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Comparing the fish diversity status in Sawa Lake with three different water habitats, southern Iraq

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Abstract:

This study includes an ecological assessment of the fish assemblage of Sawa Lake. The results were compared with studies of Shatt al-Arab River, Al-Hammar Marsh, and Al- Huwayzah Marsh (Al-Saffia Reserve) to clarify the status of fish assemblage environment in this area using (Richness, Diversity, Evenness, Similarity and Integrated Biological Index IBI). Six metrics were chosen to calculate the (IBI) depending on the following major categories. The first (species richness) is represented by the total number of native species, two species were obtained. The second major category covered three metrics the first is represented by the percentage of *Planiliza abu* individuals accounted for 71.4%. The second metrics represented by the percentage of tolerant species which is represented 100%, while not recording any percentage of individuals that are considered sensitive native species (metric three). The third major category checks two metrics which are collected the percentage of individuals that are considered omnivores and carnivores which constituted 71.4% and 28.6% respectively. The results of the present study showed that the environmental assessment of Sawa Lake was weak assessment, with a value of the Integrated Biological Index 28.9 and this value is lower compared with other results in Shatt

al-Arab River, Al-Hammar Marsh, and Al-Saffia Reserve. The values of richness index (D), diversity (H) and Evenness (J) were (0.22), (0.59) and (0.86) respectively in Sawa Lake.

Keywords: Sawa Lake, fish diversity, ecological assessment, IBI

Introduction

The evaluation and monitoring of water resources are primarily focused on physical, chemical and human health factors. Although traditional methods of assessment are available and obtainable in assessing the water quality of rivers and water bodies, there are some shortcomings or deficiencies in these methods, which led the workers in the field of conservation and protection of the aquatic environment to devise modern methods in the assessment of these bodies of water, and one of these methods is the Integrated Biological Index IBI [1]. The Integrated Biological Index can be defined as a composite environmental guide based on the quantitative measurements of many characteristics of fish populations in water bodies to assess the water quality of the water, and to assess the state of the water surface based on regional and historical measurements. This index reflects the quality of the physical environment, energy input, biological interventions and water and hydrological system. [1; 2; 3; 4]. This index is also available for use in other types of ecosystems as it has been accepted in the assessment of estuaries in studies [5; 6] As well as lakes in studies of [7; 8].

Sawa Lake is an elongated closed basin don't equip with a cannel of surface water, with no inflow and outflow. It was characterized by the high degree of salinity among the Iraqi marshes. [9]. The supply of its water may possibly be the groundwater merging between the deep and shallow aquifers at the bottom of the Lake through a system of joints and cracks [10]. Lake Sawa has attracted the attention of many Iraqi researchers. There are many local studies on water quality and fauna in water and sediments and microorganisms, in addition to various physical and geological studies [11; 12; 13; 14; 15; 9; 16]. There is no study on the fish communities and the ecological assessment of the lake using the different biological assessment evidence.

The current study aims at evaluating Sawa Lake using Integrated Biological Index IBI and compare the results of the current study with those of the Shatt al-Arab River, Al-Hammar Marsh and Al- Huwayzah Marsh (Al-Saffia reserve) to give an accurate picture of the environmental situation of the lake.

Material and Methods

Description of the study area

Lake of Sawa is located southwest of Samawah city. A distance of 32 km within the province of Muthanna in southern Iraq. It is also located south of the Atashan River, which is one of the Euphrates subdivisions, exactly at the intersection of a latitude (31º 18 ') with a longitude (45º 00´). The overall area of Sawa lake is 10 km2, with a length 4.75 km and its width varies from 0.5-1.75 km, the depth is about 4.2 m. [14] (Fig. 1 and 2).

Sawa Lake is described as a closed ground lake with a longitudinal shape towards the northwest of the southeast. One of the most prominent features of the lake is the presence of an edge or a frame of salt around the lake, which is about 2.8 m from the lake water, 6 m above the surrounding land, and about 18.5 m above sea level. The width of the base of the salt frame (15-20 m) and its top width (4-5m). This frame is a barrier between the water of the lake and the surrounding

land. This frame is made by chemical processes and consists of rough wrinkled surfaces resembling a cauliflower. This frame is believed to be the result of the crystal of the gypsum and then the construction of the gypsum barrier around the lake, which is due to the biochemical activity of sulfate-reducing bacteria, which must be present with lichens covering the surfaces of rocky outcrops in contact with water. [17].

