MARSH BULLETIN 18(2) September (2023) 148–165

MARSH BULLETIN

ISSN 1816-9848

A review study of fish assemblage and their abundance in Shatt Al-Arab River from 1989 to 2019

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Abstract

The current review study examined the fish assemblage and abundance in the Shatt Al-Arab River from 1989 to 2019. Five studies were used to gather data on the fish species present in the river during this period. A total of 88 fish species were recorded, belonging to 74 genera and 33 families. Most of the species were bony fish, with only three species being cartilaginous fish. The studies documented a combination of native, marine, and exotic fish species. Different studies had varying numbers of fish species recorded. Study 1 included 33 fish species, Study 2 had 25 species, Study 3 documented 40 species, Study 4 captured 58 species, and Study 5 recorded 44 species. The most abundant species varied between the studies, with notable species including *Nematalosa nasus*, *Gambusia speciosa*, *Planiliza abu*, *Acanthobrama marmid*, *Aphaniops dispar*, *Carassius auratus*, *Tenualosa ilisha*, *Planiliza subviridis*, and *Planiliza klunzingeri*. The diversity and richness of fish species also varied between the studies. The diversity index ranged from 1.19 to 3.06, with Study 1 having the highest diversity. The richness index ranged from 2.50 to 4.37, with Study 1 having the highest richness. The study concluded that the fish composition in the Shatt Al-Arab River had significantly changed over the years due to factors such as the introduction of exotic species, increased organic waste disposal, oil pollution, salinity intrusion, and changes in River inflow.

Keywords: Evaluation, Fish populations, Shatt Al-Arab River, Diversity

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Introduction

The Shatt Al-Arab River has undergone significant changes over time, resulting in the deterioration of river habitat represented by the decline rates of the Tigris and Euphrates River discharge, with increasing tidal wave impact from the Arabian Gulf leading to increasing salt concentrations in the river (Mohamed and Abood, 2017a). The river is subject to daily tidal fluctuations, which have resulted in significant changes in the composition and abundance of the fish community, in addition to the biotic and abiotic factors that affect the different fish populations in the river, such as freshwater, brackish, or marine species (Cheng *et al.*, 2019). Salinity has a significant impact on the distribution and spread of organisms in estuaries, including fishes (Kultz, 2015). A salt gradient occurred along the course of the river and decreased upstream. Therefore, the fish assemblage structure varies with the longitudinal extent of the river (Chea *et al.* 2017). The composition of the fish community in the Shatt Al-Arab River varies

according to the state of the daily tides, the portion of the river, the distance from the northern end of the Gulf, and other subordinate factors, including the amount of discharge coming from the Tigris and Euphrates rivers and tidal waves that depend on the amount of freshwater discharge that controls the salinity concentration in the river (Al-Mahmood and Mahmood, 2019; Mohamed and Hameed, 2019). In general, owing to the entry of marine fish species, the levels of diversity and richness increase downstream near the estuary and decrease upstream (Vasconcelos *et al.*, 2015). As a result of the aforementioned factors, the estuary's location is not constant and varies depending on the amount of freshwater received and the strength of the tidal wave coming from the sea (Zhang *et al.*, 2018). Large variations occur in the abundance of fish populations owing to hydrolytic dynamic changes, although the reduction in the flooding effect is the result of many dams that are constructed on the head of the river basin (Ducrotoy *et al.*, 2019). However, the structure of the estuarine fish assemblage, which includes freshwater, resident, and marine species, and the selection of river habitats, is voluntarily controlled by biotic and abiotic factors (Sreekanth *et al.*, 2019; Nashima *et al.*, 2021). The significance of these two factors in finding the spatial and temporal patterns of fish abundance and occurrence in estuaries is still unknown. Generally, the diversity of abiotic factors has been shown to impacts fish usage in estuaries (Sreekanth *et al.*, 2019). On a spatial scale, salinity and turbidity and on a temporal scale, temperature, have been identified as the best predictors of estuarine species abundance and temporal and spatial population structure (Polansky *et al.*, 2018; Jaureguizar *et al.*, 2021). Nonetheless, it has been proposed that biotic processes such as food availability, competitive pressure, as well as predation may play a role in the spatial and temporal distribution of fish in estuaries (Shuai *et al.*, 2016; da Silva Jr *et al.*, 2016). Hussain *et al.* (1989) investigated the seasonal fluctuation of fish assemblages in the Shatt Al-Arab River in Basrah, Province, and Hussain *et al.* (1995) investigated the influence of low salinity, temperature, and domestic sewage on the distribution of fish assemblages in the Shatt Al-Arab River. Mohamed *et al.* (2012) investigated the longitudinal patterns of fish community structure in the Shatt Al-Arab River, Mohamed *et al.*, (2015) investigated the longitudinal patterns of fish community structure in the Shatt Al-Arab River, Mohamed et, (2017a) documented compositional variability of fish assemblages in the Shatt Al-Arab River, and Mohamed and Hameed (2019) discussed the impacts of saltwater intrusion on the fish assemblage in the middle part of the Shatt Al-Arab River.

This study aimed to assess the compositional changes in fish assemblages in the Shatt Al-Arab River from 1989 to 2019.

