

## Ecological impacts of exotic and marine migratory species on the fish's composition assemblage in East Hammer marsh/south Iraq.

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### Abstract

The fish assemblage of East Hammer marsh was studied seasonally from Autumn 2018 to Summer 2019 from three stations (Al-Sada, Al –Mansory, and Al-Burkha). The marsh fish assemblage during the study period consisted mainly of non-native species, marine migratory species formed (43.4 %) followed by tilapia species, other exotic and ornamental species included (34.7 %) in the third rank was native freshwater while in the species (21.9%). The highest and lowest diversity values of Shannon and Wiener (2.11) (1.20) was recorded in autumn and spring, respectively. Brillouin diversity values fluctuated between the highest (2.09) in summer and the lowest (0.43) in winter margalef richness index scored the highest value 1.95 in spring, and lowest (1.1) in winter both at Al-Sada station evenness values of Pielou scored the lowest value (0.24) in spring and the highest (0.67) in autumn. Jaccard Species similarity index attained the highest value (88.8 %) in spring between Al-Mansory and Al-Burka stations and the lowest (58.3%) between Al-Sada and Al- Burkha in spring Species dominance by Burger- Parker reached 90.0% in winter. The lowest 0.29% in autumn kwak and Petersom individual dominance scored the highest value (93) in winter. The lowest (58) in autumn, respectively, lamp intactness values reached 212.9 in 2019 nine species considered resident seven. Five species were seasonal and rare, respectively.

Keywords: Exotic, East Hammar, Fish assemblage, Marsh, Marine

### Introduction

Wetland was considered as a significant habitat for freshwater fish (Mitsch and Gosselink ,2000). Its composite system of a lot of organisms forms it on excellent protected area feeding and nursery grounds for younger fish (Allen *et al.*, 2002 ). Van der Valk (2006) postulated that the tidal marshes are characterized by their high biological productivity consequently. East Hammer marsh became a vital feeding and nursery ground, attracted a lot of migratory organisms like fish, birds, and shrimps.

East Hammer marsh represents the southern part of the wide Iraqi southern marshes. It is a

semi-diurnal tidal marsh affected by the Arabian Gulf's tidal action via the Shatt Al Arab River. The marsh was subjected to deliberate desiccation by the Saddam regime during the nineties of the last century after inundation in 2003. The marsh exhibited the return of its flora and fauna to some extent ( Richardson and Hussain,2006). The construction of several irrigation dams on Tigris and Euphrates rivers in Turkey, Syria, Iran, and Iraq led to the reduction of freshwater flow qualitatively and quantitatively delivered to the southern marshes. The reduction of freshwater discharge to East Hammer marsh changed marsh nature to be mesosaline (Hussain and Taher 2007 ),

consequently altering its conditions to be more favorable to marine/estuarine organisms.

Several studies dealt with the nature of the fish assemblage of restored southern marshes, especially East Hammer marsh-like (Hussain *et al.* 2008. Hussain *et al.*, 2009. Mohamed *et al.* 2009, CIMI, 2009 and Mutlak *et al.*, 2012).

This study investigates the nature of the fish assemblage in East Hammer marsh after transfusion of the salt wedge from the Arabian Gulf in 2018. Calculation of the general ecological indices and comparison with previous studies and estimated the marsh instance.

### Materials and Methods:

East Hammer marsh occupied the southern part of the vast Iraqi marshes situated to the northwest of Basrah city and extended to the west to reach Dhi qar province. The marsh is affected by the semi-diurnal tide from Arabian Gulf via the Shatt Al-Arab River, characterized by hot temperate weather with short winter and long summer. The marsh Covered by emerged aquatic plants, mainly *Phragmites australis*, *Typha demoningesis*, and *Schinoplactus littoralis*. Several marine fish migrate to Hammer marsh during spring and summer seasons, mainly anadromous species *Tenaulosa ilish* and several Mugilid species and Penaeid shrimp *Metapeanus affinis* spawning or feeding or nursery ground.

Three stations were chosen to represent different marsh habitats,

1-Al Sada station: represent the marsh's actual entrance with water depth fluctuated during ebb

and tide (6-7.5 meters). It is situated at (N:30° 36' 47") (E:47° 40' 15").

2- Al Mansouri station: represent an expansive channel marsh with a mean water depth of 5-6.5 meters. It is situated at (N: 30° 40' 26") (E:47° 37' 57").

3- Al Burkha station: It represents an openness marsh with a water depth of 1-4 meters. It is situated at (N 47° 33' 2") (E:30° 41' 44").

