Turkish Journal of Fisheries and Aquatic Sciences 8: 347-353 (2008)

Spatial and Seasonal Variations in Catch of Silver Crucian Carp, *Carassius gibelio* (Bloch, 1782) in Lake Eğirdir, Turkey

Ismet Balık[1,*], Hıdır Çubuk[2], Şakir Çınar[3]
[1] Institute of Mediterranean Fisheries Research, Production and Training, P.O.Box. 190, Antalya, Turkey.
[2] Republic of Turkey, Ministry of Agriculture and Rural Affairs, Agricultural Directorate of Eskişehir, Turkey.
[3] Egirdir Fisheries Research Institute, 32500 Eğirdir, Isparta, Turkey.

* Corresponding Author: Tel.: +90.242 2510585; Fax: +90.242 2510584;
E-mail: ibalik@hotmail.com

Received 06 July 2007
Accepted 26 September 2008

Abstract

Spatial and seasonal variations of silver crucian carp catch for fishing with monofilament trammel nets were investigated in Lake Eğirdir. Fishing experiments were conducted using trammel nets of different mesh sizes ranging from 60 to 160 mm in 2005. The results of this study showed the that silver crucian carp catch importantly changed among fishing areas. Hoyran sampling site of the lake gave 5.28 and 2.86 times more catch than Köprü and Sogula sampling sites, respectively. It was found a significant positive correlation between catch and water temperature variations. The silver crucian carp catch in the summer was 4.71, 2.64, and 1.48 times higher than spring, autumn and winter, respectively.

Key words: Silver crucian carp, catch, spatial, seasonal, variation, Lake Eğirdir.

Introduction

Lake Eğirdir is the second largest natural freshwater lake in Turkey. Dramatic changes have occurred in this lake in the last 50 years. Fish assemblages were changed under introduction of exotic fish species, over-fishing, species-habitat interactions, and changes at the level of the lake water, etc. Lake systems consist of numerous components, which are not linked through a unidirectional flow of influence from nutrients to phytoplankton to zooplankton and finally to the fish (Beklioğlu, 1999). Firstly, pikeperch, *Sander lucioperca* was introduced into this lake in 1955 (Akşiray, 1961; Sarıhan, 1970). The introduction of this species led major ecological consequences. Some endemic species such as *Pseudophoxinus egridiri* and *Capoeta pestai* were exhausted from the lake. Thereafter, silver crucian carp (*Carassius gibelio*), *Tinca tinca*, *Knipowitschia caucasica* and *Atherina boyeri* were also introduced into this lake at the early 1990s (Balık and Çubuk, 1998-1999), in the winter of 1996-1997 (Balık *et al*., 1997), in the mid 1990s (Van Neer *et al*., 1999) and in 2003 (Yeğen *et al*., 2005), respectively. According to Sarıhan (1970), Bayrak *et al*. (1991), Erk'akan and Bayrak (1992), Campbell (1992), Ekmekçi and Erk'akan (1997) and Balık *et al*. (2002), the ecological characteristics of Lake Eğirdir were changed importantly after introduction of each species. The impact of especially invading species on native fish species is rarely positive and often catastrophic (Adams, 1996). Introduction of some fish species such as *Carassius carassius* cause a serious deterioration in the aquatic surroundings (Baer, 2001).

Silver crucian carp have been distributed in East Asia-Siberia, and now it is widely throughout Europe (Kottelat, 1997). This species was first reported for the European part of Turkey in 1988. Today, it seems to be widespread and may occur in all larger water bodies (Özuluğ *et al*., 2004).

Silver crucian carp is an omnivorous freshwater fish and it fed detritus and animals (Specziar *et al*., 1997). After a few years from silver crucian carp's introduction, it was increased rapidly in Lake Eğirdir. During this study, it was dominant fish species in the lake. Besides this fish species, there were *Cyprinus carpio*, *Vimba vimba*, *T. tinca*, *C. pestai*, and *A. boyeri*.

For commercial fisheries in the lake, economic value of silver crucian carp is less than especially *C. carpio* and *S. lucioperca*; but, in recent years it was observed that silver crucian carp was the most important fish species for commercial fishing due to decrease of the other economic fish stocks. Therefore, importance of knowledge about catching of this species is increased for fisheries management. Passive net catches are known to depend on the fish activity and the densities of fish species. The activity and density of fish species may vary especially related to environmental conditions. The purpose of this study was to investigate spatial and seasonal variations for catching silver crucian carp in Lake Eğidir.

