mean water capacity 130 hm<sup>3</sup> [14].

A total of 713 samples from the commercial vessels were randomly collected during the period of 2012 to 2014. All samples were maintained in cold box and transferred to the laboratory at 4°C. Total length (TL) (cm) and body weight (W) (g) of the samples were measured to the nearest 0.1 cm and 0.1 g, respectively and recorded before dissection. Length and weight distributions were given as graphics.

The relationships between TL and W were calculated for males and females separately using the allometric model:  $W = a \cdot L^b$ , Condition coefficients (CF) were calculated for both sexes using the equation  $CF = (\text{Body weight} / \text{Total Length}^3) \cdot 100$  [15].

Hepatosomatic index,  $HSI = (\text{liver weight} / \text{guttated weight}) \cdot 100$ : this estimates the relative size of the liver to body weight [16].

Sex was determined by macroscopic observation of the gonads. The overall sex ratio and stages of sexual maturity were also determined. Deviations from 1:1 null hypothesis were statistically tested by t -test analysis [15]. The spawning period was determined by means of the monthly changes in the gonadosomatic index (GSI%), as the ratio of gonad weight to the total weight of the body, which can encrypt the growth of gonads during the reproductive cycle, was calculated using the following equation,  $GSI = \text{Gonad weight} / (\text{Body weight} - \text{gonad weight}) \cdot 100$  [17].

### 3. Results

#### 3.1. Length–frequency distribution

While 346 males and 367 females of the specimens were identified, it is found that they had between 12.0-18.6 cm, and 12.4–19.6 cm of lengths, respectively. (Figure 1) ( $p > 0.05$ , t-test)

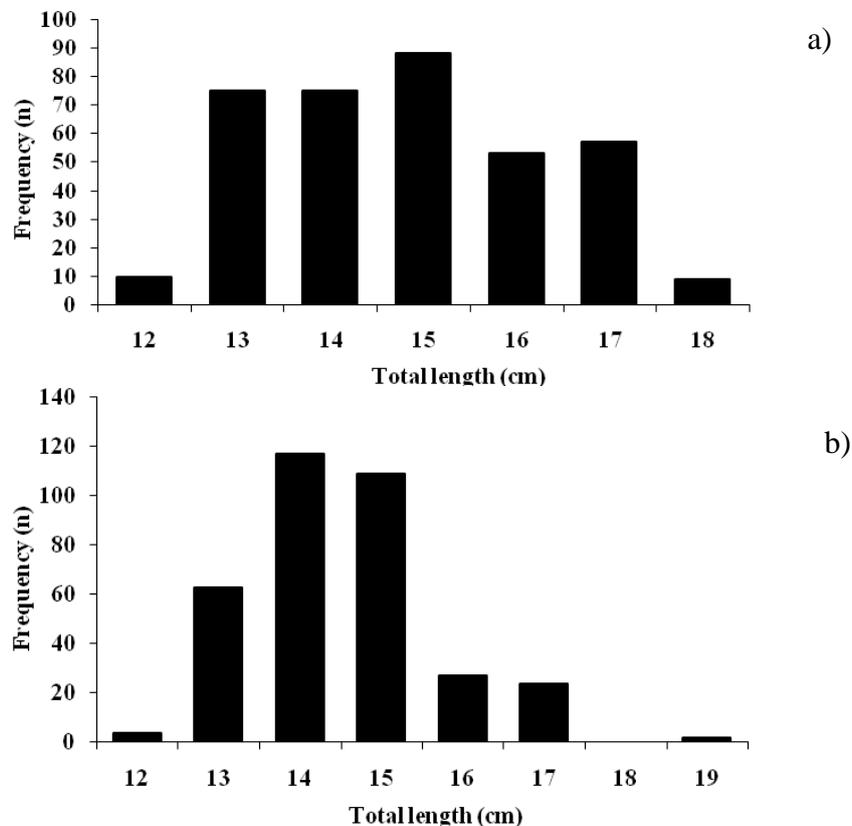


Figure 1. Total length frequency distributions of female (a), and male (b) bleak, *Alburnus alburnus* in Çaygören Dam Lake.

### 3.2. Weight–frequency distribution

The weight of males varied from 26.44 to 123.45 g while the weight of females varied from 30.47–125.28 g (Figure 2) ( $p>0.05$ , t-test).

