Journal of Water Resources and Geosciences
Vol. 2, No. 1 , 2023

Evaluation of Al-Hawizeh marsh environment Southern of Iraq using Integrated Biological Index (IBI)

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Abstract

This study to evaluate the Al-Hawizeh marsh environment using the Integrated Biological Index (IBI) after inscribed on the World Heritage. The study extended from December 2017 to November 2018. A total of 28959 individuals of fish which belong to 17 genera, 9 families and 19 species, fourteen metrics were selected for measurement (IBI) from the following major groups to assess the environment of Al-Hawizeh marsh, Species richness, Species composition and Trophic Guilds metrics. The overall Integrated Biological Index value achieved (57.71%) and which inscribed within the impaired category, the average Integrated Biological Index values of four study stations achieved 60.80, 60.88, 58.82 and 50.32% respectively.

Keywords: Integrated Biological Index, Richness metrics, Trophic metrics, Al-Hawizeh, World Heritage

Journal of Water Resources and Geosciences
Vol. 2, No. 1 , 2023

تقييم بيئة هور الحويزة جنوب العراق باستخدام المؤشر البيولوجي المتكامل(IBI)

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الخلاصة

تهدف هذه الدراسة لتقييم بيئة اهوار الحويزة باستخدام المؤشر البيولوجي المتكامل (IBI) بعد ادراجها على لائحة التراث العالمي. امتدت الدراسة من ديسمبر 2017 إلى نوفمبر 2018. حيث تم جمع 28959 فردًا من الأسماك التي تنتمي إلى 17 جنسًا و 9 عائلات و 19 نوعًا ، وقد تم اختيار أربعة عشر مقياسًا لقياس ال(IBI)من المجموعات الرئيسية لتقييم بيئة هور الحويزة ، وقد شملت قياس ثراء الأنواع ، تكوين الأنواع والتركيبة الغذائية. بلغ اجمالي قيمة المؤشر البيولوجي المتكامل (57.71٪) والتي تم إدراجها ضمن فئة الضعيف، وكان معدل قيم المؤشر البيولوجي المتكامل لمحطات الدراسة الاربعة 60.80 و 60.88 و 58.82 و 50.32٪ على التوالي.

الكلمات المفتاحية : - المؤشر البيولوجي المتكامل ، مقاييس الثراء ، المقاييس الغذائية ، الحويزة ، التراث العالمي.

Introduction

The Iraqi marshes are the largest wetlands in southwest Asia (UNESCO,2016) with an area twice the size of the Everglades in Florida (Adriansen,2006). Therefore, the Mesopotamian Marshlands (Al-Hawizeh) was listed as a world heritage site (UNESCO), making them unique wetlands in the world during the 40th session in the World Heritage Committee under cultural criteria (iii) and (v) and natural criteria (ix) and (x) in Istanbul in 2016. UNESCO considered it as one of the natural components of Iraq with
an estimated area of 906.63 km^2 (UNESCO, 2016).

To be inscribed on the world heritage list, sites must be of outstanding universal value and meet at least one out of ten world criteria selection. These criteria are explained in the operational guidelines for the implementation of the world heritage convention which, is the main working tool on world heritage (Al-Lami , et.al.,2014; UNESCO, 2018).

The Index of Biotic Integrity (IBI) provided a tool for monitoring the ecological integrity of ecosystem health as a result of habitat degradation or flow alteration, in addition to chronically poor chemical water quality (Karr & Dudley, 1981).

As the IBI became more widely used, different versions were developed for different regions and different ecosystems including lakes and wetlands (Uzarski1 , et.al.,2005; Brousseau & Randall, 2008).

Fish assemblages can be ideal integrated indicators of ecological integrity given that they are relatively easy to collect and they can have unique species and population-specific responses to environmental conditions that are reflected in their relative abundance and composition (Karr , et.al.,1986; Barbour , et.al.,1999).

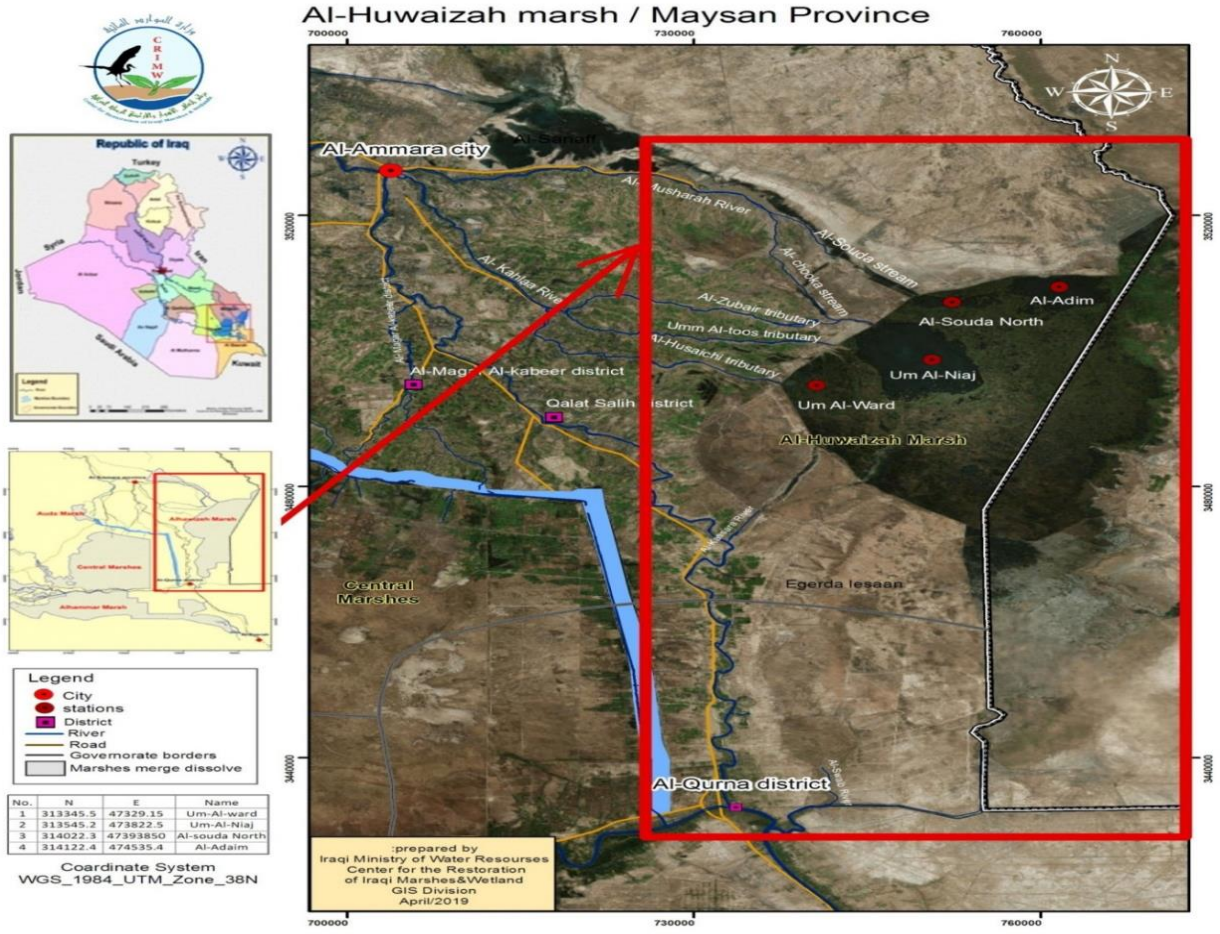
The fish integrated biological index (F-IBI) was used by several workers to evaluate the fish structure changes in the restored marshes in Iraq (Al-Shamary, 2008; Abd, 2010; Mohamed & Hussain, 2012; Mohamed, 2014; Mohamed & Hussain, 2014; Mohamed , et.al.,2015 and Mohamed & Abood, 2017) in Shatt Al-Arab River and in Garmat Ali River by (Younis , et.al.,; Mohamed , et.al.,2017 & Hameed, 2017). The aim of this study is to evaluate the environment of