Materials and methods

Description of studding area

The Shatt Al-Arab River originates from the confluence of the Tigris and Euphrates Rivers in Al-Qurna town (Fig. 1). The river flows approximately 204 km to the Arabian Gulf, and the width of the river differs from 250 m to 2 km in the estuary (Allafta and Opp, 2020). The depth of the river ranged from 4.2 m to 15 m. Three main tributaries belong to the river: the Al-Sweeb River, Garmat Ali River, and Karun River, and there are many branches coming out of the river from both sides. The Shatt Al-Arab River was subjected to twice the daily tidal current from the Arabian Gulf, water lever ranged from 3 m at the estuary to 0.5 m near the river at the origin of the river (Abdullah, 2017).

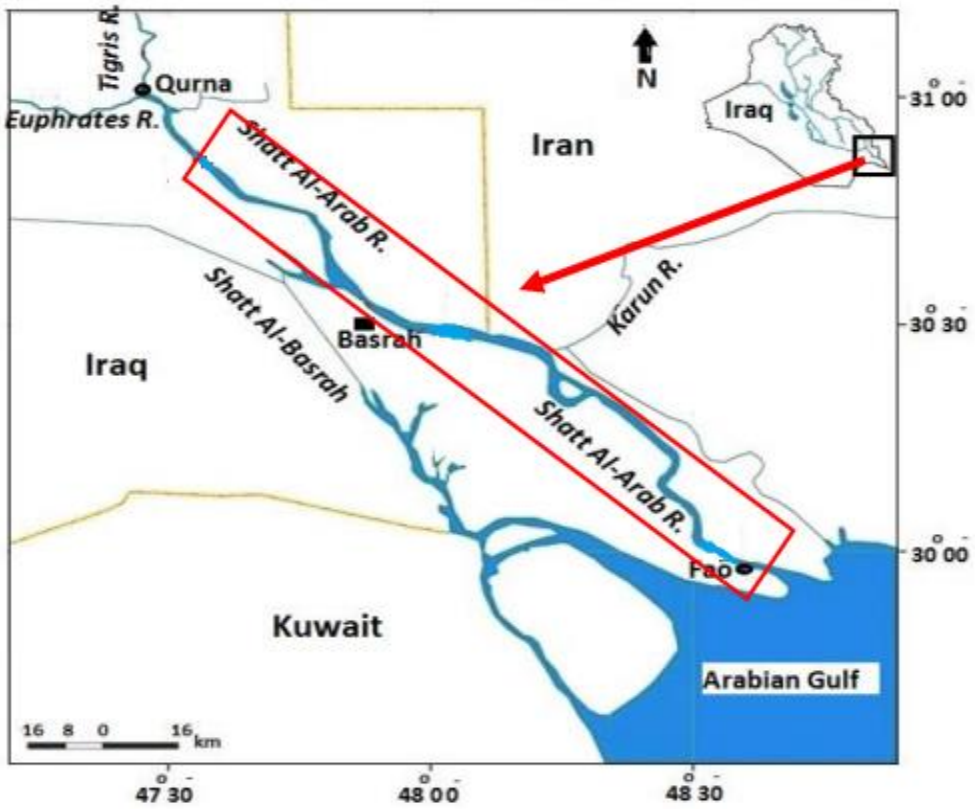

Fig.1. The map of the Shatt Al-Arab River illustrates these five study areas.

Various fishing methods were used in the five studies to collect fish samples, including gill nets, hook and line-cast nets, seine nets, and electro-fishing using generator engines (300-400 V and 10 A). Fish were identified and counted as described byMahdi (1962) and Carpenter *et al.* 1997, Coad, 2010). Some scientific names of fish species have been updated according to Fricke *et al.* (2022) and Froese and Pauly (2022), especially in pioneering studies. The data in the present study is taken from the five studies used in the present paper.

In the current review, five studies dealing with fish assemblage structure in the Shatt Al-Arab River from 1989 to 2019 were used. Hussain *et al.* (1989) regard study 1, Hussain *et al.* (1995) as study 2, Mohamed *et al.* (2012) as study 3, Mohamed *et al.* (2015) as study 4, Mohamed and Hameed (2019) as study 5 (Table 1).

Table 1. The five studies reviewed in the present study and part of the Shatt Al-Arab River

The study	Shatt Al-Arab part	Sampling period	Study
Hussain *et al.* (1989)	Al-Ashar Jetty to Al-Ashar River	Feb. 1982 to Jan. 1883	Study 1
Hussain *et al.* (1995)	Al-Sindbad Island to Dackyard	Jan. 1992 to Nov 1993	Study 2
Mohamed *et al.* (2012)	Al-Dayer to Al-Fao	Jun. 2010 to Mar. 2011	Study 3
Mohamed *et al.* (2015)	Al-Dair Bridge to Abu Al-Khasib	Dec. 2011 to Nov. 2012	Study 4
Mohamed and Hameed (2019)	Al-Sindbad Island to Abu Al-Khasib	Jan. to Dec. 2018	Study 5

Measured relative abundance %
= (ni/N) × 100 following Walag *et al.* (2016), where ni is the number of individuals of the species and N = Total number of individuals of all species.

Estimation of fish diversity
H = -Σ pi ln pi (Huang *et al.*, 2019), where H is the diversity index and Pi is the proportion of the total species caught.

The calculated richness index was
D = S-1/ln N according to Nyitrai *et al.* (2012), where D = Richness index, S is the number of species, and N = Total number of species.

Estimation of evenness index
J = H/lns according to Nyitrai *et al.* (2012), where J = evenness index and H = diversity index S: number of species.