Materials and Methods

Lake Eğirdir (lat. 37º80' and 38º43' N, lon. 30º30' and 31º37' E) is a freshwater lake located in Lakes District of Turkey. It has surface area of 470 km^2. This lake has tectonic origin and its altitude is about 916 m above mean sea level. Geographically, the lake lies on a 50 km stretch on the north-south direction. The mean depth of the lake is 8 to 9 m and the deepest point is 15 m (Terzi and Keskin, 2005). Lake Eğirdir is supplied by precipitation,

intermittently flowing tributaries and ground-water flow. The water of the lake flows to Lake Kovada and Karacaören Dam Lakes through Kovada Channel. Also, water is lost primarily through outflow to ground water or through evaporation. Lake Eğirdir is divided into main two basins: Eğirdir (large basin) in the south and Hoyran (small basin) in the north.

The experimental fishing operations were carried out monthly at three different sites (Köprü, Sogula and Hoyran) of Lake Eğirdir (Figure 1) in 2005. Mean depths of sampling sites were similar (6-7 m).

A set of trammel nets was made of monofilament webbing with ten different mesh sizes ranging from 60 to 160 mm of stretched mesh of inner sheet (Table 1). The length and hanging ratio of each net were 100 m and 0.50, respectively. The ratios of depths of outer sheets to inner sheet were about 0.70 for all nets.

The nets were set in the mornings and hauled following mornings. After hauling, fish catch was removed separately from each net. The fork length (mm) and weight (g) of each fish were measured and weighed. The catches of silver crucian carp caught from the three different localities and in the four different seasons were compared. The catches of sampling sites were compared using Kruskal-Wallis variance analyses, and Mann-Whitney test was used for comparisons of pairs of sampling sites. In addition, the mean weight, fork length and condition factor of individuals were determined for each sampling site and season. Differences in the catch, weight, length and condition factor of fish among sampling sites and seasons were determined through One-way ANOVA. The Tukey's test was applied for comparison of pairs of the catches, the mean weight, lengths and condition factors. Also, length-frequency distributions of silver crucian carp were estimated for each sampling sites and they were compared by Kolmogorov-Smirnov test.

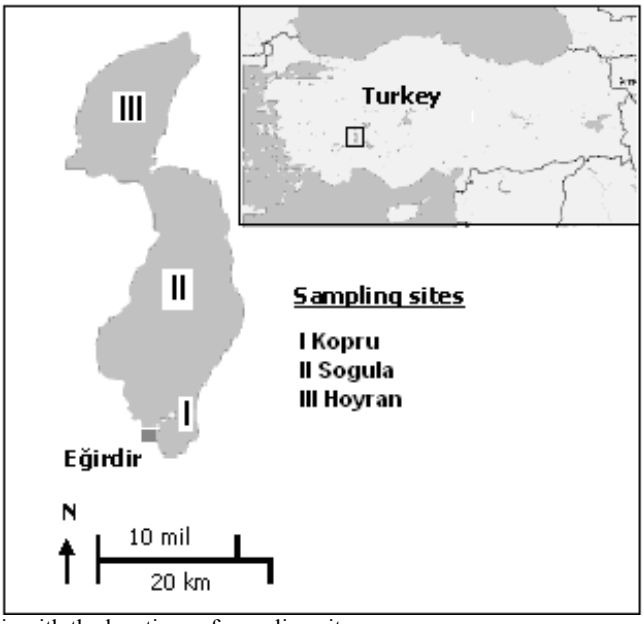

Figure 1. Map of Lake Eğirdir with the locations of sampling sites.

