The effect of some environmental variables on the abundance and distribution of aquatic macrophytes in Al-Hawizeh marsh, Iraq

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Abstract: - Aquatic macrophyte communities and environmental factors were studied at four Al-Hawizeh marsh sites from December 2017 until November 2018. Quantitative data from thirty species of aquatic plants were collected to investigate density, vegetation cover, biomass and their relationship to the environmental factors. For emerging plants, relative abundance reached the highest values (36%) than submerged and wet species, while free-floating plants produced the lowest value (17%). Physical and chemical properties have been studied including water temperature ranging from 11.3 °C in January to 31.4 °C in August, dissolved oxygen (DO) ranging from 1.88 mg/L in September to 10.5 mg/L in April, pH varied from 7.2 in June to 8.4 in December, electrical conductivity (EC μ.S/cm) differs from 2257 μ.S/cm in November to 6859 μ.S/cm in April. The results identified the highest percentages of vegetation cover reported during the summer, the lowest percentages revealed during the winter for all plant groups. The highest annual vegetation cover rates for submergent species achieved 52.54% by C. demersum, for free-floating plants 66.67% of S. polyrrhiza, for emergent plants 85.5% of P. australis, 41.62% of P. paspaloide for wet plants. Total mean biomass of plant groups showed the highest value of 844.02 (gm dry weight/m²) reported by emerging plants, the lowest value of 47.25 (gm dry weight/m²) by the wet plants. Thus, biomass values were correlated with the vegetation cover values for all plants.

1. Introduction

Wetlands form one of the most productive and important ecosystems in the world. They include a broad range of economic, social, environmental, and cultural benefits—recently identified as ecosystem services Costanza et al. [1]. These services include preserving water quality and supply, controlling greenhouse gases, carbon sequestration, protecting shorelines, preserving specific indigenous biota, and providing cultural, recreational, and educational resources [2]. Wetland is the common term used for marshes, swamps, bogs and similar areas and is the source of several important aquatic flora and endangered species [3]. While wetlands cover only six% of the earth surface [4], they provide ecosystems for approximately 20% of the total biodiversity of the earth [5]. They also play a central role in local and global water cycles and are at the core of the linkage between water, food and energy, as challenge for our community in the sense of sustainable management.

The aquatic macrophyte are a major source of fruit, fodder, herbal medicine and household materials for people living in their vicinity [6]. There are two types of wetlands that provide benefits—ecological and economic. In ecological terms, wetland plants, whether living or debris, are critical in maintaining our environment's necessary carbon and methane balance and thus maintaining greenhouse balance [7]. Wetland plants with floating or evolving leaves are also considered an important tool for reducing global temperature rise [8]. Aquatic macrophytes are a significant component of freshwater wetland ecosystems in terms of biomass, ecosystem functioning, species richness and contribute to biodiversity [9]. 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 [10]. While shifts in the distribution of freshwater macrophytes also impact the associated organisms.
as well as the single species of macrophytes [11]. Apart from changes in plant biodiversity due to direct human impacts, water quality loss often affects plant ecosystems heavily. In the aquatic environment, submerged plants are the oxygen sources. Aquatic plants can purify water in managed growth conditions, either naturally or through human intervention, but if uncontrolled growth occurs, they can reach pest levels and are often seen as aquatic weeds. It can reduce the need for Biological Oxygen Demand (BOD), and these plants are now being used in wastewater treatment systems to biofiltrate organic waste [8].

Vegetation is a significant component of wetland ecosystems, and biomass can quantify wetland vegetation’s contribution to carbon sinks and sources of carbon [12]. Studies of aquatic macrophytes in the Iraqi marshes have been limited. However, there is no large research on macrophytes except for one ecological study done by [13] in Iraqi marshes. This paper aims to investigate the vegetation cover and biomass of aquatic plant species, community forms, ecosystems and habitats of the Al-Hawizeh marsh’s main aquatic plants.

2. Materials and Methods

2.1. Study Area

Al-Hawizeh marsh lies east of the Tigris River, straddling the Iran-Iraq border and is located about 70 km from the city of Ammara. It extends across (Latitude / Longitude: 31° 00'-31° 45' N, 47° 25'-47° 50' E). The region distributed for the part of Iraq by 79% and for the part of Iran by 21% [14]. Its length is about 80 km, with a width of 30 km [15] from the Iraqi-Iranian border to the east of the Tigris River in its western part. The total marsh size is around 2400 km² which stretches to 3500 km² during the flood season and shrinks to 650 km² during the dry season which only applies to deep water areas. This marsh’s reservoir hits around 7000 billion m³ from the nearest Tigris’ water excess and 2-4 meters above sea level [16]. The marsh was mostly fed by two major distributors, known as Al-Musharah and Al-Kahla rivers, leaving the Tigris River near Al-Ammarah city. Adding to this is water from runoff, and water from rivers coming from Iran, such as Al-Karkha, Teeb, and Duwayaraj, emptying into Al-Sanna’T marsh and supplying Al-Hawizeh marsh in turn (Figure 1).

Figure 1. Study area (Al-Hawizeh marsh) map and sampling sites [17].
The Geographical Positioning System (GPS) has been used to pick four locations within the Al-Hawizeh marsh during the study period. Site 1 was situated near the Abu Khasaf village on the southern side of Al-Hawizeh marsh. Site 2 was a field of open water situated in center of the marsh. Site 3 was situated south of site 2 near to Al-Musharah village. And site 4 was located in north of the immediate border (Table 1).

Table 1: Geographical positioning system (GPS) and some characteristics of each site in the study area

| Site   | Location    | Latitude (North) | Longitude (East) | Vegetation and activities                      |
|--------|-------------|------------------|------------------|------------------------------------------------|
| Site 1 | Umm Al-Ward | 47° 32' 9.15"    | 31° 33' 43.50"  | Low vegetation, less human activities and presence fisherman |
| Site 2 | Um Al-Nia'aj | 47° 38' 22.50"   | 31° 35' 45.15"  | Med vegetation, (Open area) and high presence fisherman |
| Site 3 | Al-Souda north | 47° 39' 50.38"  | 31° 40' 22.26"  | Low vegetation, less human activities and presence fisherman |
| Site 4 | Al-Adaim    | 47° 45' 35.40"   | 31° 41' 22.36"  | Low vegetation, less human activities and No presence fisherman |

2.2. Sampling and analyzing data

2.2.1. Water analysis

Physicochemical water parameters such as pH, Electrical Conductivity (EC μS/cm), Dissolved Oxygen (DO-mg/L) and water temperature (°C) were measured directly in the field at a depth of 20 cm using a digital portable WTW Multi-meter (Multi 350i meter) device.