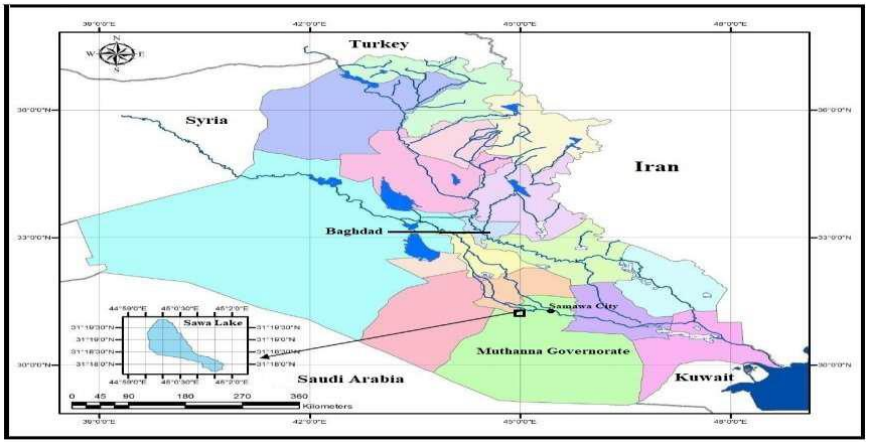

Fig. 1: Map of Iraq Showing the location of Sawa Lake in Al-Muthanna Province, Iraq.

Fig. 2: Map showing the shape of Lake Sawa.

Shatt al-Arab River is formed by the confluence of the Tigris and the Euphrates rivers in the city of Qurna in southern Iraq about 160 Km north of Arabian Gulf. It extends over 10 degrees of latitude, from 40°N to 30°S, to the southwest for around 120 km within Iraqi lands and 80 km the river creates the Iraqi-Iranian boundaries, before running into the Gulf (Figure 3A). The river's total length is about 200 km, its width ranges between 330 m in Qurna to 1250 m in the estuary and its depth varies from 8.5- 24 m [18].

Al-Hammar Marsh is located to the south of the Euphrates River (30 45'–30° 59' N, 46° 25'–47° 15' E) its area ranging from 2800 km2 of permanent marsh to 4500 km2 during flooding periods. It is fed mainly from the Euphrates River, the groundwater recharge drains ultimately into the Shatt Al-Arab River, which empties into the Arabian Gulf (figure 3B) [19]. Al-Saffia Reserve is one of the largest reserves in Iraq and is located in Al-Safia Marsh (10.887´) (E: 47 º 40.413 ´ , N: 31º) and it is part of the Suweib Marsh, which is the name given to the Hawizeh Marsh in the Basra Governorate. The southern part of Maysan Governorate, while it is connected from the east to the Iranian part of the Al-Uthaim Haur, with an area of 44 km2, a length of 11 km2, and a width of 4 km. It was established in 2006 (figure 3C) [20].

