



LIMNOLOGICAL HISTORY OF LAKE EĞİRDİR (TURKEY): FROM 1950's TO THE PRESENT

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non-native species

Synopsis

Lake Eğirdir is among of the largest freshwater lakes of Turkey, with a surface area of 480 km² and mean depth of 7-8 m. First limnological studies on the Lake Eğirdir was done in 1930s, following by the second Row of studies in 1950's coinciding the most important human induced damage to the lake, by introduction of 10,000 juvenile pikeperch from Austria in 1955 to improve the fish production. This has led to extinction of native and endemic fishes. It was followed by introduction of *Carassius gibelio* (Bloch, 1872) in 1996 and *Atherina boyeri* (Risso, 1810) in 2003. The oligotrophic character in 1950s was maintained until the late 1980s. By then rapid colonization of submerged plants (mid 90's) and cyanobacterial blooms (by 2006) as the consequences of eutrophication resulted in the sharp decreases in fish stocks. Except for the introduction of exotics, having devastative effects on the lake ecosystem, currently agricultural activity, waste discharge, sedimentation and shrinking are main ecological problems of the lake.

INTRODUCTION

26 main watershed areas of Turkey have a total of 186 billions m³/p.a. surface flow and 110 billions m³/ p.a. usable water potential. There are rivers up to 175,000 km length; lakes to 9,060 km², ponds to 150 km² and dams to 3,780 km² surface area in Turkey (ANONYMOUS, 1993; 1999). Of 2.5 x10⁶ million ha wetlands, almost half was lost in the last 4-5 decades. The biggest reason for that is the failure in water management politics and agricultural practices. Despite having similar problems the second largest freshwater lake of Turkey, Lake Eğirdir, still carries out its ecological existence.

Lake Eğirdir basin is an “A class wetland” according to international criteria and it is of great significance in terms of the protection of biological diversity (Anonymous, 1999). According to the Guide for Water Pollution Control, it has the qualification of drinkable water. This lake provides agricultural, domestic and industrial water supplies and it is being utilized for fisheries and recreationally. The first citation concerning the lake is found in the anecdotal notes in Deveciyan’s book (DEVECİYAN, 2006). The first study was carried out by PIETSCHMANN (1933), in which the ichthyofauna of Lake Eğirdir was determined. Studies of KOSSWIG (1950), GELDIAY and KOSSWIG (1952), NUMANN (1958), AKŞIRAY (1961) and KARAMAN (1972) followed that study.

During that period, the only limnological study belonged to NUMANN (1958), all other being focused on ichthyofauna. According to him, the density of reeds and submerged plants were low, the shallow parts were sand-gravel and a yellowish-grey coloured mud constituted most of the bottom in 1950s. In last 50-60 years, submerged plant coverage has remarkably increased due to siltation; fisheries stocks disappeared greatly and recently algal blooms came to existence.

In this study, the history of the lake from 1950s to now was summarized and the studies in the period were revised.

GENERAL CHARACTERISTICS OF LAKE EĞİRDİR

Geological Origin

Lake Eğirdir, located within the Isparta angle, has been developed in a rift tectonic regime related to the Burdur transform fault (ALTINKALE, 2001). Tectonically originated lake bottom gained its present form with karstic developments and filled with water in pluvial periods (INANDIK, 1965; KAZANCI, 1993). Several fault lines in different directions surround the lake. Generally rocks of calcareous type and there are numerous karstic formations (like dolines) near the lake (KAZANCI, 1999).

