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The Effect of Environmental Fluctuations on Fish Diversity at the Lower Ends of the Shatt Al-Arab River, Iraq

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ABSTRACT

The present study was organized to address the effect of environmental fluctuation on the diversity of fish communities from November 2021 to October 2022 in the lower area of the Shatt Al-Arab River/Iraq. To collect fish samples, two stations were chosen, one of which is at Al-Seeba region and the other in Ras Al-Bishah region. The environmental factors affecting the abundance, diversity and distribution of fish species such as temperature and salinity were studied. Air temperature ranged from 10.1 - 46.3°C in December 2021 and July 2022 respectively, and water temperature ranged from 14.6 3 - 32.5°C during January and July 2022, respectively. While, water pH fluctuated between 8.15 & 9.51, and the salinity showed high fluctuation during the study period, it ranged from 2.7g/ L – 46.8g/ L, whereas transparency values fluctuated between 11.5 and 72.5cm. Water current speed ranged from 1.5 - 4.2 cm/sec. The total number of fish samples was 1827, belonging to 31 species and 21 families. Fish samples were collected using a bottom beach gill net. Fish samples comprised of 26 marine fish species, three freshwater fish species and three estuaries fish species. Clubidae family consisted of four species, followed by Gobiidae with three species. *Thryssa whiteheads* were the most abundant species numerically comprising 27.96%, followed by Tenualosa ilisha 20.08 %, *Planiliza subviridis* (13.95%) and *Planiliza klunzingeri* (7.38%). The diversity index ranged between 1.211 & 2.073. The values of the evenness index ranged from 0.598 - 1.063; the range of richness index (Margalef) was (0.919 - 3.231) recorded. The fish classified according to their appearance in the monthly samples were divided into three groups: marine species, mirants river species and estuarine species.

INTRODUCTION

Studies on the diversity and effect of change in cological variables on the fish composition are of great importance for drawing a clear picture of the nature's structure of fish composition, as well as providing good information on commercial and non-commercial species of fish and their spread **(Korsbreke *et al*., 2001)** .

The study of the environmental aspects is one of the important strategies to know the structure of the fish community **(Al-Rudiny, 2010)**, which has an important role in understanding the reality of fish populations in the water body in order to develop them and address the causes of the deterioration or lack of productivity **(Hussain *et al*., 2008).** The abiotic environmental characteristics have an important role in the distribution of aquatic fauna **(Weiner, 2000)** since the dynamics of fish populations are regulated by abiotic and biotic factors such as the interaction between species including competition and predation **(Souza-Siqueria & Freitas, 2004)**. Fish surveys are distinguished in the study of fish communities and their importance in giving a clear picture of the nature and composition of fish stocks **(Korsbreke *et al.*, 2001)**. In addition, the weak demographics of fish community result from the absence of rational management, the practice of overfishing, the use of illegal means and methods, and the failure to allow fish to be supplied in order to obtain the best sustainable production. This was confirmed by **Pauly *et al.* (2002)**.

Mohamed *et al*. (2001) studied the assemblage of estuarine fish and recorded 116 species of fish belonging to 58 families, in which three families prevailed and showed more presence there; namely, Sparidae, Carangidae and Clupeidae, respectively, in terms of the number of species, while the Carangidae family showed more diversity. **Hussein *et al.* (2003)** studied marine fish population in the Shatt al-Arab estuary and recorded 53 species of bony fish, which formed four families that accounted for 58% of the total number of fish caught, viz. the family Engraulidae, Sciaenidae, Platycephalidae and Clupeidae, while 9 species accounted for 59% of the total catch.

Evidence of richness, diversity and evenness was used to analyze the composition of fish populations in the rivers of Iraq as well as other areas and environments of the marsh waters of southern Iraq **(Younis *et al*., 2001; Hussain *et al*., 2012; Hussain & Ahmed, 2014; Abduallh *et al*., 2019)**. Many studies were conducted earlier in different Iraqi environments on the quality of water and relationship with fish populations **(Hameed & Aljorany 2011; Moyel & Hussain 2015; Mohamed & Abood 2017; Abduallh *et al*., 2018)**. The current study aimed to evaluate fish population at selected sites of the Shatt Al-Arab River after the decrease in the rate of freshwater revenues and the increase in the salinity of Shatt Al-Arab River.

Study area description

The Shatt al-Arab is one of the important rivers and a major source of water in south of Iraq, and it consists of the concourse of the Tigris and Euphrates Rivers in the north of Basrah in the city of Qurna and extends in the southeast direction to flow into the Arabian Gulf south of Al-Fao district, where it cuts approximately 204km. The width of the river ranges from 400 meters in the city of Basrah to about 1500 meters near Ras Al-Bishah, and its depth ranges from 8-15 meters and even more in some places, as is the case on the eastern bank of Sindbad Island, it reaches 27 meters and this depends on the area and the state of the tide, which increases downstream **(Al-Lami, 2009)**.

