

Water Birds Diversity Variations in Tidal and Non-tidal Wetland Habitats in East Al_Hammar Marsh South of Iraq

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Abstract: Waterbird diversity and its distribution are deemed as one of the essential issues in the ecological conservation of wetlands areas. However, the differences in the diversity of waterbirds in tidal and non-tidal wetlands have been underestimated. This study aimed to identify the variations in bird diversity between tidal and non-tidal areas in East Al-Hammar marsh to guide the efforts of bird and habitat conservation. The bird survey was extended from August 2020 to March 2021, in three selected sites; Slien (non-tidal area), Al-Sallal and Al-Burqa (tidal areas). Twenty-nine species were observed. These species were classified into three categories: migrant 68.96, resident 6.90% and migrants and residents 24.14%. Species richness indices included; number of species, Margalef and Menhienk indices indicated that the highest values were in the Slien site, there were 19, 3.191 and 1.254, respectively. Similarly, Shannon Weiner and Berlion's indices showed the highest values in Slien. However, the Berker-Berker dominance index revealed the highest value in the Slien site 0.193. Interestingly, the Jaccard similarity index showed the highest measure of 0.791 between Al-Sallal and Al-Burqa, while the highest dissimilarity index of Whittaker was between Slien and Al-Sallal. In sum, the current data analysis demonstrated that non-tidal areas supported higher diversity of waterbirds than tidal marshes.

Key words: Bird biodiversity, tidal marshes, non-tidal marshes.

Introduction

Wetlands have been recognised as significant habitats that support numerous wildlife (Shahidullah et al., 2020). Long et al. (2021) stated that wetlands are the most biologically diverse of all ecosystems, cradle to a wide variety of plant and animal life, as they provide water and primary productivity.

The marshes are one of the wetland types and in turn classified into two types (Hussain and Sabbar, 2020). the first is called tidal marshes, which are found along the coasts and affected by tides and often fresh water from surface runoff, rivers or groundwater and

are characterized by a great diversity of plant and animal organisms. The second category is the non-tidal marshes, which are often found in poorly drained depressions, floodplains, and shallow water areas along the edges of lakes and rivers, and usually derive most of their water from surface water in addition to underground water (Hussain and Sabbar, 2020). The non-tidal marshes are characterized by the fact that the majority of them are fresh or salty water, and the water level is seasonally varied. Plants vary as well including sedge, reeds and club-rush (Caponera and Kiviat, 2020). Ramli and Norazlimi (2016) emphasised that tidal wetlands supplement adequate habitats for shorebird occurrence and diversity.

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The East Al-Hammar marsh locates south of the Euphrates River which provides the marsh with water, extending northwest from the outskirts of Basrah to Suq al-Shuyukh (Yaseen et al., 2021). The habitats of the Iraqi marshes are characterized by the great diversity of vegetation cover, which represents the structural and functional base of the food chain and thus is an important site for the breeding of many birds (Karim et al., 2021). Birds, especially waterbirds, use wetlands rather than permanent or temporary water bodies as winter sites for feeding and resting (Gavrilovic et al., 2018). Locally, many studies were focussed on the vital importance of Iraqi wetlands for waterbirds diversity. Fazaa et al. (2016) studied the central non-tidal marshes in the south of Iraq, through monthly surveys and recorded 125 species of waterbirds. Salim and Abed (2017) investigated the biodiversity in the non-tidal regions of the Najaf Sea and concluded that the winter and autumn seasons are the highest in terms of the number of species of birds, while the summer and spring seasons are relatively the lowest.

Abou Turab et al. (2017) revealed the remarkable functions of scattered and small wetland areas for bird diversity and emphasised that disappearing wetland areas constituted a bottleneck for bird movement in three regions in the Eastern Al-Hammar marshes. Al-Sheikhly (2021) recorded about 128 species of waterbirds and 25 species were sea birds in central marshes.

According to the previous illustrated studies, the comparison approach between the tidal and non-tidal marshes in waterbird diversity has not been estimated evidently nationally and internationally. Our questions in the current work were: does waterbird diversity differ between the tidal and non-tidal marshes? And which areas are the most preferable by waterbirds both the migrants and residents? The answer to these questions might provide the corner stone for ecologists to determine the conservation priority area and is deemed a base for researchers to design more works in sight to establish the conservation priority for other wildlife species.