Table 1. Specifications of trammel nets used for test fishing of silver crucian carp

Inner sheet		Outer sheet		
Mesh sizes	Depth (cm) [Mesh number]	Mesh sizes	Mesh number in depth	Depth of hung net (cm)
60	522 [100]	300	14	365
70	609 [100]	350	14	426
80	348 [50]	400	7	244
90	392 [50]	460	7	280
100	435 [50]	500	7	305
110	479 [50]	560	7	341
120	522 [50]	600	7	365
130	566 [50]	520	9	407
140	609 [50]	560	9	438
160	696 [50]	560	10	487

Results

Spatial Variation

A total of 36 fishing trials were conducted at the three different localities of Lake Eğirdir using trammel nets. 2979 silver crucian carp were caught by the experimental nets in these fishing trials. 367, 676 and 1936 individuals of these fish were caught from Köprü, Sogula and Hoyran sampling sites, respectively. According to these catch values, Hoyran region of the lake gave 5.28 and 2.86 times more catch than Kopru and Sogula sampling sites, respectively. Differences in catch between Hoyran and the other sampling sites were statistically significant (Mann-Whitney test; $P<0.05$), but not significant (Mann-Whitney test; $P>0.05$) between Köprü and Sogula sampling sites. As shown in Figure 2, similarity was about 55% between Köprü and Barla sampling sites, while it was 25% between Hoyran and the other sampling sites.

Besides silver crucian carp, during the trials *C. carpio*, *S. lucioperca*, *V. vimba*, *T. tinca* and *C. pestai* were also caught using the experimental nets. But the rate of these species was about only 5% of the total catch. The rest was silver crucian carp.

Most silver crucian carp were caught by trammel net of 80 mm mesh size. As shown in Figure 3, the number of fish was increasing from the net of 60 mm mesh size to the net of 80 mesh sizes and then decreasing with increasing of mesh size.

Mean weights, lengths and condition factors of silver crucian carp caught from three different sampling sites are given in Table 2. The mean weight, length and condition factor of individuals caught from Köprü sampling site were higher than those of the other sampling sites. In terms of the mean weight and length, this sampling site was followed by Sogula and Hoyran sampling sites, respectively. Both means of weight and length of sampling sites were significantly different (Tukey's test; $P<0.05$). On the other hand, differences in condition factor between Sogula and Hoyran sampling sites were not statistical significant (Tukey's test; $P>0.05$), but significant (Tukey's test; $P<0.05$) for the other comparisons among sampling sites.

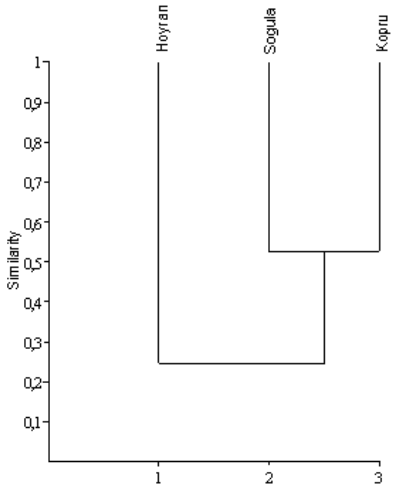

Figure 2. Bray-Curtis similarity analysis among sampling sites.

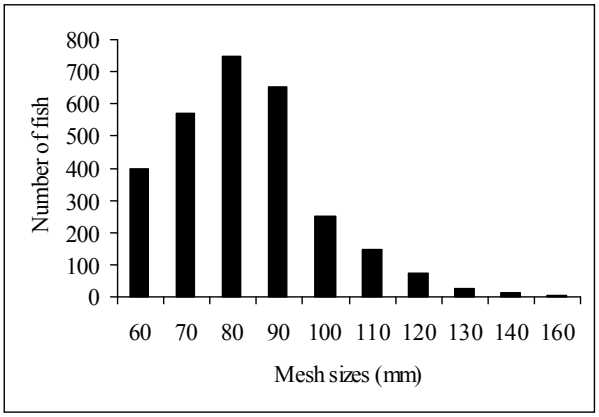

Figure 3. Numbers of silver crucian carp from net with different mesh size.

The length-frequency distributions of silver crucian carp caught from sampling sites are shown in Figure 4. The length-frequency distributions did not show significant difference between Sogula and the other two sampling sites (Kolmogorov-Smirnov test; $P>0.05$), but it was different between Köprü and Hoyran sampling sites (Kolmogorov-Smirnov test; $P<0.05$).

