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Assemblage Population of Fishes of Basrah Canal, Southern Iraq

Kadhim Hashim AL-Kanani [1], Amjad K. Resen[1] and Sajid Saad Hassan [2]

[1]Fisheries and Marine Resources, College of Agriculture, University of Basrah, Basrah, Iraq
[2]College of Health and Medical Technologies, AL-Maaqal University, Basrah, Iraq

[1]Corresponding author: kadhim.hashim@uobasrah.edu.iq

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ABSTRACT

The study was conducted in the Shatt al-Basra Canal, with two stations selected for sampling from January 2023 to December 2023. The first station was located near the Mohammed Al-Qasim Bridge, while the second station was in the Al-Khuwaisat area, downstream. Samples were monthly collected. A total of 5,673 fishes were collected, including 45 species belonging to 30 families, with 40 marine species, one endemic species, and four invasive species. The Dorosomatidae family was dominated, with seven resident species, three seasonal species, and 42 rare species. The species *Thryssa whiteheadi*, *Planiliza subviridis*, and *Coptodon zillii* made up 46.5% of the total catch. Physical and chemical parameters measured during the study included water temperature (16-35°C), dissolved oxygen (5-9 mg/L), pH (7.1-8.15), light transmittance (18-71 cm), and salinity (20.2-47 ppt). The diversity index (H) values ranged between 0.31 and 1.57 at the study stations.

INTRODUCTION

Estuaries generally play an important role in providing nursery sites for juvenile fish to protect against predators, as well as serving as feeding grounds where young fish can benefit from the food resources available in these areas. Estuaries are breeding and nursery places for resident species that have adapted to live in this environment **(Franco *et al.*, 2001)**. The composition of the fish populations is affected by physochemical factors, including water temperature, salinity, and pH, along with nutrients such as nitrates, nitrites, and phosphates. These factors actively influence the interactions and behaviors among different fish species, given the relative importance of these factors and differing views on the controllability and maintenance of these populations **(Ibarra *et al*., 2005)**.

The interchangeable way in which ecosystem characteristics and the way an individual can carry out activities without changing physical and chemical properties through the management of aquatic environments must be understood (**Badrizadeh, 2022)**. On the other hand, climate change affects the productivity of marine and freshwater fisheries in the world through changing species distribution in water bodies (**FAO, 2018)**. Water temperature, salinity and light penetration are the most important factors affecting the composition and diversity of fish population **(Clark, 2003; Mrosso *et al*., 2004; Pérez-Robles *et al*., 2012; Fazio *et al*., 2013)**. Local studies have been conducted to describe the nature of the composition of the fish gathered from the Shatt al-Basrah Canal such as those of **Al-Dubakel (1986)**, **AL-Daham and Yousif (1990)**, **Jassim (2003)**, **Jassim *et al*. (2007)**, **Al-Shamary (2010)**, **Younis and AL-Shamary (2011)** and **Resen (2011)**. Due to limited environmental and ecological research on the Shatt al-Basrah Canal, this study aimed to provide a detailed understanding of the fish community, focusing on species dominance and abundance in the canal. It also sought to examine environmental changes in the area to assess their impact on species presence, as well as addressing environmental changes in the region to identify the extent of their impact on the presence of species.

MATERIALS AND METHODS

1: Description of the study area:

The Shatt al-Basrah Canal is one of the important areas because it connects the general Estuary and the Arabian Gulf through Khor Al-Zubair, where fish are found in estuaries and small marine fish enter the canal for reproduction or feeding, and then they return to the sea after spending a period of their life cycle **(Ahmed and Hussain, 2000)**. Two stations were selected to collect study samples as shown in Picture (1). The first station is located E47.7487406 30.4667143°N, and the second station is located at E47.7487406 30.4667143°N, as displayed in Fig. (1).

Fig. 1. Satellite picture of the Shatt al-Basrah Canal

2. Collecting fish samples

Water and fish samples were monthly collected from the study stations ~~monthly~~ between December 2022 and November 2023, timed to coincide with tidal period. Various fishing methods were employed, including the use of gill nets with different hole sizes, dimensions (28 * 28 and 25 * 25), nets measured (120m in length and 4m in height) and the withdrawal time of 30 minutes.

3. Laboratory work

Five environmental factors were measured, involving water temperature, salinity, light penetration, pH and dissolved oxygen. Fish samples were kept in an ice box and transferred to the laboratory where they were identified by species according to the classification of **Carpenter *et al*. (1997)** and **Coad (2017)**.

The numbers and individuals of each species were recorded, and the total length of each fish was measured. The numerical and relative abundance of each fish species was calculated using the Diversity index (H) (**Shanon & Wever (1949)** and the **Odum**'s **(1970)** equation. the fish were divided into three sections depending on the frequency of their presence in the monthly samples according to **Tyler (1971)**, which are the resident or common fish species that appear between the samples in (9-12) months per year.

Seasonal fish species characterize fish that appear in (6-8) months, and occasional fish species that appear during (1-5) months. Principal component analysis (PCA) was used to find out the impact of the studied environmental factors and the number of species & individuals at two study stations.

RESULTS

Water temperature

Fig. (2) shows monthly variations in water temperature at the two study stations. The lowest temperatures were recorded in January, with 16°C at the first station and 14.5°C at the second in December 2022.