2.2.2. Plant analysis

Aquatic plants were sampled monthly from four selected Al-Hawizeh marsh sites from December 2017 until November 2018 (Figure 1) Floristic lists for the species of aquatic macrophytes recording presence or absence during the study period were drawn up regularly. Belt Transect ‘s approach to evaluating and analyzing aquatic plant communities was selected in the present study [18]. At each site, estimates of vegetation cover and aboveground biomass were performed using a quadrate method (1mx1 m) divided by 10 m as described by [19]. According to the Braun-Blanquet scale mentioned in [20], percentages of vegetation cover were determined. Ten replicates for vegetation cover were selected at random per month and biomass analysis samples (five replicates for aboveground parts) were taken twice a year in mid-winter (study start) and mid-summer. The plants harvested were air-dried and weighed several times before the plants were collected [21]. Manually collected plant samples, then washed by water marsh and placed in plastic bags until they reached the laboratory, and then classified at the University of Basrah in herbarium of the college science. The aquatic plant species (Submergent, Emergent, Free-Floating, Wet macrophytes) have been determined according to Cronk and Fennessy [22]. The references that followed for classification plants by [23-26].

2.3. Statistical Analysis

In order to identify the percentages of vegetation cover and productivity biomass, mean and standard deviation (mean ±SD) values for all plant samples, statistical analysis was carried out by SPSS version 16.0. The ANOVA test (under the significance level P≤0.05) was used to estimate the variation of water parameters between study sites and months.

3. Results:

3.1. Water samples

3.1.1. Temperature in water (W.T)

Water temperature recorded monthly variations in January to achieve its highest in August 2018. Where it varied between 11.3°C achieved in January, and 31.4°C was in August (Figure 2). The finding showed non-significant differences (P≤0.05) were detected in water temperature values among study sites, while clear significant differences (P≤0.05) were observed in water temperature values among study months.
3.1.2. Concentrations of hydrogen ions (pH)

Variations in the monthly pH value were seen in (Figure 3). The minimum value of 7.2 was recorded in June and July at site 2 and the maximum value of 8.4 was recorded in December at the same site. Non-significant differences (P≤0.05) were noticed between the places and months of testing.

3.1.3. Electrical conductivity (EC μ.S/cm)

The EC is a calculation of water capacity to hold electrical current, it is used as a water quality indicator dependent on total dissolved salts. At site 2 the minimum EC value was 2257 μ. S / cm in November, while the maximum value was 6859 μ. S / cm at site 4 in April (Figure 4). The findings showed strong significant differences (P≤0.05) between months and the study sites in EC values.

3.1.4. Dissolved oxygen (DO mg/L)

Dissolved oxygen (DO) is an integer parameter that should be taken into account when determining the quality of water. Monthly variations are reported with the DO values. Site 1 achieved the maximum DO value of 10.5 mg / L in April, while site 4 detected the minimum value of 1.88 mg / L in September (Figure 5). The findings observed substantial differences (P≤0.05) were between the times and the study sites in the DO values.
3.2. Macrophyte plants

A total of thirty species of macrophyte plants were identified at four study sites within the Al-Hawizeh marsh during the current study. Results of the study showed that variation in habitat of Al-Hawizeh marsh plants included: Sub-emergent of 6 species, Free-floating of 5 species, emerging of 11 species and 8 of Wet species (Table 2).

Table 2. Distribution of macrophyte plants according to families and habitat groups in Al-Hawizeh marsh during the current study

| Habitat group | Family | Macrophyte species |
|---------------|--------|--------------------|
| Sub-emergent  | Ceratophyllaceae | Ceratophyllum demersum L. |
|               | Potamogetonaceae | Potamogeton crispus L. |
|               | Najadaceae | Najas marina (L.) |
|               | Najadaceae | Najas minor All. |
|               | Ranunculaceae | Ranunculus sphacelouspermus (L.) |
| Free-floating | Salvinia | Salvinia spiralis Lam. |
|               | Lemna | Lemna gibba L. |
|               | Lemnaceae | Lemna minor L. |
|               | Lemnaceae | Spirodela polyrhiza (L.)Schleid |
| Emergent      | Onagraceae | Jussiaea repens L. |
|               | Amaranthaceae | Alternanthera sessilis L. |
|               | Asclepiadaceae | Cynanchum acutum L. |
|               | Cyperaceae | Ruppia maritima (L.) Pohl. |
|               | Cyperaceae | Cyperus aucher Jaup.et Sp. |
|               | Cyperaceae | Cyperus laevigatus Dur. |
|               | Cyperaceae | Cyperus malaccensis L. am. |
|               | Poaceae | Phragmites australis (Cav)Trin.ex steud |
|               | Typhaceae | Typha domingensis Pers. |
|               | Lemnaceae | Lemna minor L. |
|               | Scrophulariaceae | Bacopa monnieri (L.)Penn. |
| Wet           | Poaceae | Phragmites australis (Cav)Trin.ex steud |
|               | Asteraceae | Eclipta alba L. |
|               | Asclepiadaceae | Oxystelma esculentum R.Br. |
|               | Cyperaceae | Terrninum odoratum (L.)S.S.Hooper |
|               | Primulaceae | Samolus valerandi (L.) |
|               | Poaceae | Polypogon monspeliensis (L.) Desf. |
|               | Poaceae | Panicum repens L. |
|               | Poaceae | Paspalum paspaloides (Michx)Scrib |
|               | Verbenaceae | Phyla nodiflora (L.) Greene |

The relative abundance (Ra) of four plant groups appears to show that emerging species had the highest values (36%) significantly (P<0.05), while free-floating plants had the lowest value (17%). Thus, emerging species predominated in the marsh (Figure 6).
3.2.1. Percentage of vegetation cover (%)

According to habitat, the vegetation cover can be classified into four plant groups included Sub-emergent, Free-Floating, Emergent, and Wet group. However, the monthly variations in percentages of vegetation cover (%), mean and standard deviation (mean%±SD) in all studied sites of Al-Hawizeh marsh were shown in (Tables 3, 4, 5 and 6). In submerged aquatic plants the vegetation cover percentage for *C. demersum* community ranged from 26 % at site 4 during winter months to 72% at site 3 during the summer in August. As for the *P. pectinatus* the largest ratio 75% found in August at site 2, while the smallest ratio 36% in January at site 4. Then *N. marina* community the highest value 61% revealed in August at site 2, the lowest value 18% presented in January at site 1. Whereas *R. sphaerospermus* appeared only in two months of the present study, however, the vegetation cover percentage recorded during the spring season especially in both March and April months which was a suitable season for the prosperity of this species. Thus, the highest value 57% recorded in April at site 2, the lowest value 34% in March at site 4.

Vegetation cover percentages of free-floating plants as *A. filiculoides* community were measured, where the highest value 79 % found in August at site 3, the lowest value 25 % reported in January at site 4. Also, *L. minor* community has identified in all sites of marsh, the highest ratio achieved 92% in August at site 2, the lowest ratio 23% found in January at site 4. Likewise, *S. Polyrrhiza* species showed strong differences in the vegetation cover where the highest value 95% occurred at site 2 in August, the lowest value 27% done at site 4 in January.

