Journal of Limnology and Freshwater Fisheries Research
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Actual Status of Eber Lake in Terms of Fish Community Structure

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ABSTRACT

Lake Eber is a small, shallow tectonic lake, located in the central part of Anatolia. Lake is under effect of pollution and exotic fish species. In order to define environmental degradation within the lake and its effects on fish assembly in a historical perspective field study was conducted. Water sampling was conducted seasonally between December, 2012 and September, 2013. Physico-chemical paramaters as dissolved oxygen, pH, total phosphorus and total Kjeldahl nitrogen was assessed. Trophic state index was calculated from phosphorus concentrations and trophic state of the lake was assessed. Fishing was carried out in April, 2013, on randomly selected eight stations with benthic multimesh nets (30 m long, 1.5 m depth, 12 different mesh size from 5x5 mm to 55x55 mm) and fyke net. Fish assembly, catch data (catch per unit effort), length-weight relationships of the species with enough sample size is reported.

Keywords: Fish fauna, length-weight relationship, eutrophication, Afyonkarahisar

ARTICLE INFO

RESEARCH ARTICLE

Received : 11.07.2017
Revised : 10.08.2017
Accepted : 14.08.2017
Published : 21.08.2017

DOI: 10.17216/LimnoFish.327824

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Eber Gölü'nün Balık Komunite Yapısı Açısından Güncel Durumu

Öz: Eber Gölü, İç Anadolu Bölgesi'nde bulunan küçük ve sığ bir tektonik göldür. Göl kirlenme ve egzotik balık türlerinin baskısı altındadır. Tarihsel çerçevede, göldeki çevresel bozunmayı tanımlamak ve bunun balık toplulukları üzerindeki baskısını tanımlamak amacıyla alan çalışmaları gerçekleştirilmiştir. Su örneklemesi Aralık, 2012 ile Eylül, 2013 tarihleri arasında gerçekleştirilmiştir. Çözünmüş oksijen, pH, toplam fosfor ve toplam Kjeldahl azotu gibi fiziko-kimyasal özellikler belirlenmiştir. Fosfor konsantrasyonları üzerinden trofik statü indeksi hesaplanmış ve trofik statü değerlendirilmiştir. Balık avcılığı, sekiz farklı istasyonda, bentik çok gözlü ağlar (30 m uzunluğunda, 1,5 m eninde, 5x5 ila 55x55 mm göz açıklığında) ve pinter ile Nisan, 2013 tarihinde gerçekleştirilmiştir. Balık toplulukları, av verisi (birim av çaba), yeterli sayıda örnek bulunan türlerin boy-ağırlık ilişkileri rapor edilmiştir.

Anahtar kelimeler: Balık faunası, boy-ağırlık ilişkisi, ötrifikasyon, Afyonkarahisar

How to Cite

Mangıt F, Korkmaz M, Sü U, Yerli SV. 2017. Actual Status of Eber Lake in Terms of Fish Community Structure. 3(2):101-106. doi: 10.17216/LimnoFish.327824

Introduction

Lake Eber is a small, shallow tectonic lake, located in the central part of Anatolia, it is surrounded by Emir Mountains from the south and Sultan Mountains from the north (Atalay 1977; Köle et al. 2016). Eber is the biggest lake in the Akarçay River Basin after drying of Akşehir Lake. Basin which the lake resides is a closed basin, made up mainly by Akarçay River which is also the main influent into the lake. Changes in climatic conditions which are effecting the water regime, and anthropological activities are the main threats for the basin and lake itself.

Eutrophication is the process of nutrient accumulation causing water body to become more productive (Moss 1988). This process promotes algal blooms causing high variations in dissolved oxygen content of water and can cause release of bloom related algal toxins. From fisheries perspective, all this can lead to fish deaths and in the long term changes in fish fauna. In addition to this environmental degradation, presence of exotic species can speed up this process. Introduction of fish species can alter ecosytem and effect biodiversity by means of predation, competition, hybridization and habitat alteration (Cowx 1998).

Lake Eber is under effect of these anthropogenic pressures. This study aims to define environmental degradation within the lake and its effects on fish assembly in a historical perspective.

Materials and Methods

Water sampling was conducted seasonally between December, 2012 and September, 2013 whereas fish sampling was conducted in April, 2013. Physico-chemical parameters such as dissolved oxygen (DO; mg/l) and pH were recorded in situ with YSI 5739 and YSI 33 SCT meter respectively. Chemical parameters such as total phosphorus (TP; mg/l), total Kjeldahl nitrogen (TKN; mg/l) was analyzed in an accredited laboratory conditions (OSİB SYGM 2013).

