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ECOLOGICAL SURVEY OF AQUATIC MACROPHYTES IN AL-HUWAIZAH MARSH SOUTHERN OF IRAQ AFTER INCLUSION IN THE WORLD HERITAGE LIST

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Abstract

Ecological survey for aquatic macrophytes of four stations carried out in Al-Huwaizah marsh southern of Iraq, from period December 2017 to November 2018 to study diversity and distribution of aquatic macrophytes. A total of 30 species recorded, Registered species belong to 16 families, headed by Cyperaceae family forming 20%; Lemnaceae and Gramineae (Poaceae) families forming 13.33%, Asclepiadaceae; Najadaceae and Potamogetonaceae families 6.66%, whereas ten families forming 3.33% for each family, respectively. The highest number of aquatic plants registered in UM Al-Niaj station of (29) species in comparison with UM Al-Wared 25, Al-Souda north 26 and Al-Adaim station 19 species. *Azolla filiculoides* was first time record in Al-Huwaizah marsh. The emergent and wet plants had the highest percentage forming 36% and 27%, whereas submerged and floating plants had the lowest percent 20% and 17%. The restoration percent for plant species in the marsh reached (83.33 %). The overall values of Shanon index (H), Richness index (D), Evenness index (J) and Simpson index (1-D) reached 3.088, 3.515, 0.965 and 0.948 respectively. The highest value of percentage Similarity Jaccard index (Ss) was recorded between UM Al-Niaj and Al-Souda north stations 89.55%, while the lowest similarity was between UM Al-Ward and Al-Adaim stations by 50%.

Keywords: Aquatic plant, biodiversity indices, Al-Huwaizah marsh, Iraq.

Introduction

Aquatic macrophytes constitute a significant component of freshwater wetland communities in term of biomass, ecosystem functioning, species richness and contribute to biodiversity (Wetzel, 2001). Macrophytes in shallow lakes are involved in various feedback mechanisms that tend to maintain a clear water state (Scheffer, 1998). Increased eutrophication, acidification and salination of water adversely affect the growth and development of aquatic macrophytes via phenological and metabolic alterations (Dhir, 2015).

Aquatic macrophytes are very necessary for marshes and freshwater bodies in general due to their actions in providing habitat, food, and oxygen for organisms. Furthermore, their role in maintaining water quality Due to these reasons aquatic macrophytes are considered to be keystone elements in freshwater ecosystems (Tews *et al.,* 2004; Al-Mayah *et al*., 2012), Also considered one of the most beneficial communities on Earth, their role as primary producers in trophic food chains and in nutrient cycling in aquatic systems (Ondiviela *et al*., 2014). Aquatic macrophytes used for environmental monitoring and water quality assessment (Schneider and Melzer, 2003; Penning *et al.,* 2008a). Presence or absence of particular macrophyte species in lakes can show good or bad water status (Sugier *et al.,* 2010).

A study of the diversity and spread of aquatic macrophytes is an important component of understanding aquatic ecosystem due to the vital ecological role of aquatic vegetation and the ability of the plants to characterize the water quality (Bornette *et al.*, 1998). In Iraq, few studies on the aquatic vegetation have published. The first study in this field was Al-Hilli (1977) then (Al-Rekabi, 1992; Al-Abbawy, 2009; Al-Mayah *et al.,* 2012) studied the ecology of aquatic macrophytes in Iraqi Marshes but the last study on Al-Huwaizah Marsh conducted by Al-Abbawy and Al-Mayah (2010).

Aquatic biodiversity has large economic and aesthetic value and is efficient for maintaining and supporting overall environmental health. Aquatic organisms rely upon the great diversity of aquatic habitats and resources for food, materials, and breeding grounds (Williams *et al.,* 2004). Overexploitation of species, the introduction of exotic species, pollution from urban, industrial, and agricultural fields, as well as habitat loss and alteration through damming and water diversion all contribute to the declining levels of aquatic biodiversity in both freshwater and marine environments.

This work is first survey for the aquatic plants in Al-Huwaizah marsh after inclusion on the World Heritage List. The objectives of this work were to Collection and identification of aquatic plant species in four stations within Al-Huwaizah marsh from period December 2017-November 2018; determination of restoration percentage (%) of plant species and comparing it with recent and historical studies; as well as survey the extent and distribution of macrophytes.

Materials and Methods

Study Area

Al-Huwaizah marsh lies to the east of the Tigris River, straddling the Iran-Iraq border and lies approximately 70 km of Ammara city. It extends between (Latitude/ Longitude : 31°00'-31º45'N,47° 25'-47º 50'E). The area distributed by 79% for the Iraqi part and by 21% for the Iranian part (Domad, 2008). Its length is about 80 km, from the Iraqi-Iranian borders to the east of the Tigris river from its western part, with wide of 30-40 km (Abbas, 2006). Thus the average of the size of the marsh is about 2400 km² which extends to 3500 km² during the flood season and shrinks to 650 km² during the season of dryness, which is only applicable to deep water areas. The reservoir of this marsh attains about

7000 billions m³ obtained from the water excess of the nearest Tigris and 2-4 meters above sea level (Al-Rubaiy, 1990). The marsh largely fed by two main distributaries departing from the Tigris River near Al-Ammarah city, known as Al-Musharah and Al-Kahla rivers. Added to this is water from rainfall, and water from the rivers arriving from Iran, such as the Al-Karkha, Tayib and Duwayaraj, which empty into the Sanaf marsh and which in turn supplies Al-Huwaizah marsh.

