THE COLLAPSE OF FISHERIES OF LAKE DOJRAN - REASONS, ACTUAL SITUATION AND PERSPECTIVES

VASIL KOSTOV[1] AND MARTIN VAN DER KNAAP[2]
1. University of Ss. Cyril and Methodius, Institute of Animal Science, Fisheries Department,
Ile Ilievski 92-a, Skopje, Macedonia, e-mail: vasilkostov@yahoo.com
2. MAXILLION Consultancy, P.O. Box 43, 6700 AA Wageningen, Netherlands, e-mail: martin@maxillion.eu

KOLAPS RIBARSTVA NA DOJRANSKOM JEZERU – RAZLOZI I PERSPEKTIVE

Abstrakt
U radu je prikazano stanje ribarstva na Dojranskom jezeru, starom vodenom basenu na granici Republike Makedonije i Grčke. Pored statističkih podataka o komercijalnom ulovu od 1946. predstavljena je i njihova komparativna analiza koja pokazuje da se sastav riblje zajednice Dojranskog jezera drastično promenio. Godišnji ulov ribe u poslednje dve dekade pokazuje trend neprekidnog opadanja što se odrazilo na sastav vrsta u ulovu. Opada ulov vrsta *C. carpio*, *S. glanis* i *P. fluviatilis*, dok ulov vrste *C. gibelio* pokazuje snažan trend rasta posle njene introdukcije. Analizirani su statistički podaci o ulovu ribe od 1946. i upoređeni su sa podacima o nivou vode u jezeru od 1951. Uočene su brojne činjenice koje dovode u vezu količinu vode u jezeru i izlov ribe i pritom ukazuju da sadašnji nivo vode u jezeru može usloviti prekid komercijalnog ribolova. Promenjiv nivo vode u jezeru ubrzava proces eutrofikacije što se negativno odražava na kvalitet vode.

Ključne reči: *Dojran, ribarska područja, komercijalno ribarstvo*

INTRODUCTION

The Dojran Lake is on the south east part of Republic of Macedonia, covers 43,1km^2 from which 27,3km^2 belong to Macedonia and 15,8km^2 to Greece (Fig.1). It is the smallest among the natural lakes in Macedonia with a maximum depth of 10m. Dojran Lake is the warmest lake. The high temperature of the air and the water are influenced by the closeness of the Aegean Sea. The lake is filled with water through underground wells

as well from Golema Reka, Toplec and other rivers. The lake flows through the river Gjolaja that is on the Greek territory. The Dojran Lake was described like one of the most productive natural lakes in to the Europe. Average annual fish production was 180 kg/h or 500 tons per year, maximum 800 tons/year. The average fish production from Dojran Lake was one half (50 %) of all fish production in Macedonia.

In the period from 1987 to 1989 Dojran Lake has lost two thirds of the water, and it is facing total ecological collapse. The process of eutrophication of lake is gradually developing, threatening the existence of more than 30 autochthonous species.

The 15 years period of constant reduction of the water in Lake Dojran had negative effects to the regional fish production and tourism, resulting in the collapse of the whole regional income structure. Primarily affected were the fisherman community and the small-scale tourism that accounts for 80% of the work force in the region.

The Government of Republic of Macedonia has started a project for revitalisation of Dojran Lake at great cost, by building boreholes and pipeline system for pumping underground water from the region Gavato and flush the Dojran Lake.

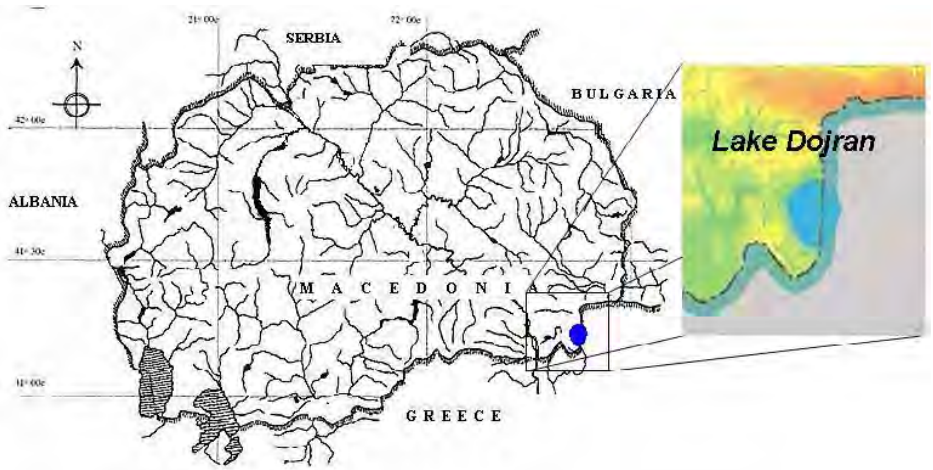

Figure 1. Republic of Macedonia and position of Dojran Lake.

