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Impacts of the tide and ebb on the fish assemblage diversity in the East Hammar Marsh, southern Iraq

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ABSTRACT

Due to the lack of studies that were conducted on fish populations and the impacts of the tide on fish diversity, composition, and abundance in the east Hammar marsh, to evaluate the status of the marsh from January to December 2020. Some ecological variables were measured and represented by water temperature, salinity concentrations, and hydrogen ions. A total of 4217 fish individuals were caught from the study area, epitomizing 18 families belonging to 29 genera and 37 fish species, all affiliated with Osteichthyes. Cyprinidae and Engraulidae represented the most abundant families sheared in four species each. Four species preside the East Hammar marsh, forming 62.58% of the overall fish in the investigated region: *Planiliza abu*, *Carassius gibelio*, *Thrayssa whiteheadi*, and *Poecilia latipinna* recorded 20.44, 17.76, 14.28, and 10.10% respectively. The fish fauna diversity included the native species where 14 species formed 28.05% of the total caught. Nine exotic species consisting 48.19% of the overall fish. The marine species were 14 species counting 23.76% of the total catch. The present study concluded that the marsh was subjected to deterioration in the environment due to increased salinity, which led to a change in fish assemblage composition to exotic, ornamental fish, and marine species, with a decline the native fish species.

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تاثير المد والجزر على تنوع التجمع السمكي في هورشرق الحمار، جنوبي العراق

عبدالحسين جعفر و محمد جاسم و قصي الحمداني

جامعة البصرة

الخلاصة

بسبب نقص الدراسات التي اعدت على التجمعات السمكية وتاثيرات المد والجزر على التنوع السمكي وتركيبتة ووفرته في هور شرق الحّمارلتقييم حالة الهور للفترة من كانون الثاني الى كانون الاول 2020. قيست بعض المتغيرات البيئية ومثلت بدرجة حرارة الماء وتراكيز الملوحة والاس الهيدروجيني. صيد مامجموعه 4217 سمكة من منطقة الدراسة، مثلت 18 عائلة و29 جنساً و37 نوعاً من الاسماك جميعها تنتمي الى صنف الاسماك العظمية (Osteichthyes). مثلت عائلتا الشبوطيات (Cyprinidae) و Engraulidae الاكثر وفرة وشاركتا باربعة انواع لكل منهما. ساد اربعة انواع هور شرق الحّمار شكلت 62.58% من المجموع الكلي لعدد الانواع في منطقة الدراسة: اسماك الخشني *Planiliza abu* و *Carassius gibelio* ونوع من اسماك الشيغة *Thrayssa whiteheadi* واسماك المولي *Poecilia latipinna* التي سجلت 20.44% و 17.76% و14.28% و 10.10% على التوالي. تضمن التنوع السمكي، الاسماك المحلية الاصيلة (native) 14 نوعاً شكلت 28.05% من الصيد الكلي. شملت الانواع الدخيلة تسعة انواع كونت 48.19% من الاجمالي العام للاسماك. كان عدد الاسماك البحرية 14 نوعاً كونت 23.76% من الصيد الكلي. استنتجت الدراسة الحالية بان الهور يتعرض لتدهور بيئي بسبب زيادة الملوحة التي تؤدي الى تغير تركيبة التجمع السمكي الى انواع دخيلة واسماك زينة واسماك بحرية مع انحدار في اعداد افراد الانواع الاسماك المحلية الاصيلة.

الكلمات المفتاحية: الأراضي الرطبة، التركيب، الأسماك، التدهور

INTRODUCTION

The East Hammar Marsh differs from other Iraqi marshes in southern Iraq, it is a tidal wetland once or twice during the day (Hussain *et al*., 2020; Habeeb *et al*., 2023). The marsh is wide lowland wetlands located northwest of Basrah City, originating from a meeting of the two main rivers (Mohamed *et al*., 2017; Olson & Speidel, 2024). The present marsh has a unique character represented by dynamic habitats and a high biodiversity of fish communities from freshwater and marine water, within the complex interaction of tide and ebb process movement that conserve the ecological balance (Hussain & Sabbar, 2020; Khaleefa *et al*., 2024). The East Hammar marsh was subjected to a drying process during the nineties of the last century, as the other marshes in Iraq. After 2003 the water was returned Farajzadeh & Jameel (2023), however, the now time, the marsh suffers from fluctuating water levels, in addition to being subject to the high concentration of salinity and the decline of the supply sources due to the water scarcity greatly of the Euphrates River, at present the marsh mainly provides water from the Shatt Al-Arab River (Rahi & Halihan, 2021). These wetlands are fragile environments, therefor the knowledge of the relationship between tide-ebb and the diversity of fish is critical to managing and maintaining the marsh ecosystem (Teichert *et al*., 2018). On the other hand, the salty tidal current coming from the Arabian Gulf rushed into the marsh significantly, affecting the environment, distribution, composition, and diversity of the fish community, as well as plant and animal organisms alike (Abdalhsan, *et al*., 2020). The fish fauna in the marsh have a characterized composition that differs from the rest of the marshes by occurrences of marine fish