Sampling and Data Analysis

Aquatic plants were sampled monthly from four selected stations included Umm Al-Ward (N 31°33′ 45.50″ : E 47° 32′ 9.15), Um Al-Niaj (N 31°35′ 45.15″ : E 47° 38′ 22.50), Al-Souda north (N 31°40′ 22.26″ : E 47° 39′ 50.38) and Al-Adaim (N 31° 41′22.36″ : E 47° 45′ 35.40) in Al-Huwaizah marsh (Figure 1) from December 2017 to November 2018. Floristic monthly lists made for the macrophytes species that recording the presence or absence during the study time. Belt Transect method was chose to assessment and analyses of the aquatic plant communities in the present study (Rader *et al*., 2001). Percentages of vegetation cover calculated according to the Braun-Blanquet scale described in Kent and Coker (1992) using randomly sampling plots within each plot a square of 1m × 1m at every meter mark situated at random , ten transects were established and listed the species present in each quadrate.

Plant samples collected manually then washed by water marsh and saved in plastic bags until reaching the laboratory then classification in the herbarium of the college science in University of Basrah. The aquatic plants species (Submergent, Emergent, Free-Floating, and Wet macrophytes) determined according to (Cronk and Fennessy, 2001). The references, which followed to classify the aquatic plant species, included (Townsend and Guest, 1985;Al-Mayah and Al-Hemeim,1991; Al-Mayah *et al*.,2014). Presence or absence of plant species recorded in each station in the marsh monthly. A restoration percentage calculated as the number of present plant species compared with the Reference study of Al-Mayah (1994) and a recent study by Al-Abbawy and Al-Mayah (2010).The recovery rate for aquatic plants calculated according to Richardson (2008) as following equation :

%Restoration=(species recorded in current study/species recorded in previous studies)× 100.

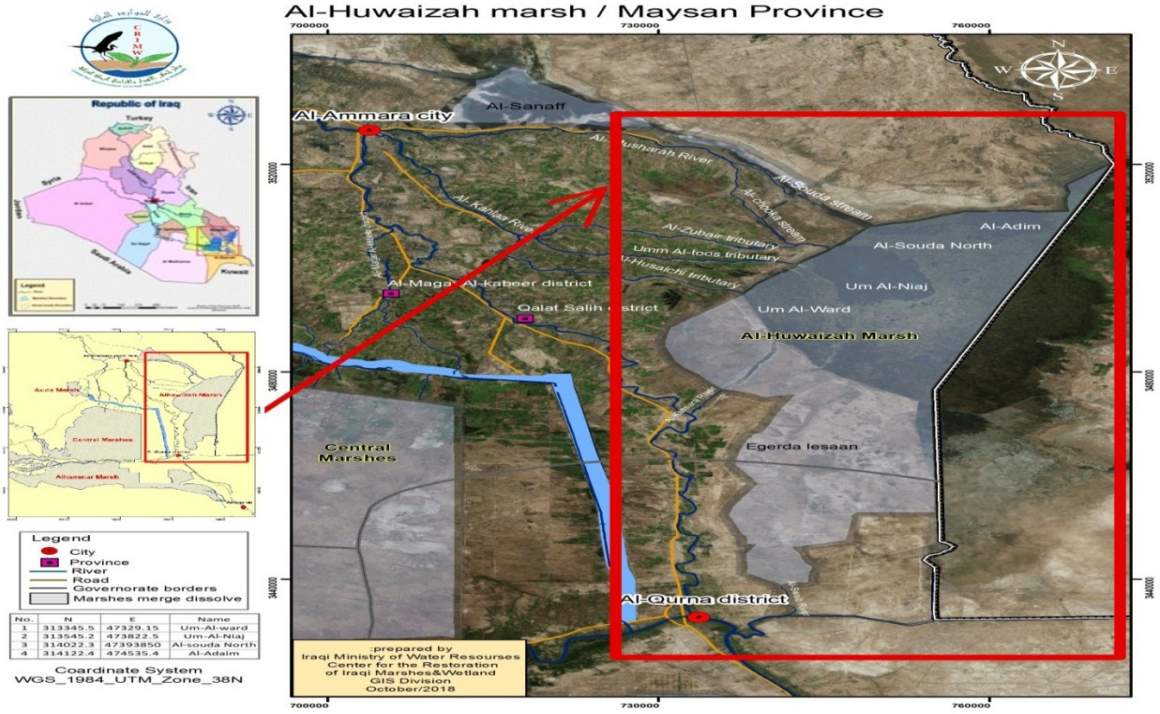


Fig. 1: Al-Huwaizah marsh location in Maysan province southern Iraq. Source (CRIM, 2018).

Ecological Indices

Shannon-Weaver index of diversity obtained by the following equation H= -Σpi lnpi (Shannon, and Weaver, 1949). The biological diversity of the community was measured using the Simpsons diversity Index by the following equation (1-D)= Σni (ni-1)/N (N-1) (Simpson,1949). The richness species was calculated using the equation D= (S-1)/ln N (Margalefe,1968).The evenness is J= H/ lnS (Pielou,1977). Jaccared Similarity Index (Ss%) was used to determine the degree of similarity among stations and study months by the following equation ISJ = [a/(a+b+c)] x 100 (Boesch,1977).

