

Structure of Fish Assemblage in Relation to Some Ecological factors in Himreen Dam Lake, Iraq

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Abstract: Spatial and temporal variability of fish assemblage in Himreen Lake was studied from summer 2014 to spring 2015. Water temperature, electrical conductivity, dissolved oxygen, transparency and potential hydrogen ion were measured from three sites in the Lake. Several fishing methods were adopted to collect fish including; gill nets, cast net, hook and line and hand net. The results showed that the fish assemblage consisted of 19 species representing seven families. Number of species increased in summer and spring and sharply decreased in winter. *Luciobarbus grypus* was the most abundant species comprising 23.6% of the catch, followed by *Carassius auratus* (20.07%) and *Cyprinus carpio* (11.39%). The dominance (D_3) value for the main three abundant species was 55.06%. The overall values of diversity index ranged from 1.71 in winter to 2.43 in summer, richness index from 2.4 in winter to 2.94 in summer and evenness index from 0.71 in winter to 0.84 in autumn. Associations between the distribution of fish species and the environmental variables were quantified by using canonical correspondence analysis (CCA).

Key words: Fish assemblage, ecological factors, Himreen Dam Lake, diversity, Iraq.

Introduction

Reservoirs have been described as an ecological hodgepodge. When a dam is built some of riverine species, trapped behind the structure survive, although most of the lotic species cannot tolerate the lentic conditions. Most of the riverine fish stay close to the shores of the reservoir, the mouth of tributaries and in the shallows [25]. The pelagic and deep waters are poorly utilized unless fishes adapted to these conditions were present before the reservoir was formed [15].

Iraq has wide and various water bodies area which approximately evaluates 1.1 million hectares, and form different environmental systems as

streams, rivers and lakes, which appropriate environmental conditions for growth and farmed fish [6]. Himreen Dam Lake is freshwater lake in Iraq. It was built for flood control of Diyala River to protect the wide land plain for beneath Diyala basin. As well as organizing the drainage for irrigation and power generation [24].

Few studies were executed concerning the fish ecology of Iraqi inland waters, mostly dealt with species composition and other biological aspects of major lakes and reservoirs like [4] on Dokan; [7, 8] on Habbaniya and Al-Qadisiya; [16] on Habbaniya, Tharthar and Razzazah; and [13] on Dokan and Derbendikian, [1] on Dokan

Lake. Unfortunately, though this site has obvious importance for fish biodiversity, no surveys were conducted here. Therefore, a central goal of our paper is to describe the composition of fish species assemblage and understand spatio-temporal patterns of population fluctuations.

Materials and methods

Himreen Lake is one of the most important lakes in Iraq, located just beyond the Himreen hills, 150 km northeast of Baghdad toward Baquba and the capital city of Diyala. It was created by the Himreen dam on the Diyala River in Northeastern Diyala governorate, which flows from the Iranian mountains and Iraqi Kurdistan. The lake is rectangular, with the Himreen dam on the southwestern edge [9]. The height of Himreen Dam is 53m and has a discharge about 4050 m³/sec., the impoundment area is reach to 373 km² and the highest level for impoundment is 107.5 m [5], and its capacity up to four billion cubic meter of water [3].

Many aquatic plants are located on the shore of the lake such as *Typha domingensis*, *Phragmites australis*, *Ceratophyllum* sp. and *Vallisneria* sp.

Three stations were chosen to execute the study from Himreen Lake (Fig. 1). Station 1 (495459 E, 3795485 N meters), station 2 (501870 E, 3781684 N meters) and station 3 (508469 E, 3770162 N meters).

Fish samples were regularly collected from each station from summer 2014 to spring 2015. Several fishing methods were adopted to collect fishes including gill nets, cast net, hook and line and hand net. Catches of other

anglers in the locations were also counted. Fish species identified and counted, and classified by consulting [14] and updated according to [17].