Al-Hawizeh marsh using the Integrated Biological Index (IBI) after Inscribed on the World Heritage List.

Study Area

Al-Hawizeh marsh is considered a water body concerted between Iraq and Iran in terms of location and food resources lies approximately 70 km of Al-Ammara city. It extends between (Latitude/ Longitude: 31°00'-31º45'N,47° 25'-47º 50'E). The area is distributed by 79% for the Iraqi part and by 21% for the Iranian part (Al-Ali,1994; Domad, 2008). As to the Iraqi part of the marsh, it is distributed by 67% and 33% to both Maysan and Basra provinces respectively. The marsh contains many bodies like Al-Sannaf, Um Al-Nia'aj, Abu-Athbah, Al-Adaim, Al-Doob, Al-Jakah, Al-Saffia, and Al-Khabta marshes.

Four locations studied were chosen within Al-Hawizeh marsh in the current study, these are station 1(Um Al-Ward station 2 (Um Al-Nia'aj) station 3(Al-Souda north),and station 4(Al-Adaim),shown in (Figure (1)).



No.	N	E	Name
1	313345.5	47329.15	Um-Al-ward
2	313545.2	473822.5	Um-Al-Niaj
3	314022.3	47393850	Al-souda North
4	314122.4	474535.4	Al-Adaim

Figure (1):Al-Hawizeh marsh location in Maysan province,southern Iraq (Source:CRIM 2019)

Material and Methods

Fish were collected monthly from December 2017 to November 2018 from four selected sites within Al-Hawizeh marsh during the study period. Sampling was taken by using three means of fishing at each site including, fixed gill nets average lengths between (50 to 100 m long with 16×16mm to 67×67 mm mesh size), cast nets, the ranging between (6-9) mm and between 25×25 and 40×40 mm mesh size, and electro-fishing by generator engine (provides 300-400V and 10A), it was used in the places where the vegetation very density and cannot be caught for 45 minutes.

Fourteen metrics were selected for measurement (IBI) from the following major groups to assess the environment of Al-Hawizeh marsh as follows:

(A)Species richness metrics which include:
1) Number of native fish species
2) Number of alien fish species

(B) Species composition metrics
3) Proportion of native individuals species
4) Proportion of alien individuals species
5) Proportion of sensitive native individual species
6) Richness Index

(C) Trophic Guilds metrics
7) Proportion of herbivores individuals species
8) Proportion of carnivores individuals species
9) Proportion of detrivores individuals species
10) Proportion of omnivores individuals species
11) Proportion of *Planiliza abu* individuals species
12) Proportion of Cichlidae individuals family

13) Proportion of *Carassius auratus* individuals

14) Number of common native species

According to the Manual of Integrated Biological Index based on the described method by (Minss , et.al.,1994). The Biological Index was divided into three groups in a similar way to (Ganasan & Hughes, 1998; Hughes , et.al.,2006).

Results

Altogether, nineteen fish species belonging to six orders includes Cypriniformes, Mugiliformes, Siluriformes , Synbranchiformes, Perciformes , Cyprinodontiformes and nine families and seventeen genera and a total of 28959 individual of fish were collected from four studied stations in Al-Hawizeh marsh southern of Iraq.

A- Species richness metrics

1-Number of native fish species

This group included 11 species of native fish comprised 57.89 % of the total number species (Table (1)) and 15870 individuals in the present study formed 54.8% of the total number of fish captured. The highest number of native fish (10) species appeared in July at station 1, in January, February, June and July at station 2, in June at station 3 and in January and June at station 4, while lowest number of native fish (0) species in September at station 4 (Figure (2)).

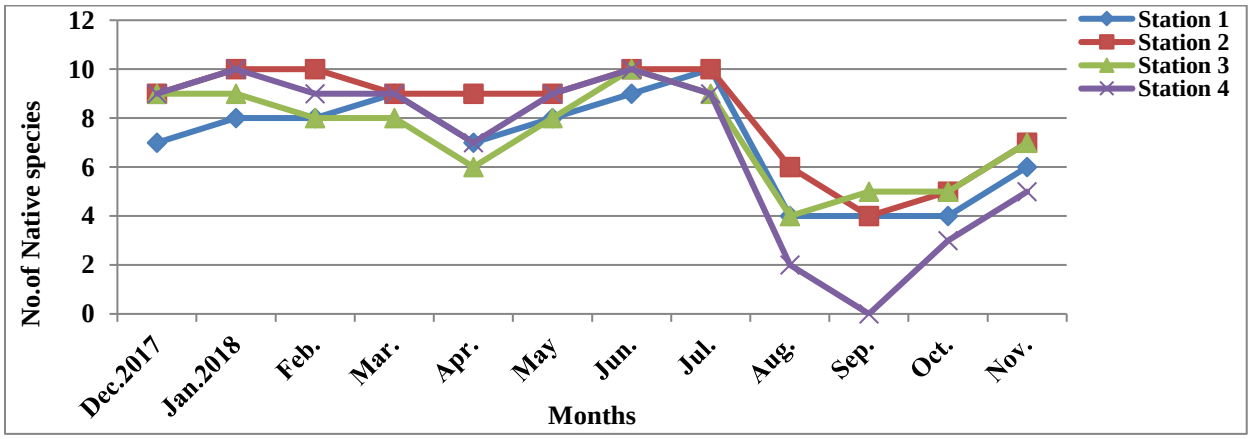


Figure (2):Monthly variations in number of Native fish species of four stations in Al-Hawizeh marsh during study period

Table (1) : Geographic origin and trophic groups of fish captured in Al-Hawizeh marsh during the study time