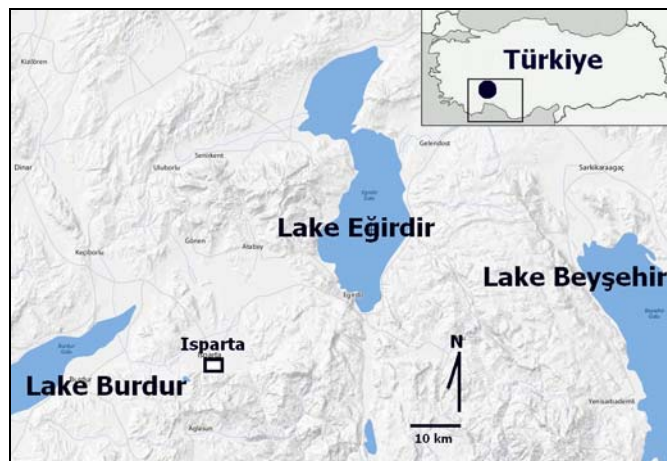


Figure 1. Map of Lake Eğirdir

Physical geography

Lake Eğirdir (35° 37'-38° 16' N, 030° 44'–030° 57' E) is situated in southwestern Turkey, to the east of province Isparta and it is surrounded by Eğirdir, Senirkent, Yalvaç and Gelendost. The length of the lake in NS direction is 48 km, the maximum width is 16 km and the total shoreline is 150 km. Drainage area of the lake covered with steppe, scrub and mostly agricultural land. The northwestern part of lake is covered by dense reeds (Figure 1) (ANONYMOUS, 1993; 1998).

Climate

Environs of the Lake Eğirdir, in climatological terms, show Mediterranean climate features, but at the same time it is under the effect of continental climate. Mean annual temperature is 12.7 °C. January is the coldest month (mean= 1.6 °C) and July is the warmest month (mean= 22 °C) (AKSOYLAR and ERTAN, 2001)

Hydrology

The catchment area is ca. 3,309 km² and the average fall is 570 mm/p.a. The surface evaporation loss is 503,78 hm³/p.a. and the income of the lake is 841.41 hm³ (ESENDAL, 2007). Data related to the minimum and the maximum altitudes of the lake are seen on the Table 1.

	Altitude (m)	Surface area (km ²)	Volume (hm ³)	Years
Maximum water level	9 1 9 . 3 1	4 9 1 . 6 2	4 , 2 0 0 . 0 3	1 9 6 9
Minimum water level	9 1 5 . 4 2	4 4 3 . 4 5	2 , 4 4 8 . 5 6	1 9 7 5

Table 1. Some data related to the minimum and the maximum altitudes of the lake in different years (ESENDAL, 2007).

The lake has the official protection status as a drinking water reservoir. Originally, DSI (State Hydraulic Works) has planned to use up to 355 hm³/p.a for irrigation, drinking water and hydro-power (for two hydro-power stations built in 1960 and 1971 which require 225 hm³/p.a). Due to the water shortage, at present only 150 hm³/p.a. can be used for irrigation and 30 hm³/p.a. for drinking water. In spite of reduced water use, the lake's water level has dropped 2.5 m down during the last 25 years (ARSLAN, 2006).

It was stated that the years of 1950s in which the first manipulations were practised, the deepest point of the lake was 11 m (to some fishermen over 12 m), average depth being nearly 10 m (NUMANN, 1958). Today, depth of the lake varies between 5 to 9 m, deepest point being 10 m. The lake is fed mainly by underground water, springs and streams. The most important of these are Pupa, Değirmen, Akçay, Hoyran and Gelendost creeks, Çay stream and Kayaagzı spring. The outflows of the lake are Kovada Canal (connecting lake to the Lake Kovada), pump stations, evaporation and dolines whose number exceeds 20 (ANONYMOUS, 1993; AKSOYLAR and ERTAN, 2001).

Water declines and rises of the lake over 5 m (Figure 2) will eventually affect its biota, microbiological features and consequently its overall development. With the help of pump and a regulator 700-1000 hm³ water is taken from the lake for different purposes every year (DURHAN, 2003).