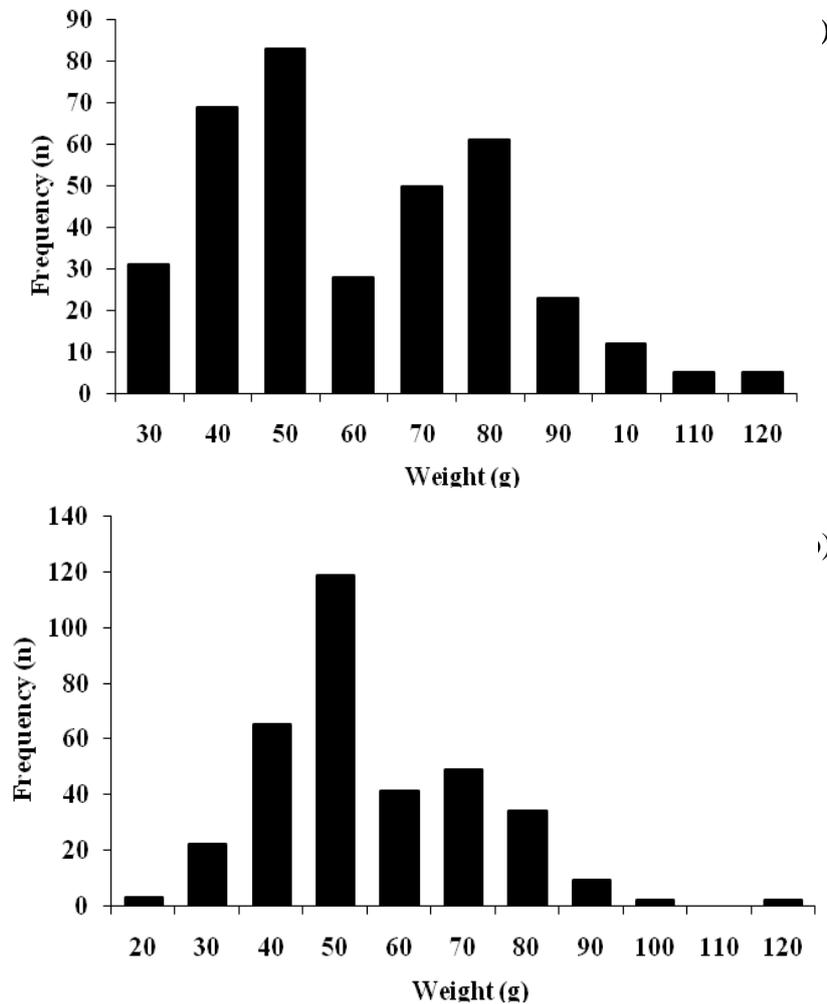


Figure 2. Total weight frequency distribution of female (a), and male (b) bleak, *Alburnus alburnus* in Çaygören Dam Lake

### 3.3. Sex ratio

In the bleak (*Alburnus alburnus*) population, the number of males and females is almost equal, with a small predominance of the females (51.0%) over the males (49.0%). Sex ratio (M:F) was 1:1.04 in the favour of females ( $p>0.05$ , t- test).

### 3.4. Length–weight relationships

The length–weight relationships were pooled for females ( $n=367$ ,  $b=3.26$ ,  $R^2 = 0.969$ ) and for males ( $n= 346$ ,  $b=3.22$ ,  $R^2 =0.980$ ) in Figure 3. The high  $b$  values ( $>3$ ) indicated a positive allometric growth. The correlation coefficient for each sex was found close to one, showing a regular growth in the population.