The similarity index was estimated to compare the similarity of species occurrence among the five studies using the following equation (Jaccard, 1908):

$$Ss\% = (a / (a+b+c)) * 100$$

Where Ss = Similarity index, a= number of species that appear in studies a and b, b= number of species that occur in study a and nonexistent in study b, and c= number of species observed in study b and absent in study a.

Results

Composition of fish species

The number of fish species that were recorded from the Shatt Al-Arab River in the present five studies conducted from 1989 to 2019 was 88 species, representing 74 genera and 33 families, including 85 species of bony fish, and three species of cartilaginous fish. Study 1 documented 33 fish species affiliated to 30 genera and 20 families, while Study 2 collected 25 fish species belonging to 22 genera and 15 families, Study 3 captured 40 species belonging to 33 genera and 19 families, Study 4 identified 58 species belonging to 46 genera and 27 families, and Study 5 identified 44 fish species, including 34 genera and 22 families (Table 2). The ANOVA analysis revealed significant differences ($p < 0.05$) between Studies 1 and 4 in the number of individuals of each species and significant differences ($p < 0.05$) between Studies 3 and 4 in the number of specimens of each species.

Table (2). Fish species were captured from the Shatt Al-Arab River in six studies conducted from 1989 to 2019.

Family	Species	Study1	Study2	Study 3	Study 4	Study 5

Carcharhinidae	*Carcharhinus leucas*				+	
Gobiidae	*periophthalmus waltoni*			+		
	Boleophthalmus dussumieri			+	+	+
	Bathygobius fuscus		+	+	+	+
	Periophthalmus kallopterus	+	+			
Engraulidae	*Thryssa whiteheadi*			+	+	+
	Thryssa vitrirostris				+	+
	Thryssa dussumieri					+
	Thryssa hamiltoni	+	+	+	+	
Cyprinidae	*Arabibarbus grypus*	+	+	+	+	
	Carasobarbus luteus	+	+	+	+	+
	Carassius auratus			+	+	+
	Cyprinus carpio		+	+	+	+
	Cyprinion kais				+	
	Garra rufa		+			
	Luciobarbus kersin	+	+		+	
	Luciobarbus subquincunciatus	+				
	Luciobarbus xanthopterus	+	+		+	
	Mesopotamichthys sharpeyi	+	+		+	
	Barbus spp.			+		
Leuciscidae	*Acanthobrama marmid*		+	+	+	+
	Alburnus mossulensis	+	+	+	+	+
	Alburnus caeruleus				+	
	Leuciscus vorax	+	+	+	+	+
Xenocyprididae	*Ctenopharyngodon idella*			+	+	
	Hemiculter leucisculus			+	+	+
	Hypophthalmichthys molitrix				+	
Cichlidae	*Coptodon zillii*			+	+	+
	Oreochromis aureus				+	+
	Oreochromis niloticus					+
Heteropneustidae	*Heteropneustes fossilis*	+	+		+	
Siluridae	*Silurus triostegus*	+	+		+	+
Bagridae	*Mystus pelusius*	+	+	+	+	+
Mugilidae	*Planiliza abu*	+	+	+	+	+
	Planiliza carinata		+			+
	Planiliza subviridis	+	+	+	+	+
	Planiliza klunzingeri			+	+	+
Clupeidae	*Tenualosa ilisha*	+	+	+	+	+
	Nematalosa nasus	+			+	+
	Anodontostoma chacunda			+	+	
	Amblygaster sirm			+		
	Sardinella albella				+	
Mastacembelidae	*Mastacembelus mastacembelus*	+	+	+	+	
Aphaniidae	*Aphaniops dispar*	+	+		+	+
	Paraphanius striptus	+			+	
	Esmaeilius sophiae	+				
Sciaenidae	*Johnius belangerii*			+		
	Johnius dussumieri			+	+	
	Johnius vogeri			+		
	Pennahia aneus	+				
	Otolithes ruber	+		+		+
	Otolithes ruber	+				
	Platycaranx alabaricus				+	

	Scomberoides commersonnianus			+	+	
Scatophagidae	*Alepes vari*				+	
	Alepes djedaba				+	
	Trachinotus mookalee				+	
	Scatophagus argus	+			+	+
Sillaginidae	*Sillago arabica*					+
	Sillago sihama	+	+	+	+	+
	Sillago attenuata					+
Poeciliidae	*Gambusia speciosa*	+				
	Poecilia latipinna			+	+	+
	Gambusia holbrooki		+		+	+
Sparidae	*Acanthopagrus arabicus*	+		+	+	+
	Acanthopagrus berda				+	
	Sparidentex hasta	+		+	+	
Belonidae	*Strongylura urvillii*	+			+	+
Soleidae	*Brachirus orientalis*	+		+	+	+
	Solea elongata					+
	Solea stanalandi					+
Polynemidae	*Eleutheronema tetradactylum*	+		+	+	
Hemiramphidae	*Rhynchorhamphus georgii*	+				
	Hyporhamphus limbatus				+	+
Nemacheilidae	*Oxynoemacheilus panthera*		+			
Pristigasteridae	*Ilisha compressa*			+	+	
	Ilisha melastoma			+		
Cynoglossidae	*Cynoglossus arel*			+		+
	Cynoglossus kopsii					+
Platycephalidae	*Platycephalus indicus*			+		+
Gerreidae	*Gerres limbatus*			+	+	
	Gerres oyena			+		
Leiognathidae	*Photopectoralis bindus*				+	+
Mullidae	*Upeneus doriae*				+	
Tetraodontidae	*Lagocephalus guentheri*				+	
Ariidae	*Plicofollis dussumieri*					+
	Plicofollis layavdi					+
Triacanthidae	*Triacanthus biaculeatus*					+

Cyprinidae was the most abundant family, which included 13 fish species, followed by Carangidae (10 species, Sciaenidae eight species, Clupeidae shares six species, Leuciscidae, Mugilidae, and Sparidae five species each, whereas the families Gobiidae, Engraulidae, Xenocyprididae, and Ariidae each comprised four species.