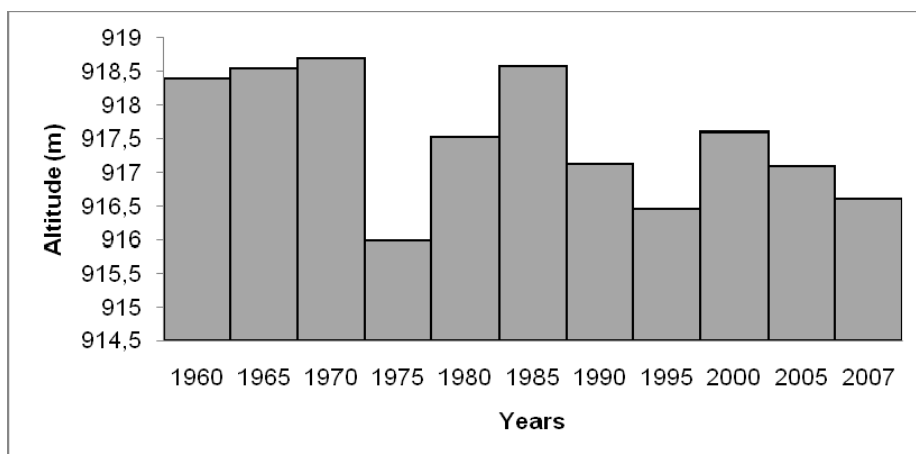


Figure 2. Changes of the Lake Eđirdir water level according to years (from DURHAN, 2007)

Surface area in 1950-1960 period was at 518 km², which declined to 479 km² following decade with maximum capacity and depth being 4360 hm³ and 14 m respectively. Today the lake's surface area has decreased up to 453 km², water volume has decreased down to 2885 hm³ and the depth has decreased up to 9 m. For the purpose of electricity production, lake's water was drained with a channel of 25 km length to support two hydroelectric power plants established in 1960 and 1971. Since 1991 these units have been operated periodically. Resulting of such regulations, Lake Eđirdir balance difference values has always showed negative trend (KESICI and KESICI, 2006)

Human impacts to the lake

Agriculture, tourism, and urbanization take place in the greatest part of the Lake Eđirdir's environs. Lake Eđirdir basin drainage area houses 49 cold-storage plants and agricultural crops process units and factories. Ecological structure of the lake has been affected by the 81 neighbouring settlements. Also, for the last fifty years, the wrong policies held by authorities yielded the present situation (KESICI and KESICI, 2006). Furthermore, the municipality of Eđirdir town discharges untreated sewage into lake prior to the completion of sewage treatment plant in 1995 (ARSLAN, 2006). With the help of the surface flows suspended solid matter, organic matter and agricultural residues flow into the lake via ay Stream and other resources in high quantities (AKSOYLAR and ERTAN, 2001).

Water Quality

The Eđirdir lake displays good drinking water quality having very low ion concentrations, and may be considered as Mg-Ca-HCO₃ water (ALTINKALE, 2001).

The anionic concentration order is $\text{HCO}_3 > \text{CO}_3 > \text{Cl} > \text{SO}_4$. It's seen that there is no important difference between pH values of previous studies: pH value (8.4-8.9) shows alkaline features, generally. Also in terms of dissolved oxygen levels were stable and relatively high (Table 2).

