Marsh Bulletin Volume 20 Issue 2 (September 2025): 126-140

MARSH BULLETIN
EISSN 2957-9848

Assessment of Biodiversity Intactness Index (BII) Level in East Hammar Marsh /Basrah /Iraq.

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Abstract:
Entirely 21 fish species were collected in East Hammar Marsh (EHM), the highest number 19 was recorded in Al Sadda and the lowest 14 in both Qarmat Ali and Al-Burkha stations. The highest relative abundance value occupied by three exotic species, first *Coptodon zillii* 19.3%, second by *Oreochromis aureus*17.6% and third rank was *Oerochromis niloticus*13.1%. The highest diversity recorded in EHM was 2.29 during November 2023 and the lowest was 1.85 in March 2024. Evenness varies between 0.7 and 0.55 in July 2024 and May 2024 respectively. Richness reaches the maximum 2.15 in November 2024 and lowest 1.3 in March 2024.Yearly grade of BII in EHM 79.42. Jaccard species similarity index scored the highest 69.98% between Qarmat Ali & Al Mansouri stations and the lowest 41.02% Between Qarmat Ali & Al Burkha stations. Sorensen similarity index indicated higher values 80.5 % between Qarmat Ali & Al Mansouri stations and the lowest 64.0% Between Qarmat Ali & Al Burkha stations. Bray-Curtis dissimilarity index reveal that the highest value 37.5 % between Al Mansouri & Al Burkha and the lowest 19.5 % Between Qarmat Ali & Al Mansouri stations. Strong opposite relationship existed between Shannon diversity index, Pielou evenness index, and BII in EHM. Fluctuation in water temperature and salinity effect BII values indirectly. Native fish species ratio showed negative relationship with BII. Generally, there is a slight improvement in BII level at EHM in comparison with that of 2018 and 2020.

Keywords: East Hammar Marsh, Biodiversity Intactness Index, Biodiversity in wetlands, Fish assemblage in marshes. BII of Iraqi marshes.

Received / 2024 Accepted / /2024 Published 1 / 9 /2025

Introduction

Southern Iraqi marshes covered vast area of southern Iraq, varied between 15000-20000 km^2, characterized by their rich biodiversity and unique socio-economic-ecological regime. Since these the only wetlands occupied by people. Their ecological significant are not confined locally but also extended regional, they represent winter route for migratory European birds passing to Africa. Southern marshes are the hub for several marine fish and shrimps migrating from the Arabian Gulf for spawning, feeding and protection beside inhabited by several rare species found only in southern marshes (AL wash and AL wash 2004;

Richardson *et al*., 2005). Numerus irrigation dams erected on Tigris and Euphrates rivers in Turkey, Syria, Iran and Iraq, resulted in considerable reduction in freshwater inflow qualitatively and quantitatively to the southern Iraqi marshes. Now East Hammer marsh (denoted by EHM) gets a considerable amount of water from Shatt Al Arab River and groundwater seepage is another source of replenishment. (Hussain and Reiss, 2018; Hussain *et al*., 2021).

BII is an indicator of the biodiversity status within a given geographical area or any define area with biota reference assemblage. Even it is possible to estimate the value of BII for the past and future (Biggs *et al*., 2004). The Biodiversity Intactness Index (BII) could be defined as straightforward and feasible method to bridges the gap between biodiversity ecologist, decision-makers and local people. The importance of the Biodiversity Intactness Index (BII) focuses on protecting the natural environment from degradation, reducing health risks associated with environmental pollution, and enhancing the health of individuals and society. BII also considered an important tool for enhancing and improving environmental laws and regulations. It also contributes to enhancing environmental awareness and knowledge among individuals and institutions. The BII is an indicator of the overall state of biodiversity in a given define area. Biodiversity losses have accelerated in southern Iraqi marshes due to shortage in freshwater supply from the sources in Turkey, Syria and Iran, habitat destruction by oil exploration and production, planned desiccation by Saddam regime and global climate change. Dudgeon *et al*. (2006) and Hui *et al*. (2008) pointed out the factors led to loss of biodiversity in rivers and wetlands. Reduced aquatic ecology functions and biodiversity stability of EHM, eventually will lead to reduce or damage ecosystem services include human welfare of Arab marsh and important economic products like buffalo dairy products and artisanal fisheries (Ayied and Reiss, 2019).

BII of EMH could be specified as an evaluated percentage of the contemporary occurrence of fish species after inundation in 2003 and their abundance. The importance of benchmark reference conditions when biodiversity is measured and reported to be used in comparison and indexing. It is always evident the importance of base line referencing as base line for BII evaluating (Allen *et al*., 2003).