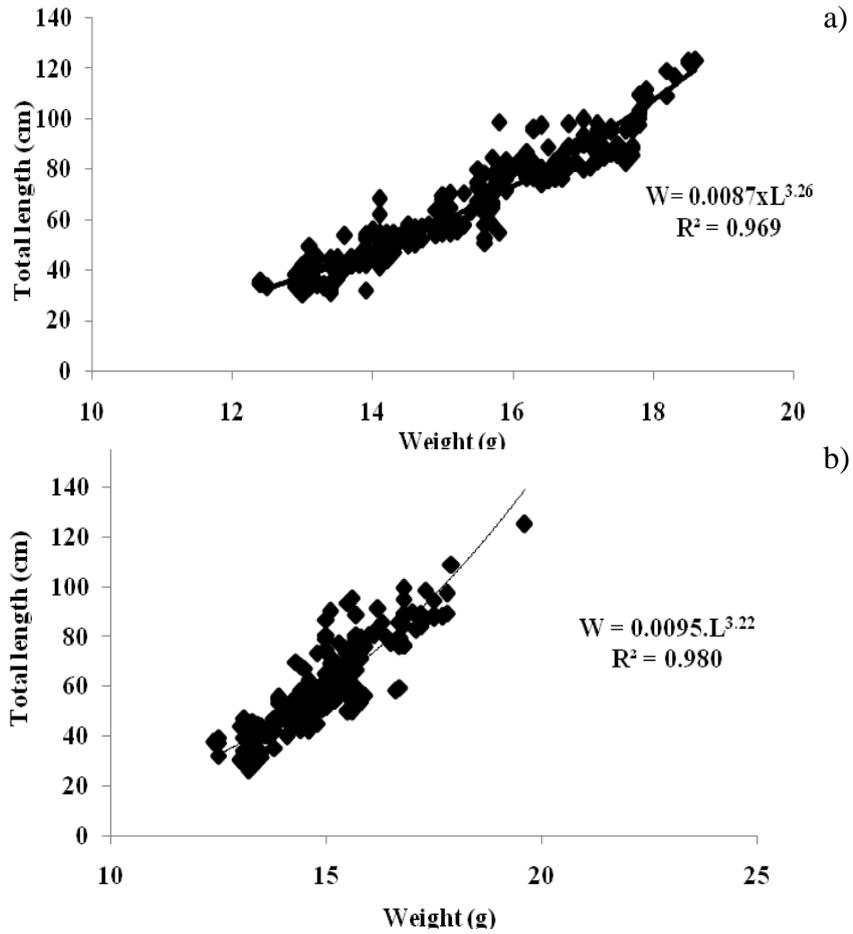


Figure 3. The length-weight relationship for female (a), and male (b) in *Alburnus alburnus* in Çaygören Dam Lake.

### 3.5. Condition factor

Monthly conditions showed a similar pattern for females and males in Figure 4.

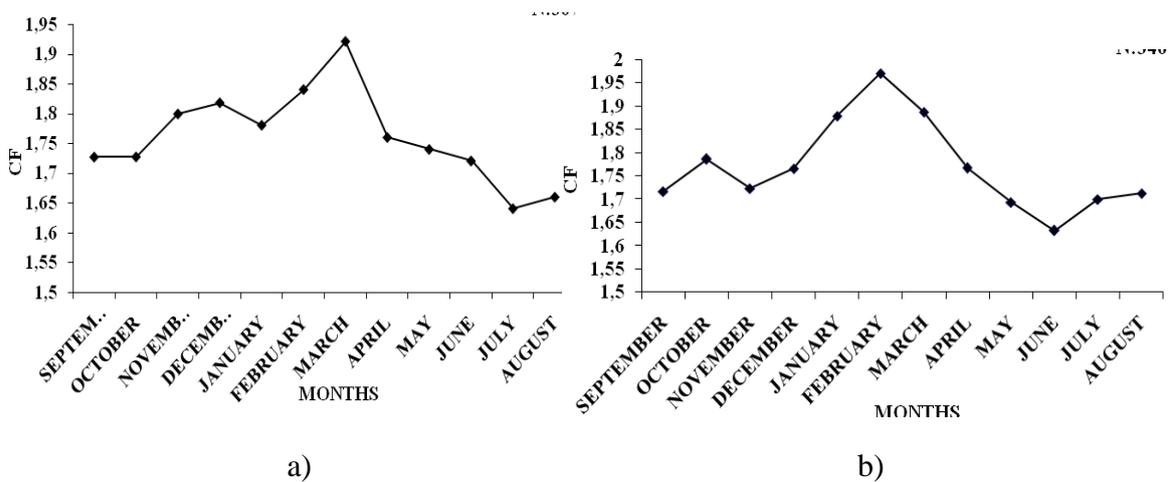


Figure 4. Condition factor values of female (a), and male (b) bleak, *Alburnus alburnus* according to months, in Çaygören Dam Lake