Parameter	1953-54	1981-82	1986-87	1988-89	1990-91	1991-1992	1996-1998	1997-1999	2006
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
pH	8.9	6.5-7.8	8.4-8.7	8.3	7.2-9.7	-	7.6-7.75	8.4	8.7
Diss. Oxygen (mg/l)	7.3-10.2	6.5-9.5	8-12.5	8.8	6.5-13.5	8.3	11.5	8.55	8.96
E.C. ($\mu\text{S}/\text{cm}$)	-	-	-	203-365	110-430	245	460	343	381
Cl (mg/l)	-	14.2-19.7	8.9-18.7	17.6	5-18	-	5-11	17	-
HCO_3 (mg/l)	-	-	207	636-810	114-248	-	177-262	216.7	-
CO_3 (mg/l)	-	-	24.8	15-100	4-18	-	10-40	19.7	-
SO_4 (mg/l)	-	-	5.8-18.3	27.2	15-70	-	7.1-17.2	11.1	-
Ca (mg/l)	-	10.6-48	35.3	20-48	20-44	-	12-16	45	-
Mg (mg/l)	-	22-24	31.8	19-41	32-53	-	4.9-19.4	59.3	-
NO_3 (mg/l)	-	-	<0.01	1.9	-	1.14	0.091	1.75	-
$\text{PO}_4\text{-P}$ (mg/l)	<0.001	-	<0.001	-	0-0.7	0.03	<0.001	0.05	0.13
Secchi Disc visibility (m)	-	0.4-2.6	-	1.95	0.4-4.6	2.0	6.2		
Chl. <i>a</i> ($\mu\text{g}/\text{l}$)					0-2.36	0.59	4.08	5.56	7.3

Table 2. Water quality parameters of Lake Eğirdir, 1950s to 2000s.

(1) NUMANN, 1958; (2) MERTER, 1984; (3) TIMUR et al., 1988; (4) BAYRAK et al., 1991 (5) ERK'AKAN and BAYRAK, 1992 (6) ÖZKÖK, 1993; (7) KAZANCI, 1999; (8) AKSOYLAR and ERTAN, 2001; (9) GÜLLE et al., 2006.

It's estimated that Lake Eğirdir classified as an oligotrophic lake in terms of its nitrogen, phosphorus and chlorophyll-a parameters (NUMANN, 1958; TIMUR et al., 1988, BAYRAK et al., 1991; DILER et al., 1997, KAZANCI, 1999). That the quantity of nitrate and phosphate found to be insignificant till 1990s is quite remarkable, the increase of nutrients afterwards led to change of its status as a mesotrophic-eutrophic lakes.

History of Biological Characteristics

Microbiology

In 1990s sewage related contamination was highlighted in the lake Eğirdir (DILER et al., 1997), with high counts of *E. coli*, coliform bacteria (numbers 0.3×10^1 - 1.3×10^3 /100 ml) and fecal *Streptococcus* (numbers 3.8×10^1 - 1.6×10^3 /100 ml) (AKSOYLAR and ERTAN, 2001).

Phytoplankton

All the investigations carried out in the Lake Eğirdir, Bacillariophyta has been found as the dominant algal group (Table 3). *Ceratium hirundinella*, *Dinobryon sertularia*, *Dinobryon tabellaria*, *Synedra ulna*, *Pediastrum duplex*, *Pediastrum boryanum*, *Anabaena affinis*, *Oscillatoria sancta* ve *Zygnema* sp. are among the commonest algae taxa (AKSOYLAR and ERTAN, 2001). Generally, it has been seen that phytoplankton found in the lake Eğirdir, show the features belonging to temperate zone lakes (ERTAN et al., 2001).

division	TIMUR et. al., (1988)	CONK and CIRIK (1995)	SAVAŞ and CIRIK (1997)	ANONYMOUS (2000)	(AKSOYLAR and ERTAN, 2001)
Bacillariophyta	13	21	19	20	34
Chlorophyta	13	13	11	10	17
Cyanophyta	2	7	7	4	8
Pyrrophyta	1	1	2	2	2
Xantophyta	1	-	-	-	-
Euglenophyta	-	1	-	-	-
Chrysophyta	-	-	-	1	2
Total	30	43	39	37	63

Table 3. Lake Eğirdir phytoplankton taxon number changes according to years.

Zooplankton

The first investigations in the lake Eğirdir zooplankton fauna started in late 1950s. According to the preliminary report, copepod *Eudiaptomus vulgaris* was the most dominant taxon, while *Leptodora kindtii* (Cladocera) was of low density; and rotifers were of no importance (as quantity) in zooplankton populations (NUMANN, 1958). Afterwards, there is long gap between further studies to be started in 1980s.