Methodology

The Study Area

Three sites were identified in Marsh East Al-Hammar and their coordinates were fixed by a GPS (model Garmin GPS Etrex 10, Carmen USA) (Figure 1) as follows: Slien marshes (N:30 47.576; E:047 12.509) is a

non-tidal marsh, the second called Sallal marshes (N:30 42.948; E:047 38.454), and the third was Al-Burqa marshes (N 47 36 44.8 E 30 41 11.5). Both Sallal and Al-Burqa are tidal marshes.

Slein marsh (S1) is a semi-artificial non-tidal area surrounded by earthen embankments. It is supplied with water from the Euphrates River at the Al-Hammar area in the village of Al-Bahr by the project of draining the floating Al-Nasr site in the Al-Madina district. The water enters this site by pipes (Personal communication.). This site was added to the Key Biodiversity Area (KBA) in 2008 as it regularly harbours large numbers of wintering waterbirds. The water level is shallow and there are beds of reeds *Phragmites australis* that scattered widely, as well as *Rigis junducus* (Anna et al., 2012).

Al-Sallal marsh (S2) locates to the north of Al-Harir marsh. The depth of the water varies in the range of 4-6 m when low tide occurs (AbouTurab et al., 2021). It is characterized by a dispersed vegetation cover that includes the reed plant Common reed and the papyrus plant called *Typha domingensi* (Class: Cattail), as well as the rush and Golan *Schoenoplectu slitoralis* (Al-Tememi et al., 2015).

Al-Burqa (S3) is 1.4 km away from the Al-Sallal site; and characterized by its shallow waters, which support prominent and submerged aquatic plants, that include common reed and cattails as well as rush and Galon (Garstecki and Amr, 2011) (Figure 1).

Survey Method

The field survey period for waterbirds at the three sites was extended, from August 2020 to March 2021. Bushnell binocular (7×50 made by Amazon), monocular telescope (Amazon-Celestron/USA), and Nikon D90 camera with a sigma lens 55-300 mm (manufactured Japan) were used. Photographic Guide of Birds of Britain and Europe was used to diagnose the waterbirds, and the numbers of birds and their species were collected (Hakan and Lars, 1996). The line transect method was used to monitor birds at Slein and Al-Sallal sites, while the point transect was performed at the Al-Burqa site. Birds were monitored once for 10 minutes (Burnham et al., 1981).

Biodiversity Indices

Paleontological Statistics Software Package for Education and Data Analysis (PAST, V.4) was used to measure the biodiversity indices: the richness index was the Margalef index (Kanieski et al., 2018). Alpha indices include; Shannon-Wiener, Brillouin, Berger – Parker and Evenness indices (Berger and Parker, 1970;

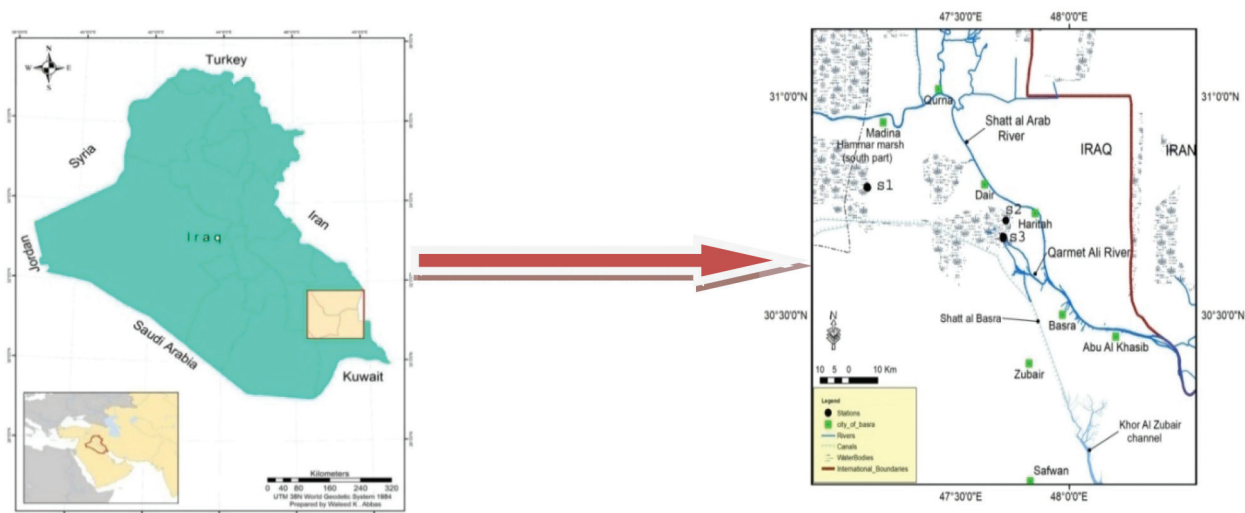


Figure 1: Eastern Al-Hammar marshes with the three studied sites.