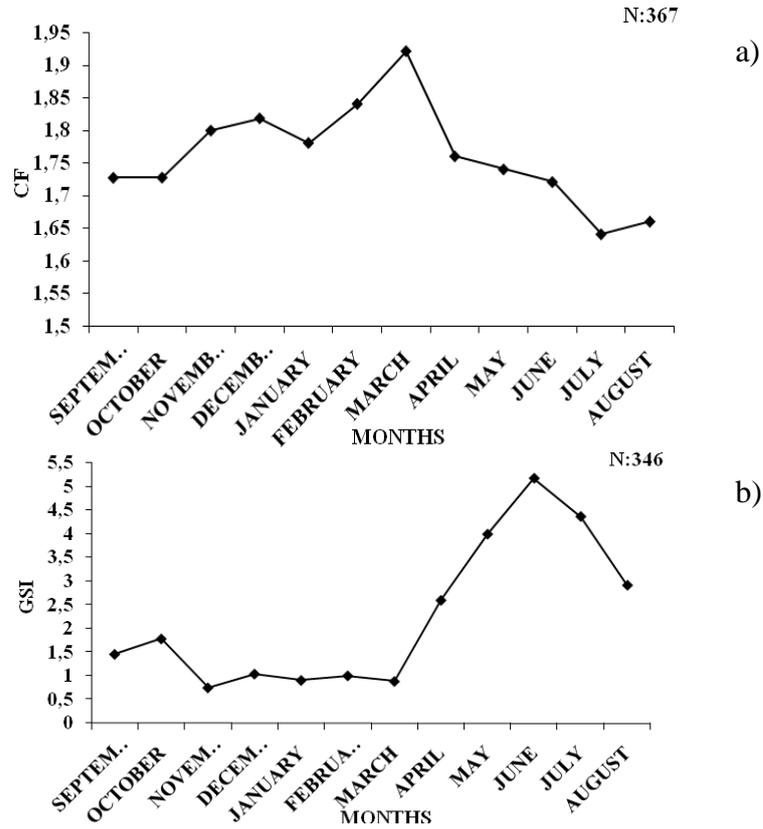


Figure 5. Gonadosomatik index (GSI%) values of female (a), and male (b) bleek, *Alburnus alburnus* according to months, in Çaygören Dam Lake

### 3.7. Hepatosomatic index (HSI%)

In general, monthly HSI values exhibited a peak in January but indicated somewhat lower values to July for all individuals in accordance with values of condition factor as seen in Figure 6.

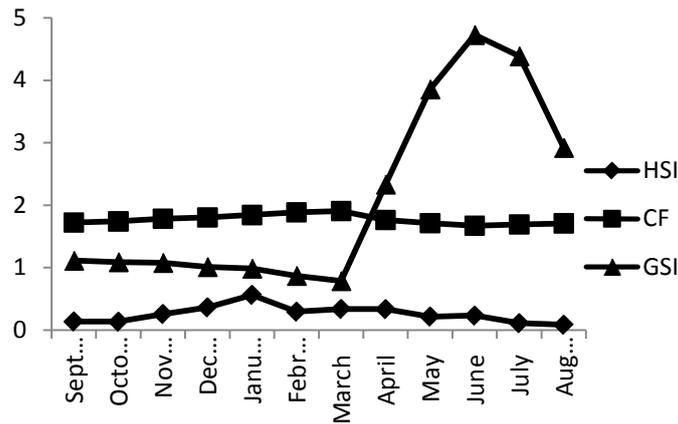


Figure 6. The comparisons of monthly HSI, CF, and GSI values of all bleek, *Alburnus alburnus* in Çaygören Dam Lake.

## 4. Discussion

In this study, the differences in lengths and weights of each sex in bleek population from Çaygören Dam Lake which were not statistically significant ( $P > 0.05$ , t-test) (Fig.

1, Fig. 2, and Table. 1), confirmed bleak population in Zhrebchevo Dam [18]. In contrast, the sex dependent difference of the growth rate was for the bleak reported by Chappaz et al. [19]. This variation may be due to geographic location and some environmental conditions such as temperature, organic matter, quality of food, water system in which the fish live [20].

The trend in sex ratio of studied population supposes an increase, dynamic changes and growth of the number of the respective individuals. Nikolsky [21] indicates different sexual dispersions of the same species in different populations. It is well known that the sex ratio in most species is close to one, but it may vary from species to species, differing from one population to another of same species and may vary year to year in the same population. The sex ratios of the bleak populations in Manyas Lake [22] and Zhrebchevo Dam [18] verify our findings, except for Keddara Dam in which the rates of two sexes are significantly different [23].