Results

Species Composition

Thirty species of aquatic plants belonging to 25 genera recorded in four studied stations within Al-Huwaizah marsh during the present study from period December 2017 to November 2018. Registered species belong to 16 families, headed by Cyperaceae of 6 species forming 20%; Lemnaceae and Gramineae (Poaceae) families of 4 species forming 13.33% for each family, *Asclepiadaceae; Najadaceae* and *Potamogetonaceae* families of 2 species with 6.66% for each family, whereas the remain families have only 1 species by 3.33% for each family, respectively. All species related to Flowering Plants (*Angiospermae*) (Table 1).

Table 1 : List of families and macrophytes species according to habitat, general appearance ,habit and plant group in Al-Huwaizah marsh.

Plant group	Habit	General appearance	Habitat	Macrophyte species	Family
Dicots	Perennial	Herbs	Emergent	*Alternanthera sessilis L.*	Amaranthaceae
Dicots	Perennial	Herbs	Emergent	*Bacopa monniei (L .)*Penn .	Scrophulariaceae
Dicots	Perennial	Herbs	Sub-mergent	*L . Ceratophyllum* demersum	Ceratophyllaceae
Dicots	Perennial	Herbs	Emergent	*Cynanchum acutum L.*	Asclepiadaceae
Dicots	Perennial	Herbs	Wet	*Eclipta alba L.*	Asteraceae
Dicots	Annual	Herbs	Emergent	*Lycopus europaeus L.*	Lemnaceae
Dicots	Perennial	Herbs	Free-Floating	*Jussiaea repens L*	Onagraceae
Dicots	Perennial	Herbs	Wet	*Oxystelma esculentum* R.Br.	Asclepiadaceae
Dicots	Perennial	Herbs	Wet	*Phyla nodiflora (L.)* Greene	Verbenaceae
Dicots	Annual	Herbs	Sub-mergent	*Ranunculus sphaerospermus (L.)*	Ranunculaceaee
Dicots	Perennial	Herbs	Wet	*Samolus valerandi (L.)*	Primulaceae
Fern	Perennial	Fern	Free-Floating	*Azolla filiculoides Lam.*	Salviniaceae
Monocots	Perennial	Herbs	Emergent	*Cladium mariscus (L.)* Pohl.	Cyperaceae
Monocots	Annual	Herbs	Emergent	*Cyperus aucher* Jaup.et Sp.	Cyperaceae
Monocots	Perennial	Herbs	Emergent	*Cyperus laevigatus* Dur.	Cyperaceae
Monocots	Perennial	Herbs	Emergent	*Cyperus malaccensis* L am	Cyperaceae
Monocots	Perennial	Herbs	Free-Floating	*Lemna gibba L.*	Lemnaceae
Monocots	Perennial	Herbs	Free-Floating	*Lemna minor L.*	Lemnaceae
Monocots	Perennial	Herbs	Sub-mergent	*Najas marina (L .)*	Najadaceae
Monocots	Perennial	Herbs	Sub-mergent	*Najas minor All.*	Najadaceae
Monocots	Perennial	Grass	Wet	*Panicum repens L.*	Poaceae
Monocots	Perennial	Grass	Wet	*paspalum paspaloides* (Michx)Scrib	Poaceae
Monocots	Perennial	Grass	Emergent	*Phragmites australis* (Cav)Trin.ex steud	Poaceae
Monocots	Perennial	Grass	Wet	*L.) Desf.) Polypogon monspeliensis*	Poaceae
Monocots	Perennial	Herbs	Sub-mergent	*Potamogeton crispus L .*	Potamogetonaceae
Monocots	Perennial	Herbs	Sub-mergent	*Potamogeton pectinatus L .*	Potamogetonaceae
Monocots	Perennial	Herbs	Emergent	*Schoenoplectus litoralis* (Sch. Palla)	Cyperaceae
Monocots	Perennial	Herbs	Free-Floating	*Spirodela polyrrhiza (L.)*Schleid	Lemnaceae
Monocots	Perennial	Herbs	Wet	*Torulinium odoratum (L.)*S.S.Hooper	Cyperaceae
Monocots	Perennial	Herbs	Emergent	*Typha domingensis* Pers.	Typhaceae

These plants included 18 species of monocot plants, 11 species of dicot plants and only one species of ferns. The monocot macrophytes species varied in its distributed from 12 species recorded in station 4 to 17 species present in station 2, whereas dicot species difference from 6 species in station 4 to 11 species found in station 2. Besides, aquatic plants classified into (Perennial and annual) habit included 27 and three species respectively, table (1).

According to the general appearance 25, aquatic plant species of herbaceous, and four species of grass and only one species of fern collected and identified in Al-Huwaizah marsh during study present. The largest number (25) of herbaceous species was presented in the station 2, followed by (22) species in station 3, and (20) species reported in station 1, whereas the station 4 contained (15) species. In case of grass plants, the largest number (4) species of grasses was presented in station (1), lowest number (3) species was found in stations (2, 3 and 4) whereas only 1 species of ferns was recorded in all studied station within Al-Huwaizah marsh during study time (Figure 2).

The composition of aquatic plant groups in Al-Huwaizah marsh varied in relative abundance (Ra%), where the emergent and wet plants had the highest percentage forming (36% and 27%) from 11 and 8 species respectively. Submerged and floating plants had the lowest percentage with (20% and 17%) from 6 and 5 species recorded in Al-Huwaizah marsh during study period, however, the emergent plants forming highest percent (36 %) while floating plants lowest percent (17%) thus, the were predominated in the marsh (Table 2).