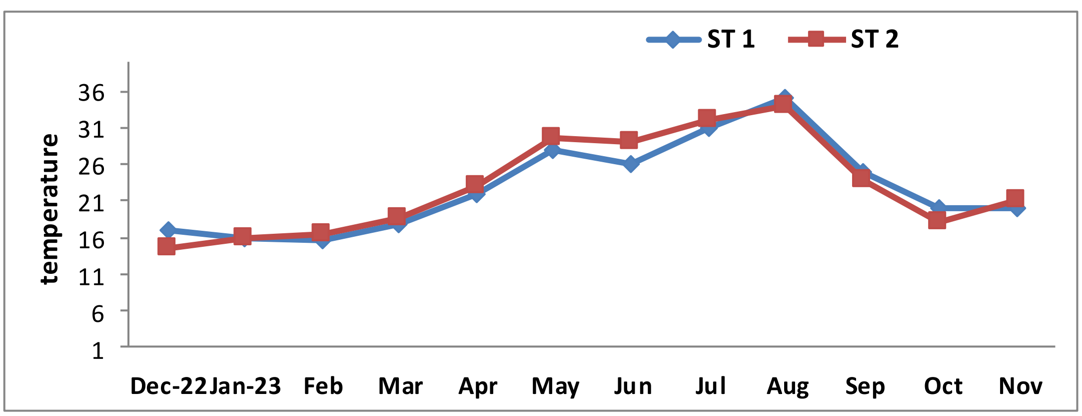

Fig. 2. Monthly changes in water temperature values for the two study stations

Temperatures gradually increased, reaching a peak of 35 and 34°C at the first and second stations, respectively, in August 2023. The statistical analysis showed no significant differences in water temperatures between the two stations at a significance level of 0.05 (F = 0.006, sig. = 0.938)

Salinity

Fig. (3) shows the monthly fluctuations in salinity levels at the two study stations. The lowest salinity values were observed in February, measuring 20.2ppt at the first station and 28.5ppt at the second station. In contrast, the highest salinity levels were recorded in August, reaching 39 and 47 ppt at the first and second stations, respectively. The analysis of variance showed a significant difference between the two stations for salinity concentrations, with F = 14.461 sig. 0.001.

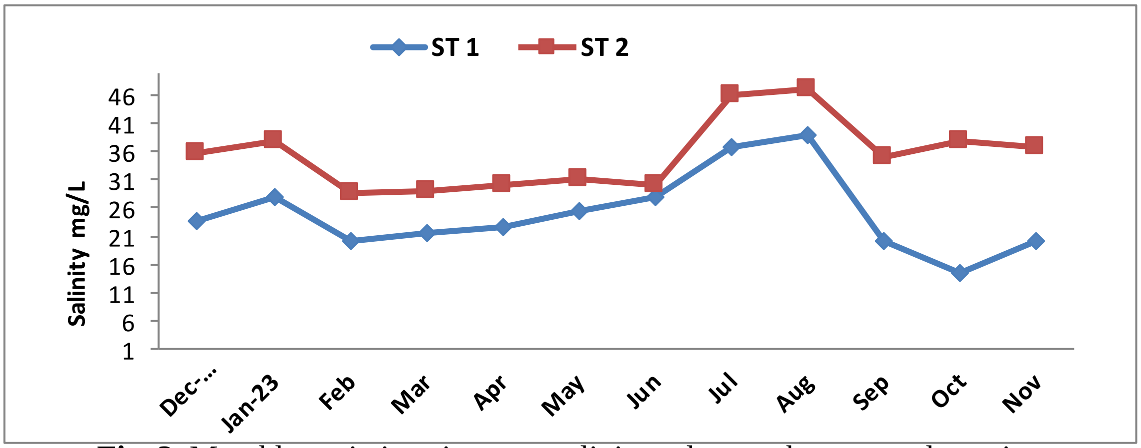

Fig. 3. Monthly variations in water salinity values at the two study stations

Dissolved oxygen (DO)

Fig. (4) shows the monthly fluctuations in dissolved oxygen values of the two study stations were oscillating in Fig. (4), as the lowest oxygen values were recorded at 5 and 6

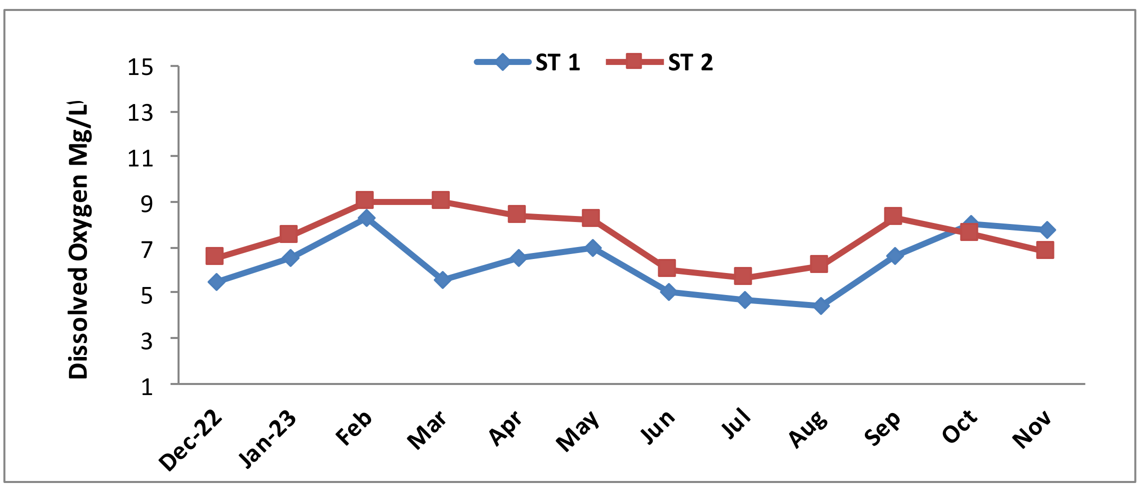

Fig. 4. Monthly variations in dissolved oxygen values at the two study stations

mg/L in June for the first and second stations, respectively, and the highest values were 8.3 and 9mg/L in February at the first and second stations, respectively. he analysis of variance indicated a significant difference between the two stations for dissolved oxygen concentrations; F = 4.790 Sig. 0.040.