species, exotic and some tolerant native species (Hussain *et al*., 2020). Densities and speared of fish in the current marsh are organized by the tide and ebb oscillation regulating the distribution of nutrients, water circulation, and availability of habitats (Colombano *et al*., 2021; Scherelis *et al*., 2020). Additionally, marshes have wide flexibility to absorption the seasonal variations in the level of water which increases the dynamics of tide and ebb, which creates a dynamic environment that continuously helps to structure fish assemblage in the marsh (Leonardi *et al*., 2018). In wetlands especially in the East Hammar marsh the diversity of fish results from the involvement of ecological interactions that are affected by both anthropogenic activities and natural processes (Aziz *et al*., 2021; Raadi *et al*., 2023). Marshes execute many functions to fish communities such as refuging, nursing grounds, spawning, and feeding areas, which sustain diversity (Meerhoff & de los Ángeles González-Sagrario, 2022). These functions can mitigate human activity pressures, like water pollution, overfishing, and habitat degradation that generate increasing pressures on the fish population (Cao *et al*., 2024). The present study has a significant benefit to the fish assemblage and survival in the future, within understanding tide pattern effect on fish diversity in the marsh, and regarding tidal zone, intertidal zone, and subtidal zone to mitigate the threats, across put and develop strategies that face habitat degradation and climate change (Colombano *et al*., 2021).

The marsh is an environment of natural life that can be a sink for heavy metals and nitrate and phosphate (Abdalhsan *et al*., 2020; Hussain *et al*., 2020). East Hammar Marsh semidiurnal tidal ecosystem works as a buffer area from upstream and downstream estuary ecosystems. It supports the high macrophyte diversity and organizes a unique macrophyte zone life pattern with a distinct system for primary production, which has high efficiency in decomposition processes (Hardwick *et al*., 2022). Several studies dealt with fish assemblage composition in the present marsh, Hussain, *et al*. (2008) studied population structure and environmental indices in the south of Iraq wetlands., Hussain, *et al*. (2009) discussed with structure and ecological indices of fish assemblage of the recently restored Hammar Marsh. Lazem (2009) investigated the Structural composition of fish assemblages and their relation with biotic factors of karmat Ali River, south of Iraq. Mohamed *et al*., (2014 a) investigated the variations in the population in the investigated region. Mohamed *et al*. (2014b) discussed the composition of fish assemblage in the East Hammar marsh, southern Iraq. Hussain *et al*. (2020) studied the pattern of zonation in the current marsh. Abdalhsan *et al*. (2020) discussed the marine fish and influence of alien species in the present investigated region. Despite the importance of the present ecological system, there were some works discussed the variations of tidal effect in current study work, but they remain a rarity.

The current study aimed to discuss fish populations, their relationship with tidal patterns, and the impact of tide and ebb on fish diversity in the East Hammar marsh, as well as assess the distribution, composition, fish size, and abundance of fish assemblages.

MATERIALS AND METHODS

The current study discussed fish population composition and the impact of the tide and ebb on the fish diversity in East Hammar Marsh, southern Iraq. The caught fish were cared for according to the animal care guidelines recommended by the Animal Ethics Committee of the Marine Science Center, University of Basrah.

The study area outreach about 25km from Al-Burkah (station 1 N 30° 45′ E 47° 30´) to Al- Al-Mansury region (station 2 N 30° 39′, E 47° 42′) and Al-Sada region (station 3 N30° 33′ E 47° 42′) northwest Al-Basrah City (Figure 1).