The original fish assemblage of Mesopotamia basin consisted mainly of naïve riverain species. During the last fifty years many exotic and ornamental species were introduced to Iraqi rivers, reservoirs and marshes. The pristine fish assemblage of EHM was altered extensively during the last 20 years, through releasing many exotic species, migration of marine fish from Shatt al Arab estuary and Arabian Gulf. Resulted in compositional changes whose consequences represent a key aspect of conservation status. At present freshwater fish assemblage in EHM facing conservation crisis. Recent studies (Abdalhsan *et al*., 2020, Al-Najjar *et al*., 2019; Abdullah *et al*., 2022) indicated that more than 60% of native freshwater species on the brink of extension. Mohammed *et al*., (2024) concluded that temporal alteration of the fish assemblages from 2009 to 2022 bound with salinity fluctuation in EHM. Thus, biodiversity of EHM is threatened by increase salinity and occurrence of non-native fish species.

The major aim of the present study to asses BII level in EHM during the periods November 2023 to September 2024 and compare that with the previous years. Identification of fish composition and calculating relative abundance, diversity indices, similarity and dissimilarity between the four sampling stations. Comparison and recalculation of diversity indices and BII values of previous data in order to estimate the degree of loss of original BII values of EHM.

Material and methods

1. Description of study area:

East Hammar marsh (EHM) is one of the largest marshes in southern Iraq, have significant Scio- economic importance, approximate length 33-40 km, and width ranges between 26-35 km.and estimated total area 82968 ha (Bachmann *et al*., 2017). The area of the EHM varies according to the status and level of the semidiurnal tidal current from Shatt Al Arab River. The marsh affected by semidiurnal tide from Arabian Gulf via Shatt Al-Arab River. Its weather characterized by dry short winter and long hot summer extending 8-9 months. Marsh water is well oxygenated, alkaline pH and with grey muddy-silt sediments.

2-Sampling stations

Four stations were selected for sampling fish assemblages. Three stations were at the main body of the marsh, Al-Sadda, Al-Mansouri and Al-Burkha represent different biotopes, the fourth Qarmat Ali at the outlet channel connected the entire marsh with Shatt Al-Arab River, their coordinates were determined using a GPS device

2-1- Qarmat Ali station: A deep channel marsh connecting the main body of EHM with Shatt Al Arab River with water depth fluctuated between 7-8 meters and length of 10.5 Km. width of 280 meters, with co-ordination (30º 34'30.93'N) (47º 44' 38.87"E).

2-2- Al Sadda station: The actual inlet zone to the marsh with water depth fluctuated during semidiurnal tidal cycle, with co-ordination (30º 36' 49.16"N) (47º 40' 13.65"E).

2-3- Al Mansouri station: Wide channel marsh with water depth fluctuated during the tidal cycle, with co-ordination. (30º 40' 28.08"N) (47º 37' 42.79"E).

2-4- Al Burkha station: Wide shallow openness marsh with water depth fluctuated 0.5-2.0 m during tidal cycle, with co-ordination (30º 41'18.97"N) (47º 35' 11.93"E).

3- Fish samples collection:

Fish samples were collected bimonthly from November 2023 to September 2024, at the four selected stations, fishing was done during ebb tide, for 4-6 hrs. Three fishing methods were used: 1- Cast net. 2- Seine net and.3- Electro fishing.

Fish samples were kept in ice box for further examination. Fish samples were classified according Al-Fasial (2010) and Coad (2012).

4- Measuring Water parameters

4-1- Air and water temperature

Air and water temperature were measured in the four choose stations by using ordinary thermometer.

4-2-Salinity

Salinity was measured by using salinometer type Lovibond, SD 320 Co. Obtained values were multiplied by 0.64 to convert to g/l or psu.

4-3- Depth of water column

The depth was estimated by meter using a rope with one meter interval and 5 kilo depressors.

5- Relative abundance

Relative abundance was calculated according to the following equation:

$\boldsymbol{R}a\ (\%) = (\boldsymbol{n_i} \backslash \boldsymbol{N}) * \mathbf{10}0$ Odum (1971)

Ra = Relative abundance

n_i= Number of individuals of *i* species in the sample.

N=Total number of individuals of all species in the sample.

6. Ecological Indices

Computer program **Past 4.03** was used to calculate the following indices

6-1- Shannon and Weaver (1949)

$H' = -\sum P_i \ln P_i$ Clarke and Warwick (2001)

H'= Shannon and Weaver diversity index.

P_i= Relative abundance of i species in the sample.

6-2- Richness index of Margalefe (1968)
$D = S - 1/ \ln N$, Krebs (2014)
D=Richness value.
S=Number of species in the sample.
N= Number of individuals in the sample.

6-3- Evenness index of Pielou (1977)
J = H'\ **lnS**, Krebs (2014)
J= Evenness value.
H'= Shannon a weaver diversity value.
S= Number of species in the sample.