Hydrogen ion concentration (pH)

The pH values were somewhat close for the two stations of the study (Fig. 5), which tends to the light base direction, as the lowest values in February were 7.1 and 7.5 for the first and second stations, respectively, and the highest values were recorded at 8.3 and 8.15 in August for the first and second stations. The analysis of variance table showed no significant differences in pH values between F = 3.231 Sig. 0.086.

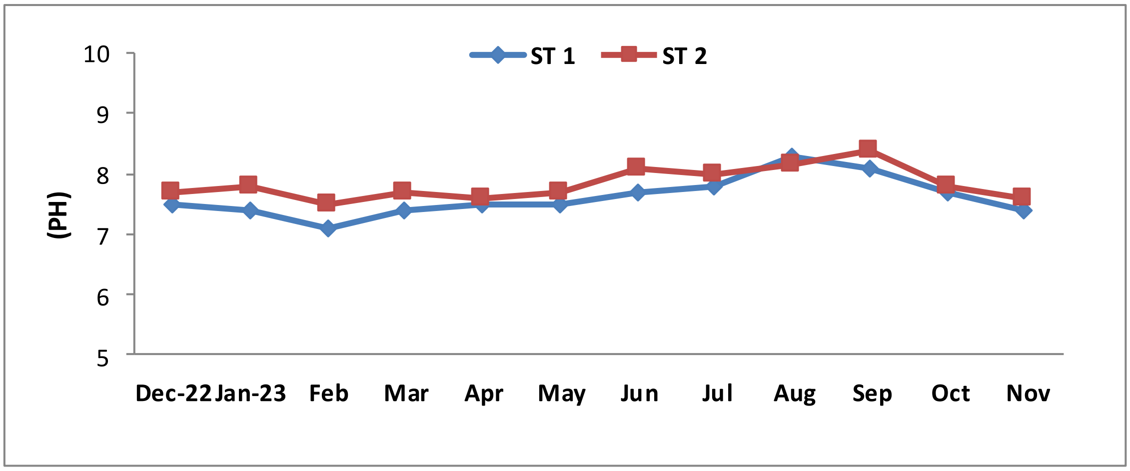

Fig. 5. Monthly variations in water pH values for the two study stations

Light penetration

Fig. (6) shows the monthly changes values at the two study stations, as the lowest values were recorded to be 27.5cm in September for the first station, and in May a value of 18cm was recorded for the second station.

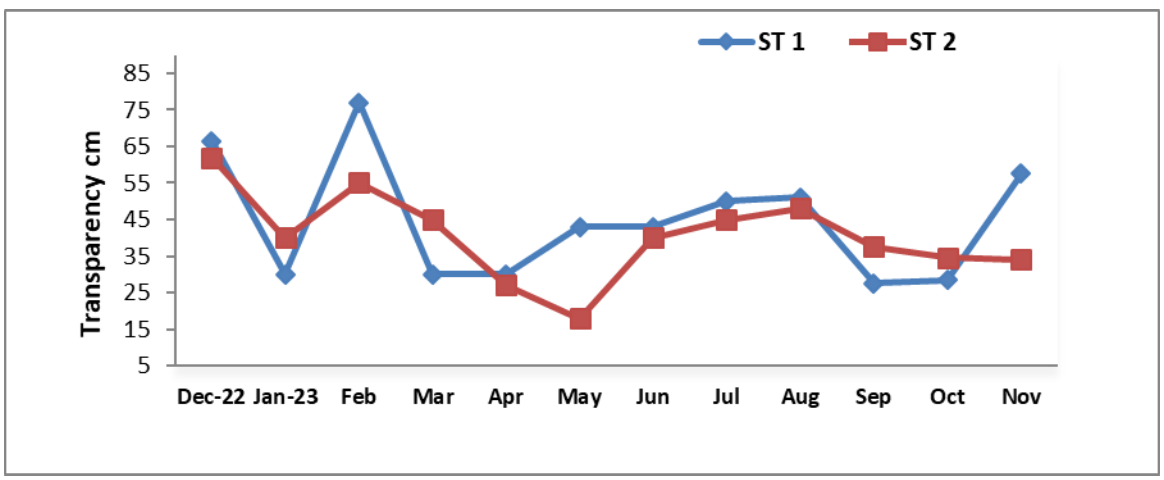

Fig. 6. Monthly variations in water light permeability values at the two study stations

The highest values were observed at 77cm in February for the first station and at 62cm in December 2022 for the second station. The analysis of variance showed no significant differences in light penetration values between the two study stations (F= 0.469, Sig.