Water temperatures (W. Tem) were measured by simple thermometer (range of 0 – 100 °C), Electrical Conductivity (EC) values were determined by using a Bischof 117 EC-Meter. Transparency (Tra) of water was measured by Secchi disk about 25 cm in diameter. The Dissolved Oxygen (DO) was analyzed by using Winkler's Modification Method. On the other hand, Potential hydrogen ion (pH) values were measured by a GTC pH-meter with an accuracy of ± 0.1 . At each location, the GPS waypoint was collected for spatial reference.

The analysis of the nature of the fish assemblage in the three sites was carried out by the following methods and indices: relative abundance [23], dominance (D_3) [21]. Fish diversity, richness, and evenness were calculated by using CANOCO program (Version 4.5). The direct gradient analysis has carried out on water parameters and fish to verify if there is any significant relationship by applying the multivariate analysis of ecological data using CANOCO program.

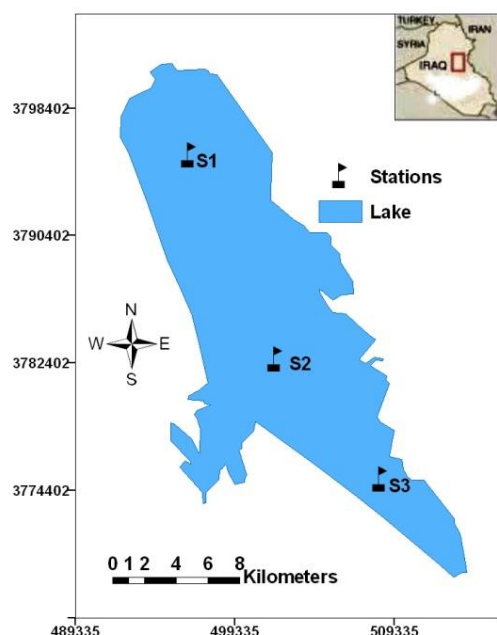


Fig. 1: Map of Himreen Dam Lake showing the study sites; S1: station 1, S2: station 2 and S3: station 3.

Results

1. Ecological factors

Seasonal variations in water temperature, transparency and electrical conductivity in Himreen Lake have shown in Figure 2. Insignificant differences ($F= 0.013, 0.073$ and $0.140, P>0.05$) were found among stations respectively. Water temperature ranged from 13.1°C in winter to 28°C in summer. Transparency values varied from 140 cm in summer to 230 cm in winter. EC values differ from $647.3 \mu\text{S/cm}$ in winter to $845.7 \mu\text{S/cm}$ in summer.

Figure 3 illustrated the seasonal changes in dissolved oxygen and pH in the study site. Insignificant differences ($F= 0.575$ and $0.168, P>0.05$) were found between stations. DO values ranged from 7.53 mg/L in summer to 11.37 mg/L in winter. Limited

fluctuations in pH values varied from 7.33 in winter to 7.82 in the spring.

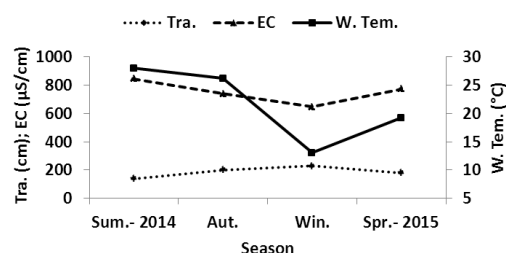


Fig. 2: Seasonal variations in water temperature, EC and transparency in the study site.

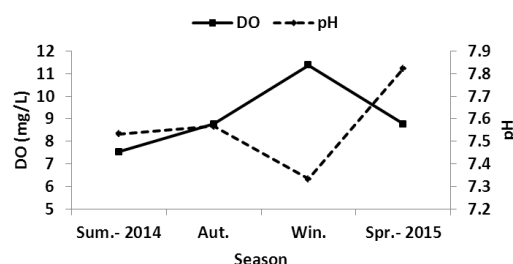


Fig. 3: Seasonal variations in dissolved oxygen and pH in the study site.