In the emergent plants group, the vegetation cover showed strong differences in studied marsh sites, like the *P.australis* community the highest value 98% reported at site 2 in August, while the lowest value reached 64% at site 4 in January. Also, *T. domingensis* ranged from 7% at site 4 in January and February to 22% at site 3 in August. Alongside *C. mariscus* communities were checked at four marsh sites, where the percentage of vegetation cover laid between 18 % at site 1 in December and 45% at site 2 in August.

In wet plants community such as *P. paspaloides* and *P. nodiflora* the vegetation cover percentages recorded the highest values 48% and 43% at both 2 and 3 sites in August, while the lowest values 16% and 24% at both 4 and 2 sites in November and June, respectively. As well as, the *E.alb* and *P. repens* species recorded significant variations ranged from 12 % and 7% in both 1 and 4 sites in January and November to 34% and 27% at site 2 in August respectively, (Tables 3, 4, 5 and 6). On the other hand, for submerged plants like *C. demersum*, *P. pectinatus*, *N. marina*, and *R. sphaerospermus* the highest annual rates of vegetation cover have recorded 52.54% of *C. demersum* at site 3 and 63.33%; 47.58%; 53% of *P. pectinatus*; *N. marina* and *R. sphaerospermus* at site 2. Nonetheless, in the present analysis, the mean percentage and standard deviation (mean% ±SD) of vegetation cover for submerged plants community are 47.1±6.58%, 53.51±8.63%, 39.24 ±8.34%, and 45.25± 8.02% respectively.

For free-floating plants such as *A.filiculoides*, *L.minor*, and *S.polyrrhiza* the highest annual rates of vegetation cover achieved 56.5%,62.33%, and 66.67% at site 2. Where the mean % and standard deviation (mean%±SD) getting 50.48±6.44%, 53.38±11.02% and 58.78±8.44% respectively, during the study period. As for emerging plant species such as *P. australis*, *C. mariscus* and *T.domingegnsis*, the highest annual vegetation cover, reached 85.5%, 32.17%, and 17.92% at both 2 and 3 sites respectively. Also, the mean% ±SD of vegetation cover for emerging plants was 81.37±4.29%, 29.77±2.38% and 13.26±3.55% respectively, for these species during the study period (Table 7). Additionally, in wet plants including *E. alba*, *P. paspaloides* and *P. nodiflora*, the highest annual rates of vegetation cover recorded 24.58%, 41.62%, and 37.4% at both 2 and 3 sites respectively. As well as, (mean%±SD) of vegetation cover for wet plants reported 20.39±3.176%, 32.87±8.86%, and 33.13±6.22% respectively, during the study period. Overall, Um Al-Nia’aj position (site 2) characterized by an increase in annual rates of vegetation cover percentage for all plant groups in the current study compared to the other sites of Al-Hawizeh marsh.
Table 3. Monthly variations in mean vegetation cover percentage and standard deviation (mean% ± SD) for aquatic plants at site 1 of Al-Hawizeh marsh.

| Plant species                  | December | January | February | March | April | May | June | July | August | September | October | November | Mean% ±SD |
|--------------------------------|----------|---------|----------|-------|-------|-----|------|------|--------|-----------|---------|----------|------------|
| **Habitat**                    | 2017     | 2018    |          |       |       |     |      |      |        |           |         |          |            |
| **Floating Sub-emergent**      |          |         |          |       |       |     |      |      |        |           |         |          |            |
| Ceratophyllum demersum         | 35       | 33      | 36       | 41    | 44    | 48  | 54   | 57   | 60     | 56        | 53      | 46       | 46.91±9.25 |
| Potamogeton crispus            | 10       | 9       | 10       | 12    | 12    | 13  | 19   | 20   | 20     | -         | -       | -        | 13.89±4.51 |
| Potamogeton pectinatus         | 38       | 36      | 40       | 43    | 45    | 47  | 46   | 51   | 56     | 51        | 46      | 42       | 45.08±5.77 |
| Najas marina                   | 22       | 18      | 20       | 23    | 23    | 27  | 28   | 34   | 40     | 35        | 31      | 28       | 27.83±6.49 |
| Ranunculus sphaerospermus      | -        | -       | 40       | 44    | -     | -   | -    | -    | -      | -         | -       | -        | 42±2.83    |
| Azolla filiculoides            | 28       | 32      | 36       | 37    | 39    | 41  | 57   | 68   | 73     | 67        | 58      | 49       | 48.75±15.41 |
| Lemna minor                    | 29       | 31      | 33       | 43    | 53    | 54  | 74   | 78   | 85     | -         | -       | -        | 53.33±21.36 |
| Lemna gibata                   | 24       | 28      | 30       | 38    | 49    | 52  | 68   | 72   | 77     | -         | -       | -        | 48.66±20.09 |
| Ludwigia repens               | 11       | 13      | 15       | 21    | 23    | 24  | 38   | 44   | 50     | -         | -       | -        | 26.55±14.12 |
| Spirodela polyrhiza           | 32       | 34      | 36       | 49    | 55    | 61  | 77   | 83   | 86     | -         | -       | -        | 57±21.2    |
| Alternanthera sessilis         | -        | -       | -        | 13    | 14    | 15  | 16   | 17   | 20     | 18        | 16      | 13       | 15.78±2.33 |
| Bacopa monnieri                | 27       | -       | -        | -     | 24    | 26  | 28   | 29   | 32     | 31        | 30      | 28       | 28.33±2.5  |
| Cladium mariscus               | 18       | 20      | 22       | 24    | 25    | 24  | 31   | 34   | 38     | 36        | 31      | 26       | 27.41±6.46 |
| Cypus laevisitatis             | 20       | 18      | 19       | 21    | 23    | 27  | 35   | 38   | 44     | 38        | 36      | 33       | 29.33±9.01 |
| Cypus malacensis               | -        | -       | -        | -     | -     | -   | -    | -    | -      | -         | -       | -        | 23.25±0.96  |
| Cymancium acutum               | -        | -       | -        | -     | -     | -   | 21   | 23   | 25     | 26        | 25      | 24       | 24.85±2.79 |
| Phragmites australis           | 75       | 76      | 77       | 78    | 79    | 80  | 86   | 89   | 92     | 89        | 85      | 81       | 82.25±5.74 |
| Typha domingensis             | 11       | 11      | 10       | 10    | 11    | 12  | 13   | 15   | 16     | 15        | 13      | 12       | 12.42±2.02 |
| Eclipta alba                   | 13       | 12      | 14       | 14    | 15    | 16  | 20   | 24   | 27     | 23        | 22      | 21       | 18.42±4.99 |
| Panicum repens                | -        | -       | -        | -     | -     | -   | 14   | 18   | 21     | 25        | 23      | 21       | 20±3.65    |
| paspalum paspaloides           | -        | -       | -        | -     | -     | -   | 34   | 37   | 46     | 38        | 33      | 31       | 36.5±5.32  |
| Phyla nodiflora               | -        | -       | -        | -     | -     | -   | 35   | 36   | 41     | 38        | 34      | 32       | 36±3.16    |
| Polypogon monspolensis         | -        | -       | -        | -     | -     | -   | 31   | 34   | 35     | 38        | 36      | 36       | 35±2.36    |
| Oxystedea esculenta            | -        | -       | -        | -     | -     | -   | 16   | 16   | 19     | 20        | 20      | 20       | 18±2.05    |
| Torulium odoratum              | -        | -       | -        | -     | -     | -   | 19   | 22   | 26     | 23        | 21      | 19       | 21.66±3.97 |

