JEE Journal of Ecological Engineering
Volume 20, Issue 5, May 2019, pages 235–241
https://doi.org/10.12911/22998993/105358

Received: 2019.02.06
Revised: 2019.02.20
Accepted: 2019.03.18
Available online: 2019.04.01

The Composition, Distribution and Abundance of Fish Species According to the Effects of Water Physicochemical Parameters in the Livoq Lake, Kosovo

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ABSTRACT
In this study, the results of fish composition, distribution and abundance are presented according to the effects of water physicochemical parameters from the Livoq Lake in the eastern part of Kosovo. The fish specimens were sampled in six sampling stations in 2018 by using a variety of methods, including electro-fishing devices, fishing rod and cast nets. The measured physicochemical parameters included: water temperature, dissolved oxygen, saturation of dissolved oxygen, pH, conductivity, total dissolved solids. In total, 320 fish specimens were collected, belonging to 10 species of the following 5 families: Cyprinidae, Silurideae, Esocideae, Percideae and Centrarhideae. The most species rich family is Cyprinidae with 6 species in total: *Cyprinus caprio* Linnaeus, 1758, *Rutilus rutilus* Linnaeus, 1758, *Carassius carassius* Linnaeus, 1758, *Squalius cephalus* Linnaeus, 1758, *Leucaspius delineatus* Linnaeeus, 1758 and *Alburnus alburnus* Linnaeus, 1758. Four other families are represented by one species each: Silurideae with *Siluris glanis* Linnaeus, 1758, Esocidea with *Esox lucius* Linnaeus, 1758, Percideae with *Perca fluviatilis* Linnaeus, 1758 and Centrarhideae with *Lepomis gibosus* Linnaeus, 1758. The knowledge on fish fauna in Kosovo is still very fragmentary, and this investigation contributes to determining the qualitative composition and abundance features based on the water physicochemical parameters in this part of the Balkan Peninsula.

Keywords: Livoq Lake, fish distribution, fish composition, abundance, water quality.

INTRODUCTION

Freshwater fishes are one of the most highly threatened species groups in Europe with approximately 37% of species threatened (Freyhof and Brooks, 2011). Documenting diversity, abundance and threatening factors is thus an important step towards the conservation and protection of fish species. Despite unfavorable trends in the management of freshwater ecosystems in Kosovo, directly impacting the fish fauna, many alien species were intentionally or unintentionally introduced in the past decades, thus increasing the threat towards the native fish species (Gashi et al., 2016). The physicochemical parameters of water were also analyzed in different water bodies in Kosovo (Musliu et al., 2018)

It is well-known that the distribution of fish species in lake depends on several abiotic and biotic factors (Kadye et al., 2008). Among the biotic factors, predation and competition play a main role on fish population. Moreover, the abiotic factors such as water temperature and oxygen are two parameters that have influence on the fish distribution and population survival in the lake. High temperatures influence on high physiological demands apart from reducing the dissolved oxygen level from the water body. This process indicates the importance of the oxygen and its relationship with water temperature (Jackson et al., 2011).

Freshwater ecosystems in the Republic of Kosovo belong to three water basins: the Black Sea, the Adriatic Sea and the Aegean Sea. The fish fauna in Kosovo is still moderately investigated

with many areas still completely unknown in regards to the diversity and abundance of fish species. The previous ichthyofaunal investigations in Kosovo were more focused on the rivers belonging to the Adriatic Sea basin, while the other two basins have only been investigated occasionally (e.g. Grapci-Kotori et al., 2010; Maxhuni et al., 2010).

The Livoq Lake is a small artificial lake in eastern Kosovo, located on the eastern side of Gjilan and bordering the Gollak Mountains to its west. It is located in 42° 27′ 50″ N latitude and 21° 24′ 55″ E longitude coordinates, above 565 m of see level. The lake is fed by a small tributary of the South Morava River. It is the second largest lake in the east of Kosovo. The maximum length of the lake is 700 m with maximum width of 200 m and a total surface area 0.08 $km^{2.}$

This study is a first attempt to examine the current state of fish composition, distribution and abundance and relationship between fish fauna and physicochemical parameters in the artificial Livoq Lake which belongs to Black See basin.