The commercial fishery in Dojran Lake is operating gillnets of XX mesh from traditional dug-out canoes. The Lake Dojran fishery is famous for its collaboration with wild birds (herons and cormorants). The birds are used for chasing fish into so-called “Mandras”, enclosures made of locally available reed (*Phragmites australis*), which keep fish concentrated during the winter period. The enclosures protect the fish from being preyed upon by the birds. In the time that the lake had its original water level the total number of fishermen was of the order of more than 100, all employed by the concessionary.

The fish community of Dojran Lake and specific methods of fishing were object of investigation for huge number of scientists. The published scientific papers for fish from Dojran Lake are separated in three different periods (K o s t o v 2007).

After decreasing of water level in Dojran Lake and after abatement of Institute of Fishery are published several papers A p o s t o l s k i (1991), N a u m o v s k i (1991), T

a v c i o s k a (1994). This is the period when fishery and fish from Dojran Lake become less interesting for scientists and fish production in Dojran Lake drastically decreases.

MATERIALS AND METHODS

The available catch statistics for the period 1946 to 2003 were obtained from the archives of the Institute of Animal Science - Fisheries Department in Skopje and from the former concessionaries of Dojran Lake catch data.

The investigation of fish fauna in Dojran Lake was made in 2006. Fish specimens for this investigation were caught by means of gill nets with different mesh sizes, using a modified Swedish fishing system (A p p e l b e r g 2000). Gill nets with mesh sizes of 14, 18, 20, 22, 24, 26, 30, 34, 38, 40, 50, 70 mm were used.

Gill nets were placed in two groups. The first block of gill nets—mesh sizes of 14 to 30 mm—were placed in the littoral zone parallel to the shoreline. The second block of nets, with mesh sizes of 34 to 70 mm, was placed in the limnetic zone of the lake. Nets were placed in afternoon hours and taken out the morning of the following day. After examination by the Lake Dojran fishing concessionaire, the caught fish specimens were taken for study. Twenty-five representatives of each fish species were conserved in formalin and taken to the ichthyologic laboratory at the Institute of Animal Science in Skopje. Additional specimens were taken via electro-fishing using a Samus 725G. Electro-fishing was conducted in the littoral zone near macrophytic vegetation.

Collection of basic measurements and other base data was performed at the premises of the local fishing concessionaire. The following data were collected: analysis of species distribution; number of individuals caught per gill net; weight of individuals caught per gill net; total number of individuals caught by species; total weight of fishes caught by species; total number of individuals caught by gill nets according to mesh size; total weight of fishes caught by gill nets. Basic measurements taken for all specimens included standard length and total weight. Fish scales were taken for later age determination. Lake level data were obtained from HYDROMED, Skopje, Macedonia. Volume data were obtained from Manley (personal communication, Water Resource Associates Ltd., P.O. Box 838, Wallingford, Oxon, OX10 9XA, UK) and plotted against total annual fish production. Lake level data as well as lake volume information were compared with the fish production figures (total catch and catch by species). The Morpho-Edaphic Index (MEI) was calculated with data obtained from XYZ. The MEI may be used as a tool for estimating potential fish yield when the catchment area and the average depth of the lake are known as well.

RESULTS AND DISCUSSION

The total fish production and the species composition of catches since 1946 is presented in Figure 2.