Bibi and Ali, 2013; Heip and Engels, 1974; Niklaus et al., 2001). In addition, two beta diversity indices were Whittaker and Jaccard similarity diversity indices (Besta et al., 2020; Magurran, 2004).

$$B_w = a+b+c/(2*a+b+c)/2 \quad (1)$$

where

B_w : Whittaker index

a: Number of similar species between the two habitats
b: Number of species that exist in habitat A and absent from habitat B

c: Number of species that exist in habitat B and absent from habitat A

$$S_j = a/(a + b + c) \quad (2)$$

where

S_j : Jaccard index

a: Number of similar species between the two habitats
b: Number of species that exist in habitat A and absent from habitat B

c: Number of species that exist in habitat B and absent from habitat A

Results

Survey recorded 10436 individuals of waterbirds belong to 29 species. In the Slein site, 3764 individuals were observed to belong to 24 species that constituted 36% of the total number of species in all sites. While 2147 waterbirds belonging to 20 species were recorded in Al-Sallal which constitutes 30%. Al-Burqah recorded 4525 individuals belonging to 23 species that constitute 35% (Figures 2 and 4).

Percentages of species in three sites

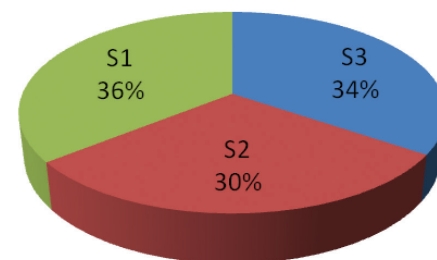


Figure 2: Percentage of waterbirds species registered in the three sites (S1, S2, S3) during the study period.

Interestingly, 7900 individuals of migratory waterbirds were recorded in the current study that belongs to 20 species and comprise about 69%. Likewise, the number of residing species of birds residing in the three sites was 300 individuals, distributed among only two species its percentage was 7%. While 2236 individuals were resident-immigrant birds, belonging to seven species; which composed about 24% (Figure 3).

In Slein, seventeen species were migrating species (71.0%), whereas, resident species represented about 4.0%. Of the resident-migratory species, six species constituted 25.0% (Figure 3). While, in Al-Sallal, thirteen species were migrating species representing 65.0%, whereas, the resident species represented about 5.0% of the total species. Of the resident-migratory species, six species constituted approximately 30.0% (Figure 3). In the Al-Burqah site, fifteen species were migrating species and represented mostly 65.0% of the total, whereas, one species was resident at 3.0%. Six

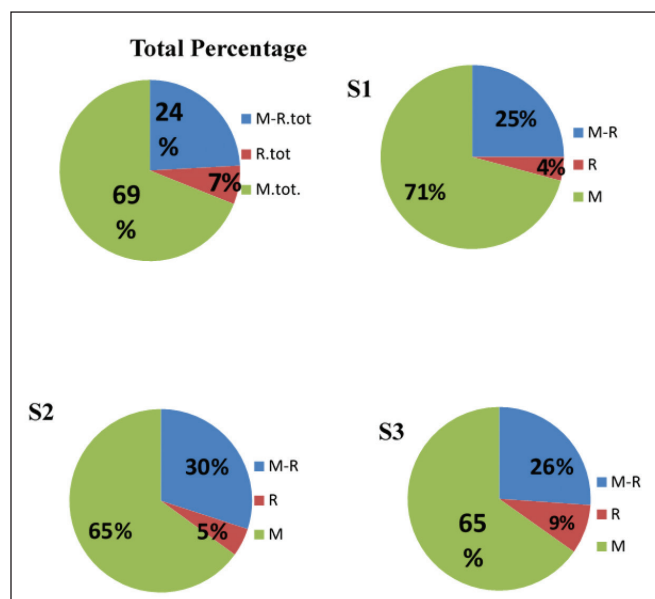


Figure 3: The total percentage of migratory (M), resident (R), migratory- resident (M_R) waterbirds in the East Hammar marsh sites (Slein (S1), Al-Salla (S2), Al-Burqah (S3)).

species were resident-migratory their number represents about 26.0% of the total individual in Al-Burqah (Figure 3).