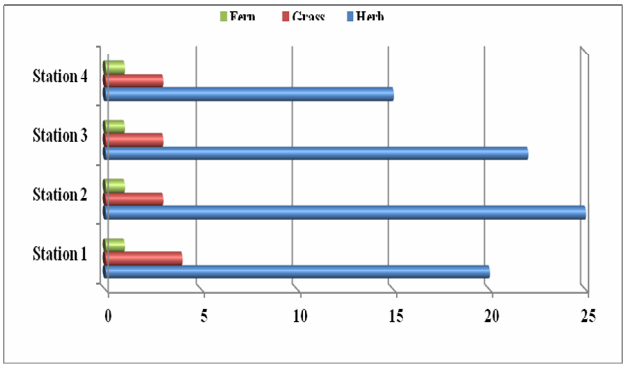


Fig. 2 : Number plant species in four stations of Al-Huwaizah marsh based on general appearance

Table 2: Aquatic plants diversity and its relative abundance in Al-Huwaizah marsh

Relative abundance %	Total	Flowering Plant		Pteridophytes (Fern)	Plant groups / Habitat
		Monocots	Dicots		
20	6	**4**	2	0	Sub-emergent
17	5	**3**	1	1	Floating
36	**11**	7	4	0	Emergent
27	**8**	**4**	**4**	**0**	Wet
100 ‰	30	**18**	**11**	1	Total

However, the variations in the number of aquatic plant species among four studied stations within Al-Huwaizah marsh showed in (Figure 3). The maximum number of plants (25) species were seen at station 2 in August, whereas the minimum number of plants (10) species appeared at station 4 in January and February months.

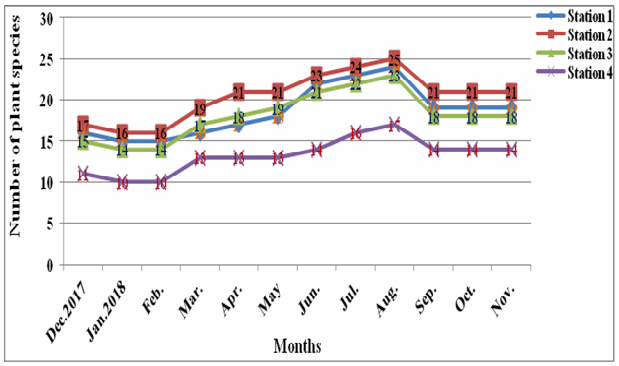
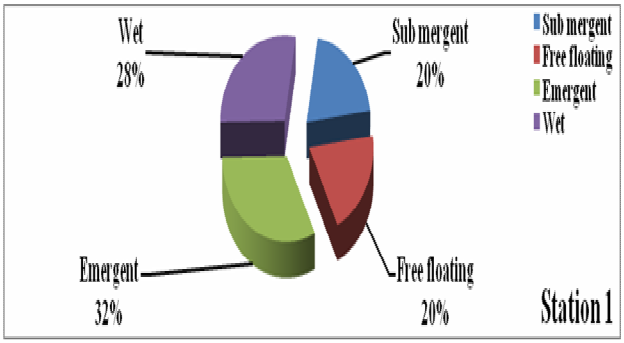
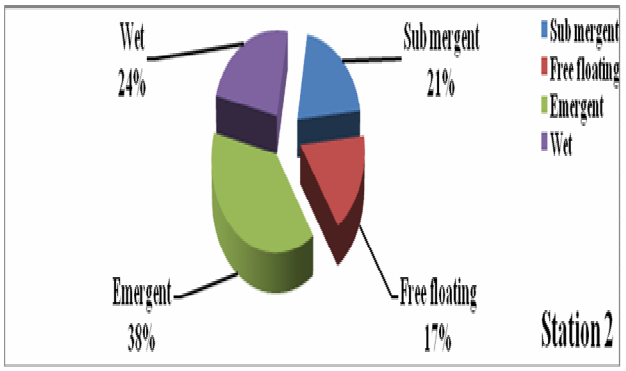
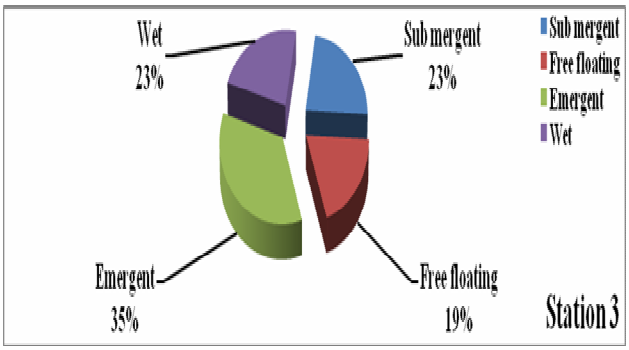


Fig. 3: Variations in the number of aquatic plant species in four stations of Al-Huwaizah marsh

In station 1, the highest number 8 species recorded of emergent plants forming 32%, while the lowest number 5 species reported of submerged and free-floating plants in relative abundance 20% for each group plant. In station 2 the highest number 11species belong to emergent plants and giving a ratio 38%, while the lowest number 5 species of free-floating plants in relative abundance 17%.In station 3 the highest number of 9 species of emergent plants forming 35%, while the lowest number 5 species of free-floating plants by 19% of the abundance. Whereas in station 4 the highest number of 5 species gave 26% belong to sub emergent, emergent and wet plant groups, while lowest number 4 species of free-floating plants were having 21% of relative abundance in this station. (Figure 4).