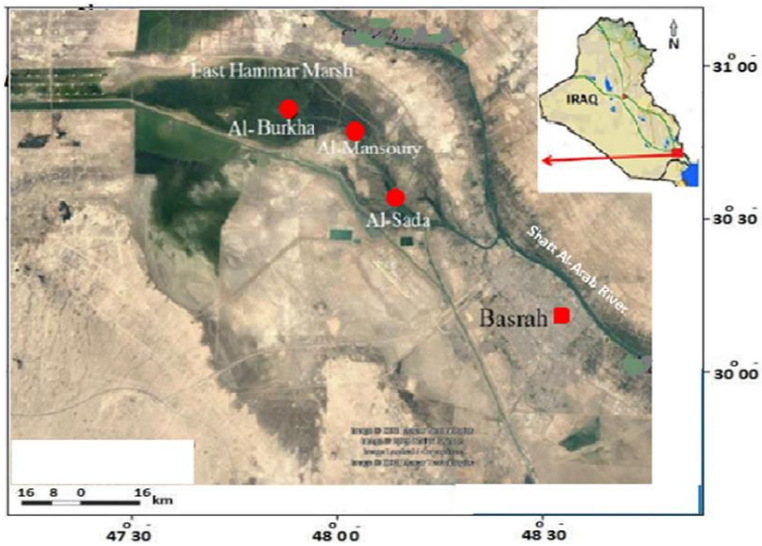

Figure (1): Map of the study area in the East Hammar marsh

The monthly sampling was taken from the marsh from January to December 2020. Some ecological parameters were taken synchronously with the fish sampling, water temperature was examined by a mercurial thermometer (-10 to 100 ºC), and salinity and pH by Lovibond-Sensor Direct 150 Germany manufactured. Samples of fish were collected monthly from the study area using various fishing methods. Fishes were classified followed by Fricke *et al.* (2020) and updated the rest of the scientific names according to Froese & Pauly, (2024). Fish diversity following Huang *et al.* (2019), occurrence of species, and ecological indices following Nyitrai *et al.* (2012).

Statistical analysis

In order measure the variance (ANOVA) among the study months and stations in the number of species and individuals ($P \leq 0.05$) used Statistical Package for Social Science-ver. 20 program (SPSS). The relationships in temperature, salinity, and Hydrogen-ion with species number and individuals were implemented by the same program.

RESULTS AND DISCUSSION

Water temperature strongly related to air temperature, with the lowest degree 14.50 ^{0} C were recorded in January 2020, then started to rise to reach its highest 34.53 ^{0} C in July then declined gradually to recorder December, the mean ± SD 25. 89 ± 7.22. The salinity was exhibited

relatively high due to semidiurnal tide from the Arabian Gulf, the lowest value 3.16 psu was recorded in April, but the highest value was 14.12 psu in September, and the mean ± SD was 4.21 ± 1.51. The hydrogen potential concentration values slightly fluctuation to recoded 7.27 in November whereas the highest value was 8.33 in March, and the mean ± SD was 7.73 ± 0.34 (Figure 2). The examination of the correlation between species number temperature of water showed a significant relationship (r = 0.643*), while a weak relationship (r = 0.238) between the number of individuals and water temperature. The ANOVA analysis of water temperature, salinity, and pH detected, referred to no significant difference (P>0.05) among all study sites.

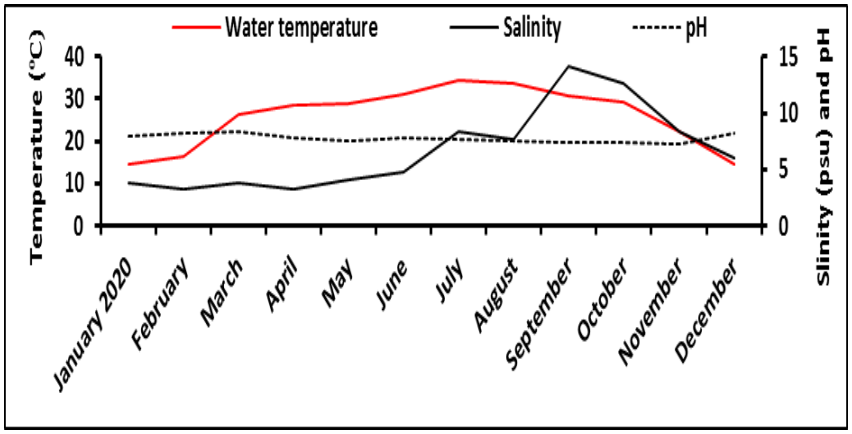

Figure (2): Monthly variations in the some of ecological factors in in the East Hammar marsh from January to December 2020

Water temperature is a significant parameter that can run an organism's activity including fish, such as migrations, feeding, spawning, and spread (Johnson *et al*., 2024). Temperature can affect other abiotic factors by increasing evaporation and raising salinity concentration, with decreasing oxygen concentration in the aquatic ecosystems, with their impact on the decomposition process in the aquatic habitats (Moxley *et al*., 2019). Water salinity has a significant impact on the normal repartition, spread, and structuring of fish assemblages in aquatic ecosystems, especially in estuarine ecosystem patterns (Koehler *et al*., 2022). Fish assemblage in the estuarine habitats has a wide range of euryhaline fish species that adapt to brackish ecosystems in which marine and freshwater species can live (Whitfield, 2021). The hydrogen ion in the East Hammar region tends to be alkaline due to the presence of carbonate and bicarbonate in the surrounding soil, therefore the present results tend to the alkaline direction (Qzar *et al*., 2021).