2. Fish community structure

A total of 19 fish species belong to seven families were collected from the study site in Himreen Lake, including 15 native and four alien. Cyprinidae was a dominated family. It was represented by 13 species namely: *Acanthobrama marmid*, *Arabibarbus grypus*, *Barbus barbulus*, *Carasobarbus luteus*, *Carassius auratus*, *Garra rufa*, *Cyprinion macrostomum*, *Cyprinus carpio*, *Leuciscus vorax*, *Luciobarbus esocinus*, *Luciobarbus kersin*, *Luciobarbus xanthopterus* and *Mesopotamichthys sharpeyi*. Six families each just represented by one species namely; *Aphanius dispar* (Cyprinodontidae), *Gambusia holbrooki* (Poeciliidae), *Heteropneustes fossilis* (Heteropneustidae), *Planiliza abu* (Mugilidae), *Mastacembelus*

mastacembelus (Mastacembelidae) and *Silurus triostegus* (Siluridae)(Table 1).

Seasonal fluctuations in number of species in the study stations were detected (Fig. 4). Nineteen fish species were recorded from station 1. They ranged from eight in winter to 19 species in summer. Fifteen species were encountered in station 2. They varied from eight in winter to 14 species in summer and autumn. In station 3 nineteen species were found. They ranged from seven in winter to 17 species in summer. Insignificant differences ($F=0.334$, $P>0.05$) were detected in number of species among stations. Nineteen species were encountered in the Himreen Lake, varied from 19 in summer to 11 in winter (Fig. 5).

Seasonal variations in number of individuals recorded from the investigated stations are represented in figure 4. A total of 466 fish individuals were recorded in station 1, they ranged from 18 in winter to 168 fish in summer. A total of 408 fish individuals were caught in station 2; they varied from 24 in winter to 159 fish in summer. Meanwhile, 461 fish individuals were recorded from station 3, they ranged from 30 in winter to 197 fish in summer. Insignificant differences ($F=0.051$, $P>0.05$) were detected in number of species among stations. A total of 1335 fish individuals were recorded in the Himreen Lake, they ranged from 72 in winter to 524 fish individuals in summer (Fig. 5).

3. Relative abundance

Table 1 revealed the relative abundance of fish species in the Himreen Lake during the study period.

It has been found that the fish assemblage was dominated by *A. grypus* (23.6%), it fluctuated from 19.44% in winter to 25.06% in the spring. *C. auratus* comprising 20.07% of the assemblage, it changed from 17.18% in summer to 43.06% in winter. *C. carpio* was formed 11.39% and relative abundance varied from 9.54% in summer to 16.67% in winter. These three species formed 55.06% of the total number of species according to dominance index (D_3).

4. Fish diversity indices

Seasonal fluctuations in ecological indices of fish assemblage in the Himreen Lake were illustrated in Figure 6. It has been found that diversity index varied from 1.71 in winter to 2.43 in summer, with an overall value of 2.21. Richness index ranged from 2.4 in winter to 2.94 in summer, with an overall value of 2.77. Evenness index fluctuated from 0.71 in winter to 0.84 in autumn, with an overall value of 0.8.

5. Fish and ecological factors

Figure 7 illustrated the canonical correspondence analysis (CCA) ordination plot which summarized the relationships between the availability of fish species and the environmental variables in the Himreen Lake. Water temperature was a greater impact factor on the total number of species and the total number of individuals compared with other factors. It was high positive correlated with number of species ($r= 0.93$) and number of individuals ($r= 0.98$), while transparency has negative correlated with total number of species ($r= -0.97$) and total number of individuals ($r= -0.99$). Most of Fish species have positive correlation with

water temperature and electrical conductivity, while negative correlation with transparency and dissolved oxygen.