The Shatt al-Arab is connected to three main tributaries: the Suwayb River, which connects to it at a distance of 15km south of Qurna, the Garmat Ali River, which connects to the Hammar marsh and the Karun River, flowing in the Iranian territory into the Shatt al-Arab, 35 km south of Basrah, but its basin was changed to the direction of the

Iranian lands during 2009 **(Hameed & Al Jorany. 2011)**. The Shatt al-Arab River is characterized by the phenomenon of tides (two daily cycles). The Shatt Al-Arab River is located in the eastern part of the city of Basrah, which is called the alluvial plain, whose height does not exceed 4m above the sea level. It is entirely located in a flat terrain consisting mainly of mud and silt deposited by the Tigris, Euphrates and Karun Rivers **(Mohamed *et al*., 2012)**.

Two stations were selected to collect samples from the Shatt al-Arab; namely,

First location, Seeba area

It is located at a distance of 2km south of the center of Seeba within the coordinates of E48.2922521 N30.3158524 and 48°17'32.108"E30°18'57.069"N (Fig. 1.) It is an area affected by the phenomenon of tides, and the movement of Iraqi and Iranian merchant ships abounds, as well as Iranian passenger ships. In addition, there are many fishing boats using drift nets, while the Iranian boats use trawl nets (Gufa).

Some plants grow on the coast ,and their presence depends on the salinity of the water and they are found at certain times of the year, including the reed Phragmites australis and the *Cholan litoralis Schoenoplectus*. The aquatic plants were classified in the study sites based on the categories set in the study of **Myiah *et al*. (2006)**.

Second location, Ras Al-Bishah area

The lower end of the Shatt al-Arab is 10km south of Al-Faw district, within the following coordinates (E48.6964577 N29.8015037) (48°41'47.248"E 29°48'5.413"N). This area is affected by tidal phenomena, and the impact of the gulf waters on this region is greater due to the decrease in the amount of fresh water released from the upper river, converting this region to a marine environment in some seasons of the year (Fig. 1).

As a result of the high salinity, all plants disappeared from the area after the growth of numerous species. Several fishing boats are found in most seasons of the year while they are less or almost non-existent in some months of the year. The nets used in this area are the gill nets, while the Iranian boats use the trawl nets.

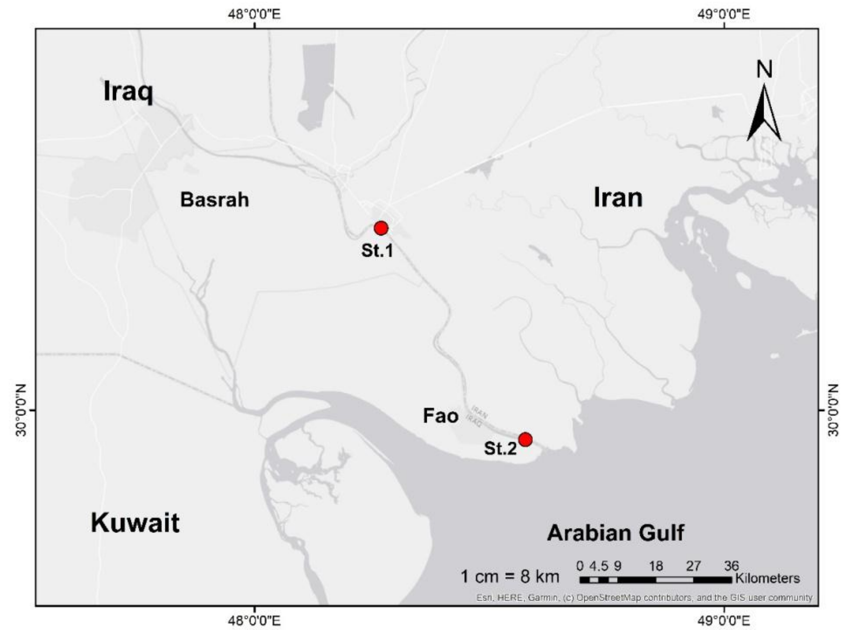

Fig. 1. Map showing the two selected stations at the lower part of Shatt Al-Arab River during 2021-2022

MATERIALS AND METHODS

Samples collection

A number of environmental factors were measured in the two study stations that were determined during the period from October 2021 to November 2022, such as water temperature and salinity using a Chinese-made METTLER TOLEDO device, air temperature with a Chinese-made mercury thermometer, pH with a Chinese-made poked-sized pH meter (pHep HI98107). For ransparency measurment, a seeki disk was used, whereas the speed of the water current was measured using a plastic bottle containing a little sand. The speed was calculated through the following equation: Current speed = distance/ time.

Fish samples were monthly collected for two days for each station, using gill nets ranging in length from 450 to 500 meters and with mesh size ranging from 20 × 20 to 50 × 50 mm, and a height of 5-10 meters. These nets were left in the water for three hours, after which the nets were lifted, and the fish stuck in them were collected, taking into consideration the stability of the fishing effort in both locations during the sampling period.