The present results recorded 18 families belonging to 29 genera and 37 fish species all of them affiliated to the Osteichthyes class, collected from East Hammar marsh included14 native species, nine exotics, and 14 marine species, three species that can live in three habitats freshwater, brackish, and marine species, and one species can be inhabiting in brackish and marine habitats **(Table 1).**

Table (1): Families with their fish species, habitat, native, and exotic in the East Hammar marsh from January to December 2021.

Family	Species	Habitat	Native	Exotic
Mugilidae	*Planiliza abu*	F	N	
	Planiliza subviridis	M		
	Planiliza klunzingeri	M		
Engraulidae	*Thryssa whiteheadi*	M		
	Thryssa vitrirostris	M		
	Thryssa hamiltonii	M		
	Thryssa mystax	M		
Dorosomatidae	*Tenualosa ilisha*	M		
	Nematalosa nasus	M		
Cyprinidae	*Carassius gibelio*	F		E
	Carasobarbus luteus	F	N	
	Carasobarbus sublimus	F	N	
	Cyprinus carpio	F		E
Leuciscidae	*Leuciscus vorax*	F	N	
	Alburnus mossulenssis	F	N	
	Acanthobrama marmid	F	N	
Oxudercidae	*Boleophthalmus dussumieri*	M-B		
Poeciliidae	*Gambusia holbrooki*	F		E
	Poecilia latipinna	F-B		
Xenocyprididae	*Hemiculter leucisculus*	F		E
Gobiidae	*Bathygobius fuscus*	F-B-M		
	Periophthalmus waltoni	F-B-M		
Bagridae	*Mystus pelusius*	F	N	
Heteropneustidae	*Heteropneustes fossilis*	F		E
Sillaginidae	*Sillago arabica*	M		
	Silago sihama	M		
Mastacembelidae	*Mastacembelus mastacembelus*	F	N	
Sulridae	*Silurus triostegus*	F	N	
Cichlidae	*Orechromis niloticus*	F		E
	Orechromis aureus	F		E
	Coptodon zillions	F		E
Sparidae	*Acanthopagrus arabicus*	M		
	Sparidentex hasta	M		
Platycephalidae	*Platycephalus indicus*	M		
Soleidae	*Brachirus orientalis*	M		
Aphaniidae	*Paraphanius striptus*	F	N	
	Aphaniops dispar	F-B-M		

F= Freshwater species B=Brackish species M= Marine species E=Exotic species

Both abiotic and biotic factors can contribute to structuring fish assemblage composition in the East Hammar marsh, especially salinity, which plays a significant role in fish assemblage composition (Fischer & Quist, 2019). The gradually increased salinity concentrations in the East Hammar wetlands could change fish assemblage building from native species to migratory marine species, ornamental, and exotic species (tilapia fish species) (Abdalhsan *et al*., 2020; Husain *et al*., 2020). The variations in the nature of water in the East Hammar marsh from oligohaline to mesohaline due to decreased discharge of the Tigris and Euphrates rivers in the last decade may be the major reason that make the native species departure toward low salinity regions or to the north (Al-Gburi *et al*., 2017; Paredes del Puerto *et al*., 2022).

The number of species exhibits a slight difference among the stations chosen stations in the present study area, for the ANOVA analysis there were no significant differences ($P > 0.05$) in the number of species among the three chosen stations. The number of species varied from 14 fish species in December to 25 species in May and September (Figure 3).

A total of 4217 fish were captured from the study area, fluctuating from 159 in December to 619 in April. The data analysis of ANOVA analysis showed no significant differences ($P > 0.05$) in the number of specimens found among the three selected stations (Figure 3).

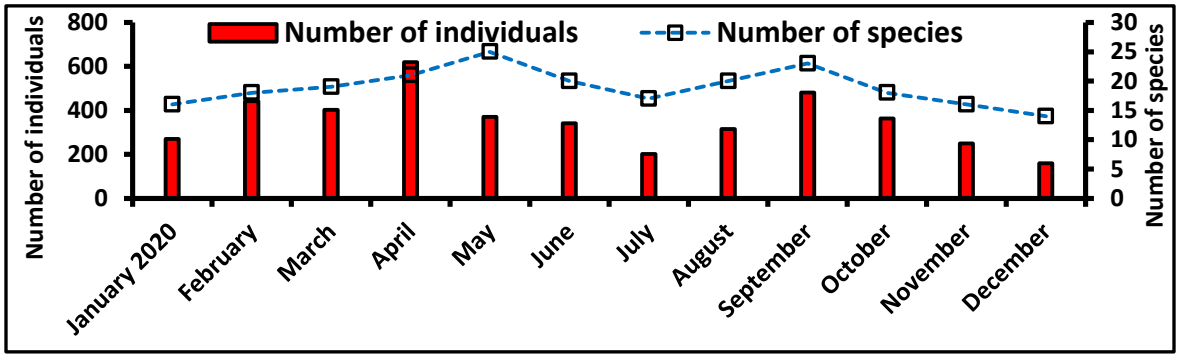

Figure (3): The monthly fluctuations in the number of species and individuals in East Hammar marsh

The present study has seen a notable increase in the number of species and their individuals, as a result, the present tidal wetland represents spawning, nursing, refuge, and feeding regions of many fish species, to join with year recruit, in addition to juveniles that migrate from Arabian Gulf and the Shatt Al-Arab estuary to the East Hammar marsh (Hussain *et al*., 2020).

