Phytoplankton primary production in southern Iraqi marshes after restoration

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Abstract:

Primary productivity and chlorophyll-a were used in this study to monitor the restoration process of southern Iraqi marshes (Al-Hewaizeh, central marshes, and Al-Hammar). The phytoplankton primary productivity was based on oxygen light/dark bottle method. Two different depths samples were taken monthly from six studied marshes stations (two stations for each marsh) during November 2005 to October 2006, while chlorophyll-a samples taken from surface water. The phytoplankton primary productivity values ranged 9.38 – 249.79 mg C/m^3.hr for all marshes, its values for surface water sample ranged 11.71 – 256.24 mg C/m^3.hr, while for 1m depth ranged 9.38 – 142.5 mg C/m^3.hr. Chlorophyll-a values ranged between (1.1 – 21.26) µg/l indicating high values of productivity in the studied marshes comparing with other aquatic Iraqi ecosystems. Also, dissolved oxygen and oxygen saturation rate were measured in this study.

Keywords: Phytoplankton, Primary Productivity, Iraqi Marshes, Restoration

Introduction:

Phytoplankton are initially responsible for primary production in an aquatic community, it can constitute a high proportion of the annual primary productivity. Although phytoplankton production in fresh water generally has a markedly higher level than in the sea. Primary production levels are significantly higher in very oligotrophic regions than has previously been supposed [1].

Studying primary productivity in the ecosystem provide more information about understanding obtainable energy and the nature of its transportation in benthic and planktonic communities and meets great interesting in the ecological studies [2].

Fresh water primary production of the world can best be calculated from the largest lakes (Lake Baikal and the Great Lakes), which account for 31% of the earth's surface fresh water. The total area of inland waters is 2 x 10^6 km^2. Combining macrophytes, Periphyton, and phytoplankton productivity, the mean net production of lakes and rivers is about 200 g C/m^2.year, giving a net annual production of about 0.4 x 10^{15} g C. A study on four constructed emergent marshes in Illinois revealed that phytoplankton contributed from 17 to 67 % of the primary production of the marshes [3].

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Primary productivity were measured in a number of aquatic ecosystems in the southern region of Iraq (4,5,6,7, 89,10,11,12). Hameed, [4] studied ecology of phytoplankton of Shatt A-Arab River measuring Primary productivity which ranged 6.03 to 15.07 mg C /M³.hr., in the same year Huq *et al.,* [5] did a preliminary studies on phytoplankton of north-west Arab Gulf, measuring primary productivity ranged 2.7 to 5.7 mg C /M³.hr. Abdullah (11) did a study on phytoplankton primary productivity in Shatt A-Basrah canal, values ranged 12.49 to 118.74 mg C /M³.hr.

The study of Al-Zubaidi [9] was the first study on the primary productivity in the southern Iraqi marshes near Qurna using light/dark bottles. The primary productivity results in his study ranged 12.49 to 407.09 mg C/m³.hr., the results refer that spatial and temporal variations in the primary productivity was companion completely with total counts and chlorophyll-a concentrations of phytoplankton. While the study of Al-Lami, [10] measured primary productivity using C^{-14} in the lower part of Al-Hammar marsh, and primary productivity results ranged 1.6 to 114.18 mg C /M³.hr. Also results of primary productivity tend to companion with variations in the phytoplankton total counts and Chlorophyll-a concentrations.

Other studies were done on phytoplankton primary productivity in other parts of Iraq besides the southern marshes and around area; in Arabian Gulf (12). Al-Handal *et al.,* [13] studied primary productivity of benthic microflora for the first time in Shatt Al-Arab near Al-Garma region by oxygen method; they found that the values ranged between (13.5 – 153) µg C/m^2.hr. Al-Saadi [14] summarized the different values of primary productivity in aquatic system of Iraq.

Recent study focus on the main three marshes in southern Iraq which is the first study done in Mesopotamian marshes to determine primary production. This study is a part of comprehensive study on Mesopotamian marshes after restoration and supported by Canadian International Development Agency (CIDA).

The study area:

Six stations had chosen in the three main Mesopotamian marshes as two stations from each marsh. For the purposes of this study, 6 representative sites were selected (Fig. 1)

Fig.(1): Map of study area.

based on the general morphology, vegetation, and the presence or absence of population in each site; the geographical coordinates of the stations (Table 1) were determined by mean of GPS.