Seasonal Variation

A total of 2979 silver crucian carp were caught in a year. 1313 individuals of these specimens were caught in the summer period. This season was followed by spring (890), autumn (497) and winter (279 individuals), respectively. The rate of silver crucian carp caught in summer was 4.71, 2.64 and 1.48 times higher than winter, autumn and spring, respectively. Bray-Curtis similarity analysis showed that catch amounts in autumn and winter periods were rather similar (Figure 5). However, similarity between these seasons and summer was decreased from about 80% to 60%. Similarity rate between spring and the other seasons was rather low (about 35%).

Table 2. Mean weight (W), fork length (L) and condition factor (K) of silver crucian carp caught from three different sampling sites

Sampling Site	W±SD	CI	L±SD	CI	K±SD	CI
Kopru	321.0±182.7	37.5	22.5±4.0	0.8	2.558±0.285	0.058
Sogula	259.0±146.5	22.2	21.5±3.6	0.5	2.370±0.272	0.041
Hoyran	224.5±131.5	12.6	20.6±3.5	0.3	2.337±0.288	0.028
Mean	246.1±146.9	11.0	21.1±3.7	0.3	2.375±0.293	0.022

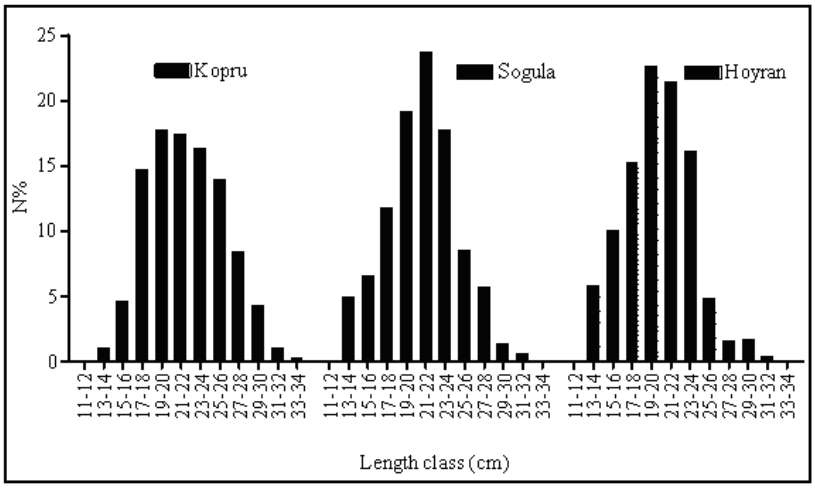

Figure 4. Length-frequency distributions of silver crucian carp in sampling sites.

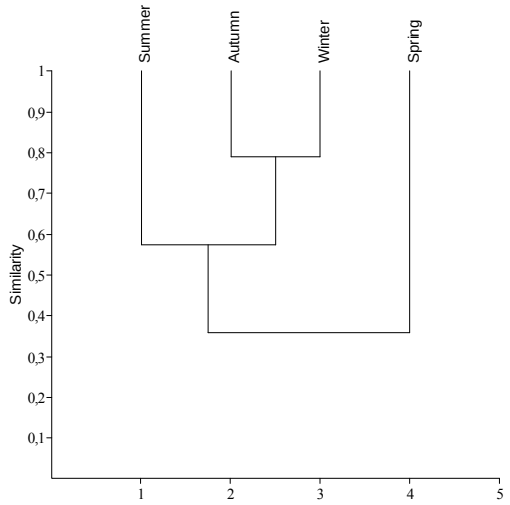

Figure 5. Bray-Curtis similarity analysis among seasons.

The mean weight, fork length and condition factor of silver crucian carp in different seasons are given in Table 3. Silver crucian carp caught in the winter period were larger than those of the other seasons. The mean weight, length and condition factor of individuals caught in this season were statistically different from the other seasons (Tukey's test; $P<0.05$). In terms of the mean weight and length, winter was followed by summer. The mean weight, length and condition factor of individuals caught in the spring and autumn were similar (Tukey's test; $P>0.05$). The mean weights and lengths of individuals caught in spring were not statistically different (Tukey's test; $P>0.05$) from those of summer and autumn. On the other hand, the mean lengths between summer and autumn were different (Tukey's test; $P<0.05$), while difference of the mean weights between the same seasons was not significant (Tukey's test; $P>0.05$). The mean weights and lengths were different (Tukey's test; $P<0.05$) for the other comparisons among seasons. There were statistical differences (Tukey's test; $P<0.05$) among condition factors of seasons except for comparison between spring and summer.