The metrics	Species
Native species	*A. marmid , A. mossulensis , C. luteus , C. sublimus , L. vorax , M. sharpeyi , P. abu , S. triostegus , M. matacembelus , A. dispar and M. pelusius*
Alien species	*C. auratus , C. carpio , H. leucisculus , H. fossilis , G. holbrooki , C. zillii , O. aureus and O. niloticus*
Herbivores species	*C. luteus , C. sublimus , C. auratus , M. sharpeyi , C. zillii , O. aureus and O. niloticus*
Carnivores species	*A. marmid , A. mossulensis , L. vorax , S. triostegus , M. matacembelus , A. dispar , M. pelusius , H. leucisculus , H. fossilis , and G. holbrooki*
Detrivores species	*P. abu*
Omnivores species	*C. carpio*

2- Number of alien fish species

This group included 8 species of alien fish comprised 42.11% of the total number species (Table 1) and 13089 individuals, in the present study comprised 45.2% of the total number of fish captured. The highest number of alien fish (8) species appeared in all study stations, while lowest number of alien fish (4) species observed in August and September at stations 3 and 1 respectively of fish captured (Figure (3)).

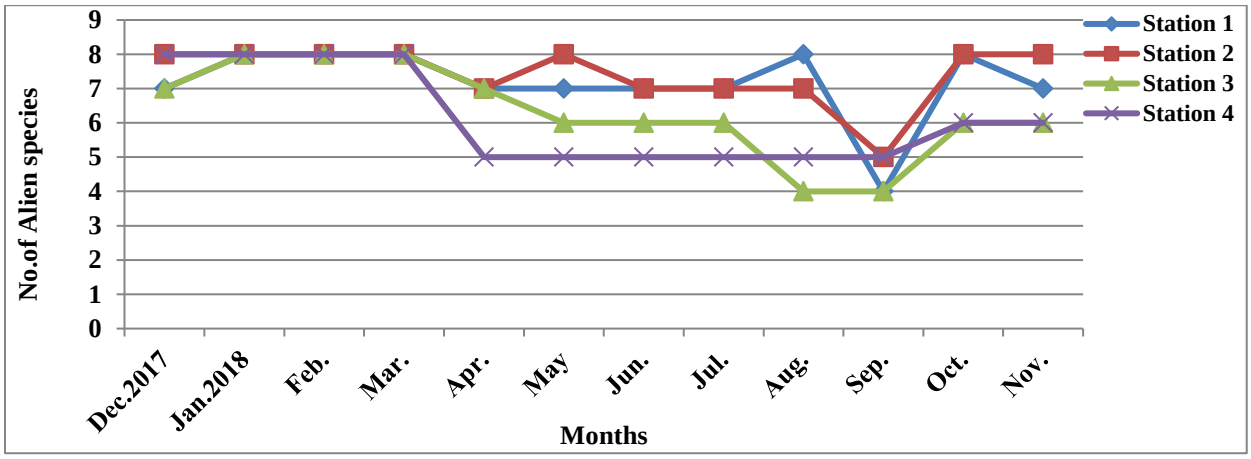


Figure (3):Monthly variations in number of Alien fish species of four stations in Al-Hawizeh marsh during study period

B-Species composition metrics

3. Proportion of native individuals species

In present study the total number of native fish catch amounted 15870 fish formed 54.8% of the total number fishing individuals. the highest percent of species native individuals formed 68.99% recorded in July at station 3, while lowest percent of species native individuals 10.71% done in September at station 4 (Figure (4)).

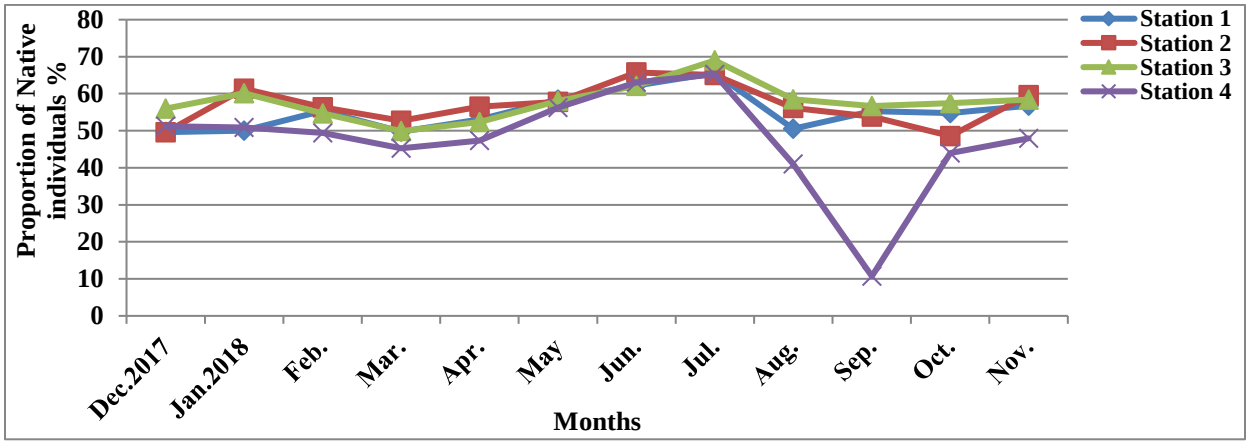


Figure (4): Monthly variations in Proportion of Native fish individuals of four stations in Al-Hawizeh marsh.

4. Proportion of alien individuals species

In current study the total number of alien fish catch reached 13089 individua formed 45.2% of the total number fishing individuals, the highest percentage of species alien individuals formed 89.29% achieved in September at station 4, while lowest percentage of species alien individuals 31.01% reported in July at station 3 (Figure (5)).

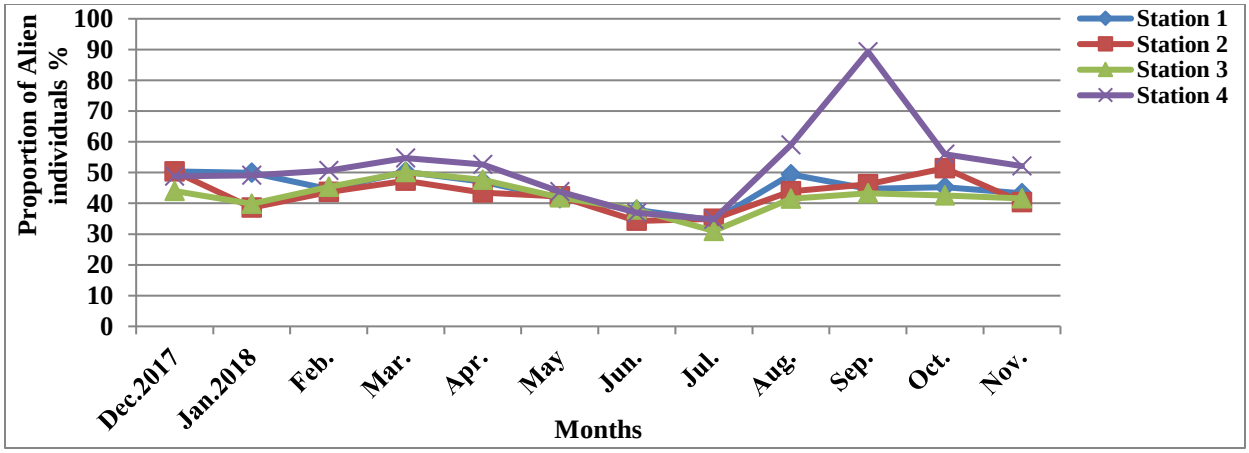


Figure (5): Monthly variations in Proportion of Alien fish individuals of four stations in Al-Hawizeh marsh.