7- Biodiversity Intactness Index (BII)
BII = [(R-O\R) +1].100, Lamp *et al*., (2009)
BII= Biodiversity Intactness Index.
R= Reference diversity value.
O= Observed diversity value.

8- Ratio of native and nonnative to total fish species
Ratio number of native species (N) / total number of species (T) = N / T *100
Ratio number of non-native species (NN) /Total number of species (T) = NN /T *100
9- Reference list (bench mark list) of occurrence and abundance of fish species in EHM was adopted from (Mohammed et al., 2024).
Results

1-Number of fish species and their relative abundance
Twenty-one fish species were recorded from four stations at EHM during the period from November 2023 to September 2024, consisting of five native species forming 23.8% and sixteen non-native species making up 76.1%. The non-native species comprised eight exotic (38.1%), seven marine species (33.3%), and exotic and invader species (4.7 %.) The highest number of species and individuals collected was in November 2023 with 17and 1691 respectively, and lowest number of species was 10 in March 2024 and the lowest number of individuals was 945 in July 2024. The highest number of species (19) was recorded in Al Sadda station and lowest (14) in both Qarmat Ali and Al-Burkha stations.
The first three score of relative abundance were occupied by exotic species, with *Coptodon zillii* at 19.3%, *Oreochromis aureus* at 17.6% and *Oreochromis niloticus* at 13.1%. The native species *Planiliza abu* coming in eighth position formed 2.6 %. The highest relative abundance of the first three species was recorded at Al-Burkha station, followed by Al Mansouri station and then Qarmat Ali station (Table 1).

Table 1. Relative abundance (RA %) of fish species collected from Qarmat Ali, Al Sadda, and Al Mansouri and Al Burkha stations at EHM during the period from November 2023 to September 2024. Exotic =E, Marine=M, I= Invader.

No	Species	Origin	RA% Qarmat Ali station	RA% Al-Sadda station	RA% Al Mansouri station	RA% Al Burkha station	RA% EHM
1	*Coptodon zillii*	Non- Native(E)	18.1	16.1	19.9	25.2	19.3
2	*Oreochromis aureus*	Non- Native(E)	19.9	8.9	23	22.1	17.6
3	*Oerochromis niloticus*	Non- Native(E)	12.8	7.9	16.2	18.5	13.1
4	*Poecilia latipinna*	Non- Native(E)	14.7	13.3	5	3.4	10.4
5	*Thryssa whitehadi*	Non- Native	9.8	9.4	8.1	10.3	9.5

		(M)					
6	*Bathygobius fuscus*	Non- Native (M)	8.3	10.1	9	2.8	7.9
7	*Carassius auratus*	Non- Native(E)	6.4	8.4	5.7	8.1	7.2
8	*Planiliza abu*	Native	2.6	4.5	0.6	1.3	2.6
9	*Cyprinus carpio*	Non- Native(E)	-	6.3	-	1.3	2.1
10	*Aphanius mento*	Native	-	1.1	6	3.4	2
11	*Tenualosa ilisha*	Non-Native (M)	2	2.6	0.8	0.2	1.6
12	*Planiliza klunzingeri*	Non-Native (M)	-	5	-	-	1.5
13	*Ctenopharyngodon idella*	Non-Native (E)	0.5	2	2.5	1.3	1.4
14	*Leuciscus vorax*	Native	3	0.5	-	-	1.1
15	*phoyopectoralis bundis*	Non- Native (M)	0.5	0.7	1.6	-	0.6
16	*Aphanius dispar*	Native	0.3	0.5	0.7		0.4
17	*Poecilia sphenops*	Non- Native(E)	-	-	-	1.3	0.2
18	*Hemiculter leucisculus*	Non- Native(I)	-	0.8	-	-	0.2
19	*Silurus triostegus*	Native	0.3	0.3	0.1	-	0.2
20	*Planiliza subviridis*	Non- Native (M)	-	0.6	-	0.17	0.2
21	*Boleophthalmus dussumieri*	Non- Native (M)	-	-	0.4	-	0
	Total no. of species = 21 Total no. of individuals = 5767						

2-Diversity indices in EHM

The highest diversity value of 2.29 in EHM was recorded in November 2023 and the lowest 1.85 in March 2024. The richness index reached a maximum of 2.15 in November 2023 and the minimum of 1.3 in March 2024. The evenness value reached a maximum of 0.7 in July 2024 and the minimum of 0.55 in May 2024.

3- Spatial diversity indices and BII values

The highest yearly average of diversity values was 2.06 and lowest was 1.85 recorded at

Qarmat Ali and Al Mansouri stations respectively. Average richness values 2.25 and lowest 1.74 in Al Sadda and Qarmat Ali respectively. The highest evenness value of 0.56. was recorded at Qarmat Ali station and the lowest 0.39 in was in Al Sadda station. The average richness values were 2.25 and the lowest was 1.74 in Al Sadda and Qarmat Ali, respectively. EHM yearly average value of Shannon diversity indices were 2.36, Margalefe richness 2.31 and evenness 0.7. Yearly BII value of EHM was 79.42 (Table 2).