In general, these individuals belonged to seven orders as follows: Order Anseriformes and included one species, *Anas crecca*. For Charadriiformes, which included 18 species, which are *Actitis hypoleucos*, *Calidris alba*, *Charadrius dubius*, *hiaticula* *Charadrius*, *Larus fuscus*, *Limosa lapponica*, *Vanellus vanellus*, *Tringa erythropus*, *Chroicocephalus ridibundus*, *Chlidonias gentaris alrusatp gene*, *Calidphalus*, *Charadrius*, *Larusa hirundo*, *Himantopus himantopus*, *Tringa stagnatilis*, *Vanellus leucurus*. Ciconiiformes, are represented by one species, the white stork, *Ciconia ciconia*. Coraciiformes included three species, *Alcedo atthis*, *Ceryle rudis*, and *Halcyon smyrnesis*. Pelecaniformes, which included four species: *Ardea alba*, *Ardeola ralloides*, *Ardea cinerea*, and *Egretta garzetta*. Podicipediformes and included one species, *Tachybaptus ruficollis*. Suliformes, included one species, *Phalacrocorax aristotelis* (Table 1).

Monthly, variations in Taxa-S index were the highest value was observed at the Slein site was 18 in November 2020, while the lowest value of the guide was 6 on the Al-Sallal site in August 2020 (Figure 4).

The highest value of the Margalef index was in Slein, which was 2,794, and the lowest value of the index was in Al- Sallal, 2.477. Monthly, the highest value of the

Table 1: Birds recorded during the study period in the East Hammar marsh and for all site from August 2020 to March 2021

Order	Sci. name
Anseriformes	<i>Anas crecca</i>
	<i>Actitis hypoleucos</i>
	<i>Calidris alba</i>
	<i>Charadrius dubius</i>
	<i>Charadrius hiaticula</i>
	<i>Larus fuscus</i>
	<i>Limosa lapponica</i>
	<i>Vanellus vanellus</i>
	<i>Tringa erythropus</i>
Charadriiformes	<i>Chroicocephalus ridibundus</i>
	<i>Chlidonias hybrida</i>
	<i>Calidris alpina</i>
	<i>Charadrius alexandrinus</i>
	<i>Larus canus</i>
	<i>Chroicocephalus genei</i>
	<i>Sterna hirundo</i>
	<i>Himantopus himantopus</i>
	<i>Tringa stagnatilis</i>
	<i>Vanellus leucurus</i>
Coraciiformes	<i>Alcedo atthis</i>
	<i>Ceryle rudis</i>
	<i>Halcyon smyrnensis</i>
Ciconiiformes	<i>Ciconia ciconia</i>
Pelecaniformes	<i>Ardea alba</i>
	<i>Ardeola ralloides</i>
	<i>Ardea cinerea</i>
	<i>Egretta garzetta</i>
Podicipediformes	<i>Tachybaptus ruficollis</i>
Suliformes	<i>Phalacrocorax aristotelis</i>

Marglef index was 3.191 in November 2020 in the Slein site, and the lowest was in the Al-Sallal site in August 2020 and it reached 1.158 (Table 2).

The results also indicated that the highest value of the Menhinick index was 0.0431 at Al-Sallal site, while the lowest value was 0.0327 at the Al-Burqah site. Monthly, the highest value of the index was on the Slein site in November 2020, while the lowest value was at the Al-Burqah site in January 2021 (Figure 5).

The highest value of the Barker-Berker index was 0.193 in Slein, whereas the lowest value was 0.170 in the Al-Sallal site. Monthly, it was found that the

Table 2: Whitaker's index for the difference in numbers of waterbirds in East Hammar for the three sites during the study period from August 2020 to March 2021

Months	Total	$S2*S1$	$S3*S1$	$S3*S2$
Among three sites	0.298	0.181	0.191	0.116
August	0.434	0.333	0.294	0.285
September	0.363	0.2	0.304	0.222
October	0.5	0.333	0.28	0.272
November	0.333	0.333	0.212	0.111
December	0.692	0.384	0.481	0.36
January	0.411	0.28	0.28	0
February	0.5	0.4	0.333	0.157
March	0.218	0.3	0.130	0.142

highest value was 0.566 in January 2021 at the Slein site, while the lowest value was 0.135 in November at Slein (Figure 5).