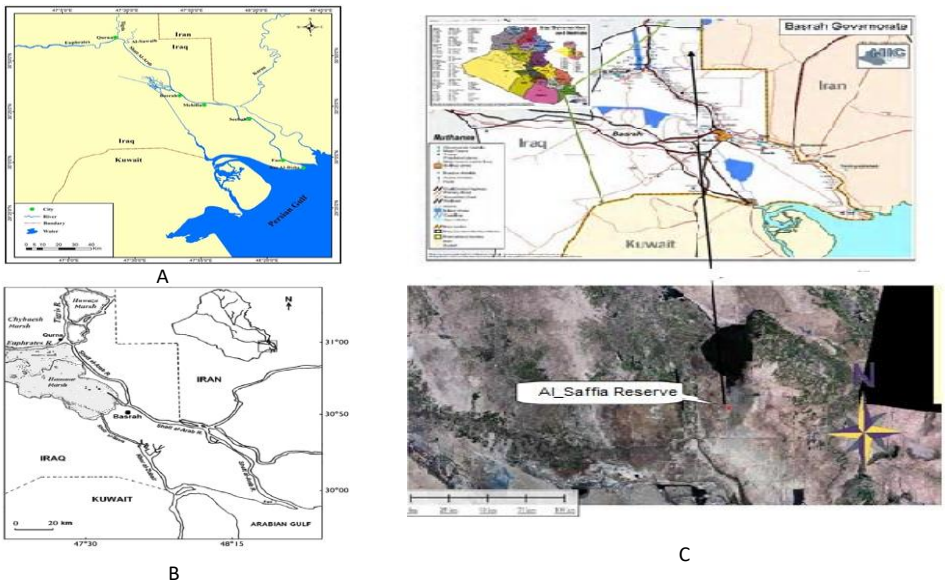

Fig. 3: Maps showing Shatt al-Arab river (A), Al-Hammar marsh (B) and Al-Saffia reserve (C) location in south of Iraq

Fish Collection

Fish samples were collected during November 2018 using two types of draft gills nets with mesh size 2×2cm. Six measurement units were selected to calculate the Integrated Biological Index:

1- Number of native species
2- Percentage of *Planiliza abu* species individuals
3- Percentage of members of sensitive native species
4- Percentage of tolerant fish species
5- Percentage of omnivorous fish species
6- Percentage of carnivorous fish species

The Integrated Biological Index was calculated based on the method described by [21]. The values of the units were determined from (0-10) and the values of the Integrated Biological Index from zero to100. To give the final assessment of Lake Sawa, the values of the overall Integrated Biological Index were divided into three groups in a similar way to [4] which were:

1- Acceptable and the value of the total Integrated Biological Index is higher than 80.
2- The edge of the weak and the value of the total Index is limited between (60-80).
3- Weak and the total Index value is less than (60).

The results in stations of the same period dependent on Shatt Al-Arab, Al-Hammar Marsh and Al-Saffia reserve. Shatt al-Arab river considered as the first station, the second station was Al-Hammar Marsh, Al-Saffia reserve was the third station and the fourth station was in Sawa Lake.

Jaccared similarity index was used according to the equation developed by [22] In order to measure the degree of similarity in the species composition between the four stations. Fishes were classified according to [23]. One - way analysis of variance (ANOVA) and Revised Least Significant Difference (RLSD) were used to compare the variances between

stations. ($P < 0.05$) was set as the significance level using SPSS program (version 20). Values were expressed as the mean (± S.D.; the standard deviation of the mean) [24].

Results

Number of Native species

This group included 10 species, 7 species of which were recorded in the first station (Shatt al-Arab), 8 species in the second station (Al-Hammar Marsh), 4 species in the third station (Al-Saffia reserve) and two species in the fourth station (Sawa Lake) (Fig. 3). One combined species *P. abu* was presented in all stations.The results of the statistical test (F. test) showed that there were significant differences ($P < 0.05$) in the number of native species between Lake Sawa and the rest of the different stations under a significant level (0.05). The results of the Jacquard similarity coefficient showed that the highest percentage of similarity in species composition between Sawa Lake - Al-Saffia reserve amounted to 20%, and the lowest similarity rate between Sawa Lake and the two stations of Al- Hammar marsh and Shatt al-Arab river, which amounted to 11.1% and 12.5%, respectively.