The length-frequency distributions of silver crucian carp caught in different seasons are shown in Figure 6. It was determined that the length-frequency distribution of individuals among seasons did not have differences (Kolmogorov-Smirnov test; $P>0.05$).

During the study, water temperature was ranged from 3.7°C (February) to 24°C (August). Mean water temperature were 10.7, 22.1, 13.8 and 4.2°C in spring, summer, autumn and winter, respectively. It was found a positive correlation (Pearson r= 0.740; P=0.0059) between water temperature and catch. As shown in Figure 7, the catch of silver crucian carp was depending on temperature.

Table 3. Mean weight (W), fork length (L) and condition factor (K) of silver crucian carp in seasons

Season	W±SD	CI	L±SD	CI	K±SD	CI
Spring	231.2±154.1	24.2	20.7±3.8	0.59	2.290±0.263	0.041
Summer	243.4±136.2	14.8	21.3±3.6	0.40	2.295±0.244	0.026
Autumn	232.1±132.1	23.2	20.2±3.3	0.57	2.559±0.259	0.045
Winter	319.0±180.9	43.2	22.2±4.0	0.95	2.620±0.343	0.082

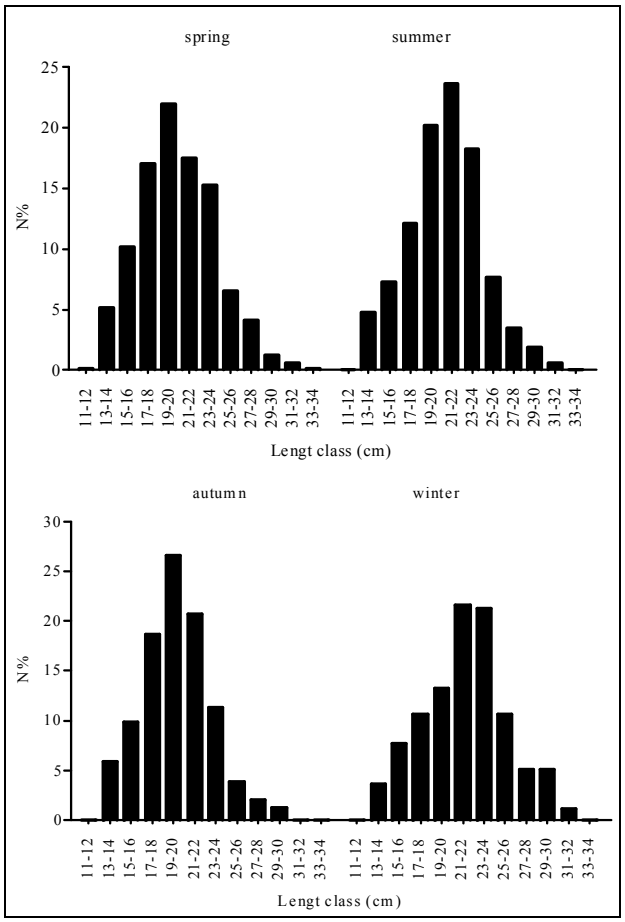

Figure 6. Length-frequency distributions of silver crucian carp by sampling seasons.

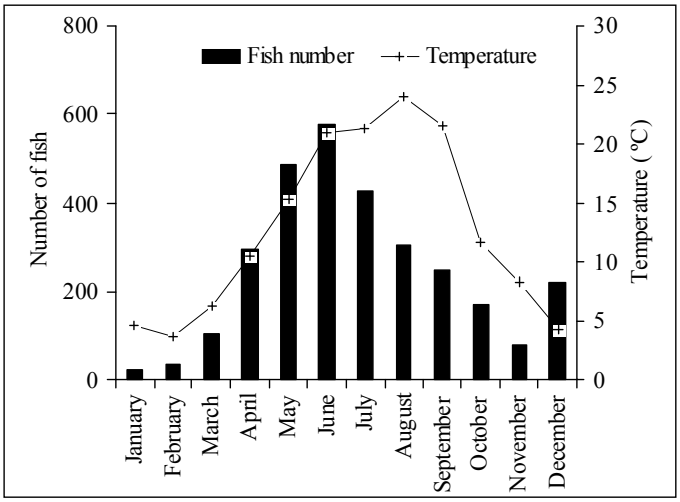

Figure 7. Monthly variations of fish number and temperature.