MATERIAL AND METHODS

The study was carried out during the period of January-June 2018. The sampling stations were divided in two groups: 3 sites are located along the littoral zone (L1, L2 and L3) and another three were from limnetic zone of lake (L1.1, L2.2 and L3.3) with the distance from 34.56 m up to 72.13 m from the shore (Fig. 1).

The selection of 6 sampling stations in Livoq Lake was done based on the habitat structure, water depth and velocity, size and structure of the substratum, and, above all, the information gained from fishermen about the most suitable zones for fish sampling. The first station (L1) is located at the beginning of the lake from the main road Prishtina-Gjilan. The second station L1.1 is located 72.13 m from the shore at the middle part of lake. The third station L2 is located 241m from the L1 along the lake shore. The fourth station L 2,2 is located at the middle part of lake, 34.56 m from the shore. The fifth station L3 is located near the dam, 150 m from L2. The sixth station L3.3 is located at the middle of the lake, 60m from the shore.

In order to capture fish species in the littoral areas we have used fishing rod for 2 h, and in the limnetic area, net was cast two hours before sunset. The electrofishing device was used only twice in the littoral area. In order to explore the fish fauna of the Livoqi Lake, monthly samples were taken during January-June 2018. We did not sample in April because of the breeding time. Sampling was conducted simultaneously at the littoral and limnetic regions of lakes. The sampling

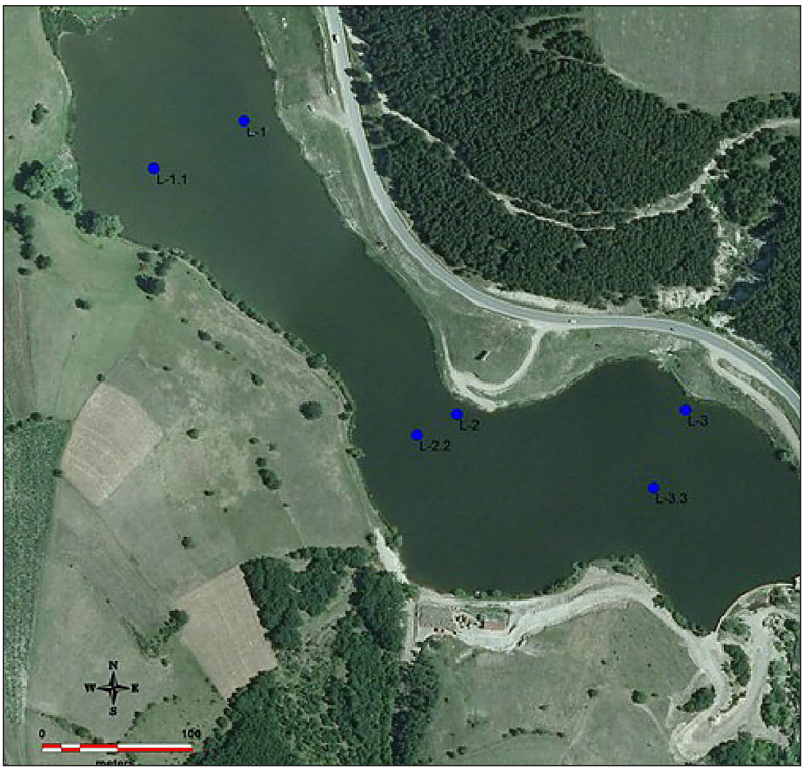

Figure 1. The location of the six sampling stations at the Livoq Lake

program and strategy were adopted according to the lake type and covering the seasonal variation of fish composition and also having in mind the breeding season for most of the fishes found in the lake. The fish were measured and identified by using the keys according to Kottelat and Freyhof (2007), Simonović (2001), Rakaj (1995) and Vuković and Ivanović (1971). All fish species were identified up to the species level. The fish community structure was analyzed in terms of total number of species (s), Shannon Wiener diversity index and the Margalef's index. The statistical analysis was performed using Excel and the ComEcoPac software.

The physiochemical parameters such as water temperature, dissolved oxygen, saturation of dissolved oxygen, pH, conductivity and total dissolved solids were measured with Multi-Parameter Water Quality Portable Meter HI-9828 Hanna.

RESULTS

During this investigation, we found 320 fish specimens belonging to 10 species and 5 families (Table 1). The highest number of species belongs to the family Cyprinidae (6), while each of the other 4 families is represented by a single species.