Fish diversity

Study 1 comprised 16 native species, 17 marine species, and no exotic species recorded. Study 2 documented 15 native species, eight marine species, and two exotic species. In Study 3, nine native species, 25 marines, and six exotic species were observed. In Study 4, 16 native fish species, 32 marine species, and ten exotic species were captured. Study 5 documented eight native species, 28 marines, and eight exotic species (Fig. 2).

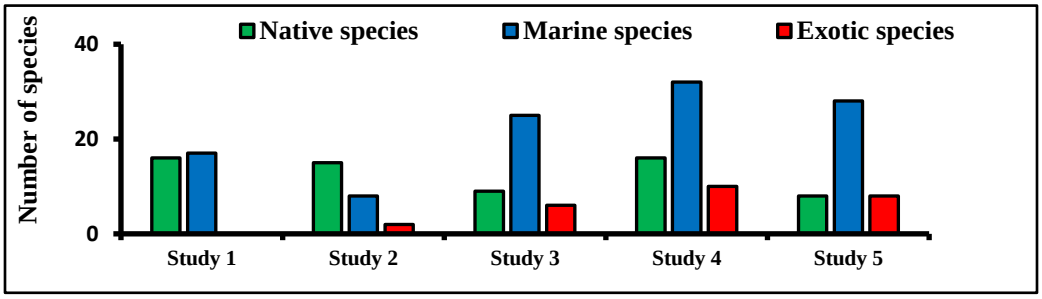

Fig. 2. Number of native, marine, and exotic species in six studies of the Shatt Al-Arab River from 1989 to 2019.

Relative abundance

The five studies showed some significant differences in the densities of the various species, particularly in pioneering studies (Table 3). Study 1 found that *N. nasus* was the most abundant species, forming 13.27% of the total catch. *G. speciosa* was the second most abundant species, accounting for 8.64% of all species. *Planiliza abu* accounted constitute 8.62% of all species. In Study 2, *A. marmid* was the most abundant, accounting for 70.84% of the total number of species. *P. abu* recorded 7.49% of the total samples, followed by *A. dispar* at 5.20%. Study 3 pointed out that the species *C. auratus*, was the most abundant species, forming 20.30% of the total catch, followed by *T. ilisha* recorded 13.60%, and *P. subviridis* accounting for 8.90% of the total number of species. The study 4 documented that the most abundant species was *T. ilisha* comprising 27.40%, followed by *C. auratus*, constituting 23.70% of the total catch, and *P. klunzingeri* contributing 10.60% of the total number of species. Study 5 accounted for species that were harvested at more than 1% and were inserted into two separate sites. At station1 (Al-Sindbad Island), the most abundant species was *P. latipinna* (13.80 %), followed by *T. ilisha* (11.80 %), and *O. aureus* (11.70 %). At station2 in Abu Al-Khasibs, *O. aureus*, the most abundant species, contributed 12.50% of the total number of species, followed by *C. auratus* (12.30 %), and *P. latipinna* (12.10% of the total catch).

Table 3. The relative abundance of fish species in five studies of the Shatt Al-Arab River from 1989 to 2019.

Species	Study 1	Study 2	Study 3	Study 4	Study 5*	
					Station 1	Station 2
Carcharhinus leucas				0.004		
Periophthalmus waltoni			0.10			
Boleophthalmus dussumieri			0.30	0.05		
Bathygobius fuscus		0.13	0.40	0.30	4.80	
Periophthalmus kallopterus	3.45	0.02				
Thryssa whiteheadi			4.40	1.70	9.90	11.30
Thryssa vitrirostris				0.10	7.90	3.97
Thryssa hamiltoni	2.79	0.10	6.10	1.00		