The number of fish species individuals caught after the completion of the fishing operations was recorded, based on the taxonomic characteristics of each species. Then, samples were freezed and transferred to the laboratory to record measurements. They were classified according to the categorization of **Al-Daham (1982)** and **Coad (2010).**

The relative abundance of each species of fish was determined according to the equation of **Odum (1979)**. While, the diversity index (H) was recorded according to the equation of **Shannon and Weaver (1949),** and the evenness index (J) was set according to the equation of **Pielou (1977)**. The richness index (D) was deermined according to the equation of **Margalefe (1968)**. The numerical and descriptive levels were adopted to assess environmental indicators **(Hussain, 2014)**; fish were divided according to the frequency of their presence in monthly samples according to the study of **Tyler (1971)**. The statistical program SPSS 15 was used to conduct the statistical tests.

RESULTS

Results and discussion

Ecological variables

The results of the monthly rating evaluation of the environmental factors at both stations were shown (Table 1.). Water temperature ranged from 14.6^{o}C during January 2022 in the St. 2 to 32.5^{o}C during July 2022 in the St. 1; air temperature ranged between 10.0^{o}C in St. 2 during January to 46.0 ^{o}C in St. 1 during June and July. The pH values rangd from 8.15 during April in St. 1 to 9.51 during March in St. 2. Salinity, current speed and transparency showed significant differences between the two stations ($P \leq 0.05$). Salinity changed from 2.7 g/L during January 2022 in St. 1 to 44.8 g/L during August 2022 in St. 2. The lowest value of transparency was 11.5cm recorded in September 2021 in St. 2, and the highest value was 72.5cm in St. 1. Current speed ranged from 1.5 cm/sec during January in the St. 2 to 4.2 cm/sec during November in the St. 2. The physicochemical properties of water are one of the factors affecting water quality and have a role in the distribution and spread of living fauna, especially the spread of fish in water bodies **(Diana *et al.*, 2006)**.

The variation in water temperature between the two study stations is due to the local variation and the difference in the times of sampling due to the dependence on the instantaneous measurement of this factor, and this conforms with the findings of **Atte and Hussein (2000)**. The current study detected an increase in salinity values in June, July, August, September and October 2021, and the salinity values recorded an increase in the summer & autumn months. However, they witnessed a decrease in the winter & spring months (Table 1). This may be due to the lack of freshwater releases coming into the Shatt Al-Arab River, which causes the advancement of **(Alkm *et al.*, 2010)** some physical and chemical properties of the Euphrates River water in the city of Samawah. The St. 2 showed an increase in the level of salinity as a result of the adjacent tidal front in terms of proximity to the sea and the lack of incoming water, and this coincides with the finding of **Al-Tamimi (2004)** in another environment.

The current study recorded a positive significant correlation (r = 0.659) between the number of species and temperatures, and the effect of water temperature was positive on the availability of the number of species and individuals of fish in the study area, and these results concur with those of **Mohamed and Mutlak (2008)** who addressed the effect of water temperature on the distribution and spread of fish in another environmental study, where a significant positive correlation was recorded (r = 0.728) with salinity and number of species. Transparency showed negative low correlation with the number of fish species (r= -0.214). The marine fish species were affected more by water temperature and salinity than by other factors.

Table 1. Monthly variations in some ecological variables at two sites in lower part of Shatt Al-Arab River throughout study period in 2021-2022

Date	Salinity mg/l		Air temperature C^0		Water temperature C^0		pH		Transparency (cm)		Current speed (cm/sec)	
	St. 1	St. 2	St.1	St. 2	St.1	St. 2	St.1	St. 2	St.1	St. 2	St.1	St. 2
Nov-21	7.8	21.2	21.7	23.1	19.2	19.3	9.21	8.5	62.5	44.0	2.2	4.2
Dec-21	5.7	14.2	15.5	16.5	15.1	17.2	9.05	8.55	52.5	42.5	2.7	1.9
Jan-22	2.7	5.0	11.5	10.0	14.3	14.4	9.25	9.20	57.5	42.0	2.1	1.5
Feb-22	3.5	11.0	17.5	17.5	17.1	17.7	9.25	9.00	55.5	46.5	3.1	1.6
Mar-22	6.6	21.1	22.5	24.0	20.5	21.5	8.95	9.51	72.5	64.0	3.7	3.2
Apr-22	4.7	22.4	29.5	33.4	24.8	27.2	8.15	8.95	44.0	35.5	2.7	3.0
May-22	5.1	19.4	33.5	33.0	26.5	26.4	8.80	8.51	28.0	17.0	2.4	2.8
Jun-22	7.25	31.3	46.0	43.5	30.5	29.3	8.35	8.00	36.5	18.0	2.1	2.6
Jul-22	25.8	31.0	46.0	44.0	32.5	28.5	8.70	9.11	32.5	19.0	2.7	4.0
Aug-22	25.1	44.8	42.0	39.5	30.1	30.5	8.61	8.90	27.5	21.0	3.2	2.3
Sep-22	29.5	41.0	39.5	38.5	32.4	31.5	8.70	9.10	28.5	11.5	2.9	1.9
Oct-22	41.6	32.7	29.5	26.5	26.1	21.5	8.95	8.45	40.5	35.0	3.7	3.2

The fish species consisted of 25 marine species (M), three freshwater fish species (F) and three estuary fish (E) (**Table 2**). Clubidae, the dominant family, was represented by four species. followed by Gobiidae in three species, the remaining families were represented by either two or one species.