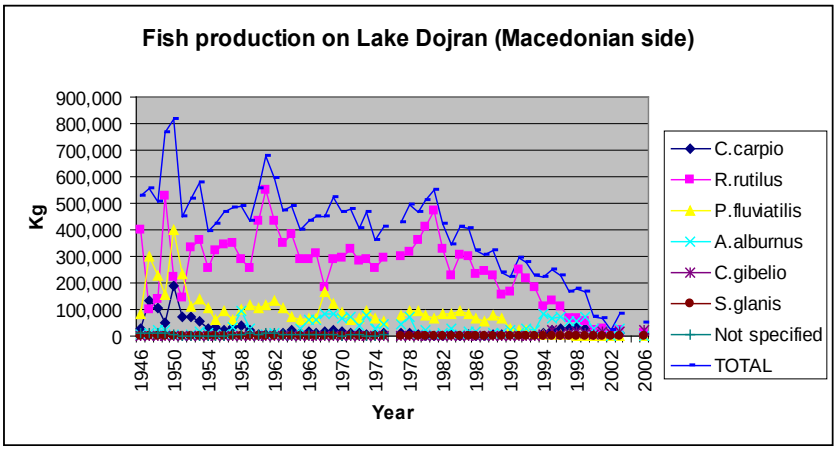

Figure 2 Catch statistics (kg) for Lake Dojran (Macedonian side) for the period 1946-2006.

The highest recorded catch of 817 tons occurred in 1950, followed by another peak catch of 680 tons in 1961. Catches started declining after 1981 when the yield was of the order of 548 tons. From then onwards the catches decreased to 25 tons per year in 2002.

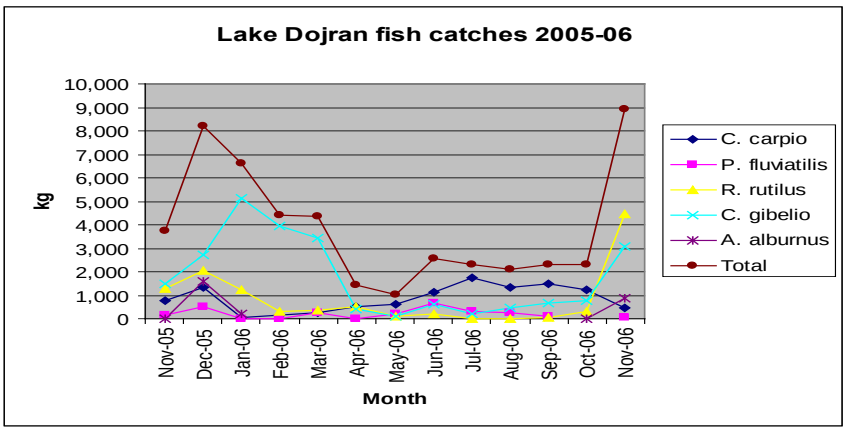

Figure 3. Monthly catch data by species on Lake Dojran from November 2005 to November 2006.

The catches in the 1940s and 1950s consisted mainly of *Cyprinus carpio*, *Perca fluviatilis* and *Rutilus rutilus*. The quantity of 188 tons of carp in 1950 definitely was the maximum output of the fishery of this most sought-after species. Although not recorded it is believed that the fishery was enhanced by carp stocking activities in that period. The evolution of catches of *Perca* and *Rutilus* seems to indicate some inverse relationships. Peaks in *Rutilus* catches in the period until 1970 coincide with dips in *Perca* catches.

Carassius gibelio was introduced between 1988 and 1990 and appeared to be a successful newcomer. It appeared in the catch statistics for the first time in 1994, before this year it was counted in not specified fish species together with *Leuciscus cephalus, Barbus peloponnesius, Rutilus macedonicus* and *Tinca tinca*. The 2006 catch data show that 46% of the total catch consists of this species. Its commercial value, however, is much lower than that of *C. carpio*, *P. fluviatilis* or *R. rutilus*.

For the period November 2005 to November 2006, 50,269 kg (50.27 tons) of fish were caught. The greatest percentage, approximately 23 tons, or about 46% of the total catch, belonged to *C.gibelio*. As a result, the concessionaire suffered negative economic consequences since *C. gibelio* is an introduced fish species in Lake Dojran and has a low market price. It is one of the very invasive species which has drastically reduced the abundance of other fish species within the lake.

Table 1 presents data for fish catches by the Lake Dojran fish concessionaire during the period November 2005 to November 2006.