The relative abundance of species in the represented study area is distributed among some native, exotic, and marine species (Table 1). Four species preside over the East Hammar marsh, all of them exceeded 10% percent forming 62.58% of the overall species in the investigated area. The species *Planiliza abu*, *Carassius gibelio*, *Thrayssa whiteheadi*, and *Poecilia latipinna* were recorded 20.44, 17.76, 14.28 and 10.10% respectively. However, many species recorded proportions of abundance less than 1% represented in 25 fish species.

Table (1): Monthly variations in the relative abundance of species in the East Hammar marsh

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Octo.	Nov.	Dec.	Total
P. abu	29.63	42.56	13.90	18.74	15.63	25.51	15.35	12.70	25.36	18.96	24.80	23.90	20.44
C. gibelio	20.00	37.60	22.33	12.92	11.59	18.18	19.80	21.90	15.80	19.51	17.60	18.24	17.76
T. whiteheadi		39.67	16.63	15.02	17.52	24.34	20.79	5.71	13.51	18.68	1.20	1.26	14.28
P. latipinna	16.30	31.82	16.38	12.76	7.82	3.23	4.46	17.78	4.37	2.47	10.00		10.10
O. aureus	7.04	5.79	5.96	12.12	9.16	5.28	10.89	6.67	13.93	13.19	19.20	15.72	9.84
T. ilisha	0.74	1.65	12.66	13.25	16.44	9.38	6.44	13.02	2.91	3.85	1.20		7.52
C. zillii	11.85	6.61	4.47		2.43		5.45	4.76	5.61	4.67	4.80	7.55	4.01
O. niloticus		4.55		5.33	5.39	2.64	0.99	6.03	4.16	4.40	5.60		3.41
A. mossulenssis	0.74		0.50	0.16	1.62	1.47	1.98	1.90	1.87	6.87	3.60	10.06	2.02
G. holibrooki	2.59	3.72	0.99	2.42	2.16	1.17		1.27	2.29			5.66	1.68
S. triostegus	1.48	1.65	0.99	0.97	1.08	1.76	3.96		1.66	1.65	3.60	3.77	1.54
L. vorax	1.48	1.24	1.49	1.45	1.08	1.17	2.97	1.90	1.46			5.03	1.35
C. luteus	0.74	1.65		0.65	0.81	0.88	0.99	1.59	0.83		2.40	2.52	0.88
C. carpio	1.11		0.99		1.08	1.17	0.50	1.27	1.25	1.10	1.60		0.81
A. arabicus			0.50	0.65	0.81	0.88	2.48	0.32	0.83	0.55	0.80	1.26	0.66
H. leucisculus				0.81		0.88	1.98		0.83	0.55	1.20		0.50
A. marmid	2.22		0.25		0.81				0.62			2.52	0.40
A. dispar	2.59				0.81					1.10			0.33
B. fuscus				0.65	0.27	0.59		0.32	0.42			1.89	0.33
P. klunzingeri		0.83		0.97		0.59		0.63		0.55			0.33
C. sublimus		0.83	0.74		0.81					0.55			0.24
S. sihama			0.25		0.54			0.32		0.82	0.80		0.21
P. subviridis		0.83		0.32				0.63	0.62				0.21
B. dussumieri								0.95	0.62		1.20		0.21
M. mastacembelus	0.37	0.41	0.25	0.32	0.27			0.32					0.17
N. nasus			0.25		0.54	0.29				0.55			0.14
T. vetrirostris	1.11					0.29							0.09
S. arabica			0.50			0.29							0.07
H. fossilis		0.41							0.21			0.63	0.07
T. hamiltonii				0.16					0.42				0.07
P. waltoni					0.27		0.50						0.05
M. pelusius				0.16			0.50						0.05
T. mystax		0.83											0.05
P. striptus									0.42				0.05
B. orientalis					0.54								0.05
S. hasta					0.54								0.05
P. indicus				0.16									0.02

The results show that four species topped the relative abundance of the studying area *Planiliza abu*, *Carassius gibelio*, *Thrayssa whiteheadi*, and *Poecilia latipinna* forming 62.39% of the total catch, the results agree with the most recent studies that implemented in the East Hammar marsh (Al-Shamary *et al*., 2011; Mohamed *et al*., 2014a; Mohamed *et al*., 2014b; Mohamed *et al*., 2017). All these studies correspond with the present results regarding the dominance of these species. This species is characterized by a high tolerance of difficult conditions. Most of them possess small sizes that enable this species to live in shallow areas,

with high concentrations of salinity and low oxygen levels in the segregated pools (Abdullah *et al*., 2022).