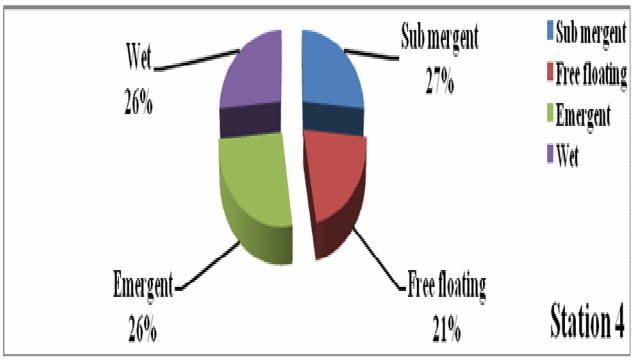


Fig. 4: Composition of different plant groups in four stations of Al-Huawizeh marsh

Furthermore, monthly variations were clear in the total number of plant species, the highest number species were recorded in summer months (June, July and August),while the lowest number species was occurrence in winter months (December, January and February) respectively, (Table 3).

Table 3: Monthly variations in the presence of aquatic plant species according to group plants recorded in Al-Huwaizah marsh from December 2017-November 2018 **(+ Presence and - absence)**

Habitat	Plant species	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
		2017	2018										
Sub- mergent	*Ceratophyllum demersum*	+	+	+	+	+	+	+	+	+	+	+	+
	Najas marina	+	+	+	+	+	+	+	+	+	+	+	+
	Najas minor	-	-	-	+	+	+	+	+	+	-	-	-
	Potamogeton pectinatus	+	+	+	+	+	+	+	+	+	+	+	-
	Potamogeton crispus	+	+	+	+	+	+	+	+	+	-	-	-
	Ranunculus sphaerospermus	-	-	-	+	+	-	-	-	-	-	-	-
Free--Floating	*Azolla filiculoides*	+	+	+	+	+	+	+	+	+	+	+	+
	Jussiaea repens	+	+	+	+	+	+	+	+	+	-	-	-
	Lemna minor	+	+	+	+	+	+	+	+	+	-	-	-
	Lemna gibba	+	+	+	+	+	+	+	+	+	-	-	-
	Spirodela polyrrhiza	+	+	+	+	+	+	+	+	+	-	-	-

Emergenr	*Alternanthera sessilis*	-	**-**	-	+	+	+	+	+	+	+	+	+
	Bacopa monnieri	+	+	+	+	+	+	+	+	+	+	+	+
	Cladium mariscus	+	+	+	+	+	+	+	+	+	+	+	+
	Cyperus laevigatus	+	+	+	+	+	+	+	+	+	+	+	+
	Cyperus malaccensis	-	-	-	-	-	-	-	-	+	+	+	+
	Cyperus aucher	-	-	-	-	-	-	-	-	-	+	+	+
	Cynanchum acutum	-	-	-	-	-	+	+	+	+	+	+	+
	Phragmites australis	+	+	+	+	+	+	+	+	+	+	+	+
	Lycopus europaeus	+	-	-	-	-	-	-	-	-	-	-	-
	Typha domingensis	+	+	+	+	+	+	+	+	+	+	+	+
	Schoenoplectus litoralis	+	+	+	+	+	+	+	+	+	+	+	+
Wet	*Eclipta alba*	+	+	+	+	+	+	+	+	+	+	+	+
	Panicum repens	-	-	-	-	-	+	+	+	+	+	+	+
	Paspalum paspaloides	-	-	-	-	+	+	+	+	+	+	+	+
	Phyla nodiflora	-	-	-	-	-	-	+	+	+	+	+	+
	Polypogon monspeliensis	-	-	-	-	-	-	+	+	+	+	+	+
	Oxystelma esculentum	-	-	-	-	-	-	-	+	+	+	+	+
	Samolus valerandi	-	-	-	-	-	-	+	+	+	+	+	+
	Torulinium odoratum	-	-	-	-	+	+	+	+	+	+	+	+
Total	Species 30	17	16	16	19	21	22	25	26	27	22	22	21

Subsequently, non carry out any studies for aquatic plants in Al-Huwaizah marsh after last study done by Al-Abbawy and Al-Mayah (2010) because the security taken by the border guards, and inability most researchers to carry out such studies in this marsh. This location was protected to prevent some illegal applications in the marsh, that may affect the nature and environment of habitats as (Flora and fauna) species presented in the study area, also, the marsh was among the nominated sites for insertion on the World Heritage List.

The Occurrence of Macrophytes Species

There is clear difference in the presence aquatic plant species 25 and 29 species were recorded in site 1 and 2 respectively, subscribe site 1 with site 2 by finding 23 species of plant. While differ site 1 on 2 in found *Polypogon monspeliensis* species, while differ site 2 from site 1 in presence 6 species of plants as *Cyperus aucher; Eclipta alba; Lycopus europaeus, Najas minor, Samolus valerandi* and *Schoenoplectus litoralis.* In site 3 and 4 recorded 26 and 19 species respectively, subscribe site 3 with site 4 by presence 18 species and differ site 3 from site 4 in appear 8 species as *Alternanthera sessilis,Cladium mariscus, Cynanchum acutum, Ludwigia repens, Lycopus europaeus, Phyla nodiflora, Potamogeton crispus,* and *Torulinium odoratum,* while differ site 4 from site 3 by seen only 1 species as *Oxystelma esculentum* (Table 4).