In order to determine trophic status of the lake Trophic State Index (TSI) developed by Carlson (1977) is used. Trophic state according to total phosphorus (TSI_{TP}) is calculated using the formula below.

$$TSI_{TP} = 10(6 - \left(\frac{ln\left(\frac{48}{TP}\right)}{ln(2)}\right)$$

Fishing was carried out on 8 stations with benthic multimesh nets (30 m long, 1.5 m depth, 12 different mesh size from 5x5 mm to 55x55 mm) and fyke net following TS EN 14757 sampling standart. Due to low water depth, no significant stratification was observed in the lake and benthic positioning of the multimesh gillnets sufficiently sampled the water column. Species identification were done according to Battalgil 1944, Bogutskaya 1997, Geldiay & Balık 2007; Kuru et al. 2014. Total length (*TL*), Fork length (*FL*) and Standart length (*SL*) were measured to nearest millimeter with ruler (TL>15 cm) and digital caliper (TL<15 cm). Weighing was conducted with analog and digital scales. Sampled fish were kept in ice until all measurements were finished.

Catch per unit effort (CPUE) was reported as number of specimens and grams of fish catch per multimesh net. Length weight relationships were calculated using the Ricker (1975) (LWR) model ($W = aTL^b$); in which *W* is total weight (g), *TL* is total length (cm), a and b are the equation parameters calculated by the least squares method using the logarithmic form of the equation. Significance of the regression was reported by the correlation coefficient of the regression (R^2), and signifficant differences from isometric growth (H_0: $b = 3$) were assessed (p). LWR and frequence analyses were conducted with FSA package (Ogle 2014) developed for R 3.4.0 (R Core Team 2014).

Results

Properties of water body

Physico-chemical properties of the water is summarised in Table 1 with the results of similar analysis reported in Günay et al. (1985) and Kazancı et al. (1999) for comparison. Phosphorus concentration from Akşehir Lake is added from Numann (1958) since at this date lakes connect at certain dates throughout the year. Phosphorus levels for Eber Lake can be lower than this value (0.02 mg/L) since Akşehir Lake is the last residence for water in the basin.

Water pH seems to show variances throughout the year and there seems to be a shift to the basic side when compared to previous readings. High values of total phosphorus and nitrogen compounds seem to indicate eutrophic conditions. Nitrogen compounds seem to increase significantly over the years. Trophic state index scores for total phosphorus (TSI_{TP}) was high and indicating hypereutrophic tendency after 1980's. Rather than showing a recovery or stabilization, these values showed a significant increase after these dates.

Table 1. Some physico-chemical parameters for Lake Eber with TSI values calculated for TP

	DO *	pH	TP *	TKN *	Reference	TSI (TP)
1954	-	-	0.02**	-	Numann (1958)	47.37
12.1982	-	-	0.13	1.80	Günay et al (1985)	74.37
03.1983	-	-	0.07	2.23		65.44
04.1983	-	-	0.02	0.98		47.37
06.1983	-	-	0.15	2.18		76.44
08.1983	-	-	0.10	3.58		70.59
10.1983	-	-	0.10	1.48		70.59
06.1996	6.70	7.06	-	-	Kazancı et al (1999)	-
05.1998	5.60	7.10	-	-		-
11.2012	9.62	8.63	0.46	5.48	This study	92.61
03.2013	14.11	9.25	0.34	2.01		88.10
06.2013	14.00	8.94	0.34	4.67		88.10
09.2013	9.63	9.40	0.34	12.18		88.39

* mg/l, ** Values from Akşehir Lake

Fish assembly and LWR

A total of 3280 specimens of seven fish species were sampled from the lake. These species are *Alburnus nasreddini* Battalgil, 1943; *Cyprinus carpio* Linnaeus, 1758; *Carassius gibelio* (Bloch, 1782); *Tinca tinca* (Linnaeus, 1758); *Seminemacheilus lendlii* (Hanko, 1925); *Cobitis simplicispina* Hanko, 1925 and *Knipowitschia caucasica* (Berg, 1916). Sampled fish specimens, their total weight, catch per unit effort (CPUE) and

Length-weight relationships (LWRs) of the species with enough sample size is given in Table 2.