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Table 4. Monthly variation in mean vegetation cover percentage and standard deviation (mean%± SD) for aquatic plants at site 2 of Al-Hawizeh marsh.

| Plant species               | December | January | February | March | April | May | June | July | August | September | October | November | Mean% ± SD |
|-----------------------------|----------|---------|----------|-------|-------|-----|------|------|--------|-----------|---------|----------|-------------|
| C. demersum                 | 40       | 36      | 39       | 42    | 47    | 49  | 59   | 65   | 68     | 63        | 59      | 55       | 51.83±11.10 |
| Potamogeton crispus         | 14       | 15      | 15       | 17    | 18    | 19  | 21   | 24   | 26     | -         | -       | -        | 18.78±4.17  |
| Potamogeton pectinatus      | 54       | 52      | 53       | 59    | 63    | 64  | 67   | 70   | 75     | 72        | 67      | 64       | 63.33±7.53  |
| N. marina                   | 36       | 31      | 33       | 38    | 44    | 48  | 54   | 58   | 61     | 60        | 56      | 52       | 47.58±10.87 |
| N. minor                    | -        | -       | -        | 31    | 37    | 46  | 51   | 55   | 58     | -         | -       | -        | 46.33±10.54 |
| Ranunculus sphaeropermus    | -        | -       | -        | 49    | 57    | -   | -    | -    | -      | -         | -       | -        | 53±5.65     |
| Azolla filiculoides         | 36       | 38      | 43       | 45    | 48    | 51  | 71   | 73   | 75     | 72        | 65      | 61       | 56.5±14.57  |
| Lemna minor                 | 33       | 34      | 38       | 58    | 64    | 70  | 84   | 88   | 92     | -         | -       | -        | 62.33±23.3  |
| Lemna gibba                 | 30       | 31      | 34       | 53    | 58    | 67  | 78   | 79   | 84     | -         | -       | -        | 57.11±21.52 |
| Ludwigia repens             | 14       | 17      | 20       | 23    | 25    | 27  | 43   | 48   | 56     | -         | -       | -        | 30.33±14.89 |
| Spirodela polyrhiza         | 35       | 38      | 44       | 67    | 70    | 73  | 86   | 92   | 95     | -         | -       | -        | 66.67±22.93 |
| Alternantherum sessilis      | -        | -       | -        | 18    | 20    | 22  | 24   | 25   | 27     | 25        | 23      | 18       | 22.44±3.21  |
| Bacopa monnieri             | 27       | 29      | 30       | 33    | 34    | 37  | 38   | 40   | 41     | 40        | 38      | 36       | 35.25±4.65  |
| Cynanchum asiaticum         | -        | -       | -        | -     | -     | -   | -    | -    | -      | -         | -       | -        | 24.5±3.41   |
| Cladium maricocum           | 20       | 24      | 25       | 27    | 28    | 31  | 38   | 40   | 45     | 40        | 35      | 33       | 32.17±7.63  |
| Cypselus lasius             | 26       | 22      | 29       | 32    | 33    | 37  | 43   | 45   | 42     | 40        | 37      | 34±7.98   |
| Cypers auctorum             | -        | -       | -        | -     | -     | -   | -    | -    | -      | 26        | 28      | 27       | 27±1        |
| Cypers malaccensis          | -        | -       | -        | -     | -     | -   | -    | -    | -      | -         | 23      | 26       | 24.66±1.52  |
| Phragmites australis        | 76       | 77      | 78       | 79    | 81    | 83  | 91   | 96   | 98     | 93        | 88      | 86       | 85.5±7.67   |
| Lycopus europaeus           | 29       | -       | -        | -     | -     | -   | -    | -    | -      | -         | 23      | 27       | 29±2         |
| Schoenoplectus litoralis    | 26       | 27      | 27       | 29    | 32    | 34  | 37   | 38   | 40     | 32        | 31      | 33       | 32.16±4.53  |
| Typha domingensis           | 11       | 12      | 12       | 11    | 13    | 13  | 14   | 15   | 16     | 15        | 12      | -        | 13.4±1.97   |
| Ectida alba                 | 18       | 16      | 17       | 20    | 23    | 26  | 28   | 31   | 34     | 29        | 27      | 26       | 24.58±5.79  |
| Panicum repens              | -        | -       | -        | 17    | 22    | 25  | 27   | 25   | 23     | 22        | -       | -        | 23±3.21     |
| E. papaloides               | -        | -       | -        | 34    | 35    | 40  | 47   | 48   | 46     | 43        | 40      | -        | 41.62±5.31  |
| Phyla nodiflora             | -        | -       | -        | -     | -     | 24  | 26   | 29   | 27     | 25        | 25      | -        | 26±1.78     |
| Oxytomena esculenta         | -        | -       | -        | -     | -     | 23  | 25   | 26   | 25     | 24        | 23      | -        | 24.33±1.21  |
| Samolus valerand            | -        | -       | -        | -     | -     | 21  | 22   | 24   | 26     | 23        | 23      | -        | 22.75±1.66  |

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### Table 5. Monthly variation in mean vegetation cover percentage and standard deviation (mean%± SD) for the aquatic plant at site 3 of Al-Hawizh marsh.