Table 4: Aquatic macrophytes occurrence in four stations of Al-Huwaizah marsh

Plant species	Station 1	Station 2	Station 3	Station 4
Alternanthera sessilis	+	+	+	-
Azolla filiculoides	+	+	+	+
Bacopa monnieri	+	+	+	+
Ceratophyllum demersum	+	+	+	+
Cladium mariscus	+	+	+	-
Cynanchum acutum	+	+	+	-
Cyperus aucher	-	+	+	+
Cyperus laevigatus	+	+	+	+
Cyperus malaccensis	+	+	-	-
Eclipta alba	-	+	+	+
Lemna gibba	+	+	+	+
Lemna minor	+	+	+	+
Ludwigia repens	+	+	+	-
Lycopus europaeus	-	+	+	-
Najas marina	+	+	+	+
Najas minor	-	+	+	+
Oxystelma esculentum	+	+	-	+
Panicum repens	+	+	+	+
paspalum paspaloides	+	+	+	+
Phragmites australis	+	+	+	+
Phyla nodiflora	+	+	+	-
Polypogon monspeliensis	+	-	-	-
Potamogeton pectinatus	+	+	+	+
Potamogeton crispus	+	+	+	-
Ranunculus sphaerospermus	+	+	+	+
Samolus valerandi	-	+	+	+
Schoenoplectus litoralis	-	+	-	-
Spirodela polyrrhiza	+	+	+	+
Torulinium odoratum	+	+	+	-
Typha domingensis	+	+	+	+
Total species 30	25	29	26	19

The *Schoenoplectus litoralis* species was present only in station 2 and not recorded during this study in (1, 3 and 4) stations. In contrast, the *Polypogon monspeliensis* species was recorded in station 1 only and not observed in other stations. As well as disappearance 11 species of plants in station 4 comparing with stations (1,2 and 3) at whole study period included (*Potamogeton crispus; Jussiaea repens; Alternanthera sessilis;Cynanchum acutum; Cyperus malaccensis; Cladium mariscus; Schoenoplectus litoralis; Lycopus europaeus; Phyla nodiflora; Polypogon monspeliensis; Torulinium odoratum*, that due to decrease in water level in area, high level of salts and entering wastewater from Iranian side to station 4.

The free-floating species presented in four stations of Al-Huwaizah marsh included five species such as *L. minor, L. gibba, S. polyrrhiza , J. repens and A, filiculoides, whereas Azolla filiculoides* was recorded for the first time in all studies stations throughout the study period with densities in the marsh. In addition, it is not recorded before. *Azolla filiculoides* Lamarck (Azollaceae) (water fern), is an invasive floating macrophyte capable of rapid growth leading to the complete coverage of water surfaces. Decaying root and leaf

matter below a mat of *A. filiculoides*, coupled with the lack of light penetration, creates an anaerobic environment which can reduce the quality of water and make survival for other organisms in the water impossible, it caused disappearance the *Salvinia natans* plant from marsh and gave the thicker vegetation cover than *L. minor* and *L. giba* recorded in the study area. However, *A. filiculoides* species was growing heavily in station (2) compared with other stations.

Restoration percentage (%) for aquatic plant groups in Al-Huwaizah marsh calculated and shown in Table (5). Submerge plants group recorded the highest value for restoration percent where reached (100%), while the lowest restoration percent was by wet plants group with (66.67%), whereas the emergent and floating plant groups reached (91.67% and 83.33%) respectively.

Table 5: Comparison number of aquatic plant species according to plant groups recorded before desiccation and recent studies included the present study with % restoration percentage in Al-Huwaizah marsh

Group plant	Reference study (Before desiccation)	(After inundation)			
	Al-Mayah, 1994	Al-Abbawy and Alwan, 2010	Restoration %	Present study (2017-2018)	Restoration %
Submergent	6	10	167	6	100
Free floating	6	5	83	5	83.33
Emergent	12	9	75	11	91.67
Wet	12	11	92	8	66.67
Total species	36	35	97.22	30	83.33

The restoration percent for aquatic plant species recorded in the present study was a comparison with previous studies before drying and after re-flooding of Al-Huwaizah marsh, where reached (83.33 %) of the total number of aquatic plant species that recorded before drought period by (Al-Mayah,1994) these shown in the Table (6).

Table 6: Comparison number of aquatic plant species and restoration percent (%) with previous studies before desiccation and after inundation of Al-Huwaizah marsh

Al-Huwaizah Marsh	Before drying	Recent studies (After inundation)					
	Reference study Al-Mayah, 1994	IMPR 2006	Alwan 2006	ARDI 2007	Mahmoud 2008	Al-Abbawy and Alwan, 2010	Present study 2017-2018
Number of species	36	8	8	10	18	35	30
% Restoration	-	22.22	22.22	27.78	38.89	97.22	83.33

Ecological Indices

The variations in a number of aquatic plant species and the ecological indices such as Shanon index (H) value , Richness index (D) value, Evenness index (J) value and and Simpson index (1-D) value of aquatic plants of four studied stations in Al-Huwaizah marsh showed in table (7). Aquatic plant species was recorded 29 species in station 2 compared with the 1,3 and 4 stations which recorded (25,26 and 19) of species respectively, but the highest values of the Diversity, Richness, Evenness and Simpson indices from 29 plant species reached 3.265, 4.007, 0.969 and 0.958 were recorded in station 2 , while the lowest values of the Diversity, Richness, Evenness and Simpson indices from 19 plant species giving 2.827, 2.818, 0.96 and 0.934 revealed in station 4, respectively. The overall value of (H) index that calculated for 30 aquatic plant species was recorded 3.088, the overall value of the (D)index was presented 3.515, the overall value of (J)index was found 0.965, as well as the overall value of (1-D) index reported 0.948.