Table 1. Fish catch (kg) by the Lake Dojran fish concessionaire for the period November 2005 to November 2006.

month	*C. carpio*	*P. fluviatilis*	*R. rutilus*	*C. gibelio*	*A. alburnus*	sum
November	784	174	1298	1476	4	**3736**
December	1333	533	2032	2716	1585	**8199**
January	52	9	1229	5120	214	**6624**
February	147	19	298	3953	-	**4417**
March	279	274	371	3419	-	**4343**
April	506	4	522	412	-	**1444**
May	602	225	91	96	-	**1014**
June	1123	656	202	590	-	**2571**
July	1761	304	15	215	-	**2295**
August	1358	280	24	462	-	**2124**
September	1484	106	32	667	-	**2289**
October	1227	-	290	775	9	**2301**
November	477	38	4447	3071	879	**8912**
total	**11,133**	**2622**	**10,851**	**22,972**	**2691**	**50,269**

From November to April *C. gibelio* is the most abundant species, whereas *C. carpio* occurs as the major contributor to catches from May to October. *P. fluviatilis* plays a much less distinct role in the catches in these periods. The contribution of *R. rutilus* to the catches appeared to be much larger in November 2006 than one year before.

Natural spawning has likely been affected; this may be concluded from the lag between a peak in water level followed by a peak in fish production a few years later. During the period of rising water levels the natural spawning activity possibilities of autochthonous species increased. The increased fish biomass was then exploited by the commercial fishery and when the fish sizes became vulnerable to the fishing gears this resulted in increased fish production. During the falling water level years the fish catch ability increased as the fish density increased temporarily (Figure 4). This may be better observed when the catch per unit of lake volume and the evolution of the lake volume

are compared in Figure 5. Annual catch and volume data have been presented in Figure 5. When the lake volume starts to drop in 1986 then the production of fish per unit volume peaks in 1995, after which it crashes completely to the lowest value recorded in 2002. From the observation results presented in Figure 6 it is clear that after the irrigation channel was dug the volume reduced strongly, and the fish yield decreased accordingly. In case the lake volume drops any further (i.e. below 56 MCM like in 2002) the end of the commercial fishery would be imminent. The trend line as presented in Figure 6 would intersect the X-axis at around 50 MCM.

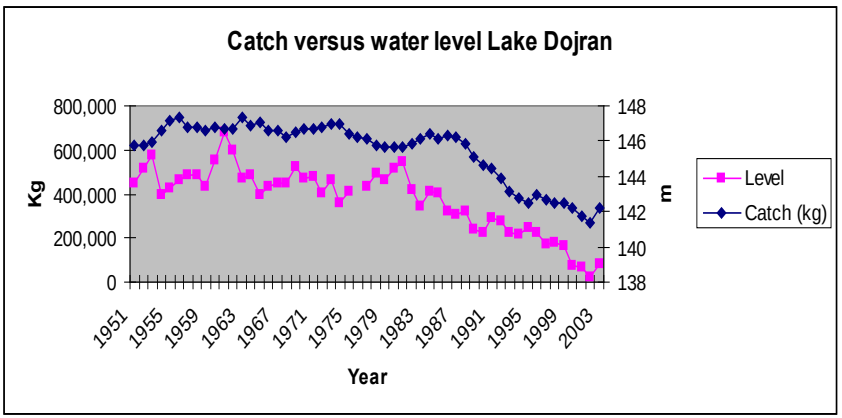

Figure 4. Fish catches (kg) on Macedonian side versus water level (m) on Lake Dojran from 1951 to 2003.

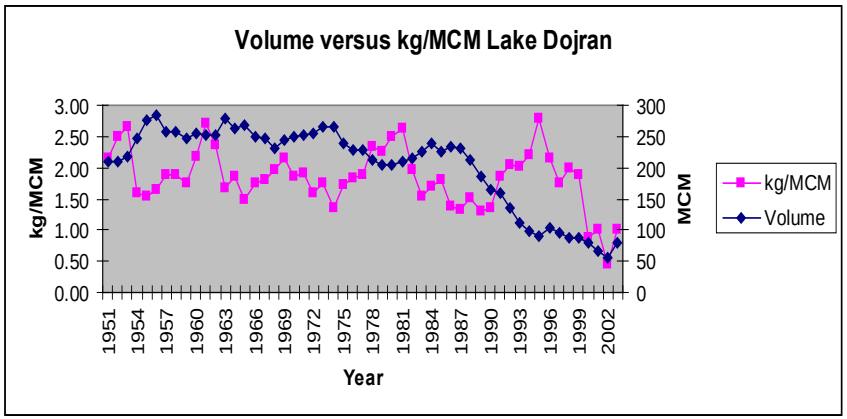

Figure 5. Fish catches (kg) on Macedonian side versus water volume (MCM) on Lake Dojran from 1951 to 2003.