Model fit is successive for *A. nasreddini*, *C. gibelio* and *C. simplicispina*. However, coefficient for determination (R^2) value for *S. lendlii* is 0.71 indicating *a* failure in model fit possibly due to variative weights at same length rather than sample size. All *b* values for the species (except *S. lendlii*) with enough number of specimens for the model are over three indicating *a* positive allometry. Length-weight relationship plots, residuals of the regression model and frequency analysis of *A. nasreddini*, *C. gibelio*, *C. simplicispina* and *S. lendlii* are illustrated between Figures 1-4.

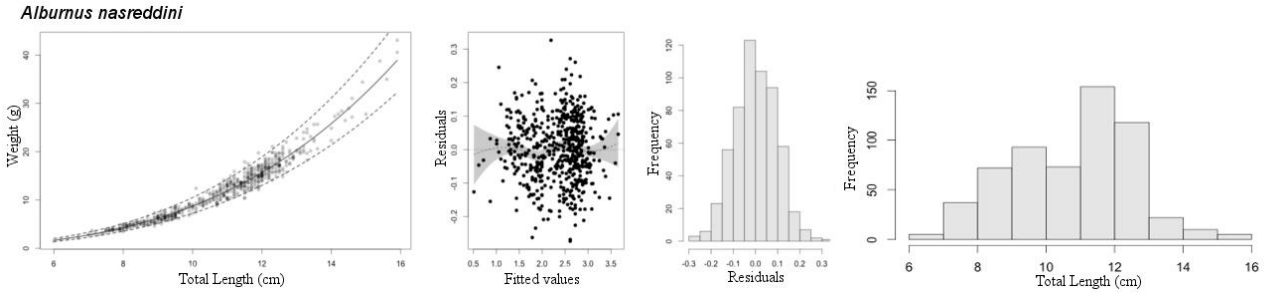

Figure 1. *A. nasreddini* length weight relationship plot, regression model fit plots and length frequency

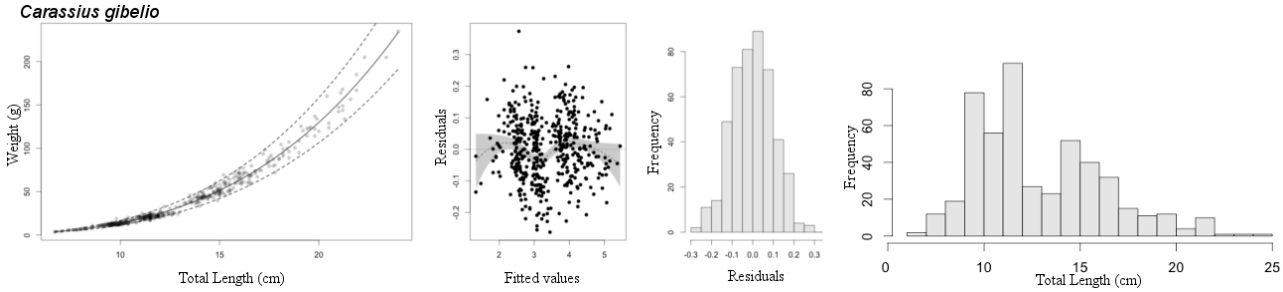

Figure 2. *C. gibelio* length weight relationship plot, regression model fit plots and length frequency

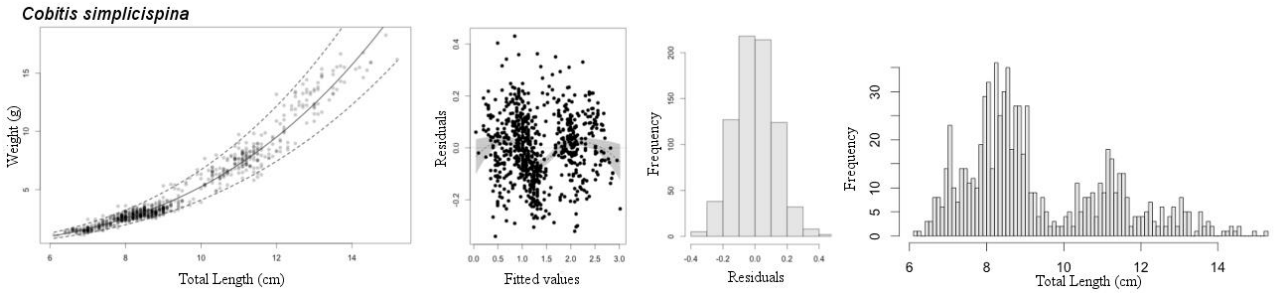

Figure 3. *C. simplicispina* length weight relationship plot, regression model fit plots and length frequency