Arabibarbus grypus	2.32	0.01	0.10	0.01		
Carasobarbus luteus	4.18	4.30	0.30	1.30		
Carassius auratus			20.30	23.70	6.60	12.30
Cyprinus carpio		0.59	0.30	3.10	1.20	
Cyprinion kais				0.01		
Garra rufa		4.15				
Luciobarbus kersin	0.86	0.01		0.01		
Luciobarbus subquincunciatus	2.92					
Luciobarbus xanthopterus	3.19	0.09		0.03		
Mesopotamichthys sharpeyi	1.59	0.02		0.01		
Acanthobrama marmid		70.84	2.70	0.60	1.10	
Alburnus mossulensis	1.07	4.44	2.50	0.30	3.00	
Alburnus caeruleus				0.04		
Leuciscus vorax	1.06	0.22	0.40	0.80		
Ctenopharyngodon idella			0.10	0.01		
Hemiculter leucisculus			0.20	0.50	1.50	
Hypophthalmichthys molitrix				0.01		
Coptodon zillii			0.20	9.80	8.20	9.48
Oreochromis aureus				0.70	11.70	12.50
Oreochromis niloticus					1.70	10.20
Heteropneustes fossilis	5.71	0.14		0.001		
Silurus triostegus	2.32	0.12		0.20		
Mystus pelusius	0.73	0.10	0.20	0.01		
Planiliza abu	8.62	7.49	8.30	6.50	2.90	
Planiliza carinata		1.20				
Planiliza subviridis	4.31	0.01	8.90	1.40	3.00	5.18
Planiliza klunzingeri			3.60	10.60		
Tenualosa ilisha	1.59	0.65	13.60	27.40	11.80	3.78
Nematalosa nasus	13.27			0.90		
Anodontostoma chacunda			2.10	0.001		
Amblygaster sirm			0.10			
Sardinella albella				0.003		
Mastacembelus mastacembelus	0.33	0.14	0.30	0.002		
Aphaniops dispar	4.58	5.20		0.90		
Paraphanius striptus	3.38			0.35		
Esmaeilius sophiae	3.19					
Johnius belangerii			6.20			
Johnius dussumieri			3.50	0.10		
Johnius vogeri			1.00			
Pennahia aneus	1.73					
Otolithes ruber	1.19		0.10			
Otolithes ruber	0.60					
Platycaranx malabaricus				0.001		
Scomberoides commersonnianus			0.50	0.003		
Alepes vari				0.02		
Alepes djedaba				0.003		
Trachinotus mookalee				0.001		
Scatophagus argus	2.12			0.10		
Sillago sihama	0.60	0.01	0.30	0.001		

Gambusia speciosa	8.64					
Poecilia latipinna			3.60	1.80	13.80	12.10
Gambusia holbrooki		0.01		2.10		
Acanthopagrus arabicus	8.16		4.40	2.60		
Acanthopagrus berda				0.30		
Sparidentex hasta	0.66		1.60	0.20		
Strongylura urvillii	2.85			0.002		
Brachirus orientalis	0.86		0.30	0.04		
Eleutheronema tetradactylum	0.40		0.30	0.02		
Rhynchorhamphus georgii	0.73					
Hyporhamphus limbatus				0.20	3.90	
Oxynoemacheilus panthera		0.01				
Ilisha compressa			1.60	0.10		
Ilisha melastoma			0.20			
Cynoglossus arel			0.40			
Platycephalus indicus			0.10			
Gerres limbatus				0.002		
Gerres oyena			0.40			
Photopectoralis bindus				0.04	2.70	10.40
Upeneus doriae				0.002		
Lagocephalus guentheri				0.001		

***Relative abundance of 1% and above**

Number of species and individuals

According to the river section studied, the number of species among the five studies was remarkably variable (Fig. 3). The lowest number of species was observed in Study 2, which recorded 25 species from Sindbad Island to the Dockyard region. In comparison, in Study 4, 58 species were collected from Al-Deer to Abu Al-Kasieb.

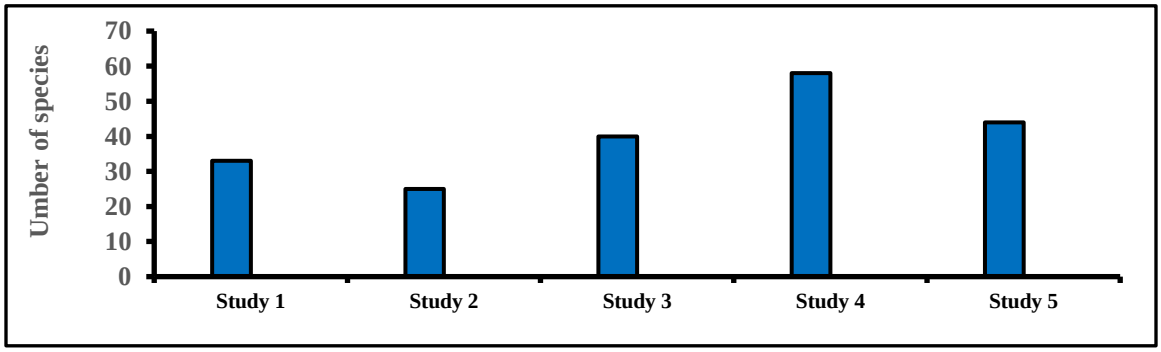

Fig. 3. The number of species in the five studies in the Shatt Al-Arab River from 1989 to 2019

The present study differed remarkably in terms of the number of species. However, Study 3 documented the lowest number of individuals (1460 specimens), while Study 4 collected the highest number 91648 specimens. However, Study 5 did not address the number of individuals, but it is a reference to percentages in both study sites, as the lowest percentage was in Abu Al-Khasib (5.3 %), which was caught in February, and the highest percentage was in Sindbad, which

accounted for 15.6% of the total number of individuals in June. (Fig. 4).

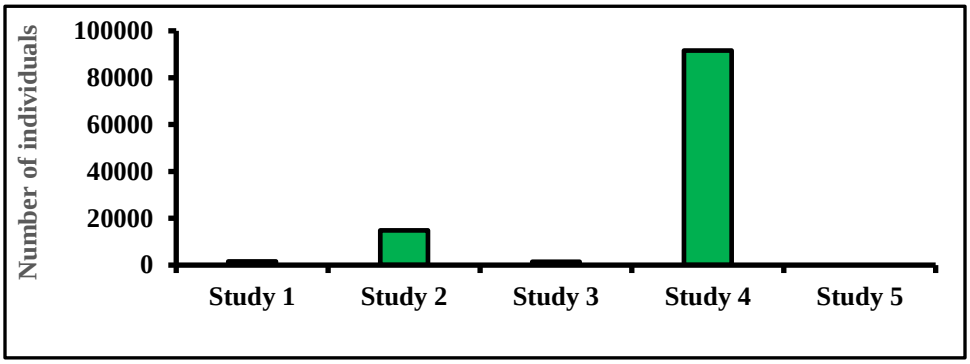

Fig. 4. The number of individuals in the five studies in the Shatt Al-Arab River from 1989 to 2019

Ecological indices

The lowest value of the diversity index was 1.19 recorded in Study 2, while the highest was 3.06 in study 1. The minimum value of the richness index was 2.50 shown in study 2, whereas the maximum value was 4.37 in study 1. The evenness index ranged from 0.37 in study 2 0.88, the study 5 (Fig.5).