The highest number of fish species is found in L1, L1.1, L2 and L3 (per 7 species) whereas in the remaining two sampling stations (L2.2 and L3.3) were found 4 species each. The highest number of specimens was caught at station L3 (83), while the lowest – at station L2.2 (28 specimens). The *Carassius carassius* species is found in all sampling stations. The family Percidae with *P.fluviatilis* is missing in stations L2.2 and L 3.3. The representatives of other two families *S. glanis* (Siluridae) and *E.lucius* (Esocidae) are found only in the stations located in the middle section of the lake (L1.1, L2.2, L3.3) where fishing was done by using nets. *Lepomis gibbosus*, representing the family Centrarhidae, is the only alien species that was present at three investigated stations (L1. L2. and L3) of Livoqi Lake where fishing was done with electrofishing device and by fish hook.

According to the Jaccard index of similarity, it is shown that the stations L1, L2 and L3 are similar between each other regarding fish species composition. The lowest values of the similarity

Table 1. Composition of fish fauna in 6 sampling stations in Livoqi Lake

No.	Taxa/ Family	Recorded previously in Kosovo	Native/introd.	L1	L1.1	L 2	L2.2	L 3	L3.3	IUCN status
	CYPRINIDEA									
1	*Cyprinus caprio* Linnaeus,1758	+	Introduced	-	+	-	+	-	+	VU
2	*Rutilus rutilus* Linnaeus,1758	+	Native	+	+	+	-	+	-	LC
3	*Carassius carassius* Linnaeus,1758	+	Native	+	+	+	+	+	+	LC
4	*Squalius cephalus* Linnaeus, 1758	+	Native	+	+	+	-	+	-	LC
5	*Leucaspius delineatus* Linnaeeus, 1758	+	Introduced	+	-	+	-	+	-	LC
6	*Alburnus alburnus* Linnaeus, 1758	+	Introduced	+	-	+	-	+	-	LC
	PERCIDEAE									
7	*Perca fluviatilis* Linnaeus,1758	+	Introduced	+	+	+	-	+	-	LC
	ESOCIDEAE									
8	*Esox lucius* Linnaeus,1758	+	Introduced	-	+	-	+	-	+	LC
	SILURIDEAE						-		-	
9	*Siluris glanis* Linnaeus,1758	+	Introduced	-	+	-	+	-	+	LC
	CENTRARHIDAE									
10	*Lepomis gibbosus* Linnaeus,1758	+	Alien	+	-	+	-	+	-	LC

coefficient were found between stations L1.1, L2.2 and L3.3.

The highest value of Menhinick's index of diversity was found at station L2, while the lowest value was found at station L3.3. The Shannon-Wiener index reaches the highest value at station L1 while the lowest value was found at station L3.3 (Table 2).

The highest number of specimens in the litoral area was sampled in June (65 in total), while during the other three months, the number of the caught specimens was almost similar. In this area the highest number of specimens belongs to the *Leucaspius delineatus* species (41 in total) and the lowest number to *Lepomis gibbosus* (14). The rest of the species were sampled with almost similar number of individuals. The highest number of specimens in the limnetic area was sampled in June as well (44 in total) while in the remaining three other months the number of the caught specimens was almost similar. In this area the highest number of specimens belongs to the *Cyprinuys caprio* species (50 in total) which is also the highest number of specimens caught during the all sampling period in all sampling stations per species. The lowest number of specimens in limnetic area was sampled for *Rutilus rutilus* species (only 5). Low number of specimens in this area was sampled for *Squalius cephalus* as well (8 in total).

The main average values of physicochemical parameters of water recorded according to the investigation time are given in Table 5.

The average of temperature in Livoqi Lake varied from 16.1–16.9 °C, values of DO range from 5.3–6.99 mg/l, saturated dissolved oxygen recorded was between 71.6–94.4%, values of pH ranging from 8.18–8.44, conductivity recorded was between 556–596 µS/cm and the TDS was between 10.5–14.2 mg/l.