Table 1: Seasonal variations in relative abundance of fish species.

Species	families	Code	Sum.	Aut.	Win.	Spr.	Total
<i>Arbibarbus grypus</i>	Cyprinidae	Agr	24.05	21.99	19.44	25.06	23.60
<i>Carassius auratus</i> *	Cyprinidae	Cau	17.18	19.58	43.06	20.15	20.07
<i>Cyprinus carpio</i> *	Cyprinidae	Cca	9.54	12.05	16.67	12.29	11.39
<i>Luciobarbus xanthopterus</i>	Cyprinidae	Lxa	8.59	8.73	4.17	8.85	8.46
<i>Luciobarbus kersin</i>	Cyprinidae	Lke	8.59	8.43	2.78	3.44	6.67
<i>Carasobarbus luteus</i>	Cyprinidae	Clu	4.20	3.92	1.39	5.41	4.34
<i>Gambusia holbrooki</i> *	Poeciliidae	Gho	5.92	3.92	-	1.47	3.75
<i>Planiliza abu</i>	Mugilidae	Pab	4.20	3.61	1.39	2.95	3.52
<i>Acanthobrama marmid</i>	Cyprinidae	Ama	2.86	3.92	-	4.18	3.37
<i>Barbus barbuls</i>	Cyprinidae	Bba	2.67	2.71	1.39	4.18	3.07
<i>Aphanius dispar</i>	Cyprinodontidae	Adi	2.67	3.01	-	2.21	2.47
<i>Silurus triostegus</i>	Bagridae	Str	1.72	1.20	5.56	2.95	2.17
<i>Leuciscus vorax</i>	Cyprinidae	Lvo	2.29	2.11	1.39	1.23	1.87
<i>Luciobarbus esocinus</i>	Cyprinidae	Les	1.53	0.90	2.78	1.72	1.50
<i>Mesopotamichthys sharpeyi</i>	Cyprinidae	Msh	1.72	1.51	-	1.47	1.50
<i>Cyprinion macrostomum</i>	Cyprinidae	Cma	0.95	1.81	-	1.23	1.20
<i>Mastacembelus mastacembelus</i>	Mastacembelidae	Mma	0.38	0.60	-	0.98	0.60
<i>Garra rufa</i>	Cyprinidae	Gru	0.38	-	-	0.25	0.22
<i>Heteropneustes fossilis</i> *	Heteropneustidae	Hfo	0.57	-	-	-	0.22
No. Individuals			524	332	72	407	1335
No. Species			19	17	11	18	19

*Alien species

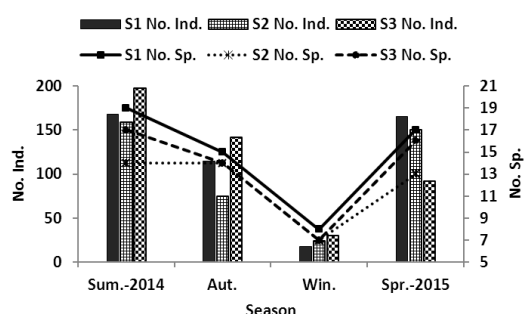


Fig. 4: Seasonal variations in number of individuals and species in the study stations.

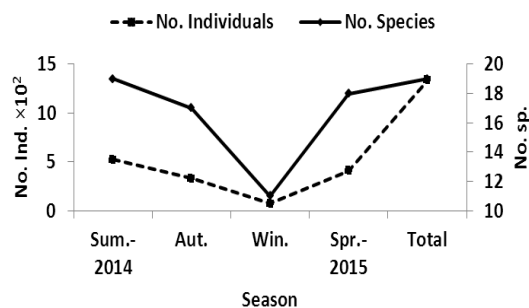


Fig. 5: Seasonal variations in the total number of individuals and species in the study stations.