Table 1. Parameters of length–weight relationship (a, b, R<sup>2</sup>), and CF of bleak, *Alburnus alburnus* in this and previous studies (– indicates absence of data)

References	Length range	Weight range	N	a	b	R <sup>2</sup>	CF	Locality
Bialokoz, 1980	5.6-9.6							Lake Toyty
Crivelli and Dupont (1987)					2.787			Muga River
Politou et al.(1993)					2.79			Strymon River
Biro and Musco (1995)	4.3-10.6	-	-	-	-	-	-	Balaton Lake
Kleanthidis et al. (1999)	9.4-15.6	-	86	0.0185	2.70	0.85		Lake Volvi
Kompowski (2000)	1.3-16.2	-	-	0.0134	2,947	-		Miedzyodrze
Georgiev (2003)	3.1-1.0	-	106		3.12	-	-	Vardar River
Koutrakis and Tsikliras (2003)	2.0-10.5	-	244	0.0098	2.79	0.985	-	Northern Aegean Estuary
Vasek and Kubeca (2004)	11.0-17.0		298					Rimov Reservoir
Leunda et al. (2006)					3.25			River Thames
Copp et al. (2008)	4.3-21.3	0.50-116.0	456					-
Raikova-Petrova, et al. 2006	3.1-13.0		52	0.1490	1.85	0.95		Sand-Pit Lake
Koyun and Karadavut, 2010	-	-	-	-	3.23	-		Enne Dam Lake
Verreycken et al. 2011					3.64			Lake Mikri Prespa
This study	12.4-18.6 (M)	26.44-125.45 (M)	346 (M)	0.0095 (M)	3.22 (M)	0.98 (M)	1.15-2.62 (M)	Çaygören Dam Lake
	12.4-19.6 (F)	30.47-123.28 (F)	367 (F)	0.0087 (F)	3.26 (F)	0.97 (F)	1.39-2.15 (F)	

Length-weight relationships are very useful for fisheries research as it allow the easy conversion of length in weight and and biomass when only length measurements are available and are required in fishery management and conservation. The same equation is useful for the application of stock assessment models and for the comparison among geographical regions [24-26]. These relationships also enable the computation of condition indexes and allow for comparisons of species growth paths between sexes, different seasons, and regions [27].

The slope ( $b$ ) values of the length-weight relationships in both sexes ( $b=3.22$  for males  $b=3.26$  for females) showed that weight increased positive allometrically with length (Fig. 3A, B). The population of bleak in Çaygören Dam Lake can be classified as growing with a high rate in respect to some European populations of the species. As seen in Table 1, the  $b$  values were not accordance in relevant literature [1, 7, 28-38], except for Koyun and Karadavut [13]. The  $b$  values in fish differ according to species, sex, age, seasons, feeding, diseases, and parasiteloards [39].

For a better evidence of the natural life conditions of the bleak population in Çaygören Dam Lake, we have calculated also the values of condition factor for each sex according to months. Maximum condition factors are found in February, being generally higher just prior to spawning season and lower after spawning with no difference between sexes as seen in Figure 4a, b.

Gonadal development was studied by using the gonadosomatic index of fishes. Mean gonadosomatic index increased gradually from April and then decreases in August (Fig. 5a, b). Altitude, climate and the ecological differences of stagnant and running water as well as altitude, temperature and quality of food have great effects on the spawning period as stated by Bennett [40]. As shown on Table 2, the spawning period in Çaygören Dam Lake is similar to the previous investigations [30, 41-43], except for those in Keddara Dam Lake [23] and Keith and Allardi [44].

Table 2. Spawning seasons of bleak, *Alburnus alburnus* at various localities and average temperatures according to previous studies.