Occurrence and composition of fish species

A total of 1829 fish catches include 32 species belonging to 21 families, all these species were captured from two stations in the lower area off Shatt Al-Arab River using a bottom beach gill net. (Tables 3, 4). A total of 812 fishes caught from station 1 ranged between 26 individuals in September 179 in February, and the number of species differed from five species in October to 11 species in July. The total number of 996 individuals were captured from station 2 and varied from 37 in February to 150 individuals in September, and most of the fish species were recorded in this station (26 species) and ranged between five species in February to 14 species in September and December. The difference was significant between the number of species in St. 1 and St. 2. St. 2 was characterized by an increase in the number of species compared to St. 1, considering the catch, the water of the first station and the mixing water. Estuary water is the place in which fresh or marine fish cannot exist. While, the station has marine water that forms a habitat for marine fish species and estuarine fish species. This result agrees with that of **Abdullah *et al*. (2017)**.

Table 2. The scientific name and family name of the fish species caught in two stations at lower part of Shatt Al-Arab River throughout the study period (2021-2022)

Families	**Species names**	**Local names**	**Habitat**
Clupeidae	*Tenualosa ilisha* (Hamilton, 1822)	Hilsa shad	M
Mugilidae	*Planiliza klunzingeri* (Day, 1888)	Klunzinger's mullet	M
Mugilidae	*Planiliza subviridis* (Valenciennes, 1836)	Greenback mullet	M
Sciaenidae	*Pennahia anea* (Bloch, 1793)	Donkey croaker	M
Sciaenidae	*Johnius belangerii* (Cuvier, 1830)	Belanger's croaker	M
Soleidae	*Brachirus orientalis* (Bloch & Schneider, 1801)	Oriental sole	M
Engraulidae	*Thryssa whiteheadi* Wongratana, 1983	Whitehead's thryssa	M
Engraulidae	*Thryssa hamiltonii* (Gray, 1835)	Hamilton's thryssa	M
Clupeidae	*Ilisha compressa* Randall, 1994	Compressed ilisha	M
Chirocentridae	*Chirocentrus nudus* Swainson, 1839	Whitefin wolf-herring	M
Clupeidae	Nematalosa nasus (Bloch, 1795)	Bloch's gizzard shad	M
Cichlidae	*Oreochromis niloticus* (Linnaeus, 1758)	Nile tilapia	F
Cyprinidae	*Carassius carassius* (Linnaeus, 1758)	Crucian carp	F
Cyprinidae	*Cyprinus carpio* Linnaeus, 1758	Common carp	F
Gobiidae	*Bathygobius fuscus* (Rüppell, 1830)	Dusky frillgoby	E
Gobiidae	*Boleophthalmus dussumieri* Valenciennes, 1837	Mud Skipper	E
Carangidae	*Scomberoides commersonnianus* Lacepède, 1801	Talang queenfish	M
Chanidae	Chanos chanos (Forsskål, 1775)	Milkfish	M
Platycephalidae	*Platycephalus indicus* (Linnaeus, 1758)	Bartail flathead	M
Clupeidae	*Sardinella longiceps* Valenciennes, 1847	Indian oil sardine	M
Sparidae	*Sparidentex hasta* (Valenciennes, 1830)	Sobaity seabream	M
Sparidae	*Acanthopagrus arabicus* Iwatsuki, 2013	Arabian yellowfin seabream	M
Trichiuridae	*Eupleurogrammus glossodon* (Bleeker, 1860)	Longtooth hairtail	M
Gobiidae	*Trypauchen vagina* (Bloch & Schneider, 1801)	The burrowing goby	E
Synanceiidae	*Pseudosynanceia melanostigma* Day, 1875	Blackfin stonefish	M
Sillaginidae	*Sillago sihama* (Forsskal, 1775)	Silver sillago	M
Cynoglossidae	*Cynoglossus arel* (Bloch & Schneider, 1801)	Largescale tonguesole	M
Scatophagidae	*Scatophagus argus* (Linnaeus, 1766)	Spotted scat	M
Ariidae	*Netuma thalassina* (Rüppell, 1837)	Giant catfish	M
Triacanthidae	*Triacanthus biaculeatus* (Bloch, 1786)	Short-nosed tripodfish	M
Carangidae	*Alepes kleinii* (Bloch, 1793)	Razorbelly scad	M
Carcharhinidae	*Carcharhinus leucas* (Müller & Henle, 1839)	bull shark	M

1. Relative abundance

The total number of fish individuals in the study area was 1829; the lowest number of fish individuals (77) was caught in January and the highest (216) in February in both stations. The total number of fish individuals (812) was caught in (St. 1) and (996) in (St.