0.501). Fig. (7) shows the principal components analysis (PCA) of the environmental factors measured at the first station, as temperature, salinity and pH are directly correlated with each other and inversely with dissolved oxygen and light penetration. The direct correlation is observed at the second station between temperature, salinity and pH and inversely with dissolved oxygen, while a light penetration is directly correlated with salinity and pH, and inversely correlated with temperature and dissolved, as indicated from data in Fig. (8).

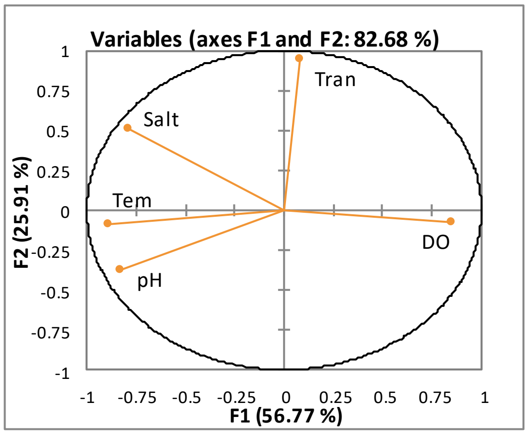

Fig. 7. Analysis of the basic components of environmental factors at the first station

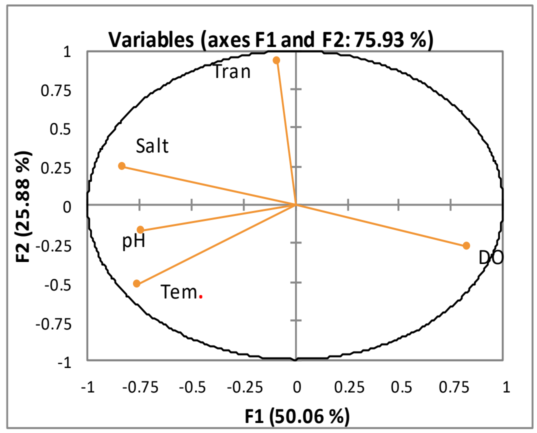

Fig. 8. Analysis of the basic components of environmental factors at the second station

3.2. Fish assemblage structure

5673 fish were caught including 45 species from the two study stations belonging to 30 families, represented by 40 marine species, one endemic species and four exotic species, as depicted in Table (1).

Table 1. Families, species and fish habitats in the Shatt al-Basrah Canal for the period from December 2022 to November 2023

NO.	Family	Fish species	Habitat	
1	Engraulidae	*Thryssa whiteheadi*	M	Ab
2		*Thryssa hamiltonii*	M	Ab
3	Dorosomatidae	*Nematalosa nasus*	M	Ab
4		*Anodontostoma chacunda*	M	B
5		*Sardinella longiceps*	M	B
6		*Tenualosa ilisha*	M	Ab
7	Poeciliidae	*Poecilia latipinna*	F+	A
8	Cichlidae	*Coptodon zillii*	F+	Ab
9		*Oreochromis aureus*	F+	A
10		*Oreochromis niloticus*	F+	A
11	Sparidae	*Acanthopagrus sheim*	M	B
12		*Acanthopagrus arabicus*	M	B
13	Gobiidae	*Bathygobius fuscus*	M	Ab

14		*Periophthalmus waltoni*	M	B
15		*Boleophthalmus dussumieri*	M	Ab
16	Leiognathidae	*Photopectoralis bindus*	M	Ab
17	Mugilidae	*Planiliza abu*	F	Ab
18		*Planiliza subviridis*	M	Ab
19		*Planiliza klunzingeri*	M	Ab
20		*Osteomugil speigleri*	M	B
21	Soleidae	*Brachirus orientalis*	M	Ab
22	Mullidae	*Upeneus doriae*	M	B
23	Sciaenidae	*Johnius dussumieri*	M	B
24		*Johnius belangerii*	M	B
25	Synanceiidae	*Pseudosynanceia melanostigma*	M	B
26	Sillaginidae	*Sillago arabica*	M	B
27		*Sillago sihama*	M	A
28	Soleidae	*Soles stanalandi*	M	B
29	Cynoglossidae	*Cynoglossus arel*	M	B
30	Chirocentridae	*Chirocentrus dorab*	M	B
31		*Chirocentrus nudus*	M	B
32	Scatophagidae	*Scatophagus argus*	M	B
33	Carangidae	*Scomberoides commersonnianus*	M	B
34	Platycephalidae	*Platycephalus indicus*	M	B
35	Siganidae	*Siganus sutor*	M	B
36	Muraenesocidae	*Muraenesox cinereus*	M	B
37	Synodontidae	*Saurida macrolepis*	M	B
38	Triacanthidae	*Triacanthus biculiatus*	M	B
39	Dussumieriidae	*Dussumeria elopsoides*	M	B
40	Pristigasteridae	*Ilisha compressa*	M	Ab
41	Hemiramphidae	*Hyporhamphas limbatus*	M	Ab
42	Ariidae	*Netuma thalassina*	M	B
43	Plotosidae	*Plotosus lineatus*	M	B
44	Trichiuridae	*Eupleurogrammus glossodon*	M	B
45	Hemiscylliidae	*Chiloscyllium arabicum*	M	B

Fig. (9) shows the monthly variations in the number of fish species in the study area. At the first station, 18 species were recorded, with the number ranging from three species in May to eight in both December 2022 and September 2023. At the second station, 41 species were documented, with the count varying from six species in January 2023 to 19 species in October 2023.