Table 1: The Geographical positions of the studied sites (GPS).

Stations (St.)		Location	Co-ordinates					
			Latitude (North)			Longitude (East)		
			°	‘	“	°	‘	“
Al-Hawizeh Marsh	St.1	Um Al-Warid	31	34	0.1	47	30	9.1
	St.2	Um An-Niāj	31	36	37.1	47	34	28.4
Central Marshes	St.3	Beginning of Baghdadia	31	01	19.8	47	02	14.4
	St.4	Middle of Baghdadia	31	02	9.0	47	02	9.4
Al-Hammar Marshes	St.5	Al-Naggarah	31	40	3.7	47	38	37.8
	St.6	Al-Burgah	31	41	17.8	47	35	23.9

Al-Hewaizeh Marsh:

The Hewaizeh Marsh lies to the east of the Tigris River, straddling the Iran-Iraq border between 31° 00’-31º45’ N, 47° 25’-47º 50’ E (Scott, 1995). Four sources of water feeding Al-Hewaizeh Marsh: Al-Musharah (flows directly into Al-Hewaizeh), Al-Ka'hla (divides into three tributaries: Al-Zubair, Umm Al-Toos, and Al-Husa'chi; each tributary flows directly into Al-Hewaizeh), Al-Faisal channel (its water inlet flows from Al-Sanna'f marsh north of Al-Hewaizeh), and Al-Karkheh (flows from Iran across the border into Al-Hewaizeh Marsh) [15]. For this study two stations (Um Al-Warid (St. 1) and Um An-Niāj (St. 2)) were chosen in this marsh:

Um Al-Wared marsh is located in the north west of Al-Hawizeh, just below Um El-Nia’aj open water body. Um Al-Wared marsh is dense with the presence of Phragmites ustralus. Also, this marsh is dominated by Potomogeton leucenus, P. perfoliatus and P. crispus.

Um El-Nia’aj is the largest water body and located in the north western section of Al-Hawizeh. It occupies an area between 140-200 Km2. This area has a various plant species like P. australus, Ceratophyllum demrasum, P. leucenus P. perfoliatus, Najas marin, and N. minor.

Central Marshes:

Located immediately above the confluence of the two Mesopotamian Rivers, the central marshes are at the heart of the Mesopotamian wetland ecosystem. These marshes are bounded by Tigris River to the east and Euphrates River in the south. In the central marshes two stations (Beginning of Al-Baghdadia (St. 3) and Middle of Al-Baghdadia (St. 4)) were chosen for present study. These are freshwater lakes and clear and water depth reach to 1.5m. Several agricultural activities, buffalo farm, and fisheries activities nearby and there are some small village beside our stations.

Al-Hammar Marshes:

Al-Hammar Marsh represents about 21% of the total marshland in the southern Iraq. The marsh area comprises 2,800 km2 of permanent marsh and lake, expanding to over 4,500 km2 during periods of seasonal and temporary inundation. During the summer, large parts of the littoral zone dry out, and banks and islands emerge in many places. At times, more than 80% of the Tigris discharge goes to this marsh, while the Euphrates River disappears in it and its discharges directly to the Shatt al-Arab. In this marsh two stations (Al-Naggarah (St. 5) and Al-Burgah (St. 6)) had chosen. Al-Naggarah is so closed with the Shatt Al-Arab River (Al-Mashab, and Al-Salal) with water depth reach to 5m at tide, high turbidity, several agricultural activities, buffalo farm, and fisheries activities nearby. Macrophytic floras were:

C. demersum, P. ustralus, T. domingensis, P. perfoliatus, N. marin, and M. spicatum. Al-Burgah is considered as an open shallow water marsh area with light transparency reach to the bottom. The dominant

plants were similar to that in previous station but more abundance, as well as some filaments algae.

Materials and methods:

The light and dark bottles method was used to determine primary productivity (16). The water samples were collected in winkler bottles (125 ml) from surface (20-30 cm) and from 1m depth as 1 bottle for initial Li, 2 bottles for light L1 and L2, and 1 bottle for dark or opaque were suspended at both surface and 1m depth which the samples were obtained incubated for 3-4 hours for 3 sites at each station. Equation below used to determine primary productivity:

P.P mg C m^{-3}. hr^{-1} = (L – D / incubation hours) X 0.375 X 1000

Where:

P.P = Primary Productivity

L = mean of L1 and L2 (light bottles)

D= dark bottle

0.375= from conversion Oxygen to Carbon 12/32 (17)

After incubation period 2 ml of manganese sulfate and 2 ml of alkaline iodide were added to all Winkler bottles, waiting 20 minutes then adding 2 ml of concentrated sulfuric acid in the field.