2). The number of species differed from 5 in February (St. 1) and October (St. 2) to 14 in December and September in St. 2 and varied from 5.68 to 11.38 %. Results explained that the fish were dominated by *Thryssa whiteheadi*, ranging from 0.58 % in May to 18.59% in September of the total catch. *Tenualosa ilisha* including 20.08 % of the total catch and ranged from 0.54% in September to 19.61% in May, while *Planiliza subviridis* was comprised of 13.95% of the total catch in two study stations, with a range of 0.0 % in some study months to 25.98 in December. Moreover, *Planiliza klunzingeri* was consisted (7.38%) and varied from 0.0 % in some months to 38.43% in February, followed by *Thryssa hamiltonii* in the rate of 7.05% and differed from 0.0% in some study months to 21.70% in April of the total catch in the two study sites. *Ilisha compressa* was 5.41% of the total catch and varied from 0.0 % in some study months to 29.29% in September, followed by *Thryssa hamiltonii* in the rate of 7.05% and differed from 0.0% in some study months to 21.70% in April of the total catch in the two study stations. Other species are explained in Tables (3, 4). The minimum of relative abundance was recorded for each of the following fish species, includng *Ilisha compressa* , *Carassius carassius, Oreochromis niloticus*, *Bathygobius fuscus*, *Chanos chanos* and *Pennahia anea* as it formed 2.40% and under of the total number of individuals in the two study sites. The most relative abundance species (*T. whiteheadi*, *T. ilisha* and *P. subviridis*) were dominant in the fish catch in both stations, previously mentioned in the study of **Abdullah (2017)**, but it differs in the order of species /total number, and the rest species were different; these fish species were recorded in the studies of **Mohamed *et al.*(2012)** and **Al-Noor and Abdullah (2015)**.

The total numbers of fish species caught from Al-Seeba and Ras Al-Bishah stations were 24 and 26 species, respectively (Tables 3, 4). There were more marine species represented in Ras Al-Bishah station samples (25 species) than in the samples from Al-Seeba station (17 species). The numbers of freshwater fish were three species captured in Al-Seeba St. Three estuary species were collected from stations Al-Seeba St.

Fig. (2) shows variations in the number of species in two stations. The highest number in species was 14 species captured during September and December from Ras Al-Bishah St., while the lowest number was 5 species collected during October and February from Al-Seeba St. and Ras Al-Bishah St., respectively.

Fig. (3) shows the monthly variables in the number of individuals in two study stations, as the number of individuals was 812 in the St. 1 and the highest number recoded 179 fish in February. While, the lowest number was 26 fish in September. The total number of individuals caught was 996 fish in the St. 2 and varied between 41 fish in May and the lowest value achieved by the catch, while the highest catch was 150 fish in September. The results of the statistical analysis showed significant differences in the number of fish in both stations.

Table 3. Monthly variations in the numeral abundance for different species at Al-Seeba St. from November 2021 to October 2022

Species	Nov-21	Dec-21	Jan -22	Feb-22	Mar -22	Apr-22	May -22	Jun -22	Jul-22	Aug -22	Sep -22	Oct -21	Total number for any specie in all months
Planiliza klunzingeri(Day, 1888)	13	14	-	73	10	-	-	-	-	-	2	19	131
Planiliza subviridis (Valenciennes, 1836)	3	11	-	17	18	9	-	-	-	5	4	18	85
Thryssa whiteheadi Wongratana, 1983	44	19	-	53	-	20	2	14	15	24	13	27	231
Thryssa hamiltonii (Gray, 1835)	11	-	-	9	3	-	4	4	4	-	-	9	44
Ilisha compressa Randall, 1994	13	7	-	-	-	-	-	-	-	1	4	5	30
Chirocentrus nudus Swainson, 1839	1	-	-	-	-	-	-	-	-				1
Tenualosa ilisha(Hamilton, 1822)	10	6	-	24	13	47	49	22	12	17	-	-	200
Nematalos anasus (Bloch, 1795)	7	8	-	-	-	-	2	-	1	4	2	-	24
Carassius carassius (Linnaeus, 1758)	1	1	-	-	-	-	-	-	-		-	-	2
Oreochromis niloticus (Linnaeus, 1758)	3	-	-	-	2	2	4	2	2	1	-	-	16
Bathygobius fuscus(Rüppell, 1830)	-	-	-	2	1	-	-	-	-	3	-	-	6
Chanos chanos (Forsskål, 1775)	-	-	-	-	2	2	3	1	1	-	-	-	9
Scomberoidescommers onnianus Lacepède, 1801	-	-	-	-	1	-	-	1	1	-	-	-	3
Eupleurogrammus glossodon (Bleeker, 1860)	-	-	-	-	-	-	-	-	1	2	-	-	3
Brachirus orientalis (Bloch & Schneider, 1801)	-	-	-	-	-	-	2	-	-	-	-	-	2
Johnius belangerii(Cuvier, 1830)	-	-	-	-	-	4	2	2	3	-	-	-	11
Pennahia anea(Bloch, 1793)	-	-	-	-	-	-	-	-	-	3	-	-	3
Sparidentex hasta (Valenciennes, 1830)	-	-	-	-	-	-	-	7	-	-	-	-	7
Sardinella longiceps Valenciennes, 1847	-	-	-	-	-	-	-	1	1	-	-	-	2
Cyprinus carpio Linnaeus, 1758	-	-	-	1	-	-	-	-	-	-	-	-	1
Acanthopagrusara bicus Iwatsuki, 2013	-	-	-	-	-	-	-	-	-	16	-	-	16
Platycephalus indicus(Linnaeus, 1758)	-	-	-	-	-	-	1	-	1	1	-	-	3
Trypauchen vagina (Bloch & Schneider, 1801)	-	-	-	-	-	-	-	-	-	1	-	-	1
Carcharhinus leucas (Müller & Henle, 1839)	-	-	-	-	-	-	-	-	-	1	1	-	2
Total fish species	10	7	-	7	6	6	9	9	11	12	6	5	88
Total fish numbers	90	66		179	50	84	69	54	42	74	26	78	812