| Plant species                  | December | January | February | March | April | May | June | July | August | September | October | November | Mean % ± SD |
|--------------------------------|----------|---------|----------|-------|-------|-----|------|------|--------|-----------|---------|-----------|-------------|
| Habitat                        | 2017     | 2018    |          |       |       |     |      |      |        |           |         |           |             |
| **Sub emergent**               |          |         |          |       |       |     |      |      |        |           |         |           |             |
| Ceratophyllum demersum         | -        | 36      | 38       | 42    | 46    | 51  | 58   | 67   | 72     | 63        | 54      | 51        | 52.5±11.71  |
| Potamogeton crispus            | 14       | 14      | 15       | 16    | 16    | 17  | 19   | 20   | 21     | 21        |        | -         | 16.89±2.57  |
| Najas minor                    | 33       | 31      | 32       | 35    | 40    | 42  | 45   | 50   | 54     | 46        | 42      | 38        | 39.3±5.96   |
| Ranunculus plicatus            | -        | -       | -        | 27    | 28    | 27  | 30   | 32   | 33     | -         | -       | -         | 29.5±2.58   |
| **Emergent**                   |          |         |          |       |       |     |      |      |        |           |         |           |             |
| Azolla filiculoides            | 36 37    | 38      | 40       | 46    | 52    | 66  | 71   | 79   | 68     | 64        | 57      |           | 54.5±15.05  |
| Lemna minor                    | 31 33    | 35      | 52       | 62    | 72    | 79  | 85   | 91   | 77     | 74        | 79      | -         | 60±23.33    |
| Lemna gibba                    | 30 28    | 29      | 42       | 52    | 57    | 64  | 74   | 79   | -      | -         | -       | 50.5±19.53 |
| Ludwigia repens               | 15 16    | 17      | 20       | 23    | 28    | 41  | 46   | 54   | -      | -         | -       | 28.89±14.51|
| Spirodela polyrhiza            | 40 36 39 | 55      | 70       | 76    | 81    | 87  | 90   | -    | -      | -         | -       | 63.78±21.62|
| Alternanthera sessilis         | -        | -       | 13       | 14    | 15    | 20  | 21   | 24   | 22     | 21        | 18      | 18.67±3.87 |
| Bacopa monnieri                | 26       | -       | -        | 25    | 28    | 27  | 28   | 22   | 25     | 21        | 19      | 24.55±3.32 |
| Cynanchum acutum              | -        | -       | -        | -     | -     | -   | -    | 20   | -      | 22        | 23      | 21±1.29   |
| Cladium mariscus              | 20 21    | 22      | 24       | 27    | 30    | 34  | 37   | 43   | 36     | 33        | 30      | 29.75±7.18 |
| Cyperus achen                | -        | -       | -        | -     | -     | -   | -    | 25   | 24     | 24        | 24      | 24.33±0.57 |
| Cyperus laevigatus            | 32 21    | 20      | 22       | 24    | 27    | 30  | 32   | 33   | 38     | 36        | 33      | 28.75±5.98 |
| Phragmites australis          | 72 73    | 76      | 77       | 78    | 79    | 89  | 93   | 94   | 89     | 86        | 83      | 82.42±7.65 |
| Lycopus europaeus             | 23       | -       | -        | -     | -     | -   | -    | -    | -      | -         | -       | 23±2.3    |
| Typha domingensis             | 16 15    | 16      | 17       | 17    | 18    | 20  | 20   | 22   | 19     | 18        | 17      | 17.9±2.02  |
| Eclipta alba                  | 17 15    | 16      | 19       | 22    | 23    | 24  | 25   | 26   | 24     | 22        | 20      | 21.08±3.65 |
| Panicum repens                | -        | -       | -        | -     | -     | -   | 18   | 23    | 24     | 26        | -       | 21.57±3.05 |
| paspalum paspaloides          | -        | -       | -        | -     | -     | -   | 27   | 34    | 34     | 37        | -       | 32.57±3.25 |
| Samolus valerandi             | -        | -       | -        | -     | -     | -   | 21   | 22    | 23     | 23        | 20      | 21.16±1.94 |
| Phyla nodiflora               | -        | -       | -        | -     | -     | -   | 20   | 43    | 39     | 34        | 31      | 37.4±4.83  |
| Torulium odoratum             | -        | -       | -        | -     | -     | -   | 18   | 23    | 27     | 24        | 20      | 21.5±3.83  |
Table 6. Monthly variation in mean vegetation cover percentage and standard deviation (mean%± SD) for the aquatic plant at site 4 of Al-Hawizeh marsh.

| Plant species                  | December | January | February | March | April | May | June | July | August | September | October | November | Mean% ±SD |
|--------------------------------|----------|---------|----------|-------|-------|-----|------|------|--------|-----------|---------|----------|------------|
| *Ceratophyllum demersum*       | 26       | 26      | 26       | 31    | 35    | 40  | 42   | 45   | 51     | 50        | 45      | 42       | 38.25±9.22 |
| *Potamogeton pectinatus*       | 39       | 41      | 42       | 42    | 44    | 47  | 50   | 53   | 59     | 57        | 55      | 42       | 47.58±6.96 |
| *Najas marina*                 | 32       | 35      | 37       | 40    | 40    | 42  | 45   | 48   | 51     | 46        | 45      | 46       | 42.24±5.62 |
| *Najas minor*                  | -        | -       | -        | 29    | 31    | 30  | 32   | 35   | 36     | -         | -       | -        | 32.16±2.78 |
| *Ranunculus sphaeropus*        | -        | -       | 34       | 37    | -     | -   | -    | -    | -      | -         | -       | -        | 35.5±2.12  |
| *Azolla filiculoides*          | 26       | 25      | 27       | 33    | 35    | 39  | 48   | 60   | 66     | 56        | 48      | 43       | 42.17±13.74 |
| *Lemna minor*                  | 24       | 23      | 25       | 33    | 38    | 42  | 49   | 52   | 55     | -         | -       | -        | 37.88±12.43 |
| *Lemna gibba*                  | -        | -       | 29       | 34    | 35    | 41  | 49   | 51   | -      | -         | -       | -        | 39.83±8.77 |
| *Spinodela polyrhzis*          | 29       | 27      | 31       | 45    | 48    | 51  | 58   | 66   | 74     | -         | -       | -        | 47.67±16.61 |
| *Bacopa monnieri*              | 23       | -       | -        | -     | -     | -   | 22   | 23   | 24     | 23        | 21      | 20       | 22.28±1.38 |
| *Cyperus auber*                | -        | -       | -        | -     | -     | -   | -    | -    | -      | 23        | 22      | 21       | 22.66±1.67 |
| *Cyperus laevigatus*           | 21       | 19      | 20       | 22    | 22    | 24  | 28   | 30   | 38     | 35        | 33      | 28       | 26.67±6.31 |
| *Phragmites australis*         | 67       | 64      | 65       | 70    | 72    | 74  | 83   | 84   | 85     | 82        | 80      | 78       | 75.33±7.66 |
| *Typha domingensis*            | 8        | 7       | 7        | 8     | 9     | 11  | 11   | 11   | 12     | 11        | 10      | 9        | 9.33±1.67  |
| *Eclipta alba*                 | 13       | 11      | 12       | 15    | 17    | 19  | 20   | 22   | 24     | 21        | 19      | 17       | 17.5±4.1   |
| *Panicum repens*               | -        | -       | -        | -     | 11    | 12  | 12   | 13   | 10     | 9         | 7       | 5        | 10.57±2.07 |
| *Paspalum paspaloides*         | -        | -       | -        | -     | -     | -   | 23   | 24   | 22     | 19        | 16      | 16       | 20.8±3.27  |
| *Oxystelma esculentum*         | -        | -       | -        | -     | -     | -   | -    | 15   | 17     | 18        | 17      | 17       | 16.75±1.25 |
| *Samolus valerandi*            | -        | -       | -        | -     | -     | -   | 20   | 21   | 20     | 18        | 19      | 19       | 19.6±1.14  |
Table 7. Variations in mean of vegetation cover percentage (mean%± SD) at study sites for aquatic plant species of Al-Hawizeh marsh.