Table 2. Spatial variation of average diversity indices of Qarmat Ali, Al Sadda, Al Mansouri, Al Burkha stations and yearly BII value at EHM during the period from November 2023 and September 2024.

Stations	No. of species	Diversity(H')	Richness(D)	Evenness(J)	BII
Qarmat Ali	14	2.06	1.74	0.56	-
Al Sadda	19	2.01	2.25	0.39	-
Al Mansouri	15	1.85	1.9	0.42	-
Al Burkha	14	2.02	1.84	0.53	-
East Hammar Marsh	21	2.36	2.31	0.7	79

4-Temporal changes of diversity indices.

The highest seasonal diversity was 2.29 during November 2023 and the lowest was 1.85 in March 2024.The highest evenness 0.7 was in July 2024 and the lowest 0.55, was in May 2024.Richness reached the maximum 2.15 in November 2023 and the lowest of 1.3 in March 2024 (Table 3).

Table 3. Temporal variations of diversity indices of EHM during the period from November 2023 and September 2024.

Month	Diversity(H')	Evenness(J)	Richness(D)
Nov-23	2.29	0.58	2.15
Jan-24	2.02	0.69	1.5
Mar-24	1.85	0.64	1.3
May-24	2.05	0.55	1.96
Jul-24	2.14	0.7	1.6
Sep-24	1.93	0.57	1.7

5-Similarity and dissimilarity between stations at EHM

Jaccard species similarity scored the highest 69.98% between Qarmat Ali and Al Mansouri stations and the lowest at 41.02% between Qarmat Ali and Al Burkha stations. The Sorensen similarity index indicated higher values 80.5 % between Qarmat Ali and Al Mansouri stations and the lowest 64.0% between Qarmat Ali and Al Burkha stations. Both indices showed a similar theme of similarity between the stations. The Bray-Curtis dissimilarity index revealed the highest value at 37.3% between Al Mansouri and Al Burkha stations and the lowest at 19.5% between Qarmat Ali and Al Mansouri.

6-Relationship between water temperature and BII in EHM

Comparable relationship existed between water temperature and BII values measured by recent and previous studies, except that of Hussain et al (2009) (Figure 1).

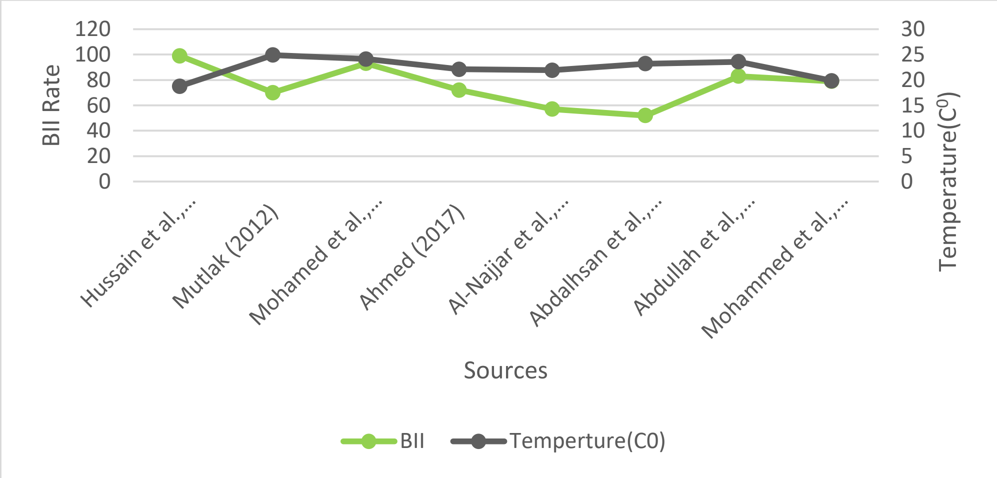

Figure 1. Showing the comparable relationship between water temperature C^0 and BII values at EHM during the period from 2009 to 2024.

7-Relationship between Salinity and BII in EHM

Inverse relationship appears to be existed between salinity values and BII scores at EHM, especially during 2012 and the period from 2019 and 2020 (Figure 2).