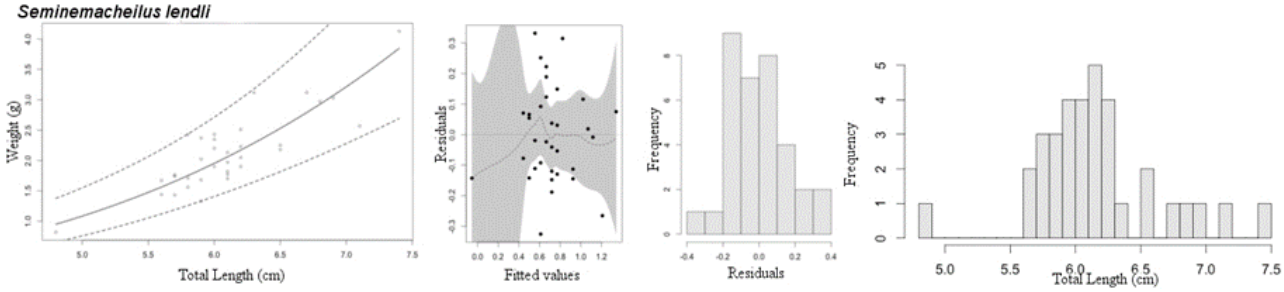

Figure 4. *S. lendlii* length weight relationship plot, regression model fit plots and length frequency

Table 2. Fish abundance and length weight relationship values

			CPUE*			TL (cm)		W (g)		Regression Parameters			
Species	Total n	Weight (g)	(n)	(g)	LWR n	Min.	Max.	Min	Max	*a*	*b*±SE	R^2	p
A. nasreddini	1115	7709.97	139.38	12437.25	577	6	15.9	1.47	43.05	0.0051	3.23±0.02	0.97	0.001
C. gibelio	1149	32774.8	143.63	36716.29	466	6.7	24.0	3.33	235.00	0.0083	3.22±0.02	0.99	0.001
S. lendlii	74	138.35	9.25	149.82	34	4.8	7.4	0.82	4.13	0.0059	3.23±0.35	0.71	0.514
C. simplicispina	925	4250.11	115.63	4306.15	768	6.1	15.2	1.08	18.26	0.0029	3.26±0.02	0.96	0.001
T. tinca	4	29.2	0.38	29.2	-	-	-	-	-	-	-	-	-
K. caucasica	3	1.93	0.38	1.93	-	-	-	-	-	-	-	-	-
C. carpio	10												

*Catch per unit effort: Catch per multimesh net (30 m)

Discussion

Elements which can be helpful to determine water quality is showing that lake is hypertrophic. Most of the parameters reach levels that can be classified as the worst class (class IV) according to criteria for water quality (SKKY 2004). Increased pH is typical for eutrophic lakes as can be seen in Lake Mogan (Mangıt and Yerli 2010) and Lake Uluabat (Elmacı et al. 2009), similar shallow lakes with hypertrophy tendency. Oxygen levels in lake seem to be high throughout the year. This over saturation with oxygen is typical in shallow lakes with dense submerged macrophytes as Lake Eber. Phosphorus (*TP*) and nitrogen compounds (*TKN*) seem to increase over the years compared to Günay et al. (1985) and Kazancı et al. (1999).

Fish sampling data revealed that *A. nasreddini* and *C. gibelio* is widespread in the lake whereas *S. lendlii*, *C. simplicispina*, *C. carpio*, *T. tinca* and *K. caucasica* are not caught by every gillnet. *C. gibelio* seem to dominate fish populations in the lake by means of indiviuals and biomass. According to results this invasive fish species constitutes 35% of the fish specimens and 73% of fish biomass. By means of population size it is followed closely by *A. nasreddini* (34%) and *C. simplicispina* (28%) however in terms of biomass it is by far the dominant species. Invasion potential of *C. gibelio* is demonstrated clearly in Lake Eber. *A. nasreddini* constitues 34% of the specimens sampled. Eber Lake is the type locality of *A. nasreddini* and this species is listed under Critically Endangered status by IUCN (2017) due to pollution and desiccation. However high the CPUE may seem in this study it is clearly under threat of *C. gibelio*.

This recent fauna is a consequence of pollution brought by Akarçay River and fisheries activities. In this study *E. lucius* and *C. carpio* can not be sampled by gillnets however the latter is sampled by fyke nets. Both species are present in the lake however according to fisherman catch of these species dropped significantly as it can be interpreted from gillnet catch results. In addition to this decrease in economically important species *C. carpio* and *E. lucius*, *T. tinca* is under serious fishing pressure too. Only four specimens were caught in this study.