### Ecological indices were calculated by applying for the PAST 3 program.

Lamb intactness index was calculated according to Lamb *et al.* (2009) individual dominance after Kwak and Peterson (2007). Species Similarity was calculated after Jaccard (1908).

### Water parameters measured:

Maximum and Minimum values of some water parameters were measured in the three chosen stations that affect the occurrence and distribution of different fish species in the marsh.

### Water temperature :

The maximum and minimum values of water temperature were recorded during winter and summer in all three stations. It ranged between 15.0 C° in winter 2019 at Al-Sada station and 33.0 C° in summer at Al-Burkha, Table (1).

### Salinity :

The maximum and minimum salinity values were recorded during autumn and summer in the three stations with ranges between 3.2 ‰ in summer 2019 at Al-Sada station and 14.2 ‰ in autumn 2018 Al-Burkha, (Table 2).

Table (1) maximum and minimum values of water temperatures C° recorded in the three stations at East Hammer marsh during Autumn 2018 to Summer 2019.

Stations	Minimum values (Winter 2019)	Maximum values (Summer 2019)
Al- Sada	15.0 C°	30.0 C°
Al- Mansory	15.5 C°	31.0 C°
Al- Burkha	14.0 C°	33.0 C°

Table (2) maximum and minimum salinity(%) values recorded in the three stations at East Hammer marsh during the period from Autumn 2018 to Summer 2019

Stations	Minimum (Summer2019)	Maximum Autumn2018)(
Al - Sada	3.2 ‰	12.2 ‰
Al- Mansory	3.5 ‰	14.0 ‰
Al- Burkha	3.8 ‰	14.2 ‰

#### Hydrogen Potential:

The maximum and minimum values of pH values were recorded during autumn and summer in all three stations with ranges between 7.8 in summer 2019 at Al-Sada station and 8.7 in autumn 2018 at Al-Burkha (Table 3) Positive correlation with salinity ( $r = 0.23$ ) ( $r = 0.650$ ) ( $r = 0.603$ ).

#### Dissolved oxygen (DO):

Maximum and minimum values of DO (mg/l) values were recorded during winter and summer in all three stations with ranges between 5.0 mg/l in summer 2019 at Al-Sada

station and 8.5 mg/l in winter 2019 at Al-Burkha, Table (4).

#### Turbidity (NTU):

Maximum and minimum values of turbidity values were recorded during summer and winter in all three stations, ranging between 23.4 NTU in summer 2019 at Al-Burkha station, and 10.2 NTU in winter 2019 Al-Sada (Table 4). statistically, analysis reveals the existence of a positive difference between stations ( $p < 0.05$ ).

Table (3) Maximum and minimum pH values recorded in the three stations at East Hammer marsh from Autumn 2018 to Summer 2019 .

Stations	Minimum (Summer2019)	Maximum (Autumn 2018)
Al- Sada	7.8	8.7
Al- Mansory	8.1	8.3
Al- Burkha	8.3	8.5

Table (4) maximum and minimum dissolved oxygen values mg/l recorded in the three stations at East Hammer marsh during the period from Autumn 2018 to Summer 2019

Stations	Minimum (Summer2019)	Maximum (Winter2019)
Al- Sada	5.0 mg/L	8.5mg/L
Al- Mansory	5.9 mg/L	8.4 mg/L
Al- Burkha	6 mg/L	8.3 mg/L

Table (5) maximum and minimum turbidity values (NTU) recorded in the three stations at East Hammer marsh from Autumn 2018 to Summer 2019.

Stations	Minimum (winter2019)	Maximum Summer (2019)
Al- Sada	10.2 NTU	16.2 NTU
Al-Mansory	16 NTU	21 NTU
Al- Burkha	20 NTU	23.4NTU

### Ecological indices

The number of fish species and their individuals was counted to evaluate the fish assemblages. Ecological indices assemblages qualitatively and quantitatively in three stations at East Hammer marsh during the four seasons. Past 3 program was used to calculate the following indices.

**1-Brillouin** diversity index: The Brillouin index results varied seasonally between low to medium in the studied stations. Values ranged from 1.05 in winter2019 (0.92 average) at Al-

Burkha station to 1.92 in summer 2019 (1.95 average) at Al-Sada station (Table 6).

### 2-Shannon and Wiener diversity Index (H):

The maximum and minimum values of Shannon and wiener diversity values were recorded during summer and winter in all three stations with ranges between 1.994 in summer 2019 at Al-Sada station and 0,4257 in winter 2019 at Al-Mansory (Table 7).

Table (6) maximum and minimum Brillouin diversity index values recorded in the three stations at East Hammer marsh from Autumn 2018 to Summer 2019.