5. Proportion of sensitive native individuals species

This group included six species of sensitive fish native such as C. luteus, C. sublimus , L. vorax , M. mastacembelus , M. sharpeyi and S. triostegus. A total of 3587 individual were catch of this group giving a percentage 12.4% of the total number individuals and formed 22.6% of the total number of native fish individuals, the highest proportion of sensitive native individuals species 23.95% recorded at station 4 in July , while the lowest proportion of them 6.21% at station 1 in October (Figure (6)).

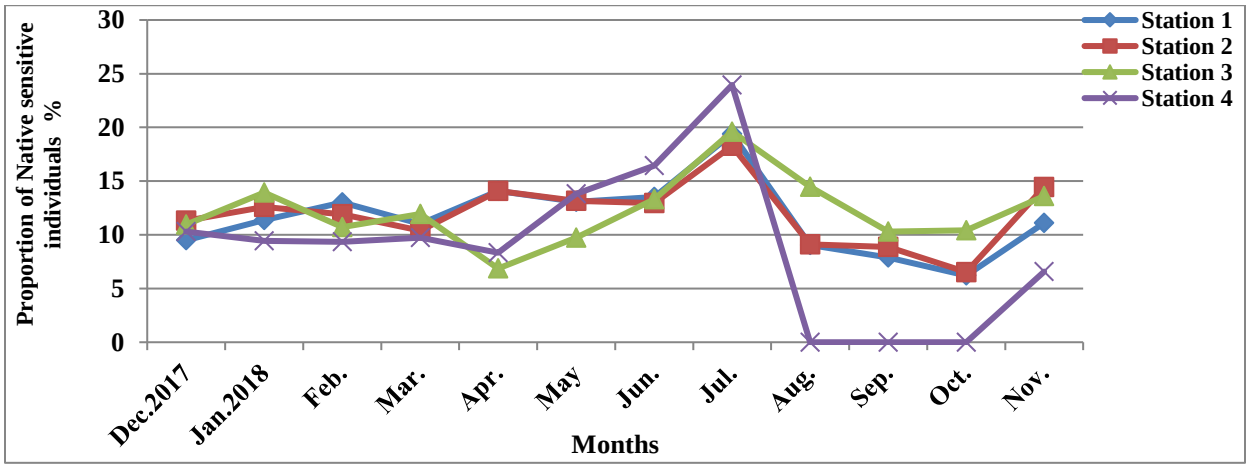


Figure (6): Monthly Changes in Proportion of Native sensitive individuals of four stations in Al-Hawizeh marsh

6. Richness Index

The monthly changes in Richness Index value among four stations was illustrated in (Figure (7)). The highest value of richness (D) index 2.44 recorded at station 4 in January, while the lowest value of this index 1.2 reported at same station in September.

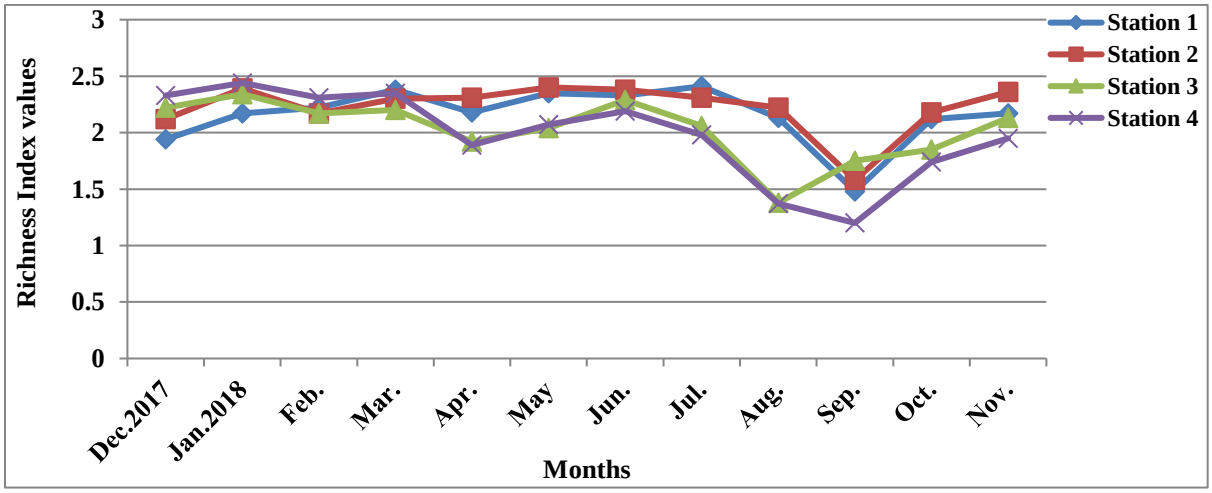


Figure (7): Monthly Changes in Richness Index values among four stations in Al-Hawizeh marsh

7. Proportion of *Planiliza abu* individuals

A total of 11063 fish were captured of this species accounted 38.2% of the total number of fish individuals in current study. The highest proportion of individuals amounted 48.02% at station 2 in June, while lowest proportion of them 28.98% finding at same station in October (Figure (8)).