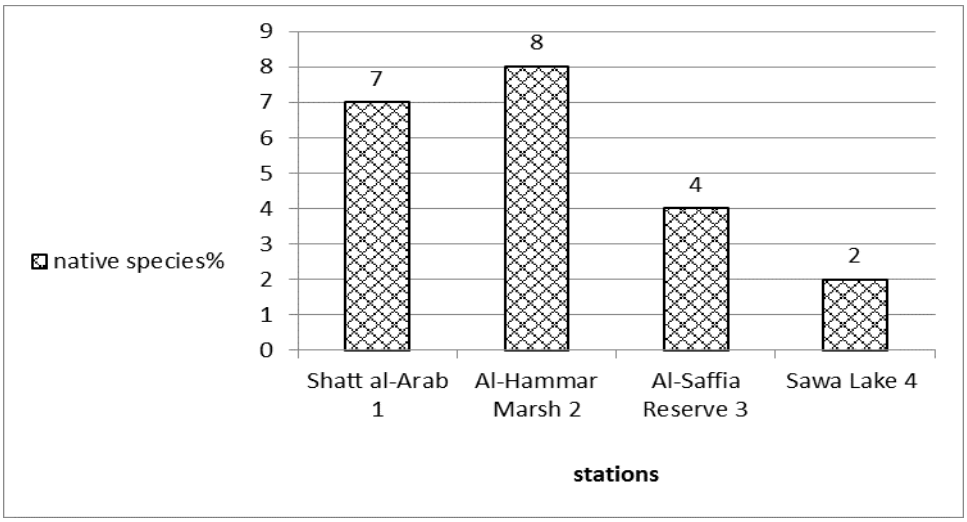

Fig. 4: Number of native species in the four study stations

Percentage of *P. abu* species individuals

The percentage of *P. abu* fish in the four stations was: Shatt al-Arab (24.8%), Al-Hammar marsh (42.02%), Al-Saffia reserve (33.4%) and Sawa Lake (71.4%) (Figure 5). The results of the statistical test showed significant differences ($P < 0.05$) in the percentage of *P. abu* fish between the four stations below a significant level (0.05).

Percentage of sensitive native species

This group included six species, five of which appeared in the first and second stations (Shatt al-Arab river and Al-Hammar Marsh) and two in the third station (AlSaffia Reserve). The percentage of individuals of the sensitive native species to the three stations were (0.88, 3.34 and 24.6%) respectively. The fourth station (Sawa Lake) was characterized by

the disappearance of sensitive native species (Figure 6). The results of the statistical test showed significant differences in the percentage of members of sensitive native species between Lake Sawa and the other studied stations under a significant level (0.05).

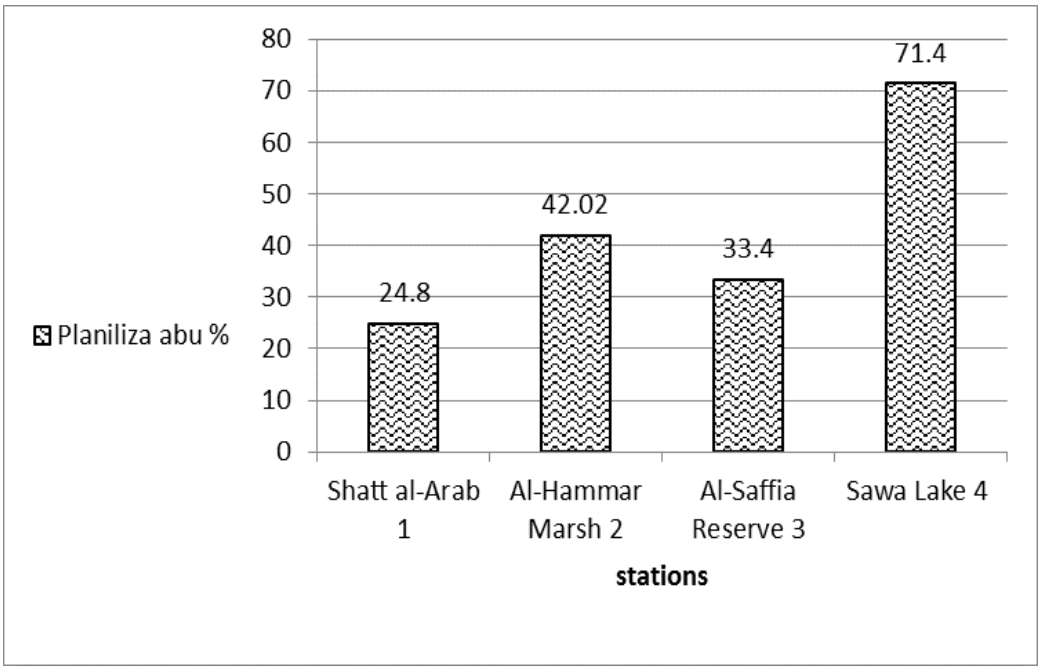

Fig. 5: Percentage of *Planiliza abu* fish in the four study stations.