DISCUSSION

The distribution and composition of species in each habitat is closely related to various factors such as food availability, breeding sites, depth, topography and water chemistry (Ali et al., 1988). This was noted in our investigation as well. The results of our investigation show that such species as *Siluris glanis, Cyprinus caprio* and *Esox lucius* are found only in the sites with deep water, while the *Leucaspius delineates* and *Alburnus alburnus* species are found only along the lake shore. The

Table 2. Number of species, number of specimens, Shannon-Wiener diversity index and values of Menhinick's diversity index in 6 investigated stations of Livoqi Lake

Sampling station	Number of species (S)	Number of specimens (N)	Shannon-Wiener diversity index	Menhinick's diversity index
L1	7	50	2.75	0.98
L1.1	7	82	2.52	0.77
L2	7	46	2.71	1.03
L2.2	4	28	1.92	0.75
L3	7	83	2.64	0.76
L3.3	4	31	1.70	0.71

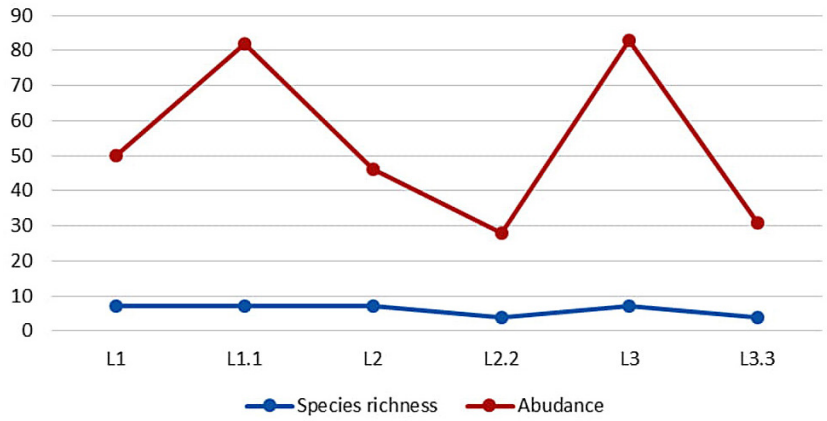

Figure 2. Species richness and abundance for six sampling stations

Cyprinus carpio has low correlation with dissolved oxygen and water temperature (Akin et al. 2005). These results concur with our findings in this study.

Two other species, *Rutilus rutilus* and *Squalius cephalus*, are more abundant and they are found both in the localities with deep water and along the lake shore. We noted that the fish species which are widespread during this investigation are those that are highly adaptable to adverse environmental factors such as variation of water physicochemical parameters, water pollution and habitat degradation.

On the basis of the conversations with local fishermen, we can conclude that the autochthonous species for this area are *Rutilus rutilus, Squalius cephalus* and *Carassius carassius* while all other species are apparently allochthonous species, although there has been no previous investigation in this area to scientifically back up these claims.

The interesting finding during this investigation is the presence of the alien species *Lepomis gibbosus,* Linnaeus (1758). This species was reported for the first time from Kosovo (Gashi et al., 2016) at Badovc Lake. Apparently, the species is more widespread in Kosovo than previously thought. It is well-known that the presence, increase in abundance or the area of occupation of invasive species may be indicative of environmental degradation (Kennard et al., 2005). The impact of this species on the populations of local autochthonous fish species is still not known. In recent years, the *Lepomis gibossus* spread rapidly into the inland water of some of the Balkan countries (Uzunova & Zlatanova 2007, Uzunova et al. 2008). On the basis of the previous investigations in Kosovo Rivers such as Drini i Bardhe River (Grapci-Kotori et al. 2006), Drenica River (Maxhuni et al., 2009) this species has not been found so far.

With regard to the IUCN criteria, most of the listed species are in the category of Least Concern and only one is in the category of vulnerable species (*Cyprinus carpio*). This species is quiet abundant; however, due to the hybridization with introduced species in Kosovo is quiet uncertain to speak precisely for pure populations of this species. It is reported as abundant in medium and lower reaches of rivers as well as lakes in Kosovo (Gashi et al., 2016).

The reasons for the variation between the littoral and limnetic areas during this investigation are ascribed to the large volume of water during investigation time, the available fish were dispersed over a wider area, and fishing became more difficult. Fishermen's catches improved greatly

Table 3. Species distribution and number of specimens during the January-June sampling period in the littoral area of the Livoq Lake