5. Fish and ecological factors

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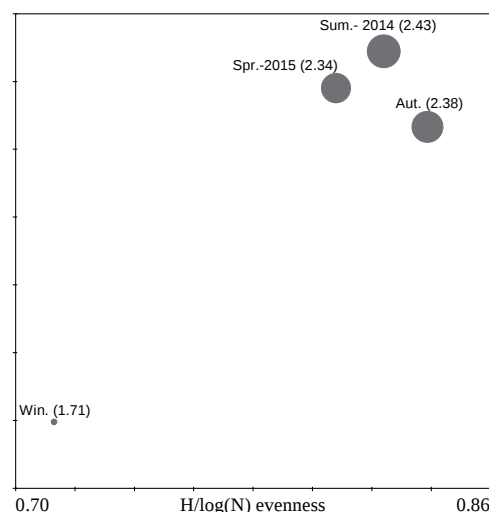


Fig. 6: Distribution of the values of diversity, richness and evenness indices in the study site.

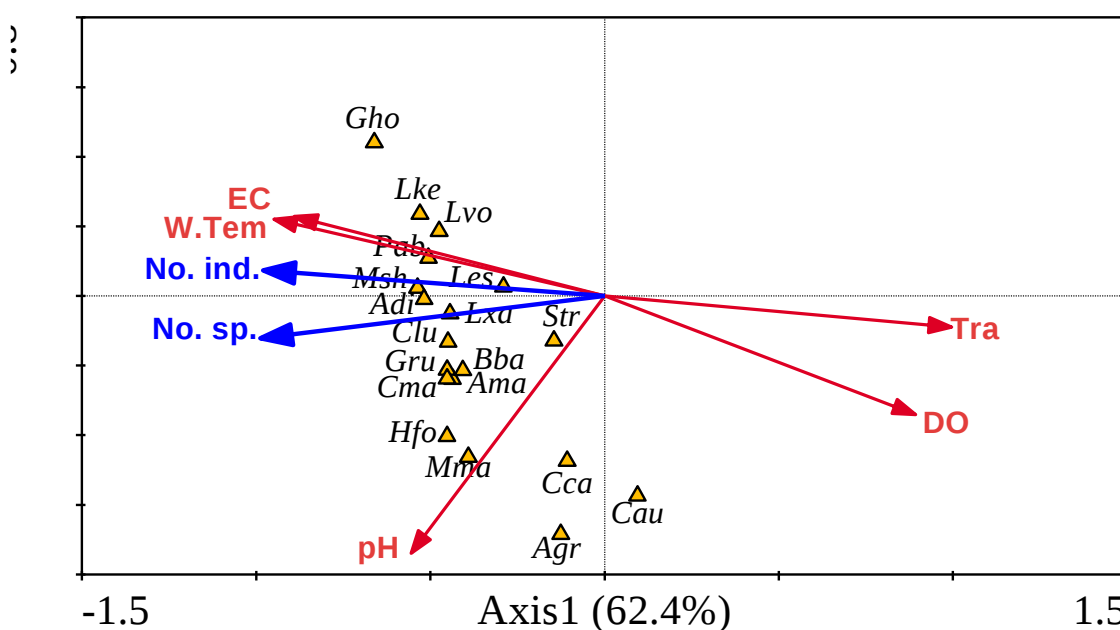


Fig. (7): CCA ordination plots showing the relationship among fish species and various ecological factors in the Himreen Lake (species abbreviations as in Table 1).

Discussion

There are 53 fish species in freshwater of Iraq, 44 native and 9 exotic freshwater species [14]. However, the building of a dam generally has a major

impact on fish populations: migrations and other fish movements can be stopped or delayed, the quality, quantity and accessibility of their habitat, which plays an important role in population sustainability, can be affected [22].