In 1986-1987, *Keratella*, *Trichocerca*, *Brachionus*, *Daphnia*, *Diaphanosoma*, Calanoids and *Cyclops* were reported from the lake. In these years, Calanoid copepods were dominant every season but rotifers and cladocerans were of quite low density (TIMUR et al., 1988). In 1990s, *Diaptomus* and *Cyclops* copepods were dominant zooplanktons in general. But in summer, *Diaphanosoma* population has showed great increase and rotifers were scarce. In these periods mean zooplankton density was 88,072 ind./m³. Copepoda and Cladocera constituted of this value 92% and 8%, respectively (Anonymous, 1991). In late 1990s, 41 Rotifer, 10 Cladoceran and 4 Copepod taxa were reported. The average zooplankton density was 26,011 ind./m³; 78% being Rotifera, 12% Veliger larvae, 10% Copepoda and 0.26% Cladocera constituted of this value (AKSOYLAR and ERTAN, 2001).

It was reported from the lake until late 1990s, *Eudiaptomus vulgaris* was the commonest taxon, which vanished in a short duration. In addition, larger Cladocera species were also rather decreasing as quality and quantity (KÜÇÜK et al., 2006).

Macrobenthic fauna

In 1950s, the lake was poor in terms of benthic organisms composed of *Tanytarsus* (chironomid larvae) and some Oligochaeta taxa (NUMANN, 1958). In 1980s, similarly, Lake Eğirdir benthic fauna was also poor in general, commonest

organisms being *Dreissena polymorpha*, oligochaetans and *Chironomus* larvae (TIMUR et al., 1988). In the latter, the benthic organism density was found as 13554 ind./m² (ANONYMOUS, 1984).

In late 1990s, 33 macrobenthic taxa were determined, the average density being 32,944 ind./m²: Gastropoda (24582 ind./m²), Bivalvia (5473 ind./m²), Oligochaeta (1606 ind./m²) and Bryozoa 788 (ind./m²). Presence of *Chironomus plumosus* and *Chironomus thummi* (307 ind./m²) can be interpreted as a pollution indicator (AKSOYLAR and ERTAN, 2001). TAŞDEMİR and USTAOĞLU (2005) determined 15 taxa to Chironomidae. In addition, YILDIZ and BALIK (2005) reported that the most common species observed from Oligochaeta was *Tubifex tubifex*.

In 2000s, Lake Eğirdir trophic level has been increased according to benthic fauna component. Recently high tubificid populations have been observed (ARSLAN, 2006). Similar results have been observed in Lake Eğirdir by YILDIZ and BALIK (2005). YILDIRIM (2004) reported that the most abundant gastropods to be Basommatophoran taxa generally being eurytopes.

Macrophytic structure

In 1990s, *Phragmites australis*, *Schoenoplectus lacustris*, *Typha angustifolia*, and *Butomus umbellatus* were dominant emerged plants. *Nuphar lutea*, *Myriophyllum spicatum*, *Ranunculus tricophylus*, *Potamogeton pectinatus*, *Ceratophyllum demersum* were abundant in shallow waters; while *Potamogeton perfoliatus* and *Chara* spp. showed density in deeper waters (KESICI, 1997). In the lake, 71 aquatic plant species were identified. Hoyran part of the lake, due to loss of water level, reed *Phragmites australis* has risen to 10-1000 m² and *Potamogeton perfoliatus* reached 5-6 depths from the lake surface. *Chara* sp. and *Myriophyllum spicatum* (less commonly) covered the bottom of the lake completely (AKSOYLAR and ERTAN, 2001).

Recently, the alien invasive *Elodea canadensis* found in various parts of the world (THIEBAUT, 2007), has now covered the whole lake after its first discovery in 2005 (unpublished observation).