| Habitat | Plant species            | Site 1  | Site 2  | Site 3  | Site 4  | Mean % ±SD |
|---------|--------------------------|---------|---------|---------|---------|------------|
| Emergent| Ceratophyllum demersum   | 46.91   | 51.83   | 52.54   | 38.25   | 47.1±6.58  |
|         | Potamogeton crispus      | 13.89   | 18.78   | 16.89   | -       | 16.52±2.46 |
|         | Potamogeton pectinatus   | 45.08   | 63.33   | 58.08   | 47.58   | 53.51±8.63 |
|         | Najas marina             | 27.83   | 47.58   | 39.33   | 42.24   | 39.24±8.34 |
|         | Najas minor              | -       | 46.33   | 29.5    | 32.16   | 35.99±9.05 |
|         | Ranunculus sphaerospermus| 42      | 53      | 50.5    | 35.5    | 45.25±8.02 |
| Free floating| Azolla filiculoides    | 48.75   | 56.5    | 54.5    | 42.17   | 50.48±6.44 |
|         | Lema minor               | 53.33   | 62.33   | 60      | 37.88   | 53.38±8.12 |
|         | Lema giba                | 48.66   | 57.11   | 50.5    | 39.83   | 49.52±7.12 |
|         | Ludwigia repens          | 26.55   | 30.33   | 28.89   | -       | 28.59±1.91 |
|         | Spirodela polyrrhiza     | 57      | 66.67   | 63.78   | 47.67   | 58.78±8.44 |
| Sub emergent| Alternanthera sessilis  | 15.78   | 22.44   | 18.67   | -       | 18.96±3.34 |
|         | Bacopa monnieri          | 28.33   | 35.25   | 24.55   | 22.28   | 27.6±5.67  |
|         | Cynanchum acutum         | 24.85   | 24.5    | 21.5    | -       | 23.61±1.84 |
|         | Cyperus aecher           | 23.25   | 24.66   | 24.33   | 22      | 24.44±2.5  |
|         | Cyperus malaccensis      | 29.33   | 34      | 28.75   | 26.67   | 29.69±3.09 |
|         | Cladium mariscus         | 27.41   | 32.17   | 29.75   | -       | 29.77±2.38 |
|         | Phragmites australis     | 82.25   | 85.5    | 82.42   | 75.33   | 81.37±4.29 |
|         | Schoenoplectus litoralis | -       | 32.16   | -       | -       | 32.16±3.16 |
|         | Lycopus europaeus        | -       | 29      | 23      | -       | 26±4.24   |
|         | Typha domingensis        | 12.42   | 13.4    | 17.92   | 9.33    | 13.26±3.55 |
| Wet     | Eclipta alba             | 18.42   | 24.58   | 21.08   | 17.5    | 20.39±3.17 |
|         | Panicum repens           | 20      | 23      | 21.57   | 10.57   | 18.78±5.61 |
|         | Cyperus pumilus paspaloides| 36.5   | 41.62   | 32.57   | 20.8    | 32.27±8.86 |
|         | Phyla nodiflora          | 36      | 26      | 37.4    | -       | 33.13±6.22 |
|         | Polypogon monspeliensis  | 35      | -       | -       | 35.5    | 35±35     |
|         | Oxytostema esculentum    | 18.2    | 17.6    | -       | 16.75   | 17.51±0.73 |
|         | Samolus valerandi        | -       | 24.33   | 21.16   | 19.6    | 21.69±2.41 |
|         | Taraxacum odoratum       | 21.66   | 22.75   | 21.5    | -       | 21.97±0.68 |

3.2.2. Aquatic Plant Biomass

Variation in biomass values has been observed between the winter and summer seasons of aquatic plants. The submergent plants at the studied sites showed differences in the biomass values. *C. demersum* plant was superior to other submerged plants, it ranging from (145 gm / m²) at site 4 in winter to (469 gm / m²) at site 3 in the summer season. And *N. marina* reported differences in biomass values between 137 gm / m² at site 1 in winter and 328 gm / m² at site 2 in summer, but *P. crispus* ranged from 36 gm / m² at site 1 in winter to 124 gm / m² at site 2 in summer. Then *P. pectinatus* showed biomass values ranging from 98 gm / m² at site 1 in winter to 251 gm / m² at site 2 in summer. Also, the biomass values of *R. Sphaerospermus* species were examined only in the summer season and did not report in the winter season, due to the absence of this species in the winter. Thereby, the values of biomass for this species varied from 143 gm/m² at site 4, to 237 gm/m² presented at site 2 (Tables 8 and 9).

Free-floating plants, *Ludwigia repens* recorded the highest biomass values among the other species in both winter and summer seasons, where ranging from 228 gm / m² at site 1 in the winter to 445 gm / m² at site 2 in the summer. Then *A. filiculoides* ranged from 47 gm / m² at site 4 in winter to 138 gm / m² at site 2 in summer. Also, *Lema spp. (L. minor and L. giba)* biomass values ranged from 32 gm / m² at site 4 during the winter to 145 gm / m² at site 2 during the summer. And biomass values of *S. polyrrhiza* given ranged from 38 gm / m² at site 4 during winter to 153 gm / m² at site 2 during summer (Tables 8 and 9).
Compared with the other plant species, the emerging plants reported the highest biomass values at all Al-Hawizeh marsh studied sites. During the summer, *P. australis* reported the highest value among emerging plants at site 2 reaching 2985 gm/m², during the winter the lowest value was 1432 gm/m² at site 4. The *C. mariscus* species biomass ranged from 87 gm/m² at site 1 in winter to 186 gm/m² at site 2 in summer. *T. Domingensis* was considered to be between 98 gm/m² at site 4 during the winter and 304 gm/m² at site 3 during the summer. Whereas the biomass values showed a strong variance in Wet plants. However, the values of *E. Alba* species differ from 35 gm/m² at site 4 during the winter to 61 gm/m² at site 2 recorded during the summer (Tables 8 and 9).