Fish fauna diversity

The native freshwater species were 14 species ranging from four species in November and eight in May, the mean ± SD 6.25 ± 1.06, which formed 28.05% of the total caught. Exotic species were nine species fluctuating from four in December to eight in May, August, and September, with the mean ± SD 6.00 ± 2.09, the exotic species consisting 48.19% of the overall fish. The marine species counted 14 species differ from two species in January to eight species in June, the mean ± SD 6.67 ± 1.15, counting 23.76% of the total catch. The analysis of data by ANOVA detected no significant differences (P > 0.05) in the number of native, marine, and exotic species among the three selected stations (Figure 4).

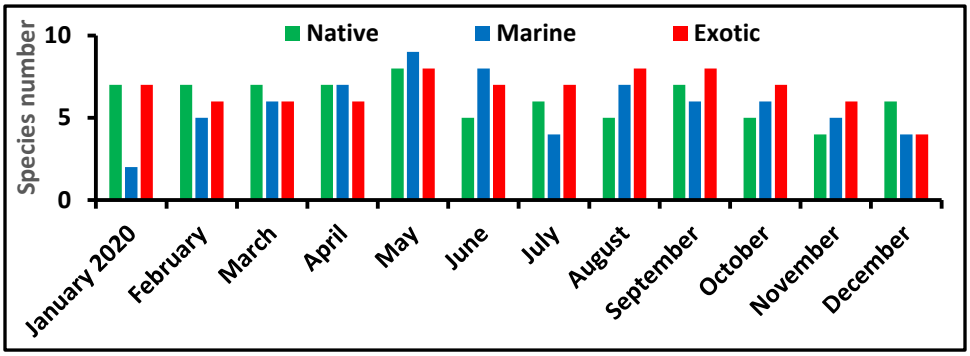

Figure (4): Monthly variations in the native, exotic, marine species in the East Hammar marsh

The native fish species continue to decline in the East Hammar marsh due to the deterioration of the environment as a result of increased salinity concentrations, caused by the reduction of the Tigris and Euphrates Rivers discharge, which enhanced the deep penetration of saltwater waves from the sea (Al-Asadi *et al*., 2023). Hussain *et al*. (2009) mentioned that the native fish species formed 51% of the total caught in the present marsh, then the percentage keeps declining with progressive time to recorded 25% with Hameed (2014) after that 21% (Abdalhsan *et al*., 2020). However, Abdullah *et al*. (2022) pointed out that native species formed 24.35% of the Garmat Ali River, these values represented a low percentage, but these differences may be due to spatial and temporal variations and due to fishing tools and methods (Gonzalez *et al*., 2021).

The diversity indices values witnessed slight monthly variations during the study time (Figure 5). The diversity index (H) in the present figure represents the mean values that measure the tide and ebb in the study area. The mean values of the diversity index ranged from 2.15 in February to 2.44 in September, with the mean ± SD 2.28 ± 0.089. The richness index fluctuated from 2.68 in January to 3.43 in June, with the mean ± SD 3.07± 0.246. The evenness index varied from 0.40 in February, and June to 0.63 in December, the mean ± SD 0.49 ± 0.070.

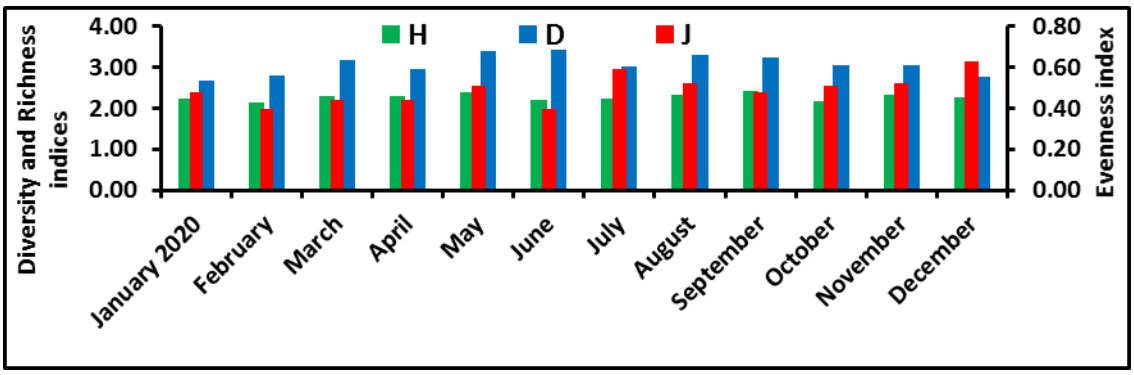

Figure (5): Monthly variations in the values of ecological indices in the East Hammar Marsh from January to December 2020

The ecological indices are within the trend of previous studies that have been implemented in the East Hammar marsh. The current results indicate a high level of diversity, as the marsh is the only tidal environment in southern Iraq that supports freshwater, brackish, and marine water species (Abdalhsan *et al*., 2020; Hussain *et al*., 2020).