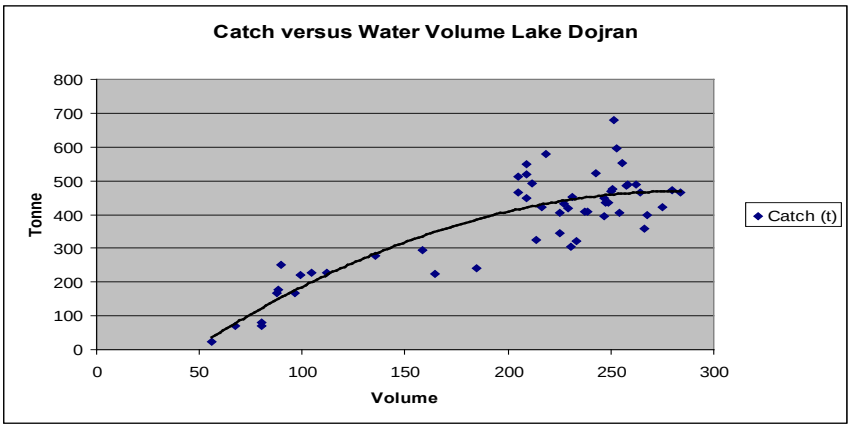

Figure 6. Macedonian fish catch (ton) versus water volume (MCM) of Lake Dojran plus a trend line.

It is beyond the scope of the present paper to discuss the extraction of water from Lake Dojran for agricultural purposes. The impact of the extraction of the water may be discussed, however. The reduced fish output as a result of the shrinking water volume of the lake is evident. Consequently the fishing sector as the economic backbone of the Lake Dojran area is at risk, jeopardizing the remaining jobs in fisheries, not only of the fishermen but also, quite importantly, of the fish consumption at resorts, hotels and restaurants. The quantity of fish available for consumption slumped from over 800 tons in 1950 to 25 tons in 2002. Until the year 1986, from when the lake level started to decline, the average fish production was 463 tons annually (n=35), as a result the fishery was reduced from 463 to 25 tons in 16 years' time. There are probably other reasons for the decline as well. In the same period a serious change in fish species composition took place at the expense of the commercially interesting species. A change in algal species composition also occurred, which led to some concern as certain blue-green algae appeared in the surface waters. Due to the reduction in the water volume the pollutants may have become more concentrated in the remaining water. Reportedly the water that was pumped in from underground sources in Macedonia contained certain pollutants as well, not contributing to the water quality of Lake Dojran. Other sources of pollution are the sewers from bordering villages.The average depth has been reduced and as a result reed beds along the banks of the lake have increased in size and surface. The reed beds provide shelter to fish fingerling, including those of the most recent introduced species (*C. gibelio*). The water level has been reduced due to the depth of the irrigation channel as it was dug in 1988. In case the water level could be manipulated so that the 1988 level could again be achieved then the potential fish yield would be of the order of 250 to 300 tons per year. That value could be achieved without active stocking carp. In case, however, carp stocking would be resumed and perhaps of additional species also, then the value of the output could be increased considerably. The increased production of high-value fish would benefit the restaurant, accommodation and tourism sector as well.

CONCLUSIONS

Based upon the current investigation and an analysis of prior commercial catch data, the composition of the fish community in Lake Dojran has changed and is worsening. Fish production (annual fish catch) during the last two decades has shown a continuous decreasing trend with a decline in the species catch structure.

The *C. carpio*, *S. glanis* and *P. fluviatilis* catch has shown a decreasing trend. The catch of *C. gibelio*, an introduced species, has shown an increasing trend.

According to this investigation and the previous commercial catch data, the only conclusion that can be made is that Lake Dojran desperately needs measures for the revitalization of its fish production and the improvement of the adverse fish composition.

Acknowledgements:

The authors are very grateful to: Mr. Pero Toncev - long year manager of fishery department in the “Dojran lake” company, ex concessionaire of Dojran Lake; Mr. Tosho Duljanov - manager of “No-Ta” company actual concessionaire of Dojran Lake; Mr. Blagoja Stefanovski – state inspector of fishery in MAFWE;

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