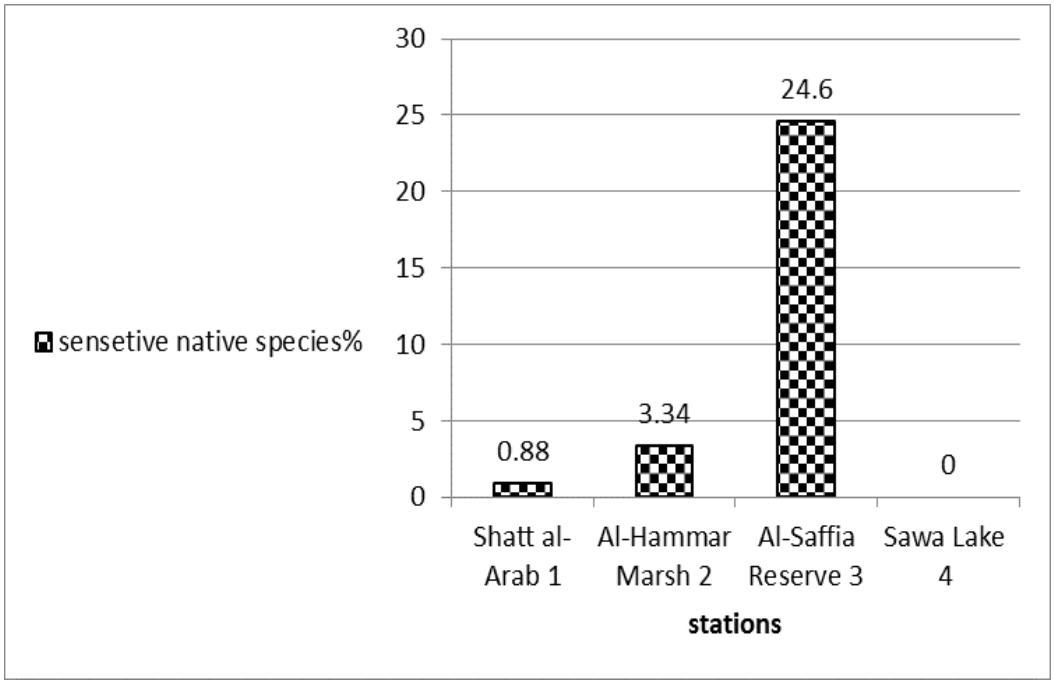

Fig. 6: Percentage of members of sensitive native species in the four study stations.

Percentage of tolerant species individuals

This group included eight species that recorded. The highest percentage of fish species in the fourth station (Sawa Lake) and reached (100%) and the lowest recorded in the third station Al-Saffia reserve reached (75.4%) (Figure 7). The results of the statistical test revealed significant differences ($P < 0.05$) in the percentage of individuals of sensitive species between the different stations below the statistical level (0.05).

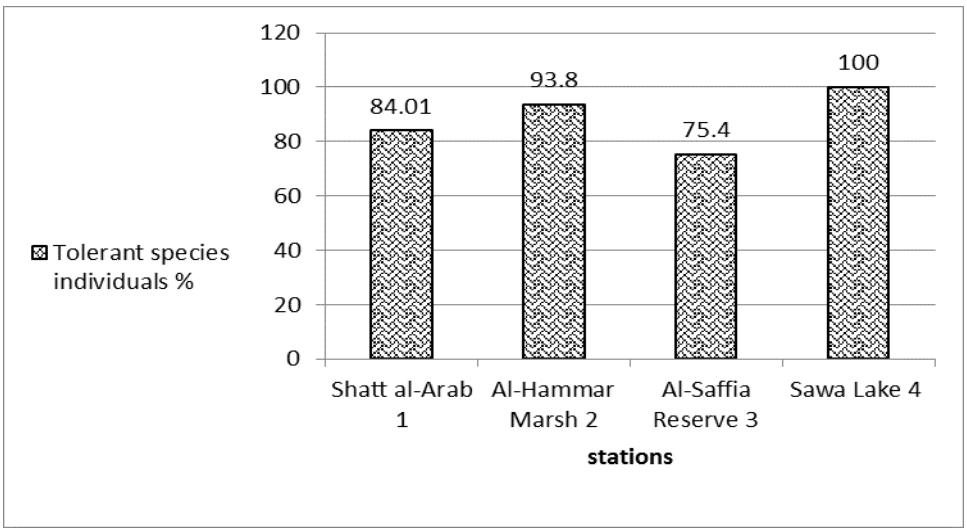

Fig. 7: Percentage of tolerant *species* individuals in the four study stations.