The diversity index values in the status of tide ranged from 1.99 in February to 2.38 in May, with the mean ± SD 2.21 ± 0.12. In contrast, the values of the diversity index in ebb were lower than in the tide and fluctuated from 2.07 in October to 2.56 in September, with mean ± SD 2.35 ± 0.14 (Figure 6).

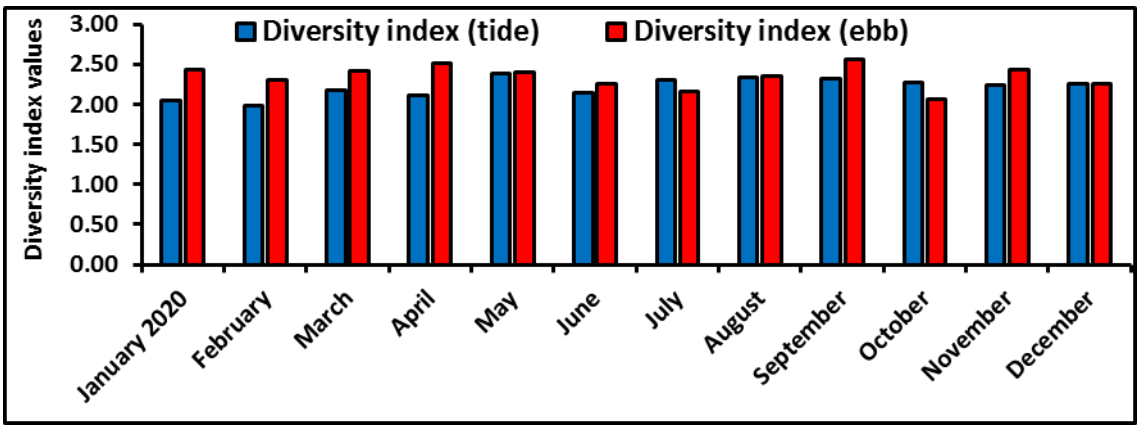

Figure (6): Monthly variations in the values of ecological indices in the tide and ebb in the East Hammar Marsh from January to December 2020

The current study is the first to measure the values of diversity in the status of tide and ebb in the marsh, requiring effort and continuous monitoring of the study environment. The findings suggest that diversity values are slightly higher in the ebb than in the tide. This could be because fishing tools perform better in low-water conditions than in high-water conditions (Tikadar et al., 2021).

Species size was assessed for three specimens that differed due to tide and ebb, as well as water level variation. The range of length groups of *Cyprinus carpio* in the tide varied from

12cm to 32cm, with the dominant length group being 20cm in three specimens of the total catch of 17 fish, with many length groups that did not appear. In the status of ebb, the results were differing, the length groups fluctuated from 12cm to 26cm addition to the disappearance of many length groups. The prevailing length group is 12cm in nine fish of the total caught 36 individuals.

The length groups of *Leuciscus vorax* in the tide varied from 13cm to 33cm, the dominant group was 18, 27, and 29cm in three individuals each of a total number of fish 30 specimens, some of the length groups were not caught. In the ebb, the length group is 9 to 26cm, with the absence of many length groups. The prevailing group was 14cm of the total caught of 38 fish.
Length groups of *Silurus triostegus* in the tide ranged from 13 to 35cm, with the absence of some length groups, the length group 14cm topped the groups in the tide in five individuals of the 35 specimens that caught of these species. In the ebb status, the length groups fluctuated from 10 to 24cm, some of the length groups did not appear, with the length group 13cm prevailing in eight individuals of the overall fish that were caught (Figure 7).