Localities	L1				L2				L3				**Total**				
Species/months	J	F	M	J	J	F	M	J	J	F	M	J	**J**	**F**	**M**	**J**	**Total**
Rutilus rutilus	2	2	1	2	1	2	1	1	3	2	2	3	**6**	**6**	**4**	**6**	**22**
Carassius carassius	3	1	4	3	0	2	1	2	0	3	0	3	**3**	**6**	**5**	**8**	**22**
Squalius cephalus	1	0	3	2	2	1	2	2	0	5	3	7	**3**	**6**	**8**	**11**	**28**
Leucaspius delineatus	2	1	2	4	3	3	2	3	5	6	5	5	**10**	**10**	**9**	**12**	**41**
Alburnus alburnus	3	1	0	1	1	2	2	3	2	5	0	5	**6**	**8**	**2**	**9**	**25**
Perca fluviatilis	0	0	1	1	1	0	0	4	2	0	3	10	**3**	**0**	**4**	**15**	**22**
Lepomis gibbosus	2	1	2	2	1	1	0	1	1	1	1	1	**4**	**3**	**3**	**4**	**14**
Total	**13**	**6**	**13**	**15**	**9**	**11**	**8**	**16**	**13**	**22**	**14**	**34**	**35**	**39**	**35**	**65**	**174**

Table 4. Species distribution and number of specimens during the January-June sampling period in the limnetic area of the Livoq Lake

Localities	L1.1				L2.2				L3.3				**Total**				
Species/months	J	F	M	J	J	F	M	J	J	F	M	J	**J**	**F**	**M**	**J**	**Total**
Cyprinus carpio	7	3	5	14	3	2	2	2	4	5	2	9	**14**	**10**	**9**	**17**	**58**
Rutilus rutilus	0	1	2	2	0	0	0	0	0	0	0	0	**0**	**1**	**2**	**2**	**5**
Carassius carassius	3	5	5	7	2	2	4	1	2	2	2	2	**7**	**9**	**11**	**10**	**37**
Squalius cephalus	2	2	2	2	0	0	0	0	0	0	0	0	**2**	**2**	**2**	**2**	**8**
Esox lucius	2	2	1	4	1	0	2	3	2	0	0	2	**5**	**2**	**3**	**9**	**19**
Silurus glanis	3	5	2	2	0	2	2	0	0	0	1	2	**3**	**7**	**5**	**4**	**19**
Total	**17**	**18**	**17**	**31**	**6**	**6**	**10**	**6**	**8**	**7**	**5**	**11**	**31**	**31**	**32**	**44**	**146**

Table 5. Average values of water physicochemical parameters during investigation time January-June 2018

Nr.	Parameters	Symbol	Units	Sampling stations					
				L1	L1.1	L2	L2.2	L3	L3.3
1	Water temperature	T	C^0	16.9	16.5	16.7	16.4	16.3	16.1
2	Dissolved oxygen	DO	mg/l	5.3	5.5	6.99	6.84	6.26	6.52
3	Saturated dissolve oxygen	Do	%	71.6	74.2	94.4	92.3	84.5	88.1
4	pH value	pH	0–14	8.43	8.40	8.44	8.35	8.18	8.26
5	Conductivity	Con	µS/cm	583	596	556	586	568	578
6	Total dissolved solids	TDS	mg/l	12	10.5	11.8	10.5	14.2	13.9

during fishing in the littoral zone especially in month of June due to the migration of deep water fishes away from the deep waters to the upper waters during this period. The high abundance in June is also in correlation with the habitat requirements of Cyprinidae family, which is the family with the largest number of species. This species of this family are known to be more active and abundant in the months with higher temperature. This is in correlation with the findings in Prespa Lake, Northwestern Greece (Crivelli et al., 1997). However, several operational factors such as mesh size, net length, set time factors are well known to drive this temporal variability suggesting that certain species become more or less catchable by cast nets in the course of the year (Grant et al., 2004; Olin et al., 2009) (Jensen, 1986; Minns and Hurley, 1988).

CONCLUSION

There is no great difference amongst the investigated localities regarding the values of diversity indices. The reason is that the distance between localities is not so great. In general, it is noted that all localities of the littoral area are characterized with higher values of diversity indices compared to the localities located in the littoral area. The main reason for this is that the waters in the littoral zone are more shallow and thus warmer than the rest of the localities. Thus, this area is more favorable for most of the species found during this investigation.

The knowledge on the fish fauna in Kosovo is still very fragmentary, and this investigation constitutes a relevant contribution. This makes further ichthyofaunal studies in Kosovo inevitable in order to determine the qualitative composition and main threats, as well as the consequent procedures and measures for protection.

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