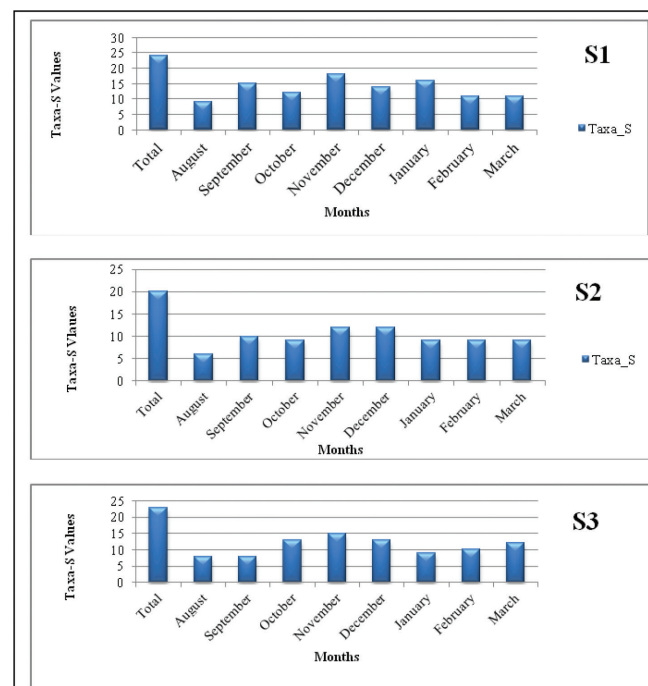
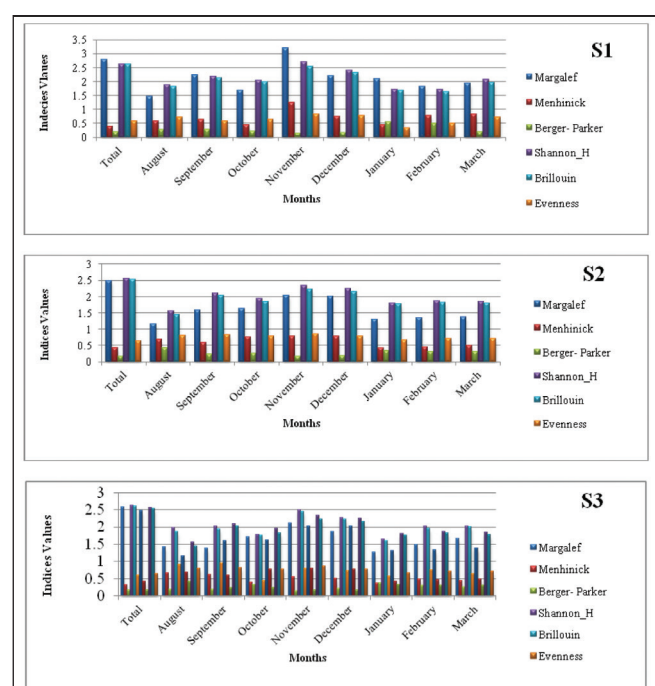
The highest value of Shannon's diversity index was 2.625 recorded in Slein, while the lowest value was 2.560 in Al-Sallal. Monthly the Shannon-Winer index showed the highest value of 2.69 in the Slein site in November 2020, while the lowest value was 1.562 in the Al-Sallal site in August 2020. Similarly, the Berlion index recorded the highest value at the Slein site, which

was 2.607, while the lowest value was 2.535 at the Al-Sallal site. Monthly the highest value Berlion Index was 2.529 in November 2020 at the Slein site. While the lowest value reached 1.436 at the Al-Sallal site in August 2020 (Figure 5).

The evenness index between among sites was 0.647 in the Al-Sallal site, while the lowest value of the index was 0.575 in the Slein site. Monthly, the highest value of the Evenness index was 0.947 in September 2020 at the Al-Burqah site, while the lowest value was 0.346 in January 2021 in Slein (Figure 5).

Indices of beta diversity of waterbirds were as follows: the total value of Whittaker's index among the three sites in the East Al-Hammar Marsh amounted to 0.298 (Table 2). In detail, the highest difference was 0.191 between Slein and Al-Burqah, while the lowest value was between Al-Sallal and Al-Burqah, and it reached 0.116. Monthly, the highest total value of the Whitaker Index was among the sites in December 2020 which were 0.692, while the lowest value of the Index was 0.218 in March 2021. The monthly differences were as follows: the highest value of the Whitaker index was in December, which was 0.481 in December between Slein and Al-Burqah, while the lowest value was 0 in January between Al Sallal and Al Burqah (Table 2).