Percentage of omnivores species

This group included six species. The highest percentage of omnivore species was obtained at the first station (Shatt al-Arab river) with 59.3% and the lowest percentage at the fourth station (Sawa Lake) which was 28.6% of the total caught in this station (Figure 8). The results of the statistical test showed significant differences in the percentage of individuals of omnivore species below a significant level (0.05).

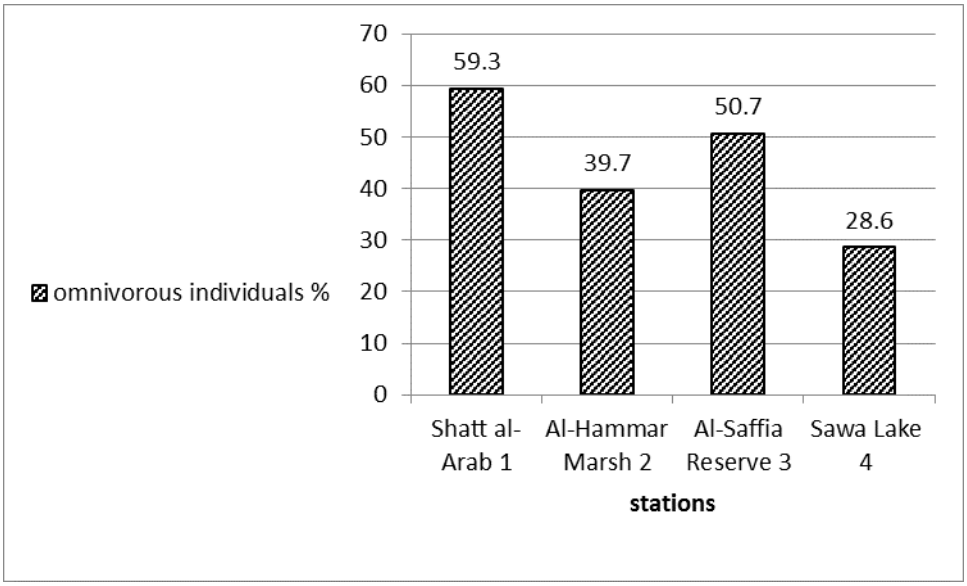

Fig. 8: Percentage of omnivores species in the four study stations.

Percentage of carnivores species

This group included five species, the highest percentage of carnivores fish obtained at the fourth station (Sawa Lake) and reached (71.4%). No high percentage of this group was recorded in the other three stations (Figure. 9). The results of the statistical test showed significant differences ($P < 0.05$) in the percentage of carnivore species between Sawa Lake and the rest of the study stations below a significant level (0.05).

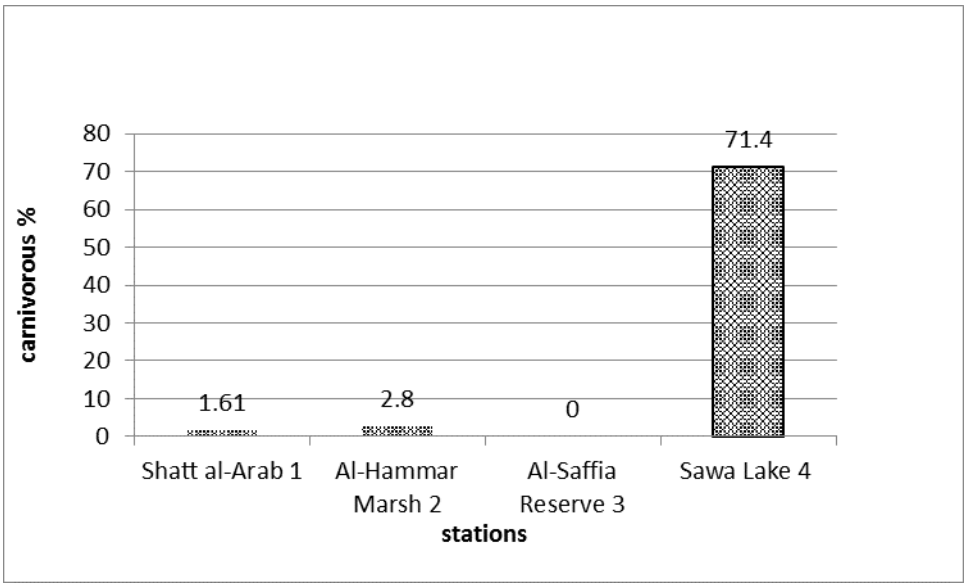

Fig. 9: Percentage of carnivores species in the four study stations.