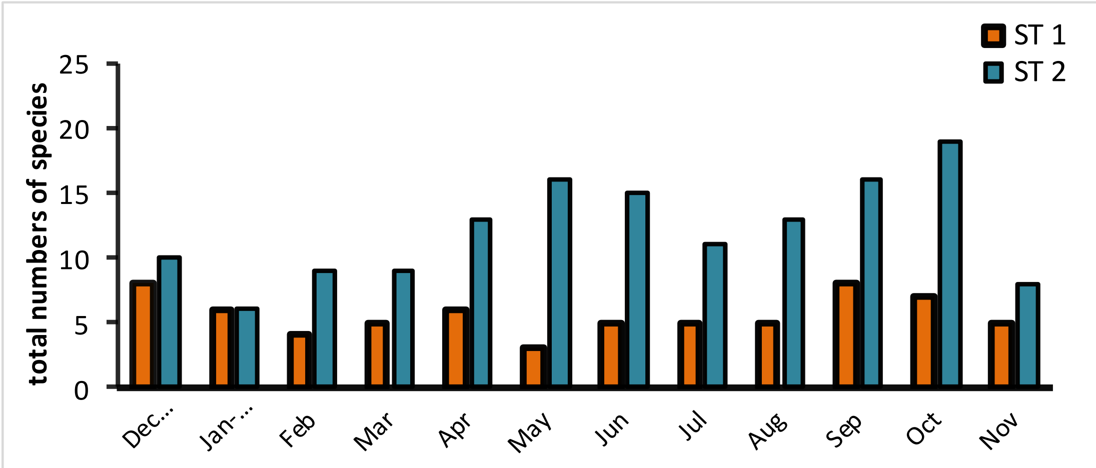

Fig. 9. Monthly variations in the numbers of fish species for the two study stations

Fig. (10) illustrates the monthly fluctuations in fish numbers within the study area. At the first station, a total of 1,125 fish were recorded, with numbers ranging from 46 fish in March to 152 fish in October 2023. At the second station, the total count reached 4,538 fish, with numbers varying between 170 fish in January 2023 and 743 fish in April for the same year.

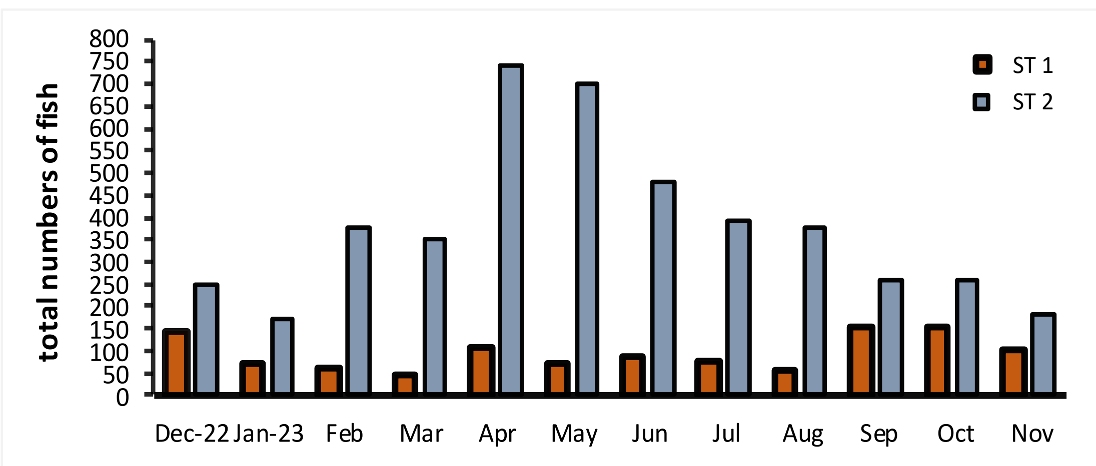

Fig. 10. Monthly variations in the total numbers of individuals for the two study stations

Fig. (11) shows the analysis of complementary variables with the effect of environmental factors on the number of species caught at the first station, as it shows the effect of direct correlation dissolved oxygen and light transmittance and inversely with temperature, salinity and pH, while the second station correlated the number of species directly with temperature, pH salinity and light penetration and inversely with dissolved oxygen, as illustrated in Fig. (12).

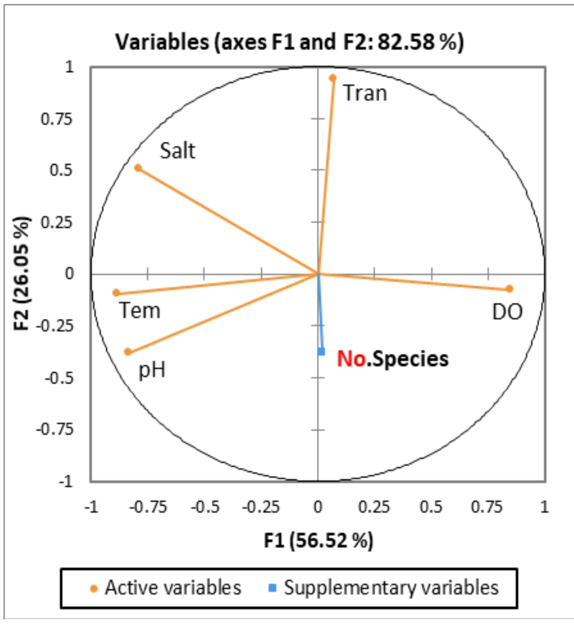

Fig. 11. Analysis of supplementary variables for the number of fish species at the first station