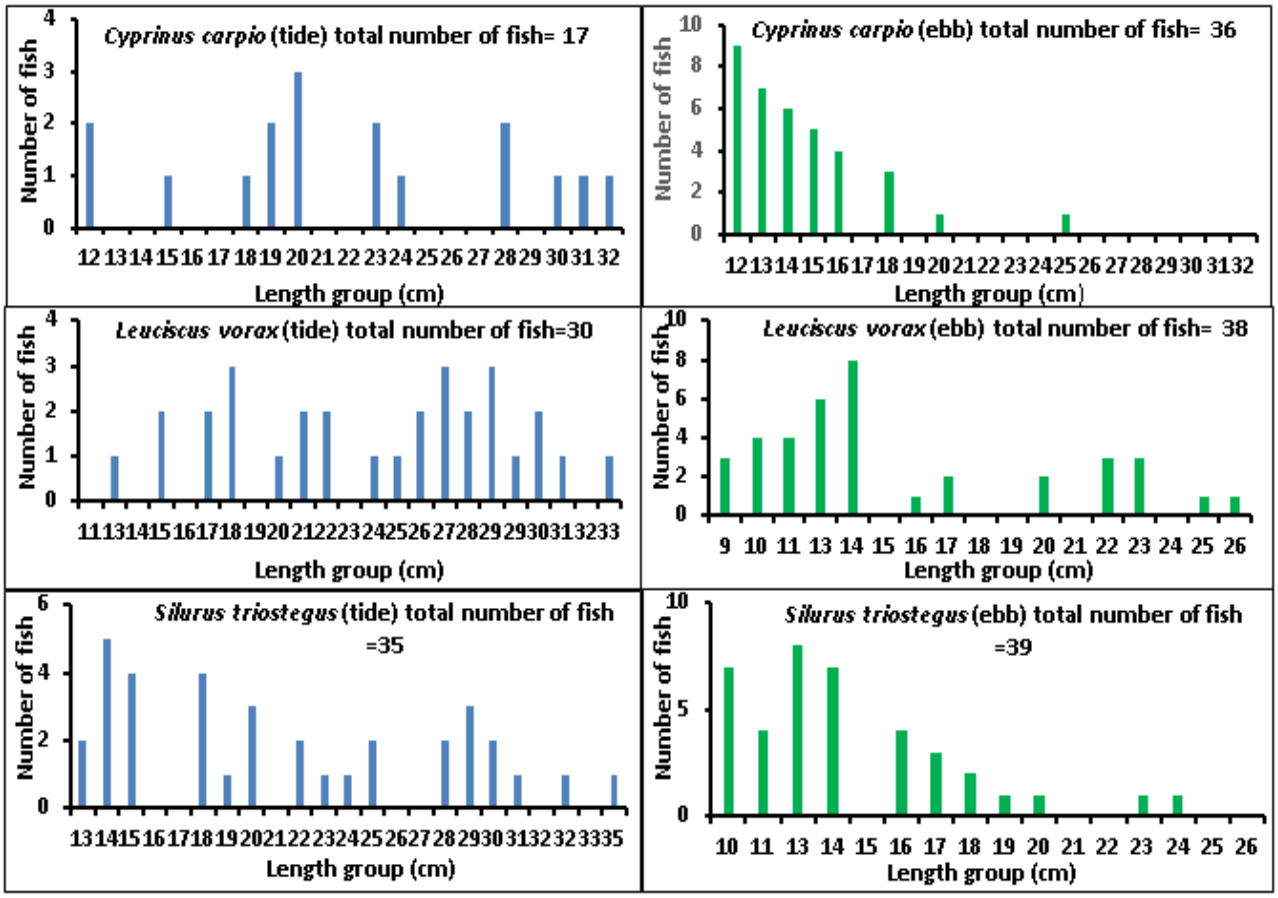

Figure (7): Fish size spectrum of three species in both tide and ebb in the East Hammar marsh from January to December 2021.

Fish size spectrum varies depending on many factors: Overfishing, pollution, Genetic aspect, suitability of habitats, food available, and depth of water (Xu *et al*., 2021). Fish size spectrum is a measuring of population features especially regarding abundance and production. An

ecosystem can have affected the fish size, due to the biological and ecological character and the trophic levels could be limiting fish size (Dantas *et al*., 2019; Keppeler *et al*., 2020). The present results show the shallow regions included many small-sized fish, in contrast, the large size has a high abundance in deeper water (Brucet *et al*., 2017; Spoljar *et al*., 2021).

CONCLUSIONS

The present study concluded that the marsh is in continuous deterioration caused by the steadily increased salinity concentrations due to the reduction in the Tigris and Euphrates rivers discharge, which allows penetration to saline waves deluge from the sea, and increased salinity with change composition of fish species to exotic, ornamental fish, and marine fish species as well as to decline in the number of native species. These impacts led to the decadence of tidal marsh environments and forced many sensitive fish species (*Arabibarbus grypus*, *Mesopotamichthys sharpeyi*, and *Luciobarbus xanthopterus*) to leave or the number of individuals of some species became scarce in the East Hammar marsh. Also, the study concluded that the fish diversity was raised with ebb and decreased with the tide. The study shows that most caught in the ebb were formed from small-size fish, but in the status of the tide were from large size fish.

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CONFLICT OF INTEREST

The authors declare no conflict of interest regarding the present manuscript.

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