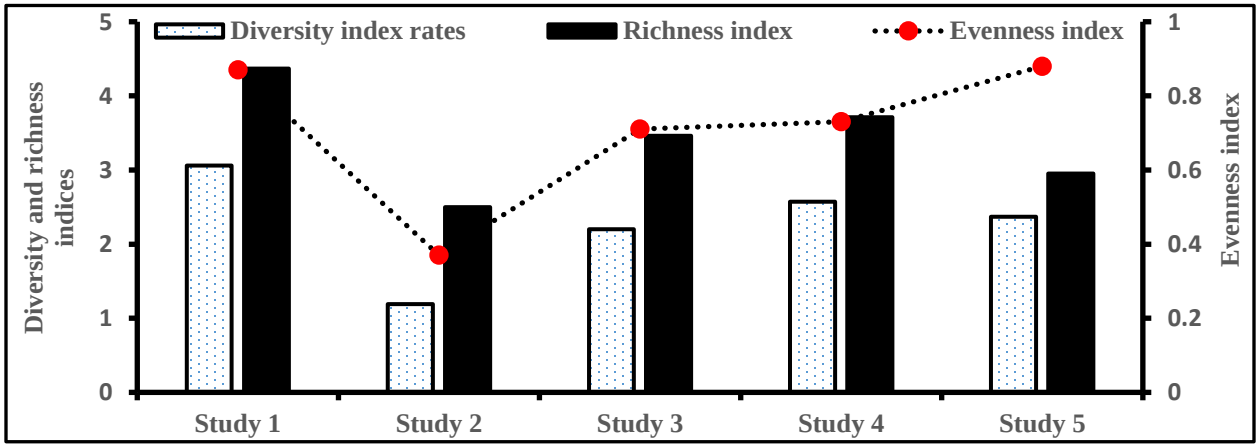

Fig. 5. Comparison of the ecological indices of the five studies in the Shatt Al-Arab River from 1989 to 2019

Occurrence of species

The fish species were arranged according to their appearance in the fishing samples in

the present study into three groups as follows:

The study 1**:** The resident species (appeared in9-12 months) The the study 1 included 12 resident fish species all of them were freshwater species *A. dispar*, *Paraphanius striptus* , *Esmaeilius sophiae*, *L. vorax*, *Arabibarbus grypus*, *Carasobarbus luteus*, *Luciobarbus subquincunciatus*, *Luciobarbus xanthopterus*, *G. speciosa*, *Heteropneustes fossilis*, *P. abu*, and *Silurus triostegus*. The seasonal species (6-8 months) comprise 15 fish species : *Acanthopagrus arabicus*, *Alburnus mossulensis*, *Mesopotamichthys sharpeyi*, *T. ilisha*, *Pennahia aneus*, *P. subviridis*, *N. nasus*, *Otolithes ruber*, *Periophthalmus kallopterus* , *Scatophagus argus*, *Sparidentex hasta*, Strongylura urvillii, *Luciobarbus kersin*, and *Brachirus orientalis*

The occlusal species (1-5 months) formed six species: *Eleutheronema tetradactylum*, *Rhynchorhamphus georgii*, *Mastacembelus mastacembelus*, *Mystus pelusius*, *Sillago sihama*, and *Thryssa hamiltoni*.

The study 2: The resident species included seven species *A. marmid*, *C. luteus*, *P. abu*, *A. mossulensis*, *Garra rufa* appeared in 12 months *A. dispar*, *Bathygobius fuscus*, caught in 11 months.

The seasonal species formed eight species *Planiliza carinata* sampled in eight months *M. pelusius* caught in seven months, whereas six species collected in six months of the year such as *Cyprinus carpio*, *M. mastacembelus*, *S. triostegus*, *L. xanthopterus*, *H. fossilis*, *T. ilisha*.

Occusional species represented ten species, two of them showed in five months *L. vorax*, *T. hamiltoni*, *P. kallopterus* appear in three months, the species *L. kersin*, *M. sharpeyi* sampled in two months. The species *A. grypus*, *G. holbrooki*, *P. subviridis*, , *Oxynoemacheilus panthera*, and *Sillago sihama* appeared in one month.

Study 3 did not mention the occurrence of monthly species.