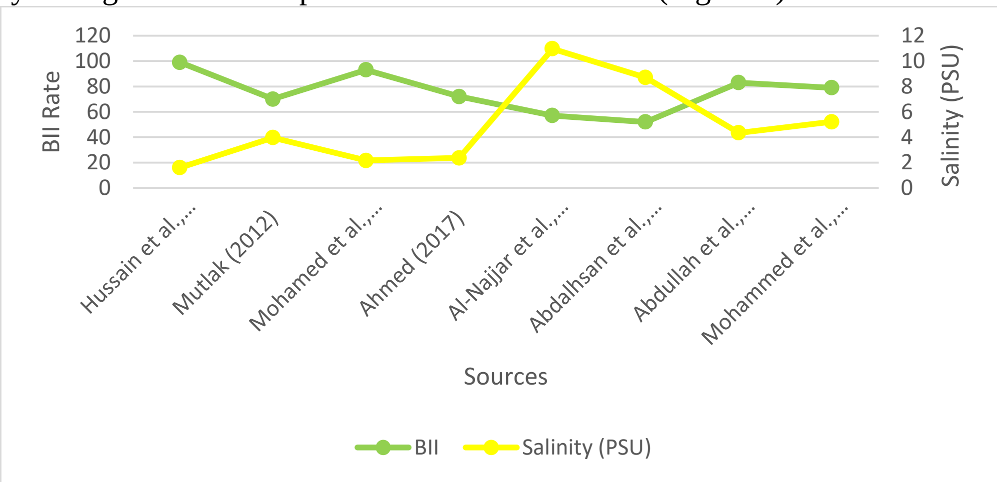

Figure 2. Showing the relationship between Salinity psu and BII at EHM during the period from 2009 to 2024.

8- Relationship between Native and Non-native species ratios and BII in EHM

Native species ratio showed negative relationship with both BII and non-native species ratio. Non- native fish ratio exhibited parallel values with BII scores in EHM during the previous period from 2009 to 2024 accept that of Hussain et al., (2009) and Mohamed et al., (2013) showed a little reduction (Figure 3).

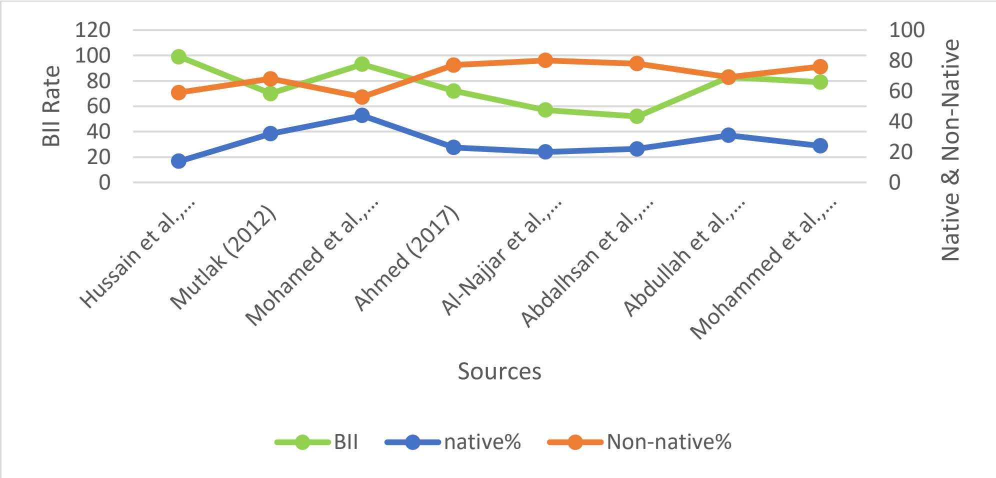

Figure 3. Illustrating the relationship between Native and Non-Native species ratio and BII at EHM during the period from 2009 to 2024.

9- Relationship between Shannon diversity index and BII in EHM

Opposite relationship existed between Shannon diversity index and BII in EHM during the period from 2009 to 2013. Later the period from 2017 to 2020 characterized by higher diversity values which accompanied by increase migration of marine species during that period (Figure 4).

Figure 4. Exhibiting the relationship between Shannon diversity index and BII at EHM during the period from 2009 to 2024.

10- Relationship between Pielou Evenness index and BII in EHM

Parallel relationship seemed to be existed between Pielou Evenness index and BII at EHM during the period from 2009 to 2020.An increase in evenness values in 2022 and 2024 (Figure 5).