References	Months												Locality	
	J	F	M	A	M	J	J	A	S	O	N	D		
Politou <i>et al.</i> 1993														Lake Koronia
Baruš <i>et al.</i> 1995														-
Rinchar & Kestemont, 1996														River Meuse
Kompowski, 2000														Szczecin
Keith & Allardi, 2001														-
Freyhof & Kottelat, 2007														-
Copp <i>et al.</i> 2008														-
Mack, 2009														Germany
Fouzia and Abdeslem, 2012														Keddara Dam
This study (2010-2012)														Çaygören Dam Lake

The hepatosomatic index is an indicator of feeding activity of fish [45]. It shows an allocation of energy to the liver during every period except reproduction, when part of the energy is used for gonad maturation [46]. As shown on Figure 6, the values of

hepatosomatic index show the highest value in January and are found to be parallel with the values of condition factor. This is accordance with the different species studied by Lenhart et al. [47]. The HSI and *CF* data for the fish species collected in the present study provided important information about the patterns of energy utilization and storage during the prespawning period, spawning period and postspawning period. *CF values* of bleak were highest in March relative to all other sampling times, except males in February in contrast to spawning period (Fig. 4a, b).

## 5. Conclusion

According to the results, it can be proposed that fishing should be prohibited between April to September for maximum productivity and the sustainability from the *A. alburnus* population in the Çaygören Dam Lake.

## Acknowledgements

We would like to thank University of Balikesir for providing financial support to 2011/67.

## References

- [1] Freyhof, J., and Kottelat, M., *Alburnus vistoncus*, a new species of shemaya from eastern Greece, with remarks on *Chalcalburnus chalcoides macedonicus* from Lake Volvi (Teleostei: Cyprinidae), **Ichthyological Exploration of Freshwaters**, 18, 3, 205-212, (2007).
- [2] Kottelat, M., and Freyhof, J., **Handbook of European freshwater fishes**, 640, M. Kottelat, Cornol & J. Freyhof, Berlin, (2007).
- [3] Ozulug, M., and Freyhof, J., *Alburnus demiri*, a new species of bleak from Western Anatolia, Turkey (Teleostei: Cyprinidae)", **Ichthyological Exploration of Freshwaters**, 18, 4, 307–312, (2007).
- [4] Elp, M., Ozulug, M., Sen, F., and Freyhof, J., Validation of *Alburnus timarensis* from the Lake Van basin, eastern Anatolia (Teleostei: Cyprinidae), **Zoology in the Middle East**, 59, 3, 235–244, (2013).
- [5] Cicek, E., Birecikligil, S.S., and Fricke, R., Freshwater fishes of Turkey: a revised and updated annotated checklist, **Biharean Biologist**, 9, 2, 141-157, (2015).
- [6] Buj, I., Vukić, J., Šanda, R., Perea, S., Čaleta, M., Marčić, Z., Bogut, I., Povž, and M., Mrakovčić, M., Morphological comparison of bleaks (*Alburnus*, Cyprinidae) from the Adriatic Basin with the description of a new species, **Folia Zoologica**, 59, 2, 129–141, (2010).
- [7] Kompowski, A., Growth rate of bleak, *Alburnus alburnus* (L., 1758) in Miedzyodrze waters, **Acta Ichthyologica et Piscatoria**, 30, 1, 37-51, (2000).
- [8] Vinyoles, D, Robalo, J.I., De Sostoa, A., Almodovar, A., Elvira, B., Nicola, G.C., Fernandez Delgado, C., Santo, CS., Doadrio, I., Sarda-Palomer, F., and Almada, VC., Spread of the alien bleak *Alburnus alburnus* (Linnaeus, 1758) (Actinopterygii, Cyprinidae) in the Iberian Peninsula: The role of Reservoirs, **Graellsia**, 63, 1, 101-110, (2007).