**Table 8.** Mean and SD of biomass values (gm/m²) for aquatic plants recorded during the winter season of Al-Hawizeh marsh.

| Group         | Plant species               | Site 1 | Site 2 | Site 3 | Site 4 | Mean % ±SD          |
|---------------|-----------------------------|--------|--------|--------|--------|---------------------|
| Sub-emergent  | *Ceratophyllum demersum*    | 168    | 184    | 181    | 145    | 169.5±17.7          |
|               | *Najas marina*              | 137    | 229    | 220    | 256    | 210.5±51.33         |
|               | *Potamogeton crispus*       | 36     | 55     | 49     | -      | 46.67±9.71          |
|               | *Potamogeton pectinatus*    | 98     | 139    | 106    | 111    | 113.5±17.82         |
| Free-floating | *Azolla filiculoides*       | 58     | 71     | 67     | 47     | 60.75±10.65         |
|               | *Lemma sp.*                 | 41     | 46     | 44     | 32     | 40.75±6.18          |
|               | *Ludwigia repens*           | 228    | 298    | 282    | -      | 269.33±36.67        |
|               | *Spirodela polyrrhiza*      | 44     | 52     | 49     | 38     | 45.75±6.13          |
| Emergent      | *Cladium mariscus*          | 87     | 99     | 92     | -      | 92.67±6.03          |
| Wet           | *Phragmites australis*      | 1666   | 1691   | 1598   | 1432   | 1596.75±116.65      |
|               | *Typha domingensis*         | 142    | 155    | 208    | 98     | 150.75±45.29        |
|               | *Eclipta alba*              | 38     | 50     | 47     | 35     | 42.5±7.14           |

**Table 9.** Mean and SD of biomass values (gm/m²) for aquatic plants recorded during the summer season of Al-Hawizeh marsh.

| Group         | Plant species               | Site 1 | Site 2 | Site 3 | Site 4 | Mean % ±SD          |
|---------------|-----------------------------|--------|--------|--------|--------|---------------------|
| Sub-emergent  | *Ceratophyllum demersum*    | 405    | 454    | 469    | 362    | 422.5±48.72         |
|               | *Najas marina*              | 194    | 328    | 256    | 287    | 266.25±56.47        |
|               | *Potamogeton crispus*       | 102    | 124    | 107    | -      | 111.5±11.53         |
|               | *Potamogeton pectinatus*    | 182    | 251    | 249    | 213    | 223.75±32.85        |
|               | *Ranunculus sphaerospermus* | 191    | 237    | 224    | 143    | 198.75±41.9         |
| Free-floating | *Azolla filiculoides*       | 124    | 138    | 135    | 109    | 126.5±13.12         |
|               | *Lemma sp.*                 | 129    | 145    | 140    | 101    | 128.75±19.67        |
|               | *Ludwigia repens*           | 399    | 445    | 419    | -      | 421±23.06           |
|               | *Spirodela polyrrhiza*      | 136    | 153    | 146    | 110    | 136.25±18.84        |
| Emergent      | *Cladium mariscus*          | 154    | 186    | 167    | -      | 169±16.1            |
| Wet           | *Phragmites australis*      | 2794   | 2985   | 2887   | 2037   | 2825.75±148.03      |
|               | *Typha domingensis*         | 216    | 229    | 304    | 168    | 229.25±56.31        |
|               | *Eclipta alba*              | 47     | 61     | 56     | 44     | 52±7.87             |

In general, during the study period, four plant groups analysed the mean and standard deviation (mean±SD) of biomass values in winter and summer at Al-Hawizeh marsh study sites. In sub-emergent plants the highest biomass mean value 422.5±48.72 gm/m² presented in *C. demersum* during the summer, the lowest biomass mean value 46.67±9.71 gm/m² tested in *P. crispus* during the winter. In free-floating plants, the highest biomass value 421±23.06 gm/m² occurred of *L. repens* during the summer, the lowest biomass value 40.75±6.18 gm/m² found in *Lemma spp.* during the winter.
In addition, the reed plant *P. australis* excellence in the biomass values of the other emerging plant species, with the highest value of 2825.75±148.03 gm / m$^2$ recorded in the summer, and the lowest biomass value of 92.68±6.03 gm / m$^2$ of *C. mariscus* during the winter. As well as, in the wet plants like *E. Alba* the highest biomass value of 52±7.87 gm / m$^2$ in the summer, and the lowest biomass of 42.5±7.14 gm / m$^2$ in the winter (Tables 8 and 9).

Figure 7 shows the general mean for biomass (gm dry weight / m$^2$) of four aquatic plant groups (Sub emerging, Free- Floating, Emerging, and Wet Plants) recorded at four Al-Hawizeh marsh studied sites. Where the highest biomass value of 844.02 (gm dry weight /m$^2$) was found by the emerging group of plants, whereas the lowest biomass value of 47.25 (gm dry weight /m$^2$) was found in group of wet plants.

Figure 7. General mean for biomass (gm dry weight /m$^2$) to four aquatic plant groups of Al Hawizeh marsh.

On the other hand, the highest general mean of 441 (gm dry weight / m$^2$) was recorded at site 2, the lowest general mean of 228 (gm dry weight /m$^2$) was reported at site 1 of the Al-Hawizeh marsh.

4. Discussion

Ecosystem plants are affected by a variety of factors, whether physical or chemical, which can have a negative or positive impact on the production, production, and growth of plants because temperature plays an important role in many Physico-chemical and biological processes due to its effects on salinity, gas melting and susceptibility[27]. The spatial differences in water temperature between sites may be due to changes in the sampling period at each site [28] or to changes in water depth at each site. Due to the broad water surface area, the temperature of Al-Hawizeh marsh depends to a large extent on the ambient temperature [29].

The study showed there was a difference in the temperature of the water during the months of the year because the summer months were marked by the high temperature of the water and its decrease during the cold months. Nonetheless, the highest value 31.4 °C recorded at site 3 in August, and the lowest value 11.3 °C at site 2 in January. This result is close to what record [30] which found the water temperature ranged from 14.3 °C to 35.6 °C in the Al-Auda marsh southern Iraq, and study [31] on Al-Hammar marsh which ranged from 15 °C in February to 31 °C in August. During the dry hot months in Iraq, water temperatures increase evaporation rates, resulting in continuous water levels declining in the Tigris and Euphrates rivers flowing from Turkey and Syria, as well as from the Iranian Al-Karkha River, Al-Masharah, and Al-Kahla Rivers into the marsh. Water depth and transparency are also impacted by this situation. High evaporation reduces the dissolved oxygen thus increasing the salt content in many aquatic species, increasing stress.

A calculation to assess the total dissolved solids (TDS) in the water is electrical conductivity [9], where the highest electrical conductivity values were 6859 (μ. S / cm) at site 4 in April and the lowest
electrical conductivity values were 2257 (µ S / cm) at site 2 in November, this result supported with the study [32]. The difference in EC values was due to rainfall in the winter and autumn months, as well as marsh erosion and runoff, which increased the dissolved salts in water [33]. Monthly changes in water conductivity can be associated with declining water levels, raising the evaporation ratio, other than more concentrations of dissolved ions, leading to increased EC and salinity as indicated by [34-36], this contributes to increases in EC and salinity. In addition, during the summer months, which are marked by high electrical conductivity values, this may be due to the discharge of agricultural activities to the bodies of water requiring fertilizer use, irrigation, and drainage of the plantations. The marsh has also undergone years of drying, contributing to the accumulation of salts in sediments[32,37 and 38].