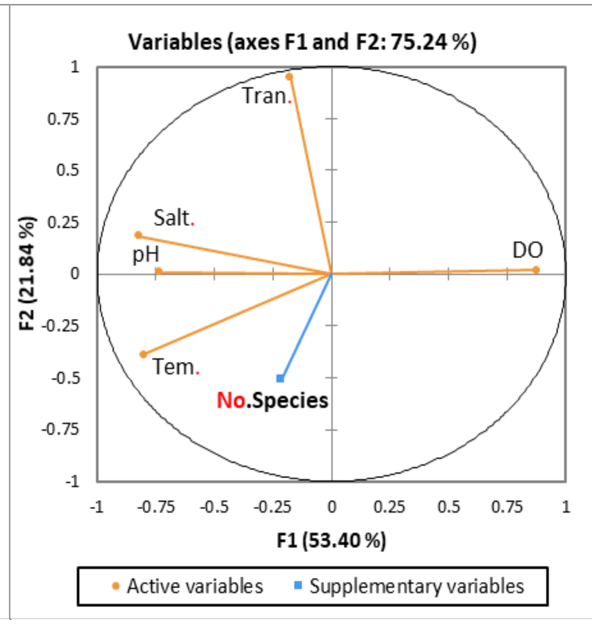

Fig. 12. Analysis of supplementary variables for the number of fish species at the second station

Fig. (13) exhibiits the complementary analysis of variables with the effect of environmental factors on the number of fish individuals at the first station, as it shows the effect of direct correlation dissolved oxygen and inversely with temperature, salinity and pH, while the second station correlated the number of individuals directly with dissolved oxygen and inversely with temperature, salinity, pH and light penetration, as in Fig. (14).

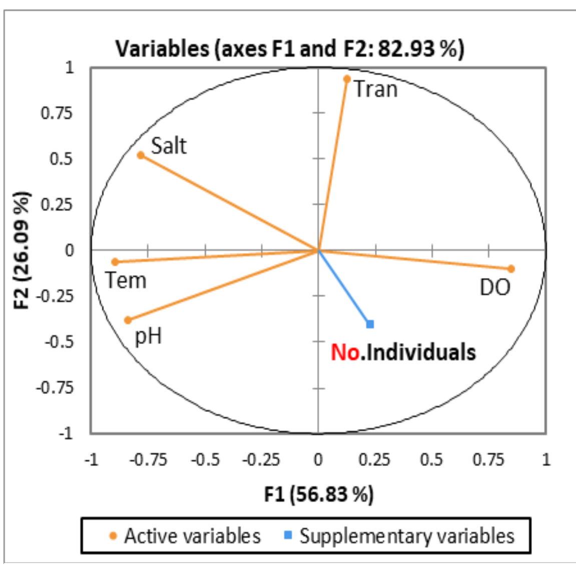

Fig. 13. Analysis of supplementary variables for the number of fish individuals at the first station

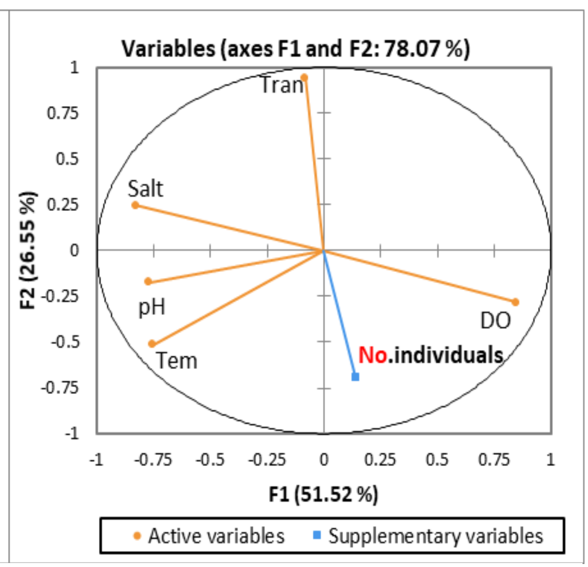

Fig. 14. Analysis of supplementary variables for the number of fish individuals at the second station

Fig. (15) displays the clear monthly variations in the number of endemic, alien and marine species at the two study stations. The first station recorded the lowest count, with one endemic species, four invasive species, and 13 marine species, while the number of invasive species was four, and the number of marine species was 13. At the second station, the number of endemic and alien species was one each, while the number of marine species was 39.