Chlorophyll-*a*

Each sample was well shaken and 0.5 liter was filtered by the Millipore Apparatus using GF/C 0.45 micron filter papers (18). Few drops of MgCO3 were added and filtered with the remaining sample before finishing the filtration process. This was done to stop the pH of the filter paper from becoming acidic and keeping the chlorophyll from breaking down. Then the filter paper is folded and kept in a closed vial in the refrigerator in the dark at -20°C until analysis in lab.

Results and Discussions:

During the study period total absence of dissolved oxygen (DO) was noticed once in the central marshes in April 2006 during incubation period. The results of this study showed that the dissolved oxygen values for the main marshes ranged 1.14 mg/l – 11.89 mg/l in central marshes during May 2006 and January 2006 respectively (table 2). Significant differences were recorded between central marshes and other studied marshes (Al-Hewaizeh and Al-Hammar Marshes). Highest dissolved oxygen values were recorded in Al-Hewaizeh marshes during most of the study period (summer & fall 2006) comparing with other studied marshes. The seasonal changes in DO values during the study period were clear, the maximum values were in winter season, while the minimum values were in summer season, in all studied marshes (fig 2),

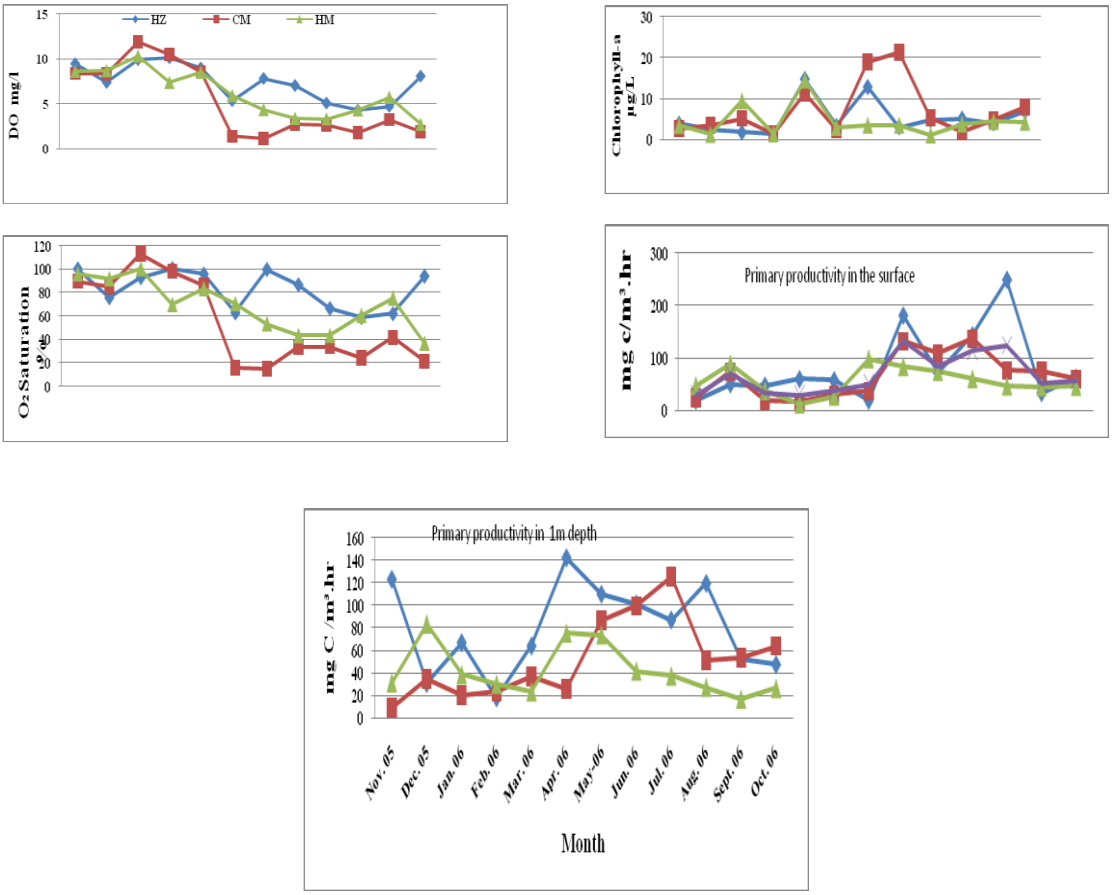

Fig.2: Seasonal variation in studied parameters for the studied Marshes, Al-Hewaizeh (HZ), Central Marshes (CM), and Al-Hammar (HM).