Table 4. Monthly variations in the numeral abundance for different species at Ras Al-Bishah St. from November 2021 to October 2022

Species	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Total number for any specie in all months
Tenualosa ilisha	6	17	18	4	6	22	23	19	15	13	2	22	167
Planiliza subviridis	4	24	1	4	2	2	-	-	-	-	-	13	50
Planiliza klunzingeri	32	9	15	25	28	-	-	-	-	-	-	15	124
Thryssa whiteheadi	37	47	9	0	3	18	1	5	28	28	82	22	280
Thryssa hamiltonii	10	7	-	-	-	28	6	-	10	6	12	6	85
Sillago sihama	3	3	6	2	12	-	-	-	-	-	-	-	26
Sparidentex hasta	-	12	6	-	-	1	-	-	2	1	1	-	23
Nematalosa nasus	-	2	12	-	2	-	1	-	3	-	-	-	20
Ilisha compressa	11	17	-	-	-	6	2	2	5	1	25	-	69
Chanos chanos	-	4	-	-	-	4	1	2	-	-	1	-	12
Pennahia anea	-	4	1	-	1	-	1	-	7	3	-	-	17
Johnius belangerii	-	-	-	-	20	-	1	6	-	-	3	-	30
Eupleurogrammus glossodon	-	2	-	-	1	3	1	-	2	-	6	-	15
Oreochromis niloticus	-	-	-	-	2	-	-	-	-	1	-	-	3
Chirocentrus nudus	14	1	1	-	-	1	-	-		1	8	-	26
Platycephalus indicus	-	1	-	-	-	-	1	-	-	2	1	-	5
Pseudosynanceia melanostigma	1	-	-	-	-	1	1	-	-	2	5	-	10
Brachirus orientalis	-	-	-	2	2	2	-	-	-	-	-	-	6
Scatophagus argus	-	-	4	-	-	-	-	-	-	-	1	-	5
Cynoglossus arel	2	-	-	-	-	-	-	-	-	-	-	1	3
Netuma thalassina	-	-	-	-	-	-	1	6	-	-	-	-	7
Sardinella longiceps	-	-	4	-	-	-	1	1	-	-	-	-	6
Scomberoides commersonnianus	-	-	-	-	-	-	-	1	-	-	1	-	2
Acanthopagrus arabicus	-	-	-	-	-	-	-	3	-	-	-	-	3
Triacanthus biaculeatus (Bloch, 1786)	-	-	-	-	-	-	-	1	-	-	-	-	1
Alepes kleinii (Bloch, 1793)	-	-	-	-	-	-	-	-	-	-	2	-	2
Total fish species	10	14	11	5	11	11	13	10	8	10	14	6	123
Total fish number	120	149	77	37	79	88	41	46	72	58	150	79	996

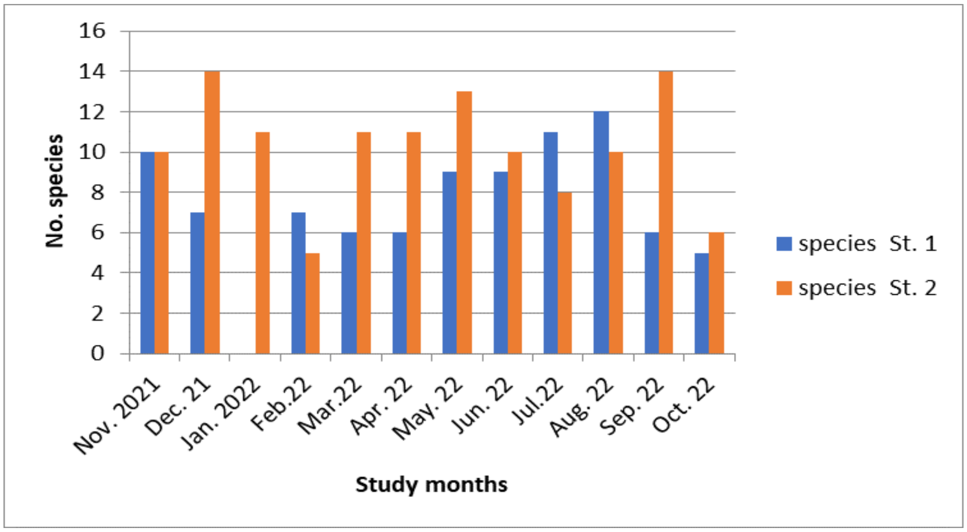

Fig. 2. Monthly variations in the total species in two study stations from November 2021 to October 2022