Table 7: Ecological indices of plant diversity in the studied stations of Al-Huwaizah marsh

Station	No. of Species	Shannon Index (H)	Richness Index (D)	Evenness Index (J)	Simpson Index (1-D)
Station 1	25	3.112	3.571	0.966	0.951
Station 2	29	3.265	4.007	0.969	0.958
Station 3	26	3.151	3.665	0.967	0.952
Station 4	19	2.827	2.818	0.960	0.934

On the other hands, the Jaccard index (Ss) showed that the highest similarity was between UM Al-Niaj and Al-Soda north (2 and 3) stations that reached to (89.55%) while the lowest similarity was between UM Al-Ward and Al-Adaim (1 and 4) stations that reached 50% (Table 8).

Table 8: %Similarity (Jaccard index) among studied stations of Al-Huwaizah marsh

Station	%Similarity (Ss)
Um Al-Ward & Um Al-Niaj	76.67
Um Al-Ward & Al-Soda north	72.41
Um Al-Ward & Al-Adaim	50
Um Al-Niaj & Al-Souda north	89.55
Um Al-Niaj & Al-Adaim	65.51
Al-Souda north & Al-Adaim	66.67

Cluster Analysis of the Similarity Degree in the Monthly Plant Samples

The results of similarity in the species composition for plants showed by using Jaccared Similarity coefficient. There are four main groups finding in the Al-Huwaizah marsh at a similarity level of 52%. The first major group included two secondary groups. The first secondary group contained September and October months at a similarity level of 100% and second secondary group consisted of November month at a similarity level of 95%.The second main group consisted of three secondary groups, the first secondary group contained May month at a similarity level of 84%, the second secondary group included June month at a similarity level of 94%, while the third secondary consisted of July and August at a similarity level of 96%. The three main group included March and April at a similarity level of 91%.Whereas the forth main group consisted of two secondary groups, the first secondary group include January and February months at a similarity level of 100% and second secondary group include December only (Figure 5).

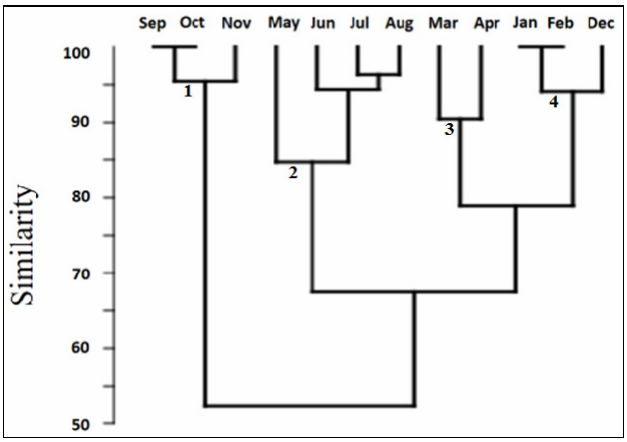


Fig. 5 : Cluster analysis of similarity degree among monthly fishing samples in the Al-Huwaizah marsh using Jaccard similarity index (%).

Discussion

A survey is a necessary tool for the conservation strategies, it is important to have investigating the past and present status of the vegetation. Knowledge of the past status of the marsh can provide insight into the chances of restoration or rehabilitation work being successful. The aquatic plants restoration, its growth and development depend largely on life history traits and strategies (Rolon and Maltchik, 2004).

It given a primary picture of aquatic plants in Al-Huwaizah marsh, where four group plants was determined subemergent, emergent, floating and wet plants .Numbers of emergent plant species were higher in the marsh comparing with other group plants. Few species of floating plants observed during the present survey in the marsh with, where disappearing of some floating plants may be explained by that desiccation associated with prolonged drawdown was fatal to survival of the seedling (Shibayama and Kadono, 2007). Results of the present study showed that the aquatic plants in the marsh vary mainly herbaceous, occasionally shrubby in nature and mostly perennial.

Some submergent, emergent and floating plants affected by water chemistry, which in turn affects on biodiversity values. The difference in diversity number of species that may due to number of reasons, such as that areas of the Al-Huwaizah marsh were variance in the high water level, thus providing the opportunity for survival of most species, where the drying processes of the marshes affect negatively in the disappearance of most species ,as a result the (UM Al-Niaj) pond has relatively larger water depths than the other stations.