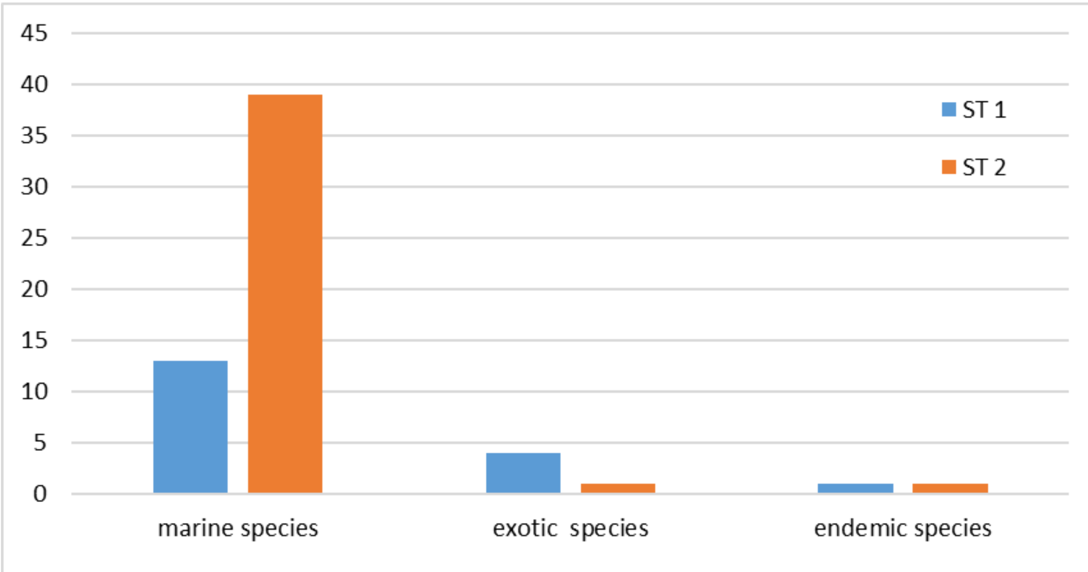

Fig. 15. Monthly variations in the number of native, exotic, and marine species at the studied stations

3.3. Relative abundance

Table (2) shows the monthly variations in relative abundance of species at the first station during the sampling period. Three fish species were dominant, collectively making up 79.02% of the total catch. *C. zilli* ranked first, with 508 individuals caught, accounting for 45.16% of the total catch. The relative abundance of *C. zilli* ranged from 25% in April to 87.67% in May and June, while *B. fuscus* came in the second place and the abundance number was recorded with 202 fish (17.96%), ranging between 4.61% in October and 84.78% in March and occupying. Whereas, *B. dussumieri* is ranked third with a numerical abundance of 179 fish at a rate of 15.91%, ranging from 2.35% in June to 36.27% in November.

Table 2. Monthly variations in both the numerical and relative abundance at the first station throughout the study period

Scientific name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	%	%	%	%	%	%	%	%	%	%	%	%	%
C. zillii	62.5		52.4		25.0	87.6	87.0	53.9	62.9	28.4	37.5	45.1	45.1
P. subviridis	15.2	31.5		2.17	1.85								4.26
T. whiteheadi	5.56	17.8		2.17	13.8		1.18		7.41	19.8	0.66	3.92	6.84
T. hamiltonii	4.17							5.26					0.88
B. fuscus	6.94	35.6	36.0	84.7	31.4	9.59	8.24	11.8	9.26	16.5	4.61	10.7	17.9
B. dussumieri	3.47	4.11			21.3	2.74	2.35	15.7	18.5	27.1	28.9	36.2	15.9
B.orientalis	1.39								1.85	1.99			0.53
S. sihama	0.69												0.09
P. abu			1.64	8.70									0.44
P. klunzingeri		9.59											0.62
H. limbatus		1.37											0.09
O. niloticus			9.84										0.53
N. nasus				2.17						3.97			0.62
O. aureus								13.16					1.51
T. ilisha							1.18						0.09
P. latipinna										1.32	1.32	3.92	0.71
I. compressa										0.66	1.97		0.36
P. bindus											25.0		3.38

Table (3) presents the monthly changes in relative abundance of species at the second station during the sampling period. Four fish species dominated, accounting for 66.95% of the total catch., and *T. whiteheadi* ranked first with a numerical abundance of 1026 fish, by 22.56%, and its relative abundance ranged between 3.20% in December 2022 and 37.39% in March, and the *P. subviridis* came in the second place, as the total number reached 977 fish, by 21.48%, ranging between 4.58% in July and 67.20% in December 2022, and *N. nasus* ranked the second, with a numerical abundance of 597 fish, by 13.13% of the total number, and its relative abundance varied between 2.40% in December 2022 and 35%. in April. The fourth place was occupied by *B. fuscus* with an abundance of 445 fish, 9.78% of the total number, ranging from 0.84% in June to 19.79% in February.

Table 3. Monthly fluctuations in both the numerical and relative abundance at the second station during the study period

Scientific name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	%	%	%	%	%	%	%	%	%	%	%	%	%
P. subviridis	67.2	82.4	32.2	31.2	14.0	13.2	20.0	4.6		24.8	10.0	19.8	21.5
P. klunzingeri	1.2								1.6		1.5		0.3
N. nasus	2.4	3.5	5.5	4.2	35.0	6.1		30.5	24.8	12.4			13.1
A. chacunda	2.4		1.6		5.7	17.9	3.8						4.4
B.orientalis	3.6		6.3	0.8	2.4	10.2	5.0	6.1	9.0		0.8		4.6
B. fuscus	14.4	3.5	19.8	13.6	1.6	19.2	0.8	5.3	4.2	13.2	17.0	7.7	9.8
P. waltoni	3.2												0.2
B. dussumieri					0.4			2.3					0.3
U.doriae	1.2	1.8				0.4					4.6		0.5
T. whiteheadi	3.2	7.1	30.6	37.4	32.8		23.2	32.8	34.8	11.6	21.6	30.8	22.6
M.cinereus	1.2			0.0			0.0					1.1	0.1
J. dussumieri		1.8	2.4	3.4	0.4	11.5	26.9	9.9	9.0	3.9	7.7	25.3	8.5
E. glossodon			0.8							0.8			0.1
S. arabica			0.8									2.2	0.2
A. sheim				1.7									0.1
C. arabicum					0.4								0.1
P. lineatus					0.4								0.1
T. ilisha				6.8	4.8	2.6	3.1	0.8		0.4	0.8		2.2
P. melanostigma				0.8									0.1
N. thalassina					0.4								0.1
H. limbatus					1.6						0.8		0.3
I. compressa						2.6	2.1	1.5	4.7	12.4	2.3	1.1	2.0
C. zillii						0.4	0.6						0.1
S. stanalandi						0.4	0.6			0.4	4.6		0.4
D. elopsoides						0.4							0.1
T. biculiatus						0.4	4.6	0.8		3.1	0.8		0.8
S. macrolepis						0.4	0.8		2.4		0.4		0.4
O. speigleri						0.9							0.1
P. bindus						13.2	0.6	5.3	4.0	6.2	1.9		3.4
P. abu							0.4						0.04
T. hamiltonii							7.3						0.8
S. longiceps									1.6				0.1
S. sutor									0.8				0.1
C. nudus									1.6				0.1
J.belangerii									1.6	1.6	21.6	12.1	1.9
P. indicus										0.4	0.8		0.1
S.commersonnianus										7.8			0.4
C. arel										0.8			0.04
C. dorab										0.4	0.4		0.04
S. argus											1.5		0.1
A. arabicus											0.8		0.04