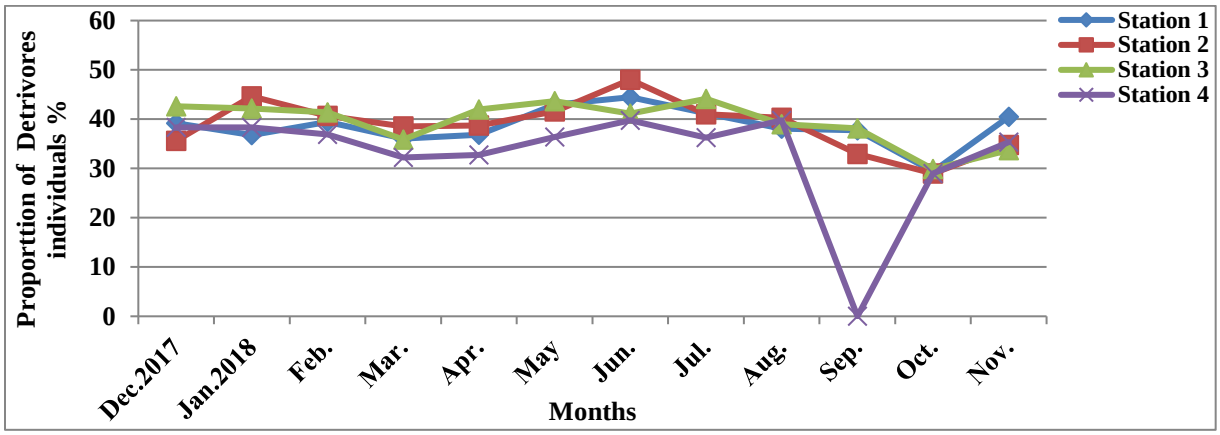


Figure (8):Monthly Changes in proportion of *Planiliza abu* individuals among four stations in Al-Hawizeh marsh

8. Proportion of Cichlidae individuals family

This group have three species as *C. zillii*, *O. aureus* and *O. niloticus* of fish recorded in the present study. A total of 9949 fish were captured of individuals this family formed 34.35% from the total number of fish caught. The highest proportion of cichlidae individuals family amounted 46.43% at station 4 in September, while the lowest proportion of them 19.91% finding at station 3 in October (Figure (9)).

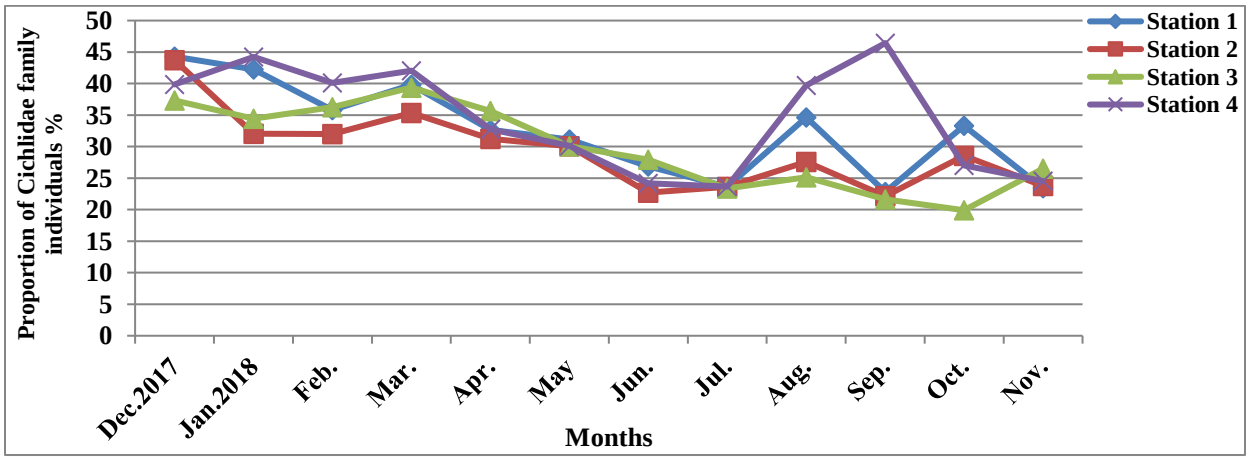


Figure (9):Monthly Changes in proportion of Cichlidae family individuals among four stations in Al-Hawizeh marsh

9. Proportion of Carassius auratus individuals

This group included only one species as *C. auratus* of fish species which caught in the present study. A total of 1926 individuals of the total number of fish caught individuals giving a percentage 6.65% of the total number of fish individuals the marsh. The highest proportion of *C.auratus* individuals 35.71% revealed at station 4 in September, while the lowest Proportion of them 0.28% observed at station 3 in September (Figure (10)).

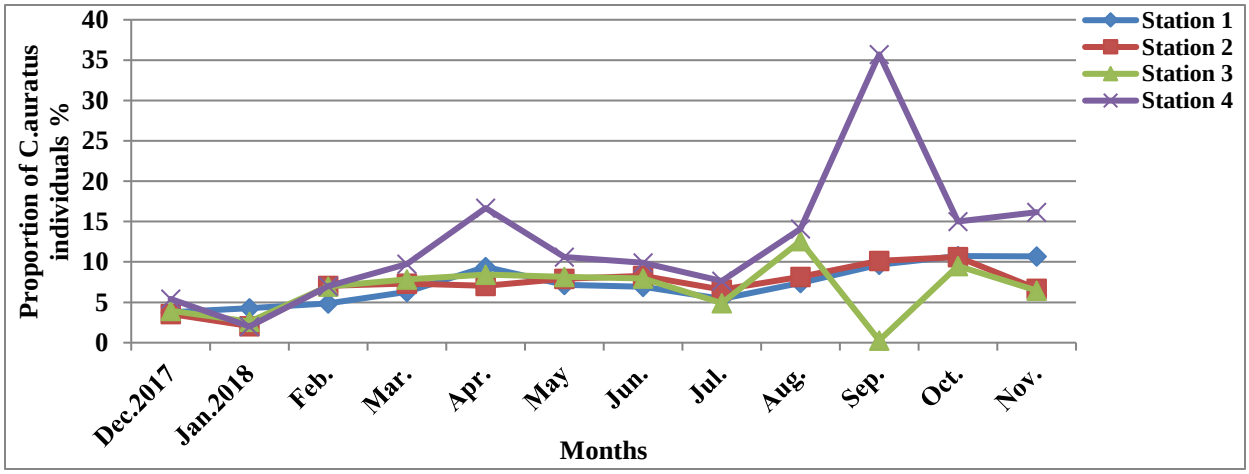


Figure (10):Monthly Changes in proportion of *Carassius auratus* individuals among four stations in Al-Hawizeh marsh

10. Number of common native species

This group have common native species which its number were more than 50 fish in monthly fishing samples. The highest number of common native species 3 fish at station 2 in July, whereas lowest number 1 fish was recorded in all four stations (Figure (11)).