Thirty species of aquatic plants recorded in Al-Huawizah marsh, the continuous changes in the aquatic environment, decreased quantities of water entering to the marshes, which led to the disappearance some aquatic plant species may found in previous studies, as well as the rise in nutrients. Withstand conditions of competition, tension and disturbance helped to appearance and persist the plants of many submerged species in the marshes such as *C. demersum , P. pectinatus* and *N. marina*, sediments of marshes act as a store for aquatic plant seeds where it load remaining rhizomes in the sediments of drought conditions for many years that lead to the restoration of their activity with the return of water, the wind contributes to dispersing the seeds and moving them to wider areas (Murphy *et al.,*1990). As well as, the bird plays an important role in the transfer of reproduction means to other areas of marshes (Vaccari *et al*., 2006). The present study showed that the most dominant species in Al-Huwaizah marsh was the common reed *Phragmites australis* due to its wide tolerance range to changes in water levels, salinity, and soil dryness. While *T. domingensis* was found in small identified areas in the studied stations, where preferred its presence in low-lying areas of the water level.

In the present study noted disappearance some of aquatic plants species such as *Hydrilla verticillata, Myriophyllum verticillatum, Potamogeton lucens, Potamogeton perfoliatus, Salvinia natans* and the herb of *Utriculaia australis* from Al-Huwaizah marsh, that might due to the presence of both grass carp and tilapia fish in this environment. Chifamba (1990) explained the *Coptodon zillii* of the genus Tilapia (tilapia fish) Prefer feeding on *Ceratophyllum, Najas,* and *Vallisneria* plants, or may be due to water or soil chemistry was inappropriate, competition on light by green algae, disturbance by herbivorous fish, and instability of sediment at the bottom؛this is illustrated by (Irfanullah and Moss, 2004) in a pond, that require to reduction in interior nitrate and control of nematodes and protection from birds. As well as, these species may be intolerant of degraded, saline, eutrophic conditions (Hamdan *et al.*, 2013). Another cause related to the degradation and disappearance of the macrophytes in the Al-Huwaizah marsh is the continued and direct impact through the burning processes of common reed by local villagers which have negative impact on the plant's life cycle and the biodiversity as a whole in the mars. There is also the need bear in mind that the absence or loss of many necessary native submerged species will certainly have a direct impact on the productivity of the marshland of Iraq such as fish and birds including migratory species (Al-Mayah *et al.,* 2012).

The floating water fern *Azolla filiculoides* competes with the common indigenous duckweed Lemna minor/gibba, interference between these species is expected (Conti *et al.*, 2005). *Azolla filiculoides* species was growing heavily in

station 2 compared with other 1,3 and 4 stations, that may occur due to the present abundant quantities of water, availability conditions for plant growth, high concentrations of DO in water, also availability nutrients in study areas (Al-Kenzawi, 2014).

Biodiversity affects ecosystem functioning (Gamfeldt *et al.*, 2015), with diverse communities expected to become crucial to ecosystem service provision with emergent environmental change (Reich *et al.*, 2012). High plant species richness may have a positive impact on ecosystem functions via, functional complementarity, the selection effect and positive species interactions (Bruno *et al.*, 2003), where one species makes the local environment more favorable for another, either directly (e.g. shading, nutrient uptake) or indirectly (Ford *et al.,* 2016).

In general, the results revealed the Diversity and Richness indices were highly in station 2 (UM Al-Niaj pond) compared with other stations. The numbers of aquatic plant species were fluctuated according to stations and months of the present study, that may occur due to different the environmental variables during study time (Santamaria, 2002) and sediment quality (Wang and Yu, 2007). Aquatic plant life mainly depends on the depth, running speed of the water, and water quality (Serag, and Khedr, 2001). Decreasing or eliminating inflow in water of marsh can bring about drastic changes in salinity and nutrient availability, which in turn leads to profound changes in plant species composition (Cronk and Fennessy, 2001).

Restoration of vegetation cover is a big challenge that facing water re-flooding processes in Iraqi marshes as a result of its importance to the ecosystem. The restoration percentages among the aquatic plant groups in Al-Huwaizah marsh during study time were difference, where the submerged plant group achieved higher restoration rates than the remained other groups (Table 5), were100% from (6 species), whereas in study Al-Abbawy and Al-Mayah (2010) recorded 167% of restoration this group in same the study area, however, this decrease in number of submerged species due to low quantities of water entering to the marsh, decreasing the nutrients value in water. On the other hand, the restoration percent of the floating plant group was 83.33% from (5 species), emergent plant group gave 91.67% from (11species), and wet plant group reached 66.67% from (8 species). Overall, in Al-Huwaizah marsh recorded 30 aquatic plant species with restoration percent reached 83.33%, however this restoration percentage was differed for what was recorded in previous studies conducted by researchers as IMPR (2006); Alwan (2006); ARDI (2007); Mahmoud (2008); Al-Abbawy and Alwan (2010) where found 22.22%; 22.22%; 27.78%; 38.89% and 97.22% respectively of the total number of aquatic plant species that recorded by (Al-Mayah,1994) which shown in (Table 6), because Al-Huwaizah marsh was suffering from the shortage of quantities entering water from Tigris river and Al-Karkha river, thus led to the disappearance of some of the aquatic plant species that recorded in previous studies, as well as the lack of water revenues from neighboring countries and introduction of some fish invasive species to Al-Huwaizah marsh which feeding on these species.

Cluster analysis explained that each month was in the same pattern in the marsh, it means that stations closed to other in species taxa and occurrence and that may refer to the same condition of marsh environment. Overall, Similarity index indicated that both Um -Al-Niaj and Al-soda north were closed stations 89.55%.

Conclusion

A recent comparison of numbers of aquatic plant species recorded in all studied stations in Al-Huwaizah marsh versus other studies shows that the marsh are continuing to improve in species richness and macrophyte restoration.

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