that may be due to increasing of photosynthesis rates by phytoplankton and aquatic plants and also, to the big surface water area which let ability for best mixed and more oxygen compensation from atmosphere [19]. The dissolved oxygen content of water is influenced by the source, raw water temperature, treatment and chemical or biological processes taking place in the distribution system. Depletion of dissolved oxygen in water supplies can encourage the microbial reduction of nitrate to nitrite and sulfate to sulfide [20].

Same results had been obtained by other researchers [21, 22, 23, 24, 25], they found that the values of DO were high in overall the marshes, which reached to 11.95 mg/l, except some rare places in which lower values (1.67 mg/L), but disagree with study of Al-Shawi [25] which recorded relative decreasing of DO in Al-Hammar and Al-Chebaysh (central marshes) from January to April 2004. Highly values of dissolved oxygen during winter in the studied marshes may related to the effect of temperature decreasing and delay of organic analysis processes in addition to the effect of continuously movement by wind in this season [26]. Lower oxygen concentrations in summer season in all studied marshes and especially in central marshes may be due to the increasing in water temperature and to increase of organic matter oxidation [26, 27]. A negative relationship between water temperature and water conductivity with dissolved oxygen was obtained, it was found throughout the results, based on the correlation, in addition that dissolved oxygen has highly significant negative correlation with chlorophyll-a.

Oxygen saturation values followed DO values approximately, lowest value recorded (14.56%) in central marshes during May 2006, while highest value (113.25%) during January 2006. Over saturation was observed during winter 2006 in all of studied marshes (fig 2), that may be due to the increasing in aquatic plants and phytoplankton photosynthesis with lower total counts in the same time (Table 2).

Table 2: The monthly variations of dissolved oxygen (mg/L) and oxygen saturation rate in the main Marshes . (Mean & standard error)

Months	Al-Hewaizeh		Central Marshes		Al-Hammar	
	DO	S%	DO	S%	DO	S%
Nov. 05	9.56±0.16 (A)abcd	100.25±1.49 (A)a	8.36±0.22 (B)cd	89.75±4,23 (B)bc	8.65±0.16 (B)bcd	95.77±1.98 (AB)a
Dec. 05	7.42±0.09 (B)ef	75.76±0.92 (B)bcde	8.3±0.38 (A)cd	85.11±3.87 (A)bc	8.76±0.27 (A)bcd	91.38±3.26 (A)ab
Jan. 06	9.94±0.68 (B)abc	94.61±7.76 (B)ab	11.89±0.33 (A)a	113.25±3.19 (A)a	10.35±0.10 (B)a	100.09±1.21 (AB)a
Feb. 06	10.14±0.14 (A)abc	100.56±0.79 (A)a	10.48±0.18 (A)b	98.15±1.99 (A)b	7.4±0.36 (B)d	69.52±3.06 (B)cdef
Mar. 06	9.01±0.11 (A)bcde	95.92±1.24 (A)ab	8.51±0.34 (A)cd	85.93±3.40 (AB)bc	8.46±0.52 (A)cd	83.12±5.50 (B)abc
Apr. 06	5.40±0.28 (A)g	62.73±3.11 (A)de	1.36±0.54 (B)h	15.56±6.28 (B)g	5.93±0.48 (A)e	70.23±6.31 (A)cde
6-May	7.86±0.82 (A)def	99.77±10.92 (A)a	1.14±0.15 (C)h	14.56±2.04 (C)g	4.37±0.25 (B)fghi	53.10±3.00 (B)fgh
Jun. 06	7.07±0.38 (A)g	86.75±4.45 (A)abc	2.7±0.11 (B)fg	33.39±1.38 (C)ef	3.4±0.06 (B)ghi	43.13±0.82 (B)gh
Jul. 06	5.13±0.62 (A)g	66.56±7.45 (A)cde	2.67±0.23 (B)fg	33.66±2.96 (B)ef	3.34±0.71 (B)hi	43.24±9.25 (B)gh
Aug. 06	4.35±1.16 (A)g	58.88±15.65 (A) e	1.8±0.22 (B)gh	23.96±2.97 (B)ef	4.37±0.66 (A)fghi	60.36±9.24 (A)defg
Sept. 06	4.77±0.09 (B)g	62.01±0.93 (B)de	3.23±0.30 (C)f	41.44±4.64 (C)e	5.75±0.34 (A)ef	75.11±4.76 (A)bcd
Oct. 06	7.72±0.86 (A)def	94.21±10.58 (A)ab	1.89±0.19 (B)gh	21.27±1.58 (B)fg	2.88±0.19 (B)i	36.63±2.36 (B)h