Fish fauna and fisheries

Ichthyofauna of Lake Eğirdir were studied by HANKO (1924; 1925), PELLEGRIN (1927; 1928), BATTALGİL (1942; 1944), KOSWIG and GELDIAY (1952), KOSWIG and SÖZER (1945), LADİGES (1960), BANARESCU (1977), BALIK (1988), KÜÇÜK (1998), and VAN NEER et al. (1999) (KÜÇÜK et al., 2007). The first record which includes the whole fish fauna of this lake was provided by GELDIAY and KOSWIG (1952). In their study, a total of 10 fish species (7 species of *Cyprinidae*, 2 species of *Cobitidae*, and 1 species of *Cyprinodontidae*) were mentioned. The fish fauna of Lake Eğirdir can be seen in Table 4.

Native	
Family: Cyprinidae <i>Cyprinus carpio</i> L. 1758	Family: Balitoridae <i>Seminemacheilus ispartensis</i> Erk'akan, Nalbant&Özeren 2007
<i>Capoeta pestai</i> (Pietschmann 1933) (CR)	<i>Barbatula mediterraneus</i> Erk'akan, Nalbant&Özeren 2007
<i>Hemigrammocapoeta kemali</i> (Hanko 1924) EX	Family: Cyprinodontidae
<i>Pseudophoxinus handlirschi</i> (Pietschmann 1933) EX	<i>Aphanius anatoliae anatoliae</i> (Leidenfrost 1912)
<i>Pseudophoxinus egridiri</i> (Karaman 1972) CR	Family: Gobiidae
<i>Vimba vimba</i> (L. 1758)	<i>Knipowitschia caucasica</i> (Berg 1916)
Family: Cobitidae <i>Cobitis cf. turcica</i>	
Non-native	
Family: Percidae <i>Sander lucioperca</i> (Linnaeus 1758)	Family: Atherinidae <i>Atherina boyeri</i> (Risso 1810)
Family: Cyprinidae <i>Carassius gibelio</i> (Bloch 1782)	Family: Poeciliidae <i>Gambusia affinis</i> (Baird and Girard 1853)
<i>Tinca tinca</i> (L. 1758)	

Table 4. Native and non-native ichthyofauna of Lake Eğirdir from past to the present (from KÜÇÜK et al., 2007) (CR: Critical, EX: Extinct)

After the introduction of pikeperch *Sander lucioperca* brought from Austria in 1955, the local fish fauna depleted rapidly. The adverse effect led to the extinction of *P. handlirschi* (in the early 1970s) and *Hemigrammocapoeta kemali* (= *Tylognathus klatti*), both being native endemics (KESICI and KESICI, 2006; KÜÇÜK et al., 2007).

Short story of ichthyofaunal elements:

Cyprinus carpio: It is native to the lake. Today, the abundance has dropped down due to overexploitation, habitat loss and adverse effects of exotic species. Efficient fishing of this species is not performed (KÜÇÜK et al., 2007).

Capoeta pestai: Type locality is Lake Eğirdir, was not caught at all by the commercial fishing nets between the years 1970 and 2003 as a result of the pressure of pikeperch, but it started to reappear even in small numbers after 2003 as this pressure decreased (KÜÇÜK et al., 2007).

Hemigrammocapoeta kemali: The first record from Lake Eğirdir is given by KOSSWIG (1950) as *T. (Neotylognathus) klatti*. In no scientific study it has been observed since 1958. It is thought to have gone extinct due to predatory effects of pike perch. Last record was given by NUMANN (1958) (KÜÇÜK et al., 2007).

Pseudophoxinus handlirschi: This species is endemic to the lake. In 1960, 175 tons have been fished. But towards the end of 1970s it come to the extinction (KÜÇÜK et al., 2007).

Pseudophoxinus egridiri: It is another endemic which could only be recorded nowadays from sources of cold water flowing on the north part of the lake (Karaot and Yalvaç Streams) (KÜÇÜK et al., 2007).

Vimba vimba: The first record was provided by DEVECIYAN (1915). The population density is decreasing and partial fishing is done on the species. Today's catches are very small quantities (KÜÇÜK et al., 2007).