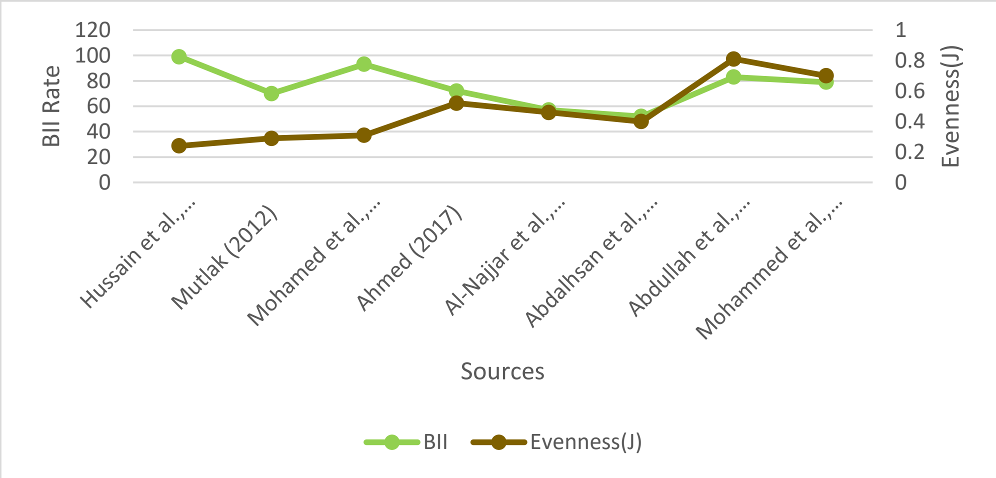

Figure 5. Demonstrating the relationship between Evenness index and BII at EHM during the period from 2009 to 2024

11- Relationship between Margalefe richness index and BII in EHM

Analogous relationship existed between Margalefe richness index and BII at EHM during the period from 2012 to 2019 and 2022, except that of Hussain et al., (2009), Abdalhsan et al (2020) and Mohammed et al (2024) express inverse relationship. (Figure 6).

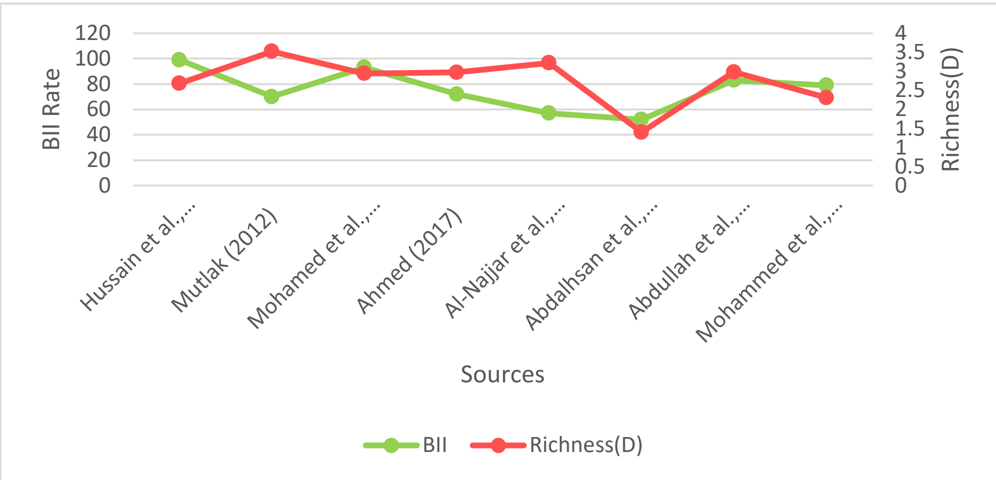

Figure 6. Showing the relationship between Margalefe richness index and BII at EHM during the period from 2009 to 2024.

Discussion

Biodiversity Intactness Index (BII) is a simple method to evaluate the biodiversity status to the decision-makers and local residents. In another word BII is comparison between the statuses of biodiversity at the time being with reference pristine previous situation. The aim of the present study to evaluate the biodiversity status of EHM and highlighted to the environmentalist, decision - makers and seiner local leaders, in order to realize the actual situation of EHM, in attempt to adopt the necessary resolutions and perform the urgent needed actions. BII of EHM reflect the changes in aquatic biodiversity of fish assemblage in comparison with reference base line status in 2006. In this study yearly BII values were used to estimate changes in aquatic biodiversity status in EHM.

Southern Iraqi marshes were among the most threatened aquatic ecosystems in Iraq and Middle East, suffer from sever freshwater shortage, intense global warming closely related to human activity, increase in scio- economic and agricultural activities, consequently need continuous monitoring to the changes in aquatic environment (Hussain and Reiss 2018).

Al-Maarofi *et al* (2012) pointed out that salinization problem of Iraqi marshes become a very serious especially in EHM. Recently Shatt Al Arab River become the only freshwater source to EHM, previously replenished mainly from Tigris and Euphrates rivers, consequently led to increase salinity and modified the aquatic environment from freshwater habitat to mesohaline or estuarine one. Shift in aquatic environment facilitated the migration of marine species from Shatt al Arab estuary and Arabian Gulf to invade the marsh. Altogether 52 fish species were recorded in EHM during the period from 2006 to 2024, consisted of 24 marine, 17 freshwater native, ten exotic and one freshwater invader. 35 species of them where non-native represent 67.1% of total fish species existed in EHM (Mohammed *et al.*, 2024). Recently only one third of the total number of fish species historically recorded in EHM, indicating a gradual degradation in number of species originally created the assemblage.