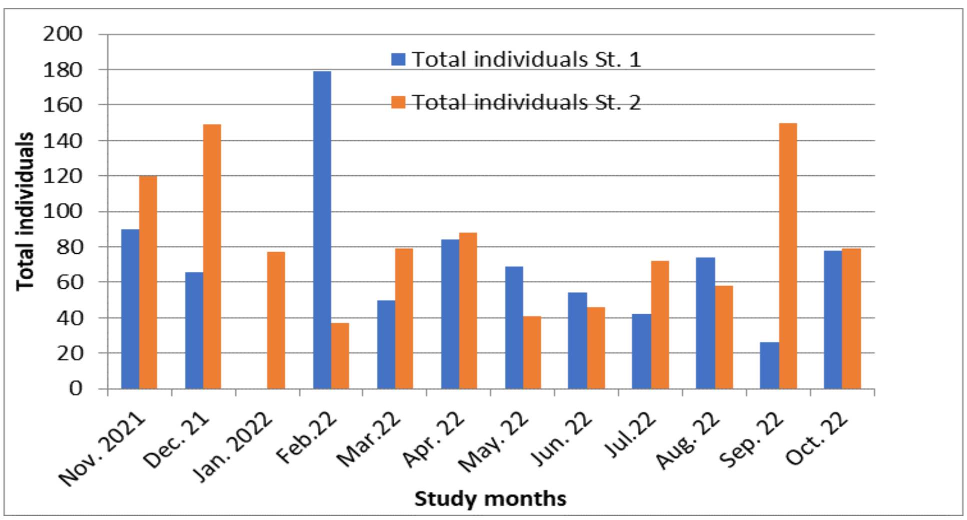

Fig. 3. Monthly variations in the total number of individuals in two study stations from November 2021 to October 2022

2. Ecological indices

Evidence of ecological indices showed (Figs. 4-6) the monthly fluctuation of the diversity index, as the lowest rate of the diversity index was 1.211 in May in St. 1 to 2.073 in January in St. 2, with ranges from poor to moderate. The variant values of evenness (E) with values of 0.598 in Dec. in St.2 & 1.063 in Oct. in St. 1 were within the ranges categorized as half balanced to balanced, and the minimum of Margalef richness (D) was recorded (0.919) in Oct. in St. 1 and the highest (3.231) in May in St. 2. These ranges were within the poor range, and no differences were recorded as significant

(P>0.05) between the two study stations, and environmental evidence is one of the important environmental criteria in assessing water bodies **(Hussain, 2014)**.

It was noticed that, the diversity index values began to gradually decrease in autumn and winter, and then began to gradually increase in the spring and summer seasons until the beginning of September. The results of the statistical analysis are explained by the correlation coefficient, which indicated a direct relationship between temperature and diversity index (P>05.0), (r = 0.591), and with the direct relationship between salinity and numerical diversity as well (P >0.05), (r = 0.311) and a third correlation between the diversity index with the number of species caught during the study (P> 0.05), (r = 0.485). This means that the factors of temperature and salinity play a radical role in increasing fish species and thus increasing diversity, as the results of diversity index reveal the total value of the Shatt al-Arab River. It was within the poor- moderate assessment during the study period, and it is close and consistent with previous studies **(Hussain *et al.* 1995; 1997; Yunus, 2005; Mohamed *et al.* 2012; 2015; Resen *et al*. 2014)**.

During the last years, the Shatt Al-Arab River was suffering from a great problem in water quality due to the decline in the discharge rates of the Tigris and Euphrates Rivers associated with the construction of more than thirty large dams, particularly those recently built in the headwater region of Turkey, the Southeast Anatolia Project basin **(Partow, 2001)**. The net average of water discharge in the upstream of the Shatt-Al-Arab declined to 186 m3/s during 2007-2008 **(Al-Lami, 2009)** and the diversion of Karun River away from Shatt Al-Arab River during 2009 **(Hameed & Aljorany, 2011)**. These factors had a direct impact on the waterbody, increasing the level of salinity in the middle and lower sites of the Shatt Al-Arab River due to the penetration of sea water further upstream. It is clear from the present study that salinity ranged from 3.5 to 46.8‰, with a mean value of 23.5‰ in the two sites of the study area. **Mahdi *et al.* (2002)** stated that, the salinity of Shatt Al-Arab River at Abu Al-Khaseeb (Hamdan site) ranged from 0.7 to 1.4‰, with a mean value 1.1‰ during 1997-1998. Additionally, **Hussain *et al.* (1999)** found that the salinity of Shatt Al-Arab River in Al-Fao port ranged from 0.7‰ to 9.7‰, with a mean value 4.9‰ during 1993. The results supported that, the physical properties, especially salinity may provide some possible causes for the differences in the distribution, abundance and species composition along the Shatt Al-Arab River. **Al-Hassan *et al*. (1989)** stated that, marine species are restricted to the middle and the lower regions of Shatt Al-Arab River, and their number decreased towards the upper reaches of the river, and freshwater fauna exhibited a reverse trend of distribution in the river. As environmental conditions change, some fish species migrate in response to the changing levels of salinity, moving up and down the estuary **(Blaber & Blaber, 1980, 1989; Barletta *et al*., 2003)**.