Integrated Biological Index (IBI)

The values of IBI were stated under weak valuation, the highest value of this guide was obtained at the third station (Alsaffia reserve) and reached (40.5%) and the lowest value at the fourth station (Sawa Lake), reaching (28.9%) (Figure. 10). The results of the statistical test showed significant differences ($P < 0.05$) between the index values of the different stations.

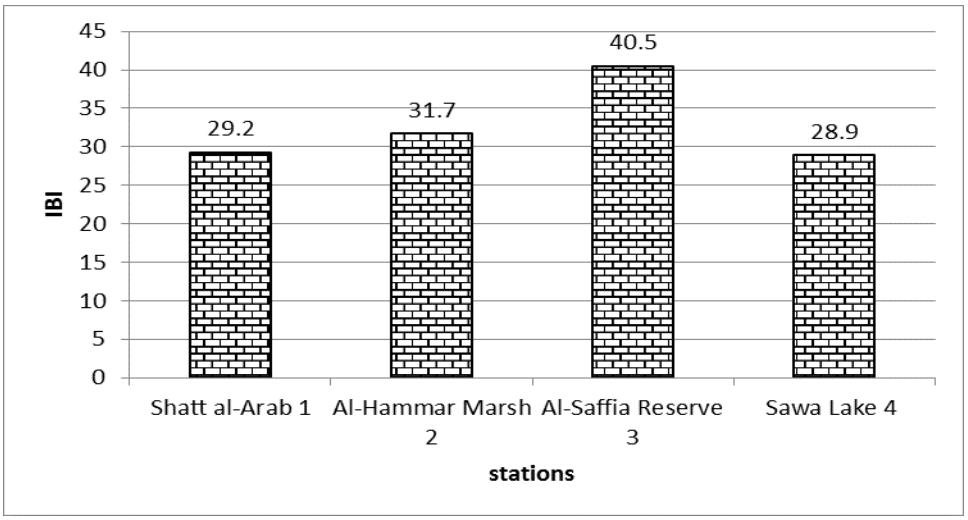

Fig. 10: Integrated Biological Index of the four stations studied.

Diversity Indices

The value of the richness index (D) for the four stations selected respectively was: Al-Hammar marsh (1.96), Shatt al-Arab river (1.40), AlSaffia reserve (0.82) and Sawa Lake (0.22). The highest value of the diversity index (H) was obtained at the second station (Al-Hammar marsh) and amounted to (1.53) and the lowest value of this index was obtained in Sawa Lake (0.59). The values of the Evenness index (J) ranged from 0.90 in the third station (Al-Saffia reserve) to 0.57 at the second station (Al-Hammar marsh) (Figure. 11). The results of the statistical test showed significant differences ($P < 0.05$) in the richness (D) values, the diversity index (H) and the Evenness index (J) between the different stations.