- [9] Billard, R., Les poissons d'eau douce des rivières de France, **Identification, inventaire et répartition des 83 espèces**, Lausanne: Delachaux & Niestlé, (1997).
- [10] Mazurkiewicz-Boroń, G., **Parametry siedliskowe i troficzne [The trophic and habitat parameters]** in: Zbiornik Dobczycki. Ekologia– eutrofizacja– ochrona. [The Dobczyce dam reservoir. Ecology– eutrophication– protection] Eds. Starmach, J. and Mazurkiewicz Boroń, G.) ZBW PAN, 63–80 (in Polish), Krakow, (2000).
- [11] Raikova-Petrova, G., Iliev, M., and Petrov, I., Growth rate and fecundity of bleak [(*Alburnus alburnus* (L.))] in the Pit Lake Chepintsi (Bulgaria), **Proceedings of Biotechnology & biotechnology**, EQ. 23/Se XI Anniversary Scientific Conference, 212-216, (2009).
- [12] Ozuluğ, M., Altun, M., and Meric, N., On the fish fauna of Lake Iznik (Turkey), **Turkish Journal of Zoology**, 29, 371-375, (2005).
- [13] Koyun, M., Karadavut, U., Sex-related growth performance of bleak (*Alburnus alburnus*), **International Journal of Agriculture and Biology**, 12, 629–631, (2010).
- [14] Anonymus, 1997. Report of İkiztepeliler and Çaygören II. Project Planning Revision. DSI, 502, 85–95, Ankara, (1997).
- [15] Froese R., Cube law, condition factor and weight–length relationships: history, meta-analysis and recommendations. **Journal of Applied Ichthyology**, 22, 241–253, (2006).
- [16] Garcia-Diaz, M.M., Lorente, M.J., and Tuset V. M., Spawning season, maturity sizes, and fecundity in blacktail comber (*Serranus atricauda*) (Serranidae) from the eastern central Atlantic, **Fisheries Bulletin**, 104, 159–166, (2006).
- [17] Sparre, P., and Venema, C.S., Introduction to tropical fish stock assessment - Part I: Manual, **FAO Fisheries Technical Paper**, 306.1 Rev. 1, 376 (1992).
- [18] Georgiev, D., Zhelyazkov, G., and Georgieva, K., Sex and size structure of roach (*Rutilus rutilus*) and bleak (*Alburnus alburnus*) populations in Zhrebchevo Dam, **Ecologia Balkanica**, 7, 2, 51-56, (2015).
- [19] Chappaz, R., Brun, G., and Olivari, G., Mise en évidence de différences de régime alimentaire dans une population d'ablettes *Alburnus alburnus* (L.) dans le lac de Sainte-Croix. Conséquences sur la croissance et la fécondité, **Annales de Limnologie**, 23, 3, 245-252, (1987).
- [20] Wootton, R.J., **Fish Ecology**, Blackwell publishing, Blackie and Son Ltd., Glasgow, (1992).
- [21] Nikolsky, G.V., **Theory of fish population dynamics as the biological background for rational exploitation and management of fishery resources**, 323, Otto Koeltz Science Publishing, Koenigstein, (1980).
- [22] Balaban, C., Fish fauna and some biological properties of fish species of Manyas Lake, MSc. thesis. University of Balıkesir, Institute of Science and Technology, (2010).
- [23] Fouzia, A., and Abdeslem, A., Environmental determinism of sex-ratio in the bleak, *Alburnus alburnus* (Linnaeus, 1758) (Cyprinidae) in Keddara Dam, Algeria, **Indian Journal of Fisheries**, 59, 4, 7-10, (2012).
- [24] Goncalves, J.M.S., Bentes, L., Lino, P. G., Ribeiro, J., Canario, A. V. M., Erzini, K., 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, 253-256, (1997).