The study 4: collected 19 resident species formed 66.8% of the total number of species included; *C. auratus*, *P. klunzingeri*, *C. zillii*, *P. abu*, *G. holbrooki*. *P. subviridis*, *L. vorax*, *A. mossulensis* all these species appeared within 12 months. Six species caught in 11 months embraced *C. carpio*, *C. luteus*, *A. dispar*, *H. leucisculus*, *S. triostegus*, *Paraphanius striptus*. Two species sampled at ten months were *P. latipinna* and *A. marmid*. Three species caught in nine months represented *A. arabicus*, *Sparidentex hasta*, and *L. xanthopterus*. The seasonal: species comprised eight species formed 31.6% of the total caught, six of them appeared in eight months *T. whiteheadi*, *T. hamiltonii*, *O. aureus*, *A. marmid*, *Acanthopagrus berda*, and *B. fuscus*. One species was sampled in seven months, *Scatophagus argus*, whereas *L. kersin* appeared in the catch in six months. Thirty-one fish species, personified as occasional species, accounted for 1.6% of the total catch. six fish species caught in five months, were *N. nasus*, *B. orientalis*, *M. pelusius*, *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, and *Cyprinion kais*. Five species collected in four months represented by *Thryssa vitrirostris*, *Ilisha compressa*, *Boleophthalmus dussumieri*, *M. sharpeyi*, and *A. grypus*. Four species appeared in three months such as *Hyporhamphus limbatus*, *Johnius dussumieri*, *Photopectoralis bindus*, *Alburnus caeruleus*. Four fish species were caught in two months: *Carcharhinus leucas*, *Gerres limbatus*, *M. mastacembelus*, and *S. urvillii*. A large number of species were sampled within one month *E. tetradactylum*, *Alepes djedaba*, *Sardinella albella*, *Scomberoides commersonnianus*, *Upeneus doriae*, *Anodontostoma chacunda, Platycaranx alabaricus*, *H. fossilis*, *Lagocephalus guentheri*, *S. sihama*, and *Trachinotus mookalee*.

Study 5: In the relative abundance, the percentages that were less than 1.0% were neglected in both study sites and dealt with the relative abundance of the two study sites, each site separately. At the Sindbad site, resident fish species constituted 32.4% of the total catch. The species represented by *T. ilisha*, *P. latipinna*, *T. whiteheadi*, *O. aureus*, *C. zillii B. fuscus*, *T. vitriastris*, *A. mossulensis*, *Hyporhamphus limbatus, H. leucisculus*, and *P. bindus*. The seasonal fish species in this station formed 17.6% of the total samples included *P. abu*, *P. subviridis*, *A. marmid*, *C. auratus*, and *P. klunzingeri*. Occasional species at the Sindbad station formed 50.0% of the total number of species. In the Abu Al-Kasib site, the resident species comprised 18.2% of the total number involved *C. auratus*, *O. aureus*, *T. whiteheadi*, *P. latipinna*, *C. zillii*, *O. niloticus*, *T. ilisha*, and *P. subviridis*. The seasonal species in the present station formed 6.8% of the total caught included *T. vitriastris*, *P. bindus*, and *B. fuscus*. The rest of the species were classified as occasional species at this site and comprised 75.0% of the total samples.

The lowest percentage of similarity among the occurrence of species in the five studies was between studies 3 and 5 (19.15%), whereas the highest was 48.57% between studies 1 and 2 (Table 4).

Table 4: The similarity (%) in species occurance among the five studies in the Shat Al-Arab River

	Study 1	Study 2	Study 3	Study 4	Study 5
Study 1	0	48.57	29.63	36.36	24.14
Study 2		0	24.00	30.65	21.15
Study 3			0	45.71	19.15
Study 4				0	37.84
Study 5					0

Disscusion

The composition of fish assemblages in estuarine rivers varies depending on the distance of the river section from the sea, which is the primary source of saline water, and this has a significant impact on the spread and distribution of fish populations (Mohamed and Hameed, 219). The Shatt al-Arab River environment has undergone significant changes in recent decades, as evidenced by a reduction in Tigris and Euphrates river discharge, which caused salinity penetration into the middle section of the river and sometimes to the upper part of the river, an increase in the concentration of organic, petroleum, and mineral pollutants, and the introduction of numerous exotic fish species, which altered the composition of fish communities (Abdullah *et al.*, 2017; Abdullah *et al.*, 2021). The current study discovered the absence of exotic species in pioneer studies, such asKhalaf (1961), Mahdi (1962), and Al-Nasiri and Shamsul-Hoda (1975). In addition, the current study found that exotic species were absent in Study 1, but their numbers gradually increased to record the highest number of these species in Studies 4 and 5. These results