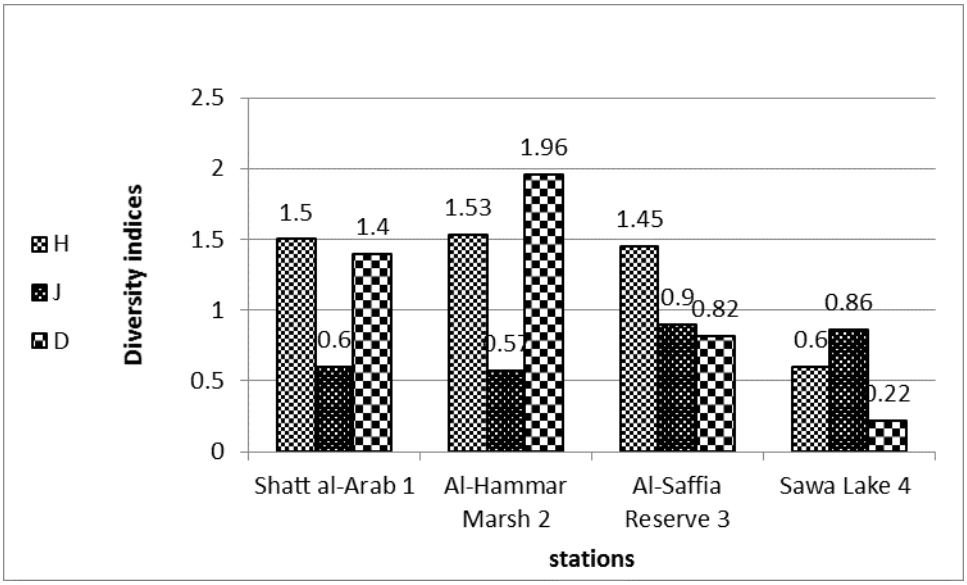

Fig. 11: Diversity indices, evenness and richness for selected study stations.

Discussion

Biotic indicators are suitable for evaluating ecosystem health because the structure of resident communities generally reflects abiotic conditions assimilated over time [25]. Accepting the idea and application of the IBI as one of the multi-unit evidence based on life assemblies is a good and useful way to assess the environmental status of the aquatic ecosystem, particularly rivers, as an alternative to other biological-assessment methods, especially the evidence of diversity and the multivariate methods [25]. The major negativity that is taken on these indices for its use of fish populations in environmental monitoring is limited to restricted aspects of fish populations such as the predominance of family species and distribution in general [26; 25].

The results of the present study showed that the environmental assessment of Lake Sawa was reduced and that it was included under a weak assessment, with the value of the Integrated Biological Index (28.9). The low values of this index reflect the state of life disturbance experienced by Lake Sawa, which resulted in a reduction in the number of endemic species, which amounted to only two species, this compatible with [1] indicates that the number of endemic species decreases with increasing disturbance. One of the results of this disturbance is the high percentage of individuals of the tolerant species to constituting 100% of the total number of individuals. This is consistent with [27], which recorded an increase in the percentage of tolerant individuals with increasing water disturbance in channels environments in the Mid-

Atlantic highland region in America, while [4] indicated a coincident increase in the percentage of individuals of tolerance species with increased disturbance, whether physical or chemically. The results of the study pointed to a high numerical dominance of *P. abu*, a highly endemic species, accounting for more than 71.4% of the total number of individuals. This is consistent with what [28] found in the use of the percentage of green sunfish in the West Rivers American Center. In contrast, Lake Sawa has been characterized by the disappearance of sensitive endemic species of fish assemblage and this is consistent with [27] who found a decrease in the number of sensitive species with water disturbance. The study of [29] pointed out that the state of the fish community in Al-Hammar marsh was fair during 2005-2006 (IBI= 42.6%), and better than them study after four years of restoration (IBI=40.8%). The results revealed that no substantial improvements have been recorded during the late years of restoration, reflect that the environment is still fragile and need time to be recovering.

The results of the diversity indices of the different stations have shown that these indices of the Shatt al-Arab river, Al-Hammar marsh, and Al-Saffia reserve are superior to that of Sawa Lake. The low values of the diversity indices of Sawa Lake (H = 0.6; D = 0.22) are due to the high numerical dominance of *P. abu* species. This is in agreement with [30], noting that the low values of these indices reflect the dominance of a few species which reduces the proportions of other species and this makes these indices very sensitive to any minor change, either numerically or quantitatively, [31] convinced this by noting that turbulence leads to a change in the diversity of fish populations, which are already distributed in parallel in terms of abundance, and were the population will abundant by few species. Ecosystem may be altered by other factors such as pollution to produce low diversity values this was announced by [32], noting a lower values of diversity indices in polluting stations than in other stations.

Conclusions

The results of the present study showed that the environmental assessment of Sawa Lake was weak assessment, with a value of the Integrated Biological Index 28.9 and this value is lower in comparison with other results in Shatt Al-Arab river, Al-Hammar marsh and Al-Saffia reserve stations, this reflects the disturbance of life experience in Sawa Lake, which resulted in a reduction in the number of endemic species by recording only two fish species.

Author Contributions Statement

half of research stages were done by first author and other half were done by second author including fish collection and classification, data analysis and research write.

Declaration of interest

The authors confirm that there was no competing interest with others.

Acknowledgment

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