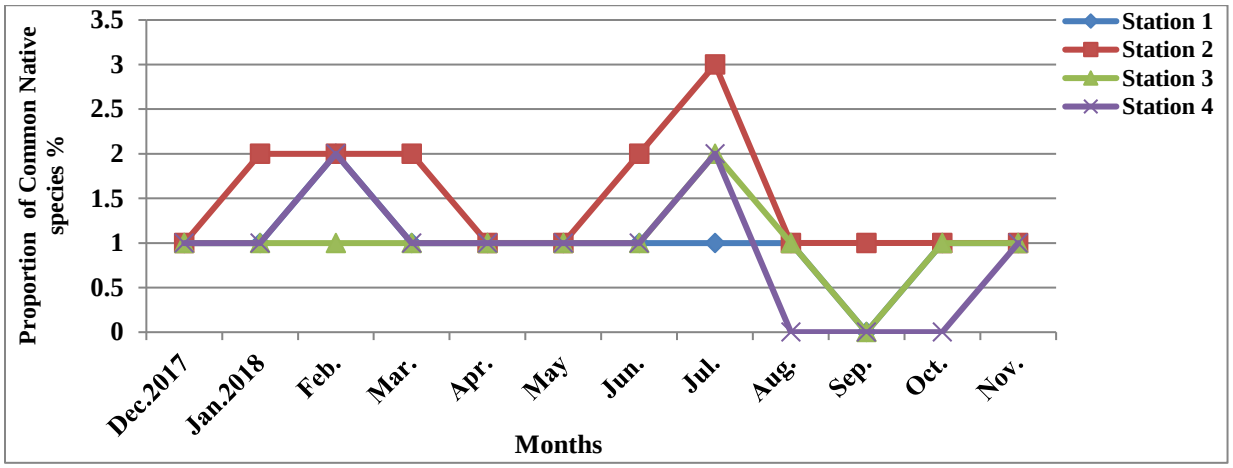


Figure (11): Monthly Changes in proportion of Common native fish individuals among four stations in Al-Hawizeh marsh

C. Trophic Guilds metrics

11. Proportion of herbivores individuals species

This group included seven species of fish recorded in the current study (Table, 1). The highest proportion of herbivores individuals species 82.14% done at station 4 in September, while the lowest proportion of them 27% reported at same station in October. The monthly changes in proportion of Herbivores fish individuals among four stations were shown in (Figure (12)).

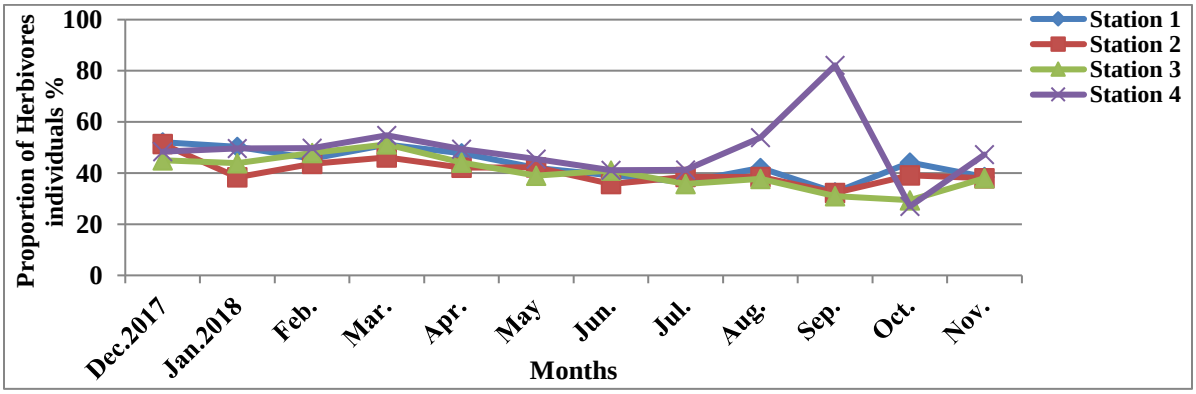


Figure (12):Monthly Changes in proportion of Herbivore fish individuals among four stations in Al-Hawizeh marsh.

12. Proportion of carnivores individuals species

There are clear monthly variations in proportion of carnivores fish individuals among four stations. This group included 10 species of fish which were appeared in the present study. The highest proportion of carnivores individuals species 42% achieved at station 4 in October, while the lowest proportion of them 6.41% found at same station in August (Figure (13)).

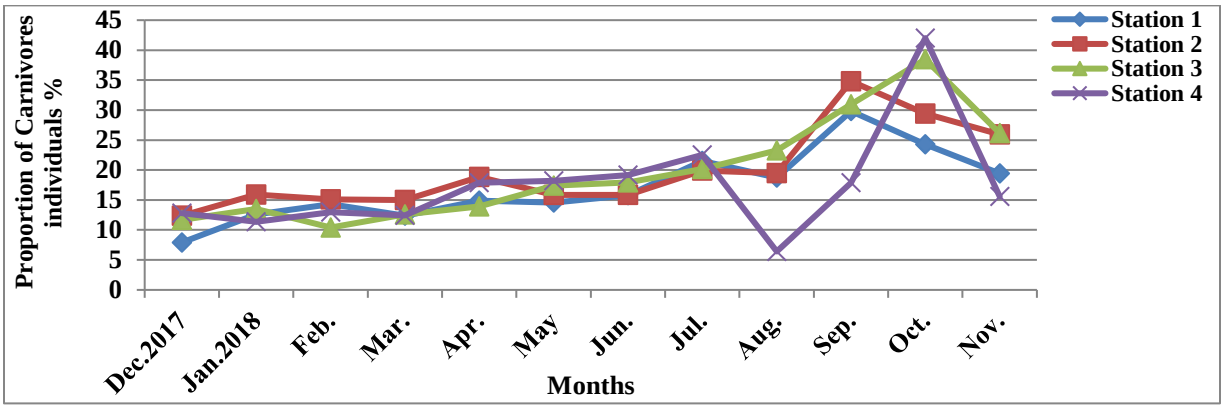


Figure (13):Monthly Changes in proportion of Carnivores fish individuals among four stations in Al-Hawizeh marsh

13. Proportion of detrivores individuals species

This group included only one species (*Planiliza abu*) of fish species that fishing in the present study. It was recorded in high proportion in all study months and in all stations. The highest proportion of detrivores individuals species 48.02% achieved at station 2 in June, while the lowest proportion of them 28.98% presence at same station in October (Figure (14)).

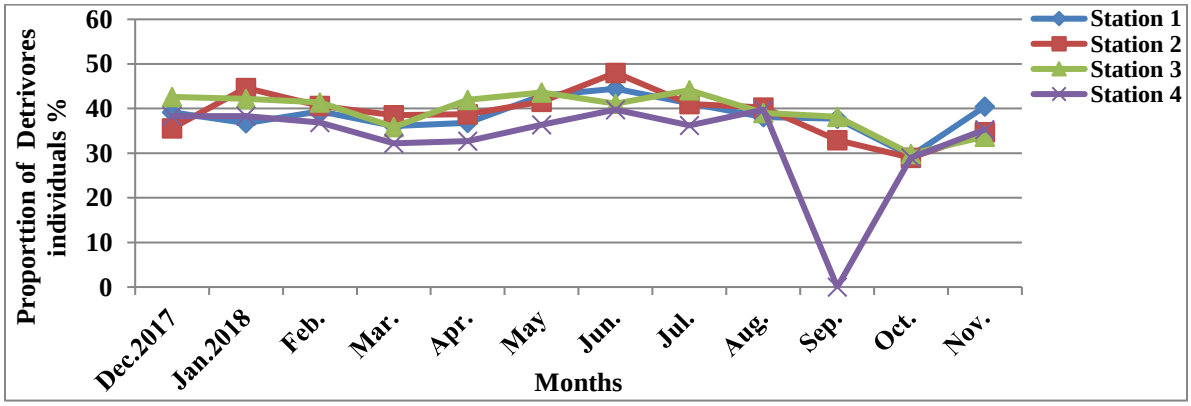


Figure (14):Monthly Changes in proportion of Detrivores (*P.abu*) fish individuals among four stations in Al-Huwaizah marsh

14. Proportion of omnivores individuals species

This group included also only one species as *C. carpio* of fish species which caught in the present study. The highest proportion of omnivores individuals species 2.45% reported at station 2 in October, while the lowest proportion of them 2% presence at same station and in same month (Figure (15)).