Fluctuation in number of species will largely affect diversity indices and ultimately BII value of the marsh. Spite-temporal variations existed in biodiversity values between the selected stations in EHM. Al Sadda station showed the highest biodiversity values, on contrary Al Burkha station was the worse. Because Al Sadda station is the actual inlet to marsh and represent the best fishing area. However, Al Burkha station is wide shallow openness marsh act as refugee for juvenile's fish. BII value depend entirely how the recent species composition is near or far from the reference or bench mark species list.

The highest similarity between the stations as demonstrated by both Jaccard species index and Sorensen similarity index scored between Qarmat Ali and Al Mansouri stations and the lowest between Qarmat Ali and Al Burkha stations. Both Qarmat Ali and Al Mansouri are similar, both classified as channel marsh wetlands. The low similarity between Qarmat Ali and Al-Burkha due to two different biotopes wetlands, the first represent longitudinal deep channel marsh while the second wide shallow openness marsh (Hussain, 2014). Increase water evaporation, long hot summer season will indirectly effect BII values, through increase salinity. Eventually effect BII values indirectly altering the aquatic environment to be more saline.

Table 4. Display the previous and present data on number of fish species, ratio of native and non -native, salinity, diversity (H˜) ' Evenness (J), Richness (D) and BII in EHM during the period from 2009 to 2024.

No	Sources	No. of species	native %	Non-native %	Salinity (PSU)	Diversity (H')	Evenness(J)	Richness (D)	BII
1	Hussain et al., (2009)	31	41	59	1.6	1.89	0.24	2.68	99

2	Mutlak (2012)	44	32	68	3.97	2.53	0.29	3.52	70
3	Mohamed et al., (2013)	26	44	56	2.16	2.1	0.31	2.94	93
4	Ahmed (2017)	22	23	77	2.37	2.49	0.52	2.97	72
5	Al-Najjar et al., (2019)	35	20	80	10.96	2.79	0.46	3.22	57
6	Abdalhsan et al., (2020)	23	22	78	8.7	2.9	0.4	1.4	52
7	Abdullah et al., (2022)	32	31	69	4.34	2.29	0.81	2.98	83
8	Mohammed et al., (2024)	21	24	76	5.21	2.36	0.5	2.31	79

Hussain *et al*., (2009) and Mohamed *et al*., (2013) achieved high BII values because the bench mark list was originally derived from their fish data. A big drop in BII values was recorded by Al-Najjar *et al*., (2019) and Abdalhsan *et al*., (2020), 57 and 52 respectively, as outcome of pronounced increased in salinity to reach 10.96 and 8.7psu respectively. Mohammed *et al* (2024) recorded lower BII values79.42 than Abdulla *et al* (2022) 83.16 due to slight increase in salinity value in EHM in 2024. Number of species has no direct effect on the value of BII but the ratio of native and non-native have. An increase in the native species ratio accompanied by an increase of BII value, on contrary decrease in BII values accompanied by increase in non-native ratio. An opposite relationship existed between the Shannon diversity index and BII values. High diversity values indicate an increase in the number of species in EHM, mainly non-native species as illustrated in table (4). Evenness data in EHM reflect an unbalanced fish assemblage with dominance of Cichlid species individuals over other species in EHM. No linear relationship seems to be existed between the richness index and BII values in EHM, which could be due to different fishing efforts exert during fish sampling.

Along 12 months of sampling in EHM the species assemblage consist of 76% non-native species and only 24%, native ones indicating dominance of non-native species over native ones. The bulk of non-native species were migratory marine and exotic species. The same recognized by other authors, Ahmed *et al* (2017), Al-Najjar *et al*., (2019) and Abdalhsan *et al*., (2020). Magurran (2004) indicated that non-native invasive species will increase the value of standard diversity indices, such case considered not positive for local biodiversity intactness. The structure of fish assemblage in EHM suffer from fundamental defects in the occurrence and abundance of native species with establishment of exotic and marine species. We noticed the disappearance of several native riverine species such as *Carasobarbus luteus*, *Mesopotamichthys sharpeyi* and *Luciobarbus xanthopterus*. After inundation in 2003, the fish assemblage in EHM was dominated by native freshwater Mugilidae species *P.abu* (CIMI, 2006). At present dominated by three exotic Tilapia species (*Coptodon zillii*, *Oreochromis aureus* and *Oerochromis niloticus)*. Nielsen *et al*. (2007) concluded that the increase in non-native species will eventually reduce BII values as non-native species can reduce ecosystem integrity, and increase biodiversity indices.