- Capital letters refers to significant differences among Marshes based on Duncan multiple range test at probability P<0.05.
- Small letters refers to significant differences among months based on Duncan multiple range test at probability P<0.05.
- DO = dissolved oxygen ; S % = oxygen saturation rate

Minimum saturation rate was recorded in Al-Hewaizeh marsh (58.88%) during August 2006, while maximum value was (100.56%) during February 2006. In Al-Hammar marsh saturation values were ranged 36.63 – 100.09 during October 2006 and January 2006 respectively (fig 2).

Chlorophyll-*a* concentration is used extensively for estimating phytoplankton biomass [28], and an algal biomass indicator [29, 30, 31]. Bimodal seasonal variations in chlorophyll-a were showed in this study (fig 2). An important factor keeping the phytoplankton biomass high is the nutrient uptake, which is enhanced by the high temperatures [32]. Chlorophyll-a concentrations in present study were ranged 1.1 – 21.26 µg/l, during July and June 2006, respectively.

In Al-Hammar marsh the values ranged 1.1 – 14.4 µg/l during July and March 2006 respectively, while in central marshes ranged 1.255 – 21.26 µg/l, and ranged 1.4 – 14.835 in Al-Hewaizeh marsh. The chlorophyll-a concentrations in phytoplankton may change according to the changes in the environment (10). Many factors play an important role in the concentration level of chlorophyll-a such as; the low suspended

particulate matter levels, that associated with high light penetration, water temperature, nutrient concentrations and grazing organisms [33]. Furthermore, the drop in chlorophyll-a concentrations in this study during winter were mainly due to the lower phytoplankton biomass [34].

The higher chlorophyll-a concentrations were recorded in Al-Hammar marshes during March 2006, while higher concentration were recorded in May 2006 at both Al-Hewaizeh and central marshes (Fig 2), this is may be due to high $PO4^{-3}$ concentrations in these three marshes . In addition, modest increases in water flow may enhance rates of algal growth because nutrient uptake and diffusion increases [35]. Previous studies in southern Iraqi marshes recorded values ranged between (0.14 – 22.18) µg/l. Many Iraqi researchers were studied the marshes after rehabilitation in 2003 and they recorded higher values of chlorophyll-a (2.2 – 63.7) µg/l in Abo Zirig marsh, [36, 37].

Studying primary productivity in the aquatic ecosystem provide more information about understanding obtainable energy and the nature of its transportation in benthic and planktonic communities (2). Primary productivity values in all main marshes ranged 9.38– 249.79 mg C/m^3.hr in the central marshes and Al-Hewaizeh marsh during November 2005 for 1 m depth water samples and August 2006 for surface water samples respectively (Fig 2), which is agreed with the previous studies done in southern Iraqi marshes and some of Iraqi aquatic ecosystems ranges between 1.6 mg C/m^3.hr recorded in Al-Hammar by Al-Lami, (10) to 750 mg C/m^3.hr was recorded in Al-Ashar canal [38]. The lowest value in the present study is higher than the lowest value recorded before, which may due to using different measuring method, while the highest value recorded in the aquatic Iraqi ecosystems was high more than highest value recorded in the present study that may because of the Eutrophication in Al-Ashar canal, in addition to the domestic wastes which increasing nutrients concentrations in the canal.

From the seasonal variation of primary productivity values, the highest values recorded during summer season months for both surface and 1m depth when clarity and water temperature were high, whereas the lowest values recorded during autumn and winter (fig 3).