Stations	Minimum (winter2019)	Maximum (Summer2019)
Al- Sada	1.30	1.92
Al-mansory	0.43	2.09
Al- Burkha	1.05	1.85
Average	0.92	1.95

Table (7) Maximum and minimum Shannon and Wiener diversity index values recorded in the three stations at East Hammer marsh during the period from Autumn 2018 to Summer 2019

Stations	Minimum (winter2019)	Maximum (Summer2019)
Al- Sada	1.337	1.944
Al- Mansory	0.4257	2.114
Al- Burkha	1.086	1.867
Average	0.98	1.98

### 3- Margalef, richness index (D):

No pattern appears for maximum and minimum values of Margalef, richness index values in the three stations at East Hammer marsh the maximum value 1.95 was recorded during spring 2019 at Al-Sada station, and the

minimum one 1.16 in winter 2019 in Al-Sada station. Also, lower values were recorded in winter in all three stations, ranging between 1.994 in summer 2019 at Al-Sada station and 0.4257 in winter 2019 at Al-Mansouri, (Table 8).

Table (8) maximum and minimum margalef richness index values estimated in the three stations at East Hammer marsh from Autumn 2018 to Summer 2019.

Stations	Minimum	Maximum
Al- Sada	1.16 (winter2019)	1.95 (spring2019)
Al- Mansory	1.19 (autumn 2018)	1.82 ( Summer2019)
Al- Burkha	1.28 (spring2018)	1.73 (Summer2019)
Average	1.21	1.83

### 4- Pielou evenness index (J)

Pielou evenness value's minimum values showed a constant trend with lower values in winter 2018 on the opposite maximum values were recorded during summer and autumn in all three stations with ranges between 0.5823 in summer 2019 at Al-Sada station and 0.2018 in autumn 2018 at Al-Burkha (Table 9).

recorded between Al-Sada and Al-Mansory station, also in autumn 2018 (Table 10).

The cluster analysis of similarity of fish catch reveals that summer catch was formed separate group from the other three seasons in all three stations studied

### 5- Jaccard Species similarity (Ss) :

Jaccard similarity index reached its maximum of species similarity between Al-Burkha and Al-Mansory stations (88.8%) in autumn 2018. The lowest similarity was

### 6- Burger-Parker dominance index :

The index of Burger-parker dominance value exhibited different modes The maximum values of Burger-Parker dominance index values were recorded during winter 2018 ( 0.9091 ) at Al-Mansory station with a minimum value of 0.2971 at Al-Burkha In autumn 2018 (Table 11).

Table (9) maximum and minimum values of the Pielou index recorded in the three stations at East Hammer marsh during Autumn 2018 to Summer 2019.

Stations	Minimum values (winter2019)	Maximum values
Al- Sada	0.4761	0.5823 (Summer2019)
Al- Mansory	0.1747	0.6353(Autumn 2018)
Al- Burkha	0.3291	0.6784(Autumn 2018)

Table (10) maximum and minimum values of Jaccard similarity index estimated in the three stations at East Hammer marsh during the period from Autumn 2018 to Summer 2019.

<i>Jaccard Similarity index</i>	Autumn 2018	Winter 2019	Spring 2019	Summer 2019
Al-Sada X Al-Burkha	69.2%	63.3%	58.3%	68.7%
Al-Burkha X Al-Mansory	88.8%	81.8%	66.6%	88.8%
Al-Sada X Al-Mansory	61.5%	63.6%	69.2%	68.7%

Table (11) Maximum and minimum values of Burger–Parker dominance index recorded in the three stations at East Hammer marsh during the period from Autumn 2018 to Summer 2019

Stations	Minimum values (Summer 2019)	Maximum value (winter2019)
Al- Sada	0.2626	0.5813
Al- Mansory	0.2453	0.9091
Al- Burkha	0.2971 (Autumn)	0.6928

### 7-Kwak & Peterson (D<sub>3</sub>)

#### Numerical dominance index

Kwak and Peterson's numerical index showed no single trend developed to illustrated numerical dominance. It seems to change according to the seasons in all the three stations in East Hammer marsh., with the maximum value ( 93 ) in winter 2019 and minimum value (53) in autumn at Al-Mansory station (Table12)

### 8 – Lamp intactness index :

The purpose of Lamp intactness index is to compare the improvement or deterioration in diversity values Hussain (2008 ) was used as a basic record since it is the oldest study on marsh

fish (Table 13) showed that Lamp intactness index facultative during the last decade, with small improvements 143.4 2008 in comparison with 124.5 in 2005. Values of.2019 increase to reach 165.24 in 2018/19.

#### Fish Origin:

Different fish species were classified according to their origin into four categories 1-Native 2- Exotic 3- Marine migratory 4-Invader.