In the sight of the Jaccard similarity index the highest among the three sites was 0.791 which was between Al-Sallal and Al-Burqah (Table 3), while the lowest value

**Figure 4: Taxa_S index of waterbirds species number at the sites during the study period.****Figure 5: Alpha indices of waterbirds species for the sites during the study period.**

was between the Slein and Al-Sallal 0.692. Monthly, the values of the similarity index varied between the sites, where the highest value was in January 2021 between Al-Sallal and Al- Burqah, which was 1, while the lowest value in December between Slein and Al-Burqah was 0.35.

Table 3: Jacquard's index for the similarity of numbers of waterbirds in the eastern Al-Hammar marsh for the three stations during the study period from August 2020 to March 2021

<i>Months</i>	<i>Values of Jaccard index</i>		
	<i>S2*S1</i>	<i>S3*S1</i>	<i>S3*S2</i>
Between sites	0.692	0.703	0.791
August	0.5	0.545	0.555
September	0.66	0.533	0.636
October	0.5	0.562	0.571
November	0.5	0.65	0.80
December	0.444	0.35	0.470
January	0.562	0.562	1.0
February	0.428	0.5	0.727
March	0.538	0.769	0.75

Discussion

Globally waterbirds population trends have been declining dramatically due to natural and anthropogenic reasons (Breiner et al., 2021; Sievers et al., 2017).

The current findings indicated that the number of migratory bird species was greater than the number of resident species in all study sites during the study period in the East Al-Hammar region. These results are consistent with Wani et al. (2020) and Ali (2021) who confirmed the rise of waterbirds between 2010 and 2020, and this was attributed to the positive increase in water bodies.

Interestingly the study showed that the non-tidal area (S1) received the most number of waterbird species, while the tidal area in the Sallal site supported a minority of species number. This may be due to the optimal availability of food in non-tidal systems and the lower disturbance rate (Wani et al., 2021).

Similarly, the total and monthly diversity of birds showed the highest values of diversity indices (species richness, Taxa, and Margalef) at the Slein site, while the lowest values were at the Al-Sallal site. These results may be attributed to the availability of ecological requirements of water birds in the non-tidal site. These results are consistent with Hamzah and Selmi (2018)

who emphasised that wetland size and water depth as well as food availability are the key factors for water bird diversity.

A similar trend was detected in alpha and beta indicators that revealed the highest values in S1, and this also may be attributed to different topographical features such as the variation of its vegetative cover as well as the expansion of the mudflats, which are affected partially by the tides. The limited disturbance resources to birds such as fishermen and bird hunters due to the location of the area near the Rumaila oil terminal and not allowing entry to public people, provided an opportunity for waterbirds to use the area safely (Habeeb et al., 2018). Tavernia et al. (2021) mentioned that the number and species of waterbirds gradually decrease when spring comes due to the departure of water birds to their breeding areas, and this may be the reason for the fluctuation in the number of species and numbers of individuals among sites monthly.

In the Al-Burqah site largest number of individuals of waterbirds were observed, with the lowest diversity of species. Although, the existence of dense vegetation cover that provide a significant support for resting behaviour, low diversity and density of invertebrates were detected (Al-Emarah and Abou-Turab, unpublished data). In the case of the Al-Sallal site, the results indicated that it was the least in terms of the numbers of individuals and species, and this may be due to the lack of vegetation cover and the location of the site close to the places of fishing and passage of fishermen's boats (Ali, 2021). Wani et al. (2021) signified that the difference in the diversity and numbers of waterbirds in wetland habitats may be attributed to feeding resources and human disturbances, Thus the waterbirds found in Al-Sallal may use it for feeding because it is characterised by the abundance of benthic invertebrates found in the sediments of these sites Al-Emarah and Abou Turab, unpublished data). However, the evenness was higher and dominance was lower in this area which may relate to the lower number of species and individuals that use it.

Conclusions and Recommendations

To sum up, the main indicator that emerged, the non-tidal wetlands in the eastern Al-Hammar marshes were the most attractive site for waterbirds. We also concluded from our current study that there is a difference in the biodiversity of waterbirds between tidal and non-tidal areas in East Hammar Marsh. These variations are still requiring more investigations including other organisms' species.

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