The progressive increase salinity in EHM from 2009 to 2024 with peaking in 2019 at (10.96) psu and then reducing to a moderate level of 5.21psu in 2024. Reflect significant alteration in aquatic environment from oligohaline to mesohaline/estuarine which may not be favorable for the survival of the native freshwater species, consequently native species may leave or escape from EHM to more fluvial environment in Tigris and Euphrates rivers. Desertion of native riverine species will reduce the value of BII in EHM. The reduction in salinity in 2023/2024 as indicated by the present study led to marginal increase in BII value. In general salinity values exceeding 8 psu in EHM reduce the value of BII on contrary increasing biodiversity scores (Mohammed et *al*., 2024). Kuiper *et al*, (2014) stated that alternation of natural water regime is considered a major threat to biodiversity in rivers and wetlands.

Value of BII in 2024 scored 79.42 indicating a marginal improvement in the EHM aquatic environment in comparison with that recorded 52.4 by Abdalhsan *et al*., (2020) and the 57.63 recorded by Al-Najjar *et al*., (2019). This suggests a gradual recovery of the damage biodiversity intactness of EHM. Yearly monitoring of BII scores in EHM from 2009 to 2024 reveals gradual reduction from a riverine environment to be mesohaline /estuarine situation. Lamb *et al*. (2009) indicated that low BII score indicate severe biodiversity degradation and a critical sign that native species is clearly facing severe environmental constrains. An increase in non-native species should be considered as result of ecosystem degradation and a clear sign of loss biodiversity intactness (Arriaga, *et al*., 2004; Hooper *et al*., 2005).

Conclusions

For the first time BII formula to be implemented on wetlands (marshes) previously used to monitor biodiversity degradation in boral forest and wide wilderness of South Africa.

We concluded that the BII of the East Hammar Marsh during 2023-24 is damaged by freshwater shortage, increase overfishing, land reclamation and oil installations are the main factors threating the intactness of aquatic biodiversity of EHM. Efficient environmental laws need to be implemented in order to recover and improve the BII of EHM. Four major steps ought to be taken 1- To rectify the environmental degradation more freshwater quota must be directed to the marsh since the present supply is not enough to change the local environment to oligohaline. 2-Stop releasing exotic fish fingerling. 3-Reintertoudce of native riverine species 4-Regulation of over fishing and harvesting of reeds and Typha.

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تقييم مستوى دليل سلامة التنوع الحيوي في هور الحمّار الشرقي – البصره – العراق

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المستخلص:

جمع خلال فترة الدراسة 21 نوعًا من الأسماك في هور الحمّار الشرقي، سجل أعلى عدد من الانواع 19 في محطات السدة والادنى 14 في كل من كرمة علي والبركة. كانت أعلى وفرة نسبية لثلاث انواع من الاسماك المدخله، *Coptodon zillii* بنسبة 19.3٪، و Oreochromis *aureus* بنسبة 17.6٪، *Oerochromis niloticus* بنسبة 13.1٪. سجل أعلى تنوع في هور شرق الحمّار 2.29 خلال تشرين الثاني 2023 وكان أدنى تنوع 1.85 في اذار 2024. اختلفت قيم التكافؤ ما بين 0.7 و0.55 في تموز 2024 وايار 2024 على التوالي. اما الغنى فكانت اعلى قيمة 2.15 في تشرين الثاني 2024 والادنى 1.3 في اذار 2024. كانت القيمه السنويه لدليل سلامة التنوع الحيوي في هور الحمّار الشرقي هو 79.سجل دليل جاكارد لتشابه الأنواع أعلى مستوى 69.98٪ بين محطتي كرمة علي والمنصوري وأدنى مستوى 41.02٪ بين محطتي كرمة علي والبركة. سجل دليل سورنسن أعلى مستوى بنسبة 80.5٪ بين محطتي كرمة علي والمنصوري وأدنى مستوى 64.0٪ بين محطتي كرمة علي والبركة. أظهر دليل براي- كيرتس للاختلاف أن أعلى قيمة كانت 37.5% بين محطتي المنصوري والبركة وأدنى قيمة كانت 19.5% بين محطتي كرمة علي والمنصوري. وجدت علاقة سلبية بين دليلي شانون للتنوع والتكافؤ لبيلو ودليل سلامة التنوع الحيوي في هور شرق الحمّار. كما أثر التذبذب في درجة حرارة الماء والملوحة على قيم دليل سلامة التنوع الحيوي. وأظهرت نسبة الأسماك المحلية علاقة سلبية مع دليل سلامة التنوع.

الكلمات المفتاحية: بيئة هور الحمّار الشرقي، دليل سلامة التنوع الحيوي، التنوع الحيوي في الأراضي الرطبة، التجمعات السمكية في الأهوار. دليل السلامة البيئية في الأهوار العراقية.