DO is considered to be a primary indicator of natural water quality since most aquatic organisms require oxygen until they survive [39]. The concentrations of DO are dependent on several factors, including the amount of rainfall, the temperature of the water, the salinity, the decomposition of organic waters, the aquatic vegetation, the composition of the substrate, and the presence of contaminants. The concentrations of DO found in the current work were sufficient to support aquatic life >4 mg /L [40]. Statistical analysis findings showed that temporal and spatial shifts in the quantity of dissolved oxygen were observed for all sites where the highest values were 10.5 in mg /L at site 1 in April, due to increased gas solubility, as well as decreased decomposition of organic waste due to higher water columns and large mixing effects on Al-Adel water [21]. This is compatible with [31,32 and 41], in addition to the amounts flowing when the water level rises at site 2, while the lowest values reached (1.88) mg /L at site 4 in September. Due to the reduction of the water level in the study region, the decrease in water movement and water currents, the lowest values were measured in all sites in September, hence the high rate of consumption and decomposition activities of organic matter that coincided with the decrease in gas solubility.

Vegetation cover had a clear role to play in maintaining the natural environment and enhancing human life and other living species, but the negative change that happens to vegetation often reaches a catastrophic limit as a result of human activity or other factors [42], as a disturbance to the balance of the habitats, biodiversity loss and low water. Nevertheless, a significant component of wetland habitats is the vegetation cover.

In this analysis, as the water column decreases, there is a substantial decrease in the production of biomass and the percentage of vegetation, the quantity of dissolved oxygen, and vice versa as the water column increases. This is similar to the work done by [32]. The results of this study showed the highest percentage of vegetation cover reported during the summer months, whereas the lowest percentage of vegetation cover revealed during the winter for all plant groups. For several factors, such as variation in quantities of water flowing to the marsh, depth water in studied sites, and environmental variables, which are the most important function of these changes in periods of plant development, these variations may occur. Whereas the difference in the vegetation cover between the studied sites can be explained by the presence of the density of the vegetation cover of emerging plants in the Al-Hawizh marsh, thus providing a sufficient opportunity to increase the cover of the vegetation of floating plants as a result of the impact on the growth of plants unique to the source of airborne carbon and oxygen [43 and 44]. The results offered a simple picture of the densities at all sites of certain free-floating plants, with variations in the number of species at each site. Distinguished by dominance of L.minor, S.polyrrhiza A.filiculoids at both 2 and 3 locations, where A. Filiculoids characterized by their rapid growth and the production of thick mats on surface water in most areas, resulting in shading of the water column and any vegetation below them[45].

On the other hand, Paudel et al.,[46] found that salinity led to a decrease in plant coverage of > 90% of floating macrophyte communities dominated by invasive plants, while increased desiccation stress led to a decrease of 100% in vegetation cover when native species dominated on the communities. The biomass includes live parts and dead parts of living plants that are still attached, while peak biomass is the single-largest value of plant material present during the growing season [47], where they reached the peak of growth in the summer season. In other words, biomass is a renewable, non-fossilized
material that resides in a given environment consisting of living and non-living beings [48]. Much of the differences in the biomass values of submerged plants are due to conditions, water level, and in-water lighting conditions. Lighting is also a factor influencing aquatic plant structure and biomass [49], and submerged plants prefer clear water [50]. As a result, the biomass rate of submerged plants in Al-Hawizeh marsh was high due to the great depth and clarity that allows for deeper penetration of the lighting. Madsen et al.,[51] stated that the biomass distribution of submerged aquatic plants is influenced by the bottom and emergent lighting characteristics, such as the presence of trees, floating plants, and algae to reduce the light coming to them, thereby reducing their photosynthesis and low biomass production.

The results of the present study showed that the biomass values of submerged plants characterized by C. demersum plant over the rest of the submerged plants studied during the study period for all stations, because of its high ability to take nutrients, as well as its freedom movement in the water, allowing it to expand to larger areas and produce more mass. The difference in the biomass values of aquatic plants found in the summer compared with the winter results of the current study is due to the direct effects of light and temperature, contributing to organic matter storage during the summer months, as well as the availability of nutrients in water and sediments. C. demersum had a maximum biomass value of 469 gm /m² dry weight at site 3, whereas N. marina, P. pectinatus, and R. sphaerocarpostermus species had a maximum value 328gm / m² dry weight, 251mg / m² dry weight, and 237gm /m² dry weight respectively, at site 2. Therefore, the biomass values were poor for all submerged plants compared to the previous studies, where [13] has reported the highest biomass value (1371) gm / m² dry weight for C. demersum, while [32] recorded 1294.4 gm / m² dry weight of biomass for the same plant and [32] found 582 gm / m² dry weight. Furthermore, the emerging plants recorded the highest biomass means, especially the P. australis plant, where Al-Hilli et al. [53] estimated the mean biomass of 5000 g /m² dry of reed plant in southern Iraqi marshes. Whereas the mean biomass value ranged from 958 g / m² in winter to 2922 g / m² in summer in the previous study conducted by [54] on Al-Hawizeh marsh.

Moreover, the studies indicated that the densities, biomass, and phenotypic characteristics of emerging plants such as reeds depend on latitude, climate, salinity, depth of water, eutrophication, and the interplay between these factors [55]. Compared to saline water, reed plants also grow better and higher biomass in brackish water [56]. Therefore, increased salinity has a negative impact on the growth of plant vegetative cover [57]. As a result, the highest biomass values were reported at site 2 which have relatively low salinity compared to the biomass values of the plants in site 4, because of the differences in the water flow levels entering the sites, the depth of water between sites, the plant densities in this site were decreased.

The findings represented seasonal and spatial differences in aquatic plant biomass values. The highest biomass values examined in the summer season compared to the winter season in the present study (Tables 7 and 8), this result agrees with [58], in reality, that plants get peaks in organic matter growth and storage during the summer months, particularly in July, due to the availability of all the required components of solar intensity radiation and the availability of nutrients and high-temperature degrees, whereas [59] found that plant biomass reached almost half of that at the end of the autumn and winter seasons. This can be seen in other plant species where biomass was measured on a dry weight per square meter basis. The depth had a direct impact on the variance between the biomass values as increasing the depth water contributes to the production of long plants and thus increases the accumulation of biomass, thus explaining the difference in the biomass values of the same plant species in four sites. Furthermore, the response of aquatic macrophyte biomass to limnological changes following variations, increases or decreases in water levels depending on the variable or species [60].

Vegetation cover rates for studied plants were associated with biomass, therefore the vegetation rate is high, particularly for C. demersum observed in months with high plant productivity in all sites, this may due to the high amount of nutrient elements appropriate for this species in the marsh, which
occupied large areas of water systems after inundation of marshes, as well as having fast-growth strategies and several different environmental conditions, making them the most dominant, the most productive plants, this is consistent with the research [31].

5. Conclusion:
The results of the present study showed that the environmental variables in the Al-Hawizeh marsh have a positive relation to density, vegetation cover, biomass of plant species. The highest percentages of vegetation cover for the plants studied were during the summer, while the lowest percentages were found during the winter. However, the biomass values were actually correlated with vegetation cover values for all plant species, therefore the vegetation cover values are high, particularly for C. demersum observed during the months with high biomass at all sites.

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