Brunger Lipsey *et al.* [12] deduced that fish distributions found to closely correspond to habitat features. Generally, 19 fish species recorded in the Himreen Lake, four of which were exotic species. However, *A. grypus*, *C. auratus* and *C. carpio* were most dominated species, which formed 55.06% of the total number of species. Results in this site were clearly unlike those of Abbas and Sadiq [1] may be due to difference of catch effort or several of the riverine species do not adapt and either die or move out of the area. They collected 27 fish species in Dokan Lake. On the other hand, the dominated species found to consist 34.9% including *A. grypus* (13.4%), *C. auratus* (11.6%) and *Chondrostoma regium* (9.9%). When made a comparison the species composition in Himreen Lake with that of Abdullah *et al.* [2] and Abbas and Sediq [1], It could gather that fish assemblages at Dokan and Darbandikhan lakes share the dominant fish family (Cyprinidae) which also the common and rich in species in all water bodies of Iraq [14].

Fish diversity in reservoirs, derived from river fishes. According to Jorgensen *et al.* [20] and Hussain *et al.* [19], the overall status of diversity index is considered as moderate status, richness index as semi disturbed and evenness index as semi-balanced in Himreen Lake. Moreover, the overall value of richness index in this site exceeded [1], they were recorded 2.36.

The contributions of biotic and abiotic factors in structure fish assemblages have important implications for conservation and management of habitats under the effect of human activities [11]. However, the

results indicated that the ecological properties, in particular temperature might provide some possible explanations for the differences in distribution, abundance and species composition in Himreen Lake. In CCA plots, it could be observed the majority of fish species have resisting temperature fluctuations. This contradicts all species may be affected by this factor [10]. Seasonal change in temperature appeared to be the main parameter structuring fish assemblage in the study site, coincided with electrical conductivity. The pH recorded during the present study was generally of near natural to alkaline range suggesting that the lake water was well buffered throughout the period of this study. Interestingly the present study confirm that the Himreen Lake the important habitat and conservation place for some native and threatened fishes in Iraq. Due to *A. grypus* one of six freshwater fishes that considered threatened species (VU) in Euphrates-Tigris system, as well as the other two threatened barbels species (*L. esocinus* and *L. xanthopterus*, both VU), that they benefit from construction of large reservoirs, where they form large stocks and can migrate into inflowing rivers in spring for spawn [18].

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تركيبة التجمع السمكي وعلاقته ببعض العوامل البيئية في بحيرة سد حمير- العراق

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الخلاصة: درس التباين الزمني والمكاني لتجمع الأسماك في بحيرة حميرين للمدة من فصل الصيف 2014 الى ربيع 2015. قيس درجة حرارة المياه والتوصيلية الكهربائية والأوكسجين المذاب والشفافية والاس الهيدروجيني من ثلاثة محطات في البحيرة. اعتمدت عدة طرق في الصيد لتجمع الأسماك وهي الشباك الخيشومية والسلية وخيوط الشص والشبكة اليدوية. أظهرت النتائج أن تجمع الأسماك يتألف من 19 نوعا تمثل سبعة عوائل. حصلت زيادة في عدد الأنواع خلال فصل الصيف والربيع وانخفضت بشكل حاد خلال فصل الشتاء. كانت أسماك الشبوط *Carassius auratus* الأكثر وفرة اذ شكلت 23.6% من الصيد الكلي، يليها النوع *Arabibarbus grypus* (20.07%) ثم النوع *Cyprinus carpio* (11.39%). كانت قيمة دليل السيادة (D_3) لأكثر ثلاثة أنواع وفرة هي 55.06%. تراوحت القيم الكلية لدليل التنوع من 1.71 في الشتاء إلى 2.43 في الصيف وتباين دليل الغنى من 2.4 في الشتاء الى 2.94 في الصيف ودليل التكافؤ من 0.71 في الشتاء إلى 0.84 في الخريف. حددت العلاقات بين توزيع أنواع الأسماك والمتغيرات البيئية باستخدام تحليل الارتباط المتعدد (CCA).