are consistent with the most recent studies in southern Iraq (Mohamed and Abood, 2017; Al-Thahaibawi *et al.*, 2019; Abdullah *et al.*, 2022). Mohamed and Hammeed (2019) reported that diverting the Karun River estuary and preventing it from flowing into the Shatt al-Arab River also reduced the water discharge rates, contributing to increased salt incursion. An increase in salinity in the Shatt Al-Arab River has changed the composition of the fish community to marine species (Zhou *et al.*, 2019). The estuary is one of the most diverse locations because of the abundance of nutrients and breeding, nursery, and refuge areas for many marine, brackish, and freshwater species (Whitfield, 2017). The composition of the fish population changes upstream, as the number of freshwater fish increases in marine species (Abdullah *et al.*, 2021;Hameed *et al.*, 2022). Fish diversity in the present study varied; the study distance was short in studies 1 and 2, and the number of species was limited. The number of exotic species was non-existent in Study 1 and defined in Study 2 because it represented the beginning of their entry, and the accidental entrance of exotic species continued through neighboring countries and ornamental fish aquariums, which is the most important factor that changes the composition of fish populations (Mohamed and Abood, 2017a; Abdullah *et al.*, 2021). In studies 3, 4, and 5, the current study found an increase in the number of marime species, a reduction in the number of native species, and an increase in the number of exotic fish species, which was explained by increased salinity concentrations, distribution of exotic species, and habitat deterioration(Mohamed and Abood 2017b; Hameed *et al.*, 2022). The relative abundance of species in studies 1 and 2 were obviously different from other recent studies (3,4, and 5), mainly because of the higher prevalence of new exotic species of the Cichlidae and Cyprinidae families with high tolerance and reproductive ability, as well as the length of their spawning season, as demonstrated in most studies performed on the Shatt Al Arab River (Al-Shamary, 2016; Mohamed and Abood 2017a; Abdullah *et al.*, 2022). The number of species in studies 3, 4, and 5 has been higher than in studies 1 and 2 because the last two studies were more downstream of the estuary than in the first two studies, because the occurrence of marine species elevates the number of species and the diversity of species; however, the number of fish individuals collected is determined by the type and number of fishing tools used in the catch (Khan *et al.*, 2013; Sa-Oliveira *et al.*, 2015). The study1 documented high values of ecological indices compared to other studies; that is, 3.06, 4.37, and 0.87 for diversity, richness, and evenness respectively. Higher values of ecological indices indicate the stability of the ecosystem, whereas lower values indicate habitat deterioration in the Shatt Al-Arab River and the distribution and dominance of tolerant exotic species (Hussain *et al.*, 2014; Abdalhsan *et al.*, 2020). The ecological index values in studies 2, 3, 4, and 5 are in line with studies performed on the present river and other water bodies in southern Iraq (Abdullah *et al.*, 2017a; Abdullah *et al.*, 2022; Hameed *et al.*, 2022). Because species occurrence varies with time and river portion, the results of the current study revealed that the composition of fish assemblages in Studies 1 and 2 differed from that of other studies due to the first studies performed in the studies that were empty of dominance exotic species, as well as the reduction of rates, discharge the Tigris and Euphrates Rivers led to penetration of marine species upstream and structural alteration of communities (Mohamed and Abood, 2017b; Hameed *et al.*, 2022). The similarity in species occurrence among the five studies was observed to be 48.57%, which explains the temporal convergence between the two

studies in which the two studies were conducted, the small number of exotic species at that time, and the convergence of the discharge rates of the Tigris and Euphrates rivers (Fitzgerald *et al.*, 2017).

The current study concluded that there were significant changes in the composition of fish populations in Shatt Al-Arab, which is clearly evident when comparing studies 1 and 2 with studies 3, 4, and 5.

Conclusions

Several variables occurred in the Shatt Al-Arab River environment, which altered the composition of the fish population and the introduction of exotic fish species, resulting in clear changes in the composition, quantity, spread, and distribution of fish (Mohamed and Abood, 2017b). Reducing the discharge of the Tigris and Euphrates rivers, damming the Al-Suwaib River, which receives water from the Al-Hawizeh Marsh, diverts the Karun River estuary into Iranian territory, causing an increase in salinity concentrations and saltwater intrusion, increased organic waste disposal, and oil pollution (Mohamed and Hammed, 2019).

Acknowledgement

I thank the administration of the Marine Science Center at the University of Basrah.

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دراسة مرجعية لتجمع الأسماك ووفرتها في شط العرب من عام 1989 إلى عام 2019

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المستخلص

تناولت هذه الدراسة المراجعة الحالية لتجمع الأسماك وكثافتها في شط العرب من عام 1989 إلى عام 2019. تم استخدام خمس دراسات لجمع البيانات حول أنواع الأسماك الموجودة في النهر خلال هذه الفترة. تم تسجيل مجموع 88 نوعًا من الأسماك، ينتميان إلى 74 جنسًا و 33 عائلة. معظم الأنواع كانت أسماك عظمية، مع وجود ثلاثة أنواع فقط من الأسماك الغضروفية. سجلت الدراسات مزيجًا من الأنواع البحرية والأصلية والغريبة. كان لدى الدراسات المختلفة أعداد متفاوتة من أنواع الأسماك المسجلة. تضمنت الدراسة 1 33 نوعًا من الأسماك، والدراسة 2 25 نوعًا، والدراسة 3 سجلت 40 نوعًا، والدراسة 4 التقطت 58 نوعًا، وسجلت الدراسة 5 44 نوعًا. اختلفت أنواع الأسماك الأكثر وفرة بين الدراسات، حيث شملت أنواعًا بارزة مثل *Nematalosa nasus* و *Gambusia speciosa* و *Planiliza abu* و *Acanthobrama marmid* و *Aphaniops dispar* و *Carassius auratus* و *Tenualosa ilisha* و *Planiliza subviridis* و *Planiliza klunzingeri*. تغيرت أيضًا تنوع وغنى أنواع الأسماك بين الدراسات. تراوح مؤشر التنوع بين 1.19 و 3.06، حيث كانت للدراسة 1 أعلى تنوعًا. وتراوح مؤشر الغنى بين 2.50 و4.37، حيث كانت للدراسة 1 أعلى غنى. استنتجت الدراسة أن تكوين الأسماك في نهر شط العرب تغير بشكل كبير على مر السنين نتيجة لعوامل مثل إدخال الأنواع الغريبة وزيادة التخلص من النفايات العضوية وتلوث النفط واختراق الملوحة وتغييرات في تدفق النهر.

الكلمات الرئيسية: تقييم، مجتمعات الأسماك، شط العرب، تنوع