Fish fauna is compared to the previous studies in order to interpret long term changes in the lake (Table 3). Changes in fish fauna and environmental degradation through the years summarised in Figure 5.

C. carpio and *E. lucius* assumed to have a natural distribution in Turkey however both of them are translocated extensively (İnnal and Erk'akan 2006, İnnal 2012, Tarkan et al. 2015). But due to having a report in the beginning of 1900's, these species are listed under native status. *A. nasreddini* has not been reported by Deveciyan (1915), but due to similar lateral line scale count it can be mistaken as *Rutilus rutilus* (Linnaeus, 1758). In addition to this possible confliction, Deveciyan (1915) reported 3 more species namely, *C. carpio*, *E. lucius* and *Squalius recurvirostris* Özuluğ & Freyhof, 2011 (given as *Leuciscus cephalus*). Other species were probably distributed in the lake however main focus at these years were fisheries rather than biological diversity. Therefore we colored these boxes as gray to indicate this probability. Following Deveciyan (1915), no reports had been found until Kosswig (1952). In this study by Kosswig, fauna for Eber Lake with Akşehir Lake combined since at that time connection between these lakes was not distrupted. And to our knowledge this was the first and last detailed report about the lake. There seems to be drastic changes in the fish fauna over the years. *C. gibelio* seem to enter this lake after 2000's and possibly with the help of environmental degradation it became the dominant species. Species with possible low tolerance to eutrophication such as

Gobio intermedius Battalgil, 1944 and *S. recurvirostris* are replaced by tolerant *C. gibelio*, *K. caucasica* and *T. tinca*.

In order to restore the lake, pollution need to be controlled. However even if influent is controlled there won't be an immediate shift to eutrophic state. Water quality of the lake need to be monitored closely and possibly some other measures can be taken to control eutrophication. Also fisheries activities need to be monitored carefully and measures to remove *C. gibelio* from the lake need to be considered.

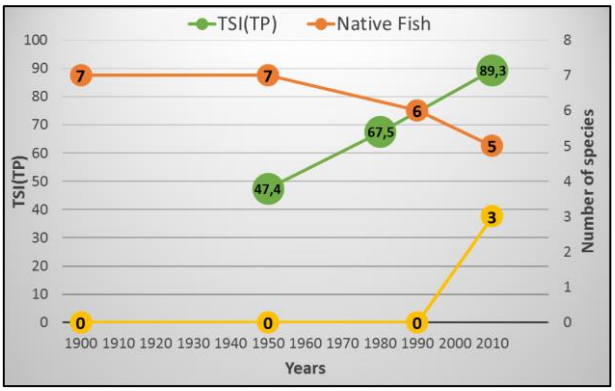

Figure 5. Environmental degradation and fish fauna in Lake Eber

Table 3. Fish fauna comparison for Lake Eber

		Deveciyan 1915	Kosswig 1952	Kazancı et al. 1999	This study
Native Species					
Alburnus nasreddini [1]	Battalgil, 1943	+	+	+	+
Cobitis simplicispina [2]	Hankó, 1925	+	+	+	+
Gobio intermedius [3]	Battalgil, 1944	+	+	+	
Rutilus rutilus [4]	(Linnaeus, 1758)	+			
Seminemacheilus lendlii	(Hankó, 1925)			+	+
Squalius recurvirostris [5]	Özulug & Freyhof, 2011	+	+		
Cyprinus carpio	Linnaeus, 1758	+	+	+	+
Esox lucius	Linnaeus, 1758	+		+	
Exotic Species					
Carassius gibelio	(Bloch, 1782)				+
Ctenopharyngodon idella[6]	(Valenciennes, 1844)				
Knipowitschia caucasica	(Berg, 1916)				+
Tinca tinca	(Linnaeus, 1758)				+

1) It has been reported as *Alburnus* orontis, *Alburnus alburnus* and *Alburnus nasreddini*. 2) It has been reported as *Cobitis taenia*. 3) It has been reported as *Gobio gobio* and *Gobio gobio intermedius*. 4) It has been reported as *Leuciscus rutilus*. 5) It has been reported as *Leuciscus cephalus* and *Leuciscus lepidus*. 6) It was released for macrophyte control, sampled in 2008 (DKMPGM 2008), but no reports since.

Acknowledgements

This study was conducted with ALKA, HT-TTM, HU SAL in a project supported by Republic of Turkey, Ministry of Forestry and Water Affairs General Directorate of Water Management. Part of this study was presented in *Ecology Symposium, 7-9 May 2015, Sinop-Turkey* as poster presentation.

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