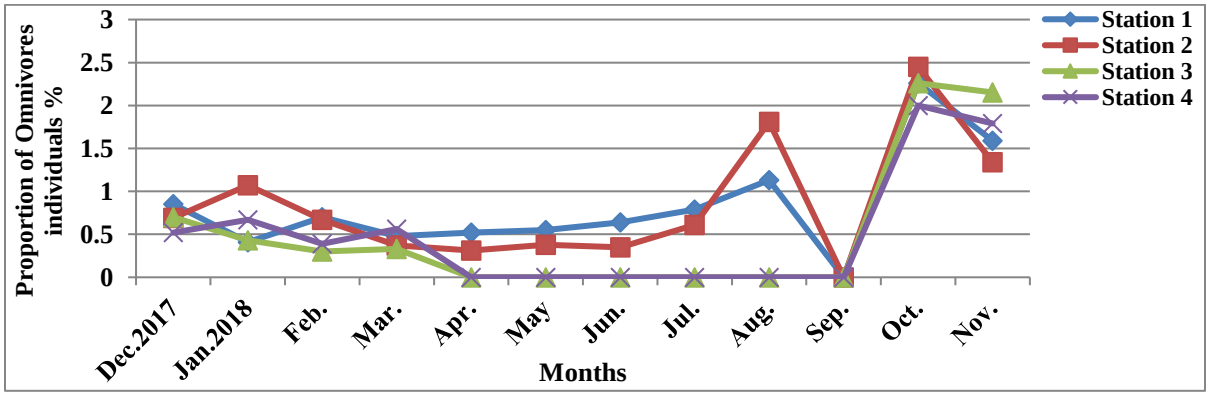


Figure (15):Monthly Changes in proportion of Omnivores (*C.carpio*) fish individuals among four stations in Al-Hawizeh marsh

Integrated Biological Index (IBI)

The overall Integrated Biological Index value which calculated from 19 species and 9 families of Al-Hawizeh marsh during the present study achieved (57.71%) and which inscribed within impaired category. On the other hand, the average Integrated Biological Index values of four study stations achieved 60.80%, 60.88%, 58.82% and 50.32% and evaluated within marginal impaired category for stations 1, 2 while impaired in stations 3 and 4 respectively. The monthly variations in Integrated Biological Index values of four studied stations of Al-Hawizeh marsh were showed in (Figure (16)).

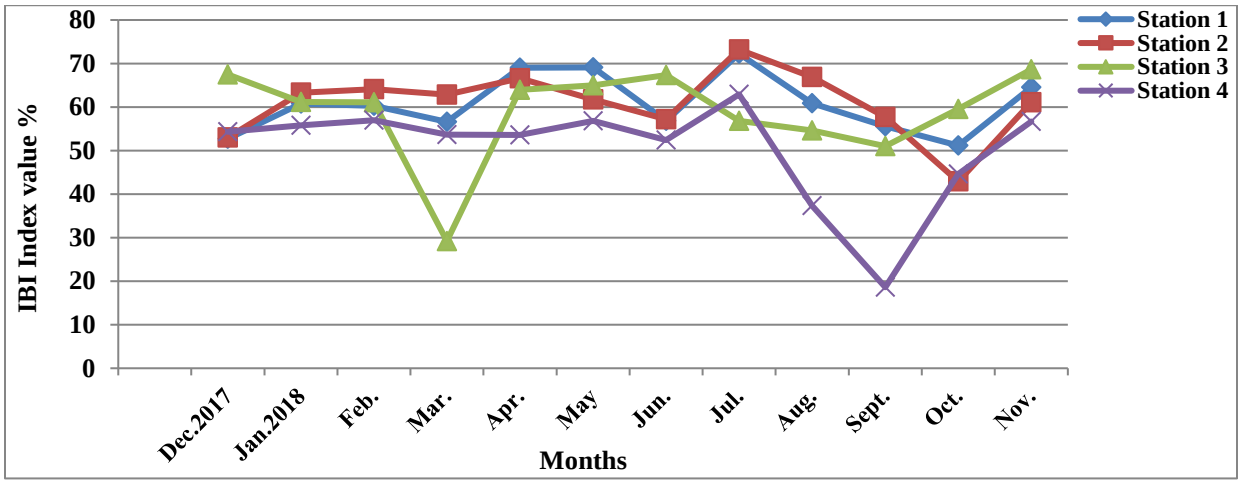


Figure (16):Variations in IBI Index values for fish caught of four studied stations within Al-Hawizeh marsh during study period

The results of similarity degree by using cluster analysis for Integrated Biological Index (IBI) in the Al-Hawizeh marsh showed presence three main groups at a similar level of 77%, the first main group included September only, , the second main group have only June at a similar level of 83%, whilst the third main group included of three secondary groups, the first secondary group consisted of March, January, December, April, May, July, August and November at a similar level of 100%, the second secondary group have only October at a similar level of 92%, whereas third secondary group have February at a similar level of 83 (Figure (17)).