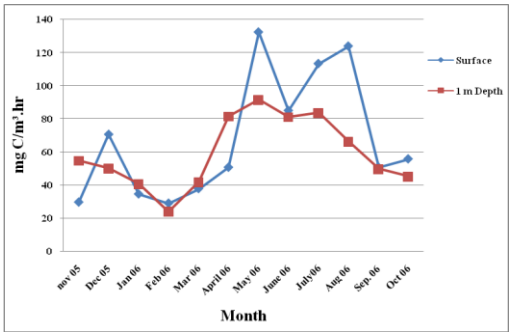

Fig.3: Seasonal variation in primary productivity for surface and 1m depth in all marshes (as a total) during study period.

The difference between two peaks that from seasonal variation during study period in primary productivity values may due to the differences in community structure and nutrient availability in the increasing periods [39], whereas the decreasing in these values in winter may be due to the decreasing in water temperature, which led to decrease in biological activities for aquatic organisms including phytoplankton.

Generally, seasonal variation in primary productivity in all of the main marshes tend to followed seasonal variation in both total count and

chlorophyll-a, which agree with [9, 10, 11].

Primary productivity values for surface marsh water were ranged 11.71 – 256.24 mg C/m^3.hr in Al-Hammar and Al-Hewaizeh marshes during February 2006 and March 2007, respectively. Seasonal variation showed that the highest values were recorded during spring and summer while the lowest values were recorded during autumn and winter (Fig 3).

Lowest values of primary productivity in Al-Hammar marsh were recorded during all of the study period (except in December 2005) and ranged 11.71 – 119.33 mg C/m^3.hr during February 2006 and March 2007 respectively. While Al-Hewaizeh recorded the highest values during most of the study period and ranged 18.75 – 256.25 mg C/m^3.hr during November 2005 and April 2006(for the lowest values) and March 2007, respectively (Table 3). Central marshes primary productivity values were ranged 15.39 – 253.13 mg C/m^3.hr during February 2006 and while April 2007 respectively.

Non significant correlation were shown between primary productivity and Chlorophyll-a in all marshes, which may be due to losses in very small phytoplankton which participated in primary productivity during filtration in chlorophyll-a extraction process. Similar dependence was stated in the study on Ely River, south Wales [40]. Primary productivity values for aquatic Iraqi ecosystems, ranged between lower values 1.6 mg C/m^3.hr recorded in Al-Hammar marsh (10) to the higher value 750 mg C/m^{3-} hr was recorded in Shatt Al-Arab [38].

Phytoplankton primary productivity values in 1m depth for all marshes ranged between 9.38 mg C/m^3.hr in central marshes during November 2005 to 142.5 mg C/m^3.hr in Al-Hewaizeh during April 2006 (fig 2). Al-Hammar marsh primary productivity values were ranged 16.63 – 83.86 mg C/m^3.hr during September 2006 and December 2005 respectively. Whereas Al-Hewaizeh primary productivity values during most of the study period were ranged between 18.33 mg C/m^3.hr during February 2006 to 142.5 mg C/m^3.hr during April 2006. Central Marshes primary productivity values were ranged 9.38 – 125.78 mg C/m^3.hr during November 2005 and July 2006 respectively (Table 3)

Table 3: The monthly variations of primary productivity (mg C/m³.hr) for surface water in the main Marshes. (Mean & standard error)