Discussion

Distributions of fish assemblages in habitats were influenced by many factors. These may include physical factors such as types of habitat and water quality, biological factors such as food availability, competition and predation. The results of our study showed that silver crucian carp catch was changed importantly from locality to locality in Lake Eğirdir. The north of the lake (Hoyran region) gave the most catch. The catch of this species was decreased gradually from the north of the lake to the south. It is well known that passive net catches depend on the activity and density of the fish which are, in addition, influenced by the season of year, weather, water temperature and transparency, depth for net setting and other factors (Sechin *et al*., 1991). In our opinion, differences in catch among fishing areas were probably related to fish abundance. Likely, silver crucian carp population is not distributed homogeneously throughout Lake Eğirdir, and fish were more abundant in the Hoyran region of the lake than the other regions. This species preferred probably to live more in the north of the lake than the south. This situation may be attributed to some environmental conditions such as food ability and vegetation density. During the study, we observed that vegetation was increased gradually from the south of the lake to the north. Kesici *et al*. (2006) reported that catch of silver crucian carp in the north of Lake Eğirdir was higher than in the south of the lake. According to same study, vegetation in the north of the lake was more than in the south. It is very important not only for feeding but also for predator avoidance.

The mean sizes of silver crucian carp samples caught from Hoyran sampling site were lower than the other sampling sites. Probably, quantity of large individuals was decreased in this region of the lake because of fishing pressure. In addition, this situation may be related to the extent of macrophyta cover: because, generally large individuals frequent areas with lower densities of macrophyta, small individuals with higher densities. In this case, the mean condition of fish was also lower than for the other sampling sites probably due to fish density or differences in fish size among fishing areas.

Silver crucian carp catch was ranged importantly from season to season. The highest silver crucian carp catch was in summer. The catch was decreased gradually from summer to winter, and then increased again from winter to summer. Passive net catches are known to depend on the activity of the fish. Activity of silver crucian carp is directly influenced by water temperature variations. It was reported by Balık *et al*. (2003) that the feeding activity of the silver crucian carp in Lake Eğirdir was decreased gradually from spring to summer, autumn and winter, and the seasonal trend in the feeding activity was related to water temperature.

It was determined that the mean weight and length of silver crucian carp was changed among seasons. Individuals caught in the winter period were larger than those of the other seasons. This variation can be attributed to changes in the population structure and water temperature. Large individuals may be less effected by water temperature changes than small.

References

Adams, C.E. 1996. The impact of introductions of new fish species on predatory-prey relationships in freshwater lakes. In: P.R. Simon, P.R. Greenstreet and M.I. Taster (Eds.), Aqautic predators and their prey. Fishing News Books, London: 98-105.

Akşiray, F. 1961. Bazı Türkiye göllerine aşılanan sudak (*Lucioperca sandra* Cuv. *et al*.) balıkları hakkında. İstanbul Üniversitesi Fen Fakültesi Hidrobiyoloji Araştırma Enstitüsü Yayınları, 4(1-2): 104-113.

Baer, A. 2001. Aquatic Biodiversity in the National Biodiversity Strategy and Action Plants of Signatories to the Convention on Biological Diversity. Funded by the United Nations Environment Program (UNEP) and International Development Research Centre

(IDRC), Canada, 102 pp.

Balık, İ. and Çubuk, H. 1998-1999. Eğirdir Gölü'ndeki *Carassius auratus* (L., 1758)'un avcılığında fanyalı ağların seçiciliği ve ağ ipi materyalinin fanyalı ağların seçiciliği üzerine etkisi. Süleyman Demirel Üniversitesi Su Ürünleri Fakültesi Dergisi, 6: 116-127.

Balık, İ., Çubuk, H., Karaşahin, B., Özkök, R., Uysal, R. and Yağcı, A. 2002. *Carassius auratus gibelio* (Bloch, 1782)'nun aşılanmasından sonra Eğirdir Gölü balıkçılığında gözlenen değişikliklerin ve bu balık türünün göl balıkçılığı üzerindeki etkilerinin araştırılması. TKB Eğirdir Su Ürünleri Araştırma Enstitüsü Müdürlüğü, Eğirdir, Isparta, 103 pp.