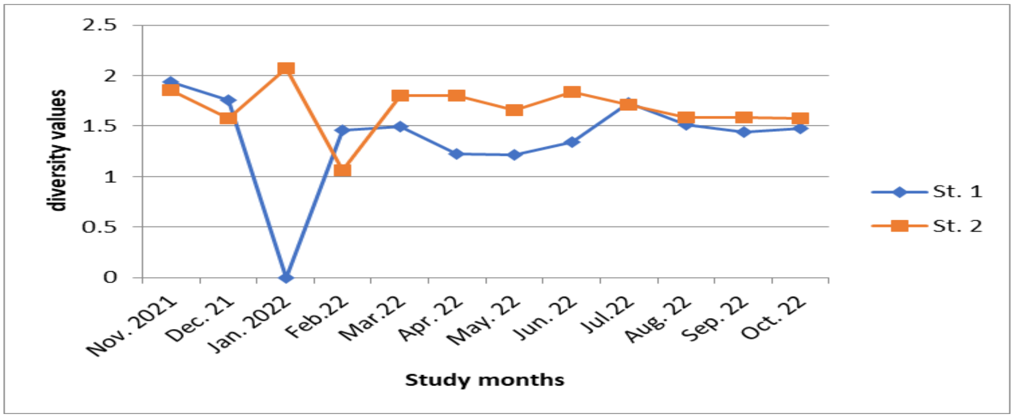

Fig. 4. Monthly rates of changes in the values of diversity index rates for the two stations during 2021-2022

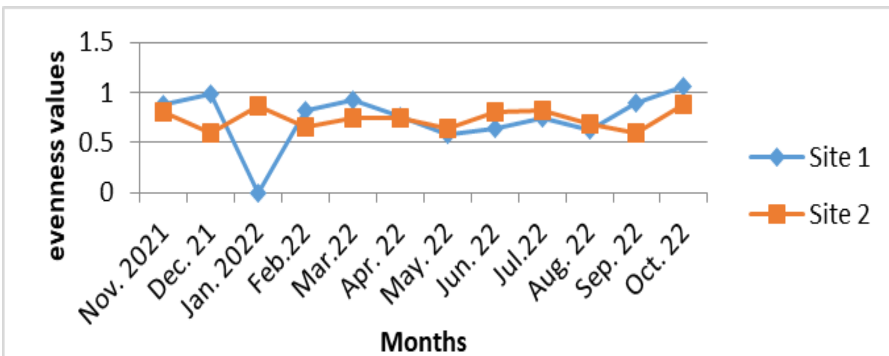

Fig. 5. Monthly rates of changes in the values of evenness index rates for the two stations during 2021-2022

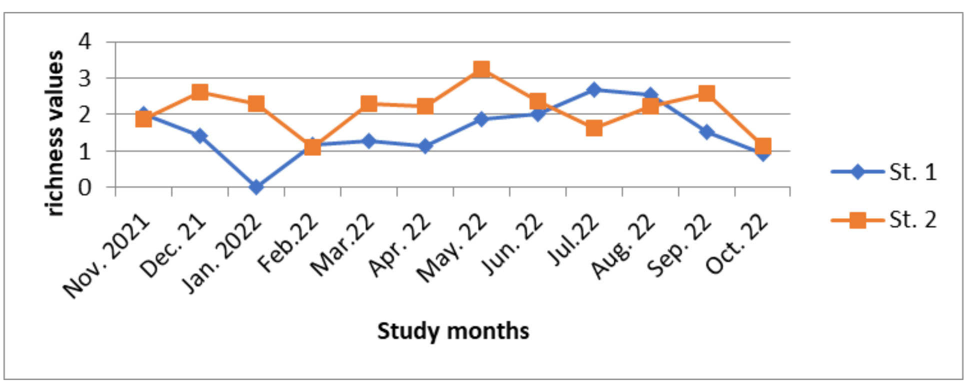

Fig. 6. Monthly rates of changes in the values of richness index rates for the two stations during 2021-2022

CONCLUSION

Fish species were classified into three groups according to their presence in the monthly samples, the marine migratory common fish species were 26 species and it represents most of the percentage of the catch (81.25%). The freshwater fish contain three species that represented low ratios (9.37%) of the catch, while the estuary fishes comprised three species in catch, represented by low rations (9.37). This study indicates that the lower number of fish species was 32 species, and lower numbers fishes were caught for most months of this study, and this may be attributed to the low levels of water during the study period, which caused increases in salinity concentrations in most study months, especially during the summer months.

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