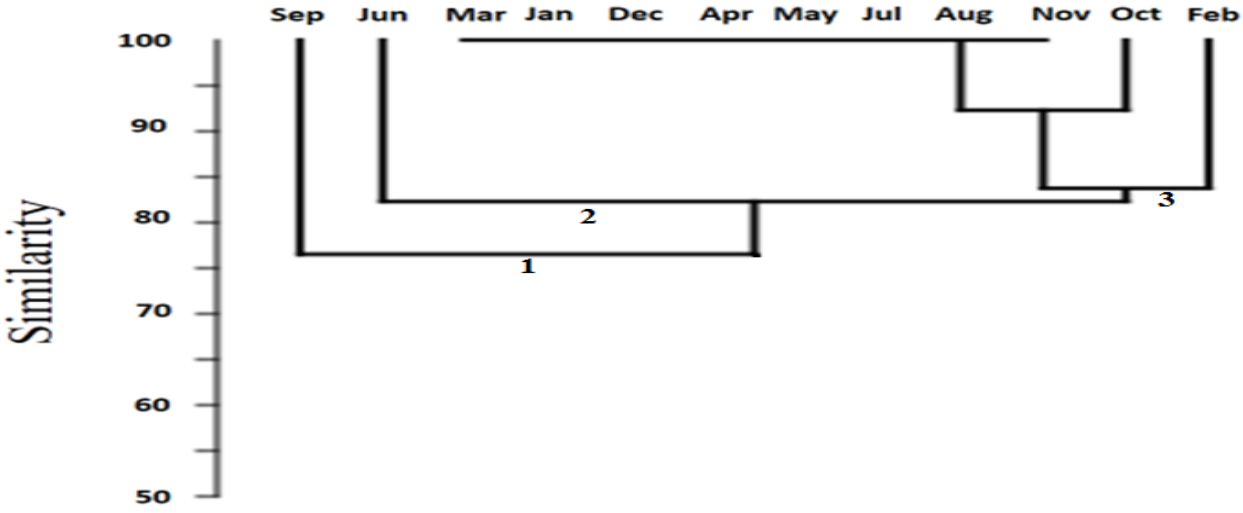


Figure (17):Cluster analysis of similarity degree (%) for Integrated Biological Index value among monthly fishing samples in the Al-Hawizeh marsh

Discussion

The overall Integrated Biological Index value which calculated from 19 species of Al-Hawizeh marsh during the present study achieved (57.71%) and which inscribed within impaired category, this value higher than that recorded during the period 2005-2006 (53.2%) by Mohamed and Hussain (2014) and which inscribed within Impaired category. Accordingly, the IBI values were clearly varied among the studied stations, which showed clear differentiation in study area. The highly scores recorded in station 2, which correspond to hydrological differences then fish composition species and richness values. The high IBI scores in station 2 was associated with highest value of fish richness, highest proportions of native and herbivores species individuals. Conversely, the lowest IBI scores was revealed in station 4 which attributed to the highly percentage of alien individuals, in addition decrease in the proportion of native individuals species and richness values, regardless the presence most alien species in this station.

In the present study recorded 19 fish species distributed into 11 species of Native and 8 species of Alien fish. In similar studies of Al-Hawizeh marsh which done by (Younis et al. 2008) revealed presence 16 species divided into 12 species of Native and 4 species of Alien, and (Younis et al. 2011) found a total of 13 species of freshwater fish divided to 10 native and 3 of alien species, Also, Mohamed and Hussain (2014) tested 15 species 11 of them were Native and 4 of Alien species.

Alien species as C. auratus and C. Zilli and native species as P. abu recorded in highly numerical abundant in all study stations which formed 6.65,29.41 and 38.2, whereas (Mohamed et al., 2014) mentioned that the fish assemblage in the East Hammar marsh during 2012-2013 was dominated by C. auratus where comprised 22.1%, while, P. abu and C. zilli giving a percentage 13.4% and 5.1% respectively of the total fishing number. The results of present study revealed that the fish assemblage was clearly shifted in the percent of alien and the dominancy species and the fish diversity compared with the previous status. The number of native species is naturally declining, accompanied by an increase in number of alien species, that represented as a form of disturbances coming from human influences, entering these species represents the increasing biological disturbance with deteriorating water quality and environment (Mohamed , et.al.,2017).

Hughes and Whittier (2005) mentioned that native species represent the basic building blocks of a fish assemblage, and are a key component of diversity and the alien species indicate biological pollution and a serious diversion from natural conditions, especially when they constitute a substantial percentage of the assemblage, and including when they are deliberately introduced. Researchers observed habitat degradation facilitating the underlying mechanisms causing the loss of native fish diversity, the temporal replacement of specialized native fish by exotic fish (Olden & Poff, 2003; Parks , et.al.,2014) .

Moreover, human modification of aquatic environment and entry Alien species might affect seriously on native fauna and flora (Gozlan , et.al.,2010; Tarkan , et.al.,2012 a,b) similar to the worldwide pattern (Hermoso and Clavero 2011). Further, the inland waters in Iraq have clearly faced several drastic variations which included habitat alterations, entry alien species and declines in native fish communities (Jawad, 2003 & Coad, 2010). As well as, (Hussein 2000) revealed the ability of alien species in influencing on composition the fish community through competition, predation and interference with resident local fish.

(Karr , et.al.,1986) showed the increase in number of alien fish species with the increase the life disturbance in the water surface that led to decrease in number of native fish species and an increase in number of entering species which are rapidly spreading, which happens its increased environmental problems at the expense of other species.

The water quality, water level fluctuation and macrophyte coverage were among the most influential factors affecting fish IBI in wetland ecosystems as reported by several authors (Minns , et.al.,1994; Brazner & Beals, 1997; Bhagat , et.al.,2007). The water quality of Al-Hawizeh marsh was good as mention (Richardson and Hussain et al., 2006; Hassan , et.al.,2011), as well as (Brazner and Beals 1997) stated that increase fish species richness and abundance were often correlated with increase macrophyte species richness and density. Therefore, the integrated biological index (IBI) gives a clear indication to assessment of water bodies according to specific criteria, and it is considered of an important means that help in manage the water resources and protect them from environmental degradation (Hermoso , et.al.,2010).

The IBI index values increased during the wet season and reached to the top during February month, which associated with higher values of metrics that contribute to improving the environment, study period characterized by an increase in the abundance index values of Al-Hawizeh marsh with an increase in number of species. Thus, it associated with an increased in number of native and alien species and their proportion, also with increase in proportion of herbivores and Carnivores of fish species, with decrease in proportion of both C.auratus and P.abu,in addition the omnivores and detrivores species during this period.

Lower the IBI scores metrics during the dry months was associated with higher metric values which contributes in reduction of the index values. Where percentage of the alien species in the marsh formed 42.11%, which is higher than 26.7% which recorded in previous study on Al-Hawizeh marsh (Mohammed & Hussain, 2014). The increasing in number of C. zilli individuals to the Iraqi environment and its presence in all monthly fishing samples this case not recorded in previously studies which conducted after re-flooding Al-Hawizeh marsh, thus the increase in proportion of alien species coincides with the high percent of individuals of the tolerant species this supported study (Costa & Schulz, 2010) where showed that the tolerant species are the last to leave the water surface at the deterioration time, that the increase in proportion of fish tolerated with the deterioration of water quality and the decrease in concentration of oxygen in some months to reach the critical limit and increase salinity during those periods (Radi, 2014), lead to dominance of P. abu species in fish community of Al-Hawizeh marsh.

ACKNOWLEDGEMENTS

The authors acknowledge the Department of Marine Vertebrates, Marine Science Centre, the University of Basrah, Iraq for supporting this project.

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