Cobitis cf. turcica: Between 1995 and 2007 no specimens could be caught in Lake Eğirdir, however a very low density population is observed in Yalvaç Creek connected with this lake (KÜÇÜK et al., 2007).

Seminemacheilus ispartensis: It is found to be distributed along the coastal regions of Lake Eğirdir, small streams that flow to the lake and Kovada Canal, which is an outlet of the lake (KÜÇÜK et al., 2007).

Barbatula mediterraneus: Type locality is the Aksu Stream connected with the lake. It is determined to exist in Çayköy channel that flows into the lake and in Kovada channel (KÜÇÜK et al., 2007).

Aphanius anatoliae anatoliae: It is a native fish of the lake. The population has instantaneously increased and became dominant in 2006-2007 when *Atherina boyeri* increased in the lake system. But, its probable reason is removal of the effects of pikeperch in the lake in the last years. This fish is unintentionally caught during *A. boyeri* fishing, at present (KÜÇÜK et al., 2007).

Knipowitschia caucasica: There is not enough references on whether it is native or non-native to the lake. There are no records in scientific studies between 1933 and 1997 (KÜÇÜK et al., 2007).

Carassius gibelio: It was first reported in 1996 but it is not known how it was introduced to the lake system. However, it is thought that there was an involuntary introduction during the fishing activities. It has become dominant share of the lake fisheries (BALIK et al., 2007; ÇUBUK et al., 2007; KÜÇÜK et al., 2007).

Sander lucioperca: It has been added to the fauna with the release of 10,000 young pikeperch that were brought from Austria by Istanbul University Hydrobiology Institute. They have well adapted to the lake and economically caught between 1960 and 2000. However, due to negative conditions that recently emerged in the lake ecosystem, it has become very rare (BALIK et al., 2007; ÇUBUK et al., 2007; KÜÇÜK et al., 2007).

Atherina boyeri: How this exotic species entered the lake is unknown but it is suspected that it has been brought for commercial fishing from another inland water body in Turkey. In a short period, it became the most dominant fish species of the lake ecosystem (KÜÇÜK et al., 2006; 2007).

Gambusia affinis: It is unknown when it was introduced to the lake and its density has dropped down in last years (KÜÇÜK et al., 2007).

With the introduction of pikeperch into the lake system, omnivorous fish production decreased up to 0.5 ton from 500 tons (Table 5). In the last 2-3 years, connected with excessive growth of sand smelt *Atherina boyeri*, only silver crucian carp could be fished since pikeperch and carp densities were decreased under a limited level. However, *A. anatoliae anatoliae* population which got free from predatory pressure was massively increased.

Years	carp	pikeperch	vimba	silver crucian carp	tench	sand smelt	total
1980	120	450	15	0	0	0	585
1985	80	300	0	0	0	0	380
1989	120	30	0	0	0	0	150
1990	110	35	0	0	0	0	145
1995	66	130	0	0	0	0	196
2001	66.3	50.2	0.5	1205.1	0	0	1322.1
2002	14.975	232.9	**	23.806	0.05	0	271.731
2003	3.8	31.825	**	12.2	1.85	0	46.68
2004	6.05	3.95	0.8	7.05	1.470	0	19.32
2005	2.55*	4.5	0.8	344.8	0.11	0	352.76
2006	*	1.2	**	54.453	**	34.5	90.15
2007	*	0.3	-	36.8	-	25.553	62.65

Table 5. Fishing quantities of the Lake Eğirdir between the years 1980-2007 (ÇUBUK et al., 2007; EKMEKÇI and ERK'AKAN, 1997; KÜÇÜK et al., 2006)

(*) Catchment inhibition (**) very little quantity

Stock identification works on economic fish species are shown as percentage in 1997-1999 years (Table 6). In these years while pikeperch managed to constitute more than half of the economic fish population, after 2003 this proportion has greatly decreased (AKSOYLAR and ERTAN, 20001).