The results obtained from the three stations indicated that native species represent 21.7%, marine species 43.4%, and exotic ones34.7%. Total of marine and exotic was 78%

Table (12) maximum and minimum values of Kwak- Peterson (D<sub>3</sub>) index estimated in the three stations at East Hammer marsh during Autumn 2018 to Summer 2019.

Stations	Minimum	Maximum
Al- Sada	62 (spring 2019)	86( autumn2018)
Al- Mansory	53 Autumn( 2018)	93 (winter2019)
Al- Burkha	65 (autumn2018)	90 (spring 2019)

Table (13) maximum and minimum values of Lamp Intactness index recorded in the three stations at East Hammer marsh during Autumn 2018 to Summer 2019.

Reference	Shanon Diversity index	Lamp intactness value
Hussain et.al,(2008)	1.91	Basic record
Hussain et al.,(2006)	1.69	202.5
Al-Shamary (2007)	2.13	179.4
Matluk (2012)	2.58	155.9
Ridee(2014)	2.29	171.1
Present study	1.49	212.9

Table (14): Percentage of Native species (N), marine (M), exotic (E), combined marine and exotic (M+E), and (T) the total of species, from 2005 to 2018 at East Hammer marsh.

Reference	M+E/T	E/T	M/T	N/T
Al-shamary (2008)	0.63	0.30	0.33	<b>0.36</b>
Hussain et.al, (2009)	0.55	0.20	0.34	<b>0.44</b>
Lazem (2009)	0.73	0.26	0.30	<b>0.42</b>
Mutlak et. al, (2010)	0.48	0.27	0.21	<b>0.51</b>
Mohamed et. al, (2012)	0.75	0.50	0.25	<b>0.25</b>
Mohamed et .al, (2013)	0.56	0.26	0.30	<b>0.43</b>
Radee (2014)	0.69	0.0.20	0.48	<b>0.28</b>
Hameed (2017)	0.76	0.23	0.52	<b>0.23</b>
Present study	0.78	0.34	0.43	<b>0.21</b>

The ratio of native to intruder species was higher in Al-Sada station than Al-Burkha on the contrary, the ratio of non-native was lower in Al- Burkha in comparison with Al-Sada station (they like to move upper intertidal shallow water zone of the marsh )

#### Seasonal occurrence :

Table (15) showed the seasonal occurrence of fish species caught in East Hammer marsh after Tyler(1971). Nine species were residences, Seven considered seasonal, and five were rare (Table 15).

Table (15): Categorization of seasonal occurrence of fish species after Tyler (1971).

Category	No. Seasonal occurrence	Species
Resident	4-3	<i>P.latipinna, O.niloticus, O.aureus, C.zillii, C.auratus, B.fscus, H.leucisculus, P.abu, T.whiteheadi</i>
Seasonal	2	<i>P.sphenops, S.sihama, T.ilisha, S.triostegus, B.luteus, C.carpio, P.supvirids ,</i>
Rare	1	<i>N.nasus, A.dispar, S.orientalis, P.indicus, P.melanostigma, B.dussmieri</i>

A comparison of major ecological indexes (Diversity, Shannon & Wiener, Richness (Marglef) and Evenness (Pioleu)) calculated in

East Hammer Marsh during the last decade is shown in Table (16).

Table (16). Comparison of major environmental indices (Diversity, Richness, and evenness) calculated in East Hammar Marsh.

Reference	Diversity (Shannon & Wiener)	Richness (Marglef)	Evenness (Pioleu)
Al-Shamary (2008)	2.76-1.40	-	-
Hussain <i>et al.</i> (2009)	2.01-1.07	2.83-0.74	0.84-0.52
Mutlak (2012)	2.61-1.28	4.50-1.98	0.78-0.45
Mohamed <i>et al.</i> (2012)	0.90-1.60	0.80-1.70	0.40-0.80
Radee (2014)	2.74-1.9	3.81-2.39	0.84-0.69
Present study	1.68-1.22	1.98-0.95	0.54-0.32

### Discussion :

The effectiveness of major abiotic factors (water temperature, dissolved oxygen, hydrogen optional, and turbidity) increase in two seasons, summer and winter, more than the other seasons. Their effectiveness coincides with other ecological indices factors or affects their basic components in a way or another. These ecological indices factors showed the same pattern like Brillouin ecological index, Shannon Wiener ecological index, Pielou evenness index and Burger-Parker dominance index.

In summer, the marsh witnessed an increase in the number of species and number of individuals due to the migration of juvenile fishes from the Arabian Gulf and the joining of young of the year recruits of the marsh fish assemblages. On the contrary, they migrate back to Shatt Al-Arab estuary and the Gulf to avoid low water temperatures in winter.