- [25] Froese, R., Length–weight relationships for 18 less studied fish species, **Journal of Applied Ichthyology**, 14, 117–118, (1998).
- [26] Moutopoulos, D.K., and Stergiou K.I., Length-weight and length-length relationships of fish species from the Aegean Sea (Greece), **Journal of Applied Ichthyology**, 18, 200-203, (2002).
- [27] Froese, R., Cube law, condition factor and weight–length relationships: history, meta analysis and recommendations, **Journal of Applied Ichthyology**, 22 (4): 241–253, (2006).
- [28] Bialokoz, W., Evaluation of the intensity and efficiency of bleak *Alburnus alburnus* (L.) feeding in Tajty Lake, Masurian Lakeland, Poland, Comparative analysis of methods. **Ekologia Polska**, 38, 163-183, (1990).
- [29] Crivelli, A.J., and Dupont, F., Biometrical and biological features of *Alburnus alburnus* X *Rutilus rutilus* natural hybrids from lake Mikri Prespa, northern Greece, **Journal of Fish Biology**, 31, 721-733, (1987).
- [30] Politou, C.Y., Economidis, P.S., and Sinis, A.I., Feeding biology of bleak, *Alburnus alburnus*, in Lake Koronia, northern Greece, **Journal of Fish Biology**. 43, 1, 33–43, (1993).
- [31] Biro, P., Musco, I.B., Population dynamics and food of bleak (*Alburnus alburnus* L.) in the littoral zone of Lake Balaton, Hungary, **Hydrobiologia**, 310, 2, 139-149, (1995).
- [32] Kleanthidis, P.K., Sinis, A.I., and Stergio, K.I., Length–weight relationships for freshwater fishes in Greece, **Naga**, 22, 4, 25–28, (1999).
- [33] Koutrakis, E.T., and Tsikliras, A.C., Length-weight relationships of fishes from three northern Aegean estuarine systems (Greece), **Journal Applied Ichthyology**, 19: 258-260, (2003).
- [34] Vasek, M., and Kubecka, J., In situ diel patterns of zooplankton consumption by subadult/adult roach *Rutilus rutilus*, bream *Abramis brama*, and bleak *Alburnus alburnus*, **Folia Zoologica**, 53, 203-214, (2004).
- [35] Pollux, B.J.A., Korosi, A., Verberk, W.C.E.P., Pollux, P.M.J., Van der Velde, G., Reproduction, growth, and migration of fishes in a regulated lowland tributary: potential recruitment to the River Meuse, **Hydrobiologia**, 565, 105–120, (2006).
- [36] Leunda, P.M., Oscoz, J., and Miranda, R., Length-weight relationships of fishes tributaries of the Ebro River, Spain. **Journal of Applied Ichthyology**, 22, 4, 299-300, (2006).
- [37] Copp, G.H., Kováč, V., Zweimuller, I., Dias, A., Nascimento, M., and Balážová, M., Preliminary study of dietary interactions between invading Ponto-Caspian gobies and some native fish species in the River Danube near Bratislava (Slovakia), **Aquatic Invasions**, 3, 2, 193-200, (2008).
- [38] Verreycken, H., van Thuyne, G., and Belpaire, C., Length-weight relationships of 40 freshwater fish species from two decades of monitoring in Flanders (Belgium), **Journal of Applied Ichthyology**, 27, 6, 1416–1421, (2011).
- [39] Bagenal, T.B., and Tesch, F.W., **Age and growth In: Methods for Assessment of Fish Production in Fresh Waters** in T. Bagenal (Editor). IBP Handbook No.3: Blackwell Scientific Publishing, 101-136, Oxford, (1978).
- [40] Benet, G.W., **Management of lakes and ponds**. 2nd ed. Robert E. Krieger Publishing Company, Malabar, Florida, (1970).
- [41] Baruš, V., Ěerný, K., Gajdůšek, J., Hensel, K., J. Holčík, I., Kála, V., Krupauer, Z., Kux, J., Libosvářský, J., Lom, S., Flusk, F., Moravec, O., Oliva, M., Peňáz, K., Pivnička, K., Prokeš, M., Ráb, P., Špinar, Z., Švátora, M., and Vostradovský,

- J., **Fauna ÈR a SR. Mihulovci Petromyzontes a ryby Osteichthyes (2)**, Akademie věd Èeské Republiky, Praha, (1995).
- [42] Rinhard, J., and Kestemont, P., Comparative study of reproductive biology in single and multiple-spawner cyprinid fish. I. Morphological and histological features, **Journal of Fish Biology**, 49, 883-894, (1996).
- [43] Mäck, A., **Biologie des ukeleis (*Alburnus alburnus*) im bodensee-obersee. Fischereiforschungsstelle des landes baden-württemberg**, 69, Universität Tübingen, (2009).
- [44] Keith P., and Allardi, V.M. 2001. **Atlas des poissons d'eau douce de France. Patrimoines naturels**, 387, 47, Paris, (2001).
- [45] Tyler, AV., and Dunn., R.S., Ration, growth, and measures of somatic and organ condition in relation to meal frequency in winter flounder, *Pseudopleuronectes americanus*, with hypotheses regarding population homeostasis, **Journal of Fish Research Board of Canada**, 23, 63-75, (1976).
- [46] Nunes, D.M., and Hartz, M.S., Feeding dynamics and ecomorphology of *Oligosarcus jenynsii* (Gunther, 1864) and *Oligosarcus robustus* (Menezes, 1969) in the Lagoa Fortaleza,, Southern Brazil, **Brazilian Journal of Biology**, 66-132, (2006).
- [47] Lenhardt, M., Jaric, I., Aric, I., Cakıcı, P., Vijanovic, G., Gacic, Z., and Kolarevic, J., Seasonal changes in condition, hepatosomatic index and parasitism in sterlet (*Acipenser ruthenus* L.), **Turkish Journal of Veterinary Animal Science**, 33, 3, 209-221, (2009).