Table 6. Stock identification works on economic fish kinds are shown as percentage (%) in 1997-1999 years (AKSOYLAR and ERTAN, 20001)

pikeperch	silver crucian carp	Carp	trout	tench	vimba
56.2	41	1.1	0.7	0.7	0.3

There has been a debate on whether or not the crayfish *Astacus leptodactylus* (Eschscholtz, 1823) is native to the lake. Some argue that it has been brought to lake in 1966. Being the most important export item of the lake in 1970-85 (10 million \$ income in 1983), 2000 tons/p.a. were harvested (BOLAT, 2001; KESICI and KESICI, 2006) (Table 7).

Table 7. Hunted crayfish quantity (ton) in the years of 1976-1987 in Lake Eğirdir (BOLAT 2001; ÇUBUK et al., 2006) (Qua: quantity, ton)

Year	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Qua.	1712	2852	2116	1781	2174	2600	1400	2075	2010	1145	12
Year	1987	1988	1989	1990	1995	2001	2002	2003	2004	2005	2006
Qua.	0	0	0	0	0	602.6	213.9	302	188.5	100.3	24.7

Due to a lethal fungal disease (called crayfish plague) broken out in 1985 the biggest part of the population was lost. It was reported that the percentage of infected individuals were 90-95 % in 1985 (TIMUR and TIMUR, 1988), determined to be %21 in 1988, 41% in 1989, 35% in 1994, 42 % in 1996, 13 % in 1998-1999, 9% in 2000. Crayfish fishery was banned in 1987, which then released in 1999. However, still

disease is encountered in individuals (BOLAT, 2001). The number of local fishermen was 1623 for the years of 1981- 1982, 50-60 in 1994, 98 in 1997; 425 in 2001 and this number reached 484 in 2005.

Ornithological state

It has been reported 37 species of waterfowl in the lake (Aksoylar and Ertan, 2001), and the total number of waterfowl taxa was determined to be 171 in the lake basin (Tabur, 2002). Lake Eğirdir is an important breeding and wintering ground for the waterfowl due to shallowness and its extensive reed beds. Waterfowl populations according to years are given (wintering and breeding) in Table 8.

Table 8. Waterbird population according to years in Lake Eğirdir

Dates	1990 (1)	2002 (2)	2005 (2)	2006 (2)	2007 (2)	2008 (3)
Waterfowl numbers	15,000- 40,000	96,184	129,727	63,201	148,194	123,000

(1) ANONYMOUS, 1993; (2) SUSEVEN et al., 2007; (3) not printed information

5. Trophic state of lake from the past to present

Since 1950, in which the first biological and ecological studies started, up to the years 1990, there has been seen not many changes in the ecosystem. But according to the increase of the nitrogen and phosphate quantity in the last 5-6 years, it acquired mesotrophic features (GÜLLE et al., 2007). In recent years, rotifer abundance (ERTAN et al., 2001), which is known as the indicator of the eutrophic lakes, has reached up to 80% proportion in zooplankton.

In 1950s, Lake Eğirdir had drinkable water quality and oligotrophic character which was maintained till mid 80s (ERTAN et al., 2001). But, sewage discharge, siltation and intensive agriculture practises led adverse effects on lake. For this reasons, lake has changed to mesotrophic level. After 2000s this inclination has reached to eutrophic state.

Today, abundance of rotifers in zooplankton, increase of phosphate and chlorophyll *a* concentrations, *Microcystis aeruginosa* blooms in 2006 summer-fall (max. Chl. *a* concentration was 45 µg/l) (GÜLLE et al., 2006) and massive *Elodea* development (since 2006) indicates eutrophic state.

CONCLUSION

The major problems of the lake are drop of water level, siltation, agricultural pollution, and non-indigenous and invasive alien introductions. Because of these reasons the lake is under great danger; the water of lake has become less suitable for drinking supply, fisheries has become nearly to dead end and its recreational features is getting lost day by day.

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