Months	Al-Hewaizeh		Central Marshes		Al-Hammar	
	Surface	I m depth	Surface	I m depth	Surface	I m depth
Nov. 05	18.75 ± 0.0 B)d)	123.44 ± 114.07 (bc (A	23.21 ± 1.79 (AB)g	9.38 ± 9.38 (g(A	46.88 ± 9.38 (A)cde	6.25 ± 31.25 (bcde(A
Dec. 05	50.21 ± 27.87 (A) cd	12.25 ± 31.14 (cd(A	73.54 ± 19.96 (def(A	11.02 ± 34.90 (efg(A	87.76 ± 51.53 (abc(A	55.21 ± 83.86 (ab(A
Jan. 06	47.62 ± 14.59 (cd(A	40.04 ± 67.32 (bcd(A	18.56 ± 2.93 (g(A	7.16 ± 20.36 (fg(A	37.37 ± 9.62 (cde(A	5.44 ± 38.54 (abcde(A
Feb. 06	59.79 ± 17.80 A)c)	4.75 ± 18.33 (d(A	15.39 ± 5.80 B)g)	3.96 ± 23.24 (fg(A	11.71 ± 3.81 (B)e	11.10 ± 29.94 (bcde(A
Mar. 06	57.92 ± 16.27 (cd(A	13.27 ± 64.38 (bcd(A	28.75 ± 8.0 (fg(A	8.98 ± 37.50 (efg(AB	26.76 ± 9.27 (de(A	4.50 ± 23.29 (de(B
Apr. 06	18.75 ± 4.27 (B)d	79.09 ± 142.50 (ab(A	35.63 ± 16.38 (B)efg	12.55 ± 26.08 (fg(A	97.49 ± 6.89 (A)ab	4.88 ± 75.69 (abcd(A
6-May	181.44 ± 56.46 (ab(A	14.56 ± 110.27 (abcd(A	132.29 ± 12.80 (bc(A	12.41 ± 87.18 (bcd(AB	82.97 ± 3.73 (abc(A	5.73 ± 73.96 (abcde(B
Jun. 06	73.54 ± 21.99 (cd(A	53.87 ± 101.63 (bcd(A	107.74 ± 7.91 (cd(A	12.53 ± 99.73 (ab(A	73.49 ± 11.78 (abcd(A	7.30 ± 41.77 (abcde(A
Jul. 06	143.75 ± 46.66 (bc(A	18.84 ± 87.50 (bcd(AB	136.09 ± 14.03 (bc(A	25.26 ± 125.78 (a(A	59.74 ± 5.61 (bcde(A	7.85 ± 37.45 (abcde(B
Aug. 06	249.79 ± 90.65 (A)ab	26.30 ± 119.79 (abcd(A	75.69 ± 25.52 (B)de	5.93 ± 51.39 (ef(B	45.83 ± 8.26 (B)cde	5.37 ± 27.24 (cde(B
Sept. 06	33.33 ± 9.50 (B)cd	4.19 ± 53.13 (bcd(A	74.52 ± 11.16 (A)de	13.78 ± 53.63 (def(A	44.74 ± 13.0 A)bcde)	16.63 ± 42.14)A(abcde
Oct. 06	62.50 ± 8.39 (cd(A	6.58 ± 47.92 (bcd(A	59.17 ± 6.28 (efg(A	6.24 ± 64.25 (cde(A	45.42 ± 9.11 (cde(A	3.75 ± 26.32 (cde(B

- **Capital letters refers to significant differences among Marshes based on Duncan multiple range test at probability P<0.05.**
- **Small letters refers to significant differences among months based on Duncan multiple range test at probability P<0.05.**

Highly significant positive correlations between primary productivity form 1m depth with primary productivity from surface and negatively significant correlation with dissolved oxygen.

The present results reveal that the restored marshes are oligotrophic to mesotrophic during the study period.

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الانتاجية الاولية للهائمات النباتية لاهوار جنوب العراق بعد اعادتها

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الخلاصة:

استعملت الانتاجية الاولية للهائمات النباتية والكلوروفيل-أ في هذه الدراسة لمراقبة عمليةِ إعادةِ اهوار جنوب العراق (الحويزة والاهوار المركزية والحمّار). اعتمدت طريقة قناني الأوكسجين ضوء/ظلام. أخذت عينتان بعمقين مختلفتين شهريا من ستة محطاتَ في الاهوار الثلاثة (محطتين لكلّ هور) للمدة من تشرين الثاني 2005 إلى تشرين الأول 2006، فيما أخذت عينات الكلوروفيل-أ من السطح فقط. تراوحت معدلات الإنتاجية الأولية بين 9.38 - 249.79 ملغم كاربون/م^3.ساعة لكلّ الاهوار، فيما تراوحت قِيَمها لعيّنةِ السطح بين 11.71 - 256.24 ملغم كاربون/م^3.ساعة بينما لعينة العمق 1m فتَراوحَت بين 9.38 - 142.5 ملغم كاربون/م^3.ساعة. سجلت قيم الكلوروفيل-أ مدى تراوح بين 1.1 الى 21.26 مايكروغرام /لتر للاهوار الثلاثة مسجلةً قيم عاليةلانتاجية الاهوارالمدروسة مقارنة بالمسطحات المائية العراقية الاخرى. ألاوكسجين الذائب ونسبة إلاشباع للأوكسجين قِيست ايضاً في هذه الدراسةِ.