Balık, İ., Karaşahin, B., Özkök, R., Çubuk, H. and Uysal, R. 2003. Diet of silver crucian carp *Carassius gibelio* in Lake Eğirdir. Turkish Journal of Fisheries and Aquatic Sciences, 3: 87-91.

Balık, İ., Kuşat, M. and Bolat, Y. 1997 Kadife balığının (*Tinca tinca* L., 1758) Beyşehir ve Eğirdir göllerine aşılanmasının etkileri. IX. Ulusal Su Ürünleri Sempozyumu, Eğirdir-Isparta: 771-777.

Bayrak, M., Karakoyun, S., Menengiç, M. and Vatansever, H. 1991. Eğirdir Gölü ekolojisi ve ekonomik su ürünlerinin incelenmesi projesi. TÜBİTAK DEB-ÇAĞ 51, Eğirdir Su Ürünleri Araştırma Enstitüsü, Eğirdir, Isparta, 44 pp.

Beklioğlu, M. 1999. A review on the control of eutrophication in deep and shallow lakes. Turkish Journal of Zoology, 23: 327-336.

Campbell, R.N.B. 1992. Food of an introduced population of pikeperch (*Stizostedion lucioperca*) in Lake Eğirdir, Turkey. Aquacult. Fish. Manage., 23: 71-85.

Ekmekçi, F.G. and Erk'akan, F. 1997. Eğirdir Gölü'ndeki sudak *Stizostedion lucioperca* (Linneaus, 1758) populasyonunda oluşan değişimlerin değerlendirilmesi. Turkish J. of Zoology, 21: 421-430.

Erk'akan, F. and Bayrak, M. 1992. Eğirdir Gölü Stok Tesbiti. TÜBİTAK DEBÇAĞ 97/G Nolu proje, Isparta, 143 pp.

Kesici, E., Becer Özvarol, Z.A., İkiz, R. and Kesici, C. 2006. Doğal göllerin balıklandırılmasının göllerdeki yüksek su bitkilerine etkisi. I. Ulusal Balıklandırma Sempozyumu, Antalya: 415-421.

Kottelat, M. 1997. European Freshwater Fishes. Biologia 52(5): 1-271.

Özuluğ, M., Meriç, N. and Freyhof, J. 2004. The distribution of *Carassius gibelio* (Bloch, 1782) (Teleostei: Cyprinidae) in Thrace (Turkey). Zoology in the Middle East, 31: 67–75.

Sarıhan, E. 1970. Eğirdir Gölüne sudak balığı (*Lucioperca lucioperca*) ilave olduktan sonra meydana gelen biyolojik ve ekonomik değişiklikler. İstanbul Üniversitesi, Fen Fakültesi Hidrobiyoloji Araştırma Enstitüsü Yayınları, 4(3-4): 33-40.

Sechin, Y.T., Bandura, W.I., Shibayev, S.W. and Blinov, V.V. 1991. A new approach to the analysis of age structure of fish stocks using surveys for various water basins and behavioural patterns of fish concentrations. In: I.G. Cowx (Ed.), Catch Effort Sampling Strategies, Fishing News Books, London: 26: 285-304.

Specziar, A., Tolg, L. and Biro, P. 1997. Feeding strategy and growth cyprinids in the littoral zone of Lake Balaton. J. Fish Biol., 51: 1109-1124.

Terzi, Ö. and Keskin, M.E. 2005. Modeling of daily pan evaporation. Journal of Applied Sciences, 5: 368-372.

Van Neer, W., Wildekamp, R.H., Küçük, F. and Ünlüsayın, M. 1999. First inland records of the euryhaline goby *Knipowitschia caucasica* from lakes in Anatolia, Turkey. Journal of Fish Biology, 54: 1334-1337.

Yeğen, V., Balık, S., Bostan, H., Uysal, R., Ustaoğlu, R., Sarı, H.M. and İlhan, A. 2005. Isparta İli Balık Faunası. Eğirdir Su Ürünleri Araştırma Enstitüsü Müdürlüğü, Yayın No: 4, Eğirdir, 33 pp.