In general, Hussain (2014) postulated that ecological indices were affected by the number of species occurred and their number of individuals present at the water bodies. Higher numbers of ecological indices express the stability of the ecosystem while the lower ones express the deterioration of the ecological system in the East Hammer marsh.

Recently i.e. during 2018-2019, East Hammer marsh fish assemblage was dramatically dominated by exotic tilapia, ornamental and marine migratory species (82.6%). Compared with previous studies (Hussain *et al.* 2008

Al-Shamary 2008, Mohammed 2009 Mutlak *et al.* 2012) indicated the native species formed more than 40% of the assemblage. On the other hand, an increase in salinity also led to the decrease of the abundance of native species. Previously the fish assemblage consisted mostly of native species with the dominance of freshwater mullet (*P. abu*), while in 2019 was by *O. niloticus*, *O. aureus*, and *C. zillii*.

During the last decade, the hydrological conditions of East Hammer marsh had been changed directly due to sharp decrease of freshwater flow from Tigris and Euphrates led to a noticeable increase in salinity due to penetration of wedge salt front from Arabian Gulf during summer 2018, that led to the rise in migration of marine fish species to be abundant in the marsh.

The fish assemblage in East Hammer marsh suffers from notable changes in its nature and origin. Due to the increase of exotic ornamentals and marine species in the marsh, salinity increases play a significant role in changing the marsh's fish assemblage composition. Exotic and marine species represented 82.6% of the population in 2019; previously, it was around 40% (Younis, 2005).

The percentage of native species keeps declining with progressive years from 51% in 2009 (Hussain *et al.*, 2009) to 25% in 2017 (Hameed, 2017) and to 17.4% (present study).

The steady increase of salinity in East Hammer marsh during the last decade could be



the main reason led to the disappearance of intolerant native freshwater species like (*B.xanthopterus* *B.grypus* *B.sharpeyi* and *A.vorax*); since these species could tolerate a limited increase in salinity oligohaline species, the increase of salinity changed the environment of the marsh from oligo to be mesosaline on the contrary the increase of salinity facilitate the environmental conditions

for exotic tilapia and migratory marine species to colonize the marsh and thrive.

Display of ecological indices recorded in East Hammar marsh

during the last decade exhibited that their values decreased continuously to current values study 2019. This conclusion was supported by Lamp intactness index 179.4 ( Al-Shmary,2007) to 212.9(present study).

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## التأثيرات البيئية لأنواع الغريبة والبحرية المهاجرة على تركيب مجتمعات الأسماك في هور شرق الحمار / جنوب العراق.

### المستخلص

تم دراسة تجمعات أسماك هور شرق الحمار موسمياً من خريف 2018 إلى صيف 2019 في ثلاث محطات (السدة، المنصوري، البركة). تألف تجمعات أسماك المستنقعات خلال فترة الدراسة بشكل رئيسي من الأنواع غير المحلية، حيث شكلت الأنواع البحرية المهاجرة (43.4%) تليها أنواع البلطي، أما الأنواع الغريبة وأنواع الزينة الأخرى المدرجة (34.7%) - أما في المرتبة الثالثة فكانت مياه عذبة محلية (21.9%). تم تسجيل أعلى وأدنى قيم تنوع لشانون ووينر (2.11) (1.20) في الخريف والربيع على التوالي. تذبذبت قيم تنوع برلويين بين اعلاها (2.09) في الصيف وأدنى (0.43) في الشتاء. سجل مؤشر غني مارجالف أعلى قيمة 1.95 في الربيع، وأدنى (1.1) في الشتاء على حد سواء في محطة السدة، بينما أدنى قيمة للتكافؤ (0.24) في الربيع وأعلى (0.67) في الخريف. سجل مؤشر تشابه أنواع الجاكارد أعلى قيمة (88.8%) في الربيع بين محطتي المنصوري والبركة وأدنى (58.3%) بين السدة والبركة في الربيع. بلغت قيمة دليل برجر باركر 90.0% في شتاء. وسجلت أقل نسبة 0.29% في قيمة سيادة كواك وبيتيرسوم في الخريف وأعلى قيمة (93) في الشتاء. سجلت أدنى قيمة (58) في الخريف، على التوالي. بلغت قيم lamp intactness 212.9 في عام 2019 تسعة أنواع تعتبر سبعة منها مقيمة. خمسة أنواع كانت موسمية ونادرة.

الكلمات المفتاحية: أسماك غريبة، شرق الحمار، تجمعات أسماك، أهوار، بحرية