3.4. Species occurrence

Fig. (16) shows the distribution of common, seasonal, and occasional species at the two study stations. The first station recorded four common species and 14 occasional species. The second station recorded six common species, two seasonal species, and 33 occasional species.

1.The common species: the first station included four species, with one species (*B. fuscus*) appearing in all months and two species in ten months, *C. zillii* and *B. dussumieri*. One species appeared in nine months, while *T. whiteheadi* was observed in nine months. At the second station, six species were recorded including one species in all months, *B. fuscus*, and the presence of three species in 11 months, *P. subviridis* and *T. whiteheadi J. dussumieri*, and two species appeared in nine months, *N. nasus* and *B. orientalis.*

2. Seasonal species: No seasonal species were recorded at the first station while the second station witnessed three species, with two species, *I. compressa* and *T. ilisha*, found for seven months, while *P. bindus* was recorded throughout 6 months.

3. Occasional species*:* At the first station, 14 species were recorded; one species, *P. subviridis*, was observed for four months; two species appeared across three months, *B. orientalis* and *P. latipinna*, five species appeared for two months, *T. hamiltonii*, *P. abu* and *N. nasus*, *O. aureus* and *I. compressa*, and six species appeared during one month (*S. sihama*, *P. klunzingeri*, *H. limbatus*, *O. niloticus*, *T. ilisha* and *P. bindus*).

The second station recorded a total of 32 rare species, with two species identified in five months (*A. chacunda* and *T. biculiatus*) and four species present for four months, *U.doriae*, *S. stanalandi*, *S. macrolepis* and *J.belangerii*; whereas, one species was detected throughout three months (*P. klunzingeri*) and repeatedly, eight species were recorded covering two months (*B. dussumieri* and *E. glossodon* and *S. arabica* and *H. limbatus* and *C. zillii* and *P. indicus* and *C. dorab* and *M.cinereus*). 17 species were found in one month (*P. waltoni*, *A. sheim*, *C. arabicum*, *P. lineatus*, *P. melanostigma*, *N. thalassina*, *D. elopsoides*, *O.* speigleri, *P. abu*, *T. hamiltonii*, *S. longiceps*, *S. sutor*, *C. nudus*, *S.commersonnianus*, *C. arel*, *S. argus* and *A. arabicus*) .

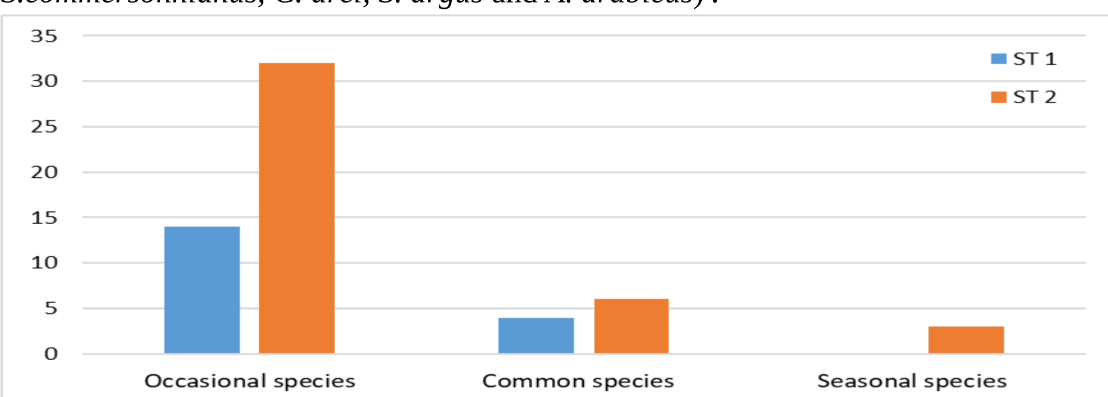

Fig. 16. Monthly variations in common, seasonal, and occasional species at the two study stations

3.5. Diversity index (H)

Fig. (17) shows the monthly variations in the numerical diversity index of fish species at the study stations. The highest values recorded were 1.45 in January 2023 for the first station and 1.57 in May for the second station. The lowest values were 0.31 in March 2023 for the first station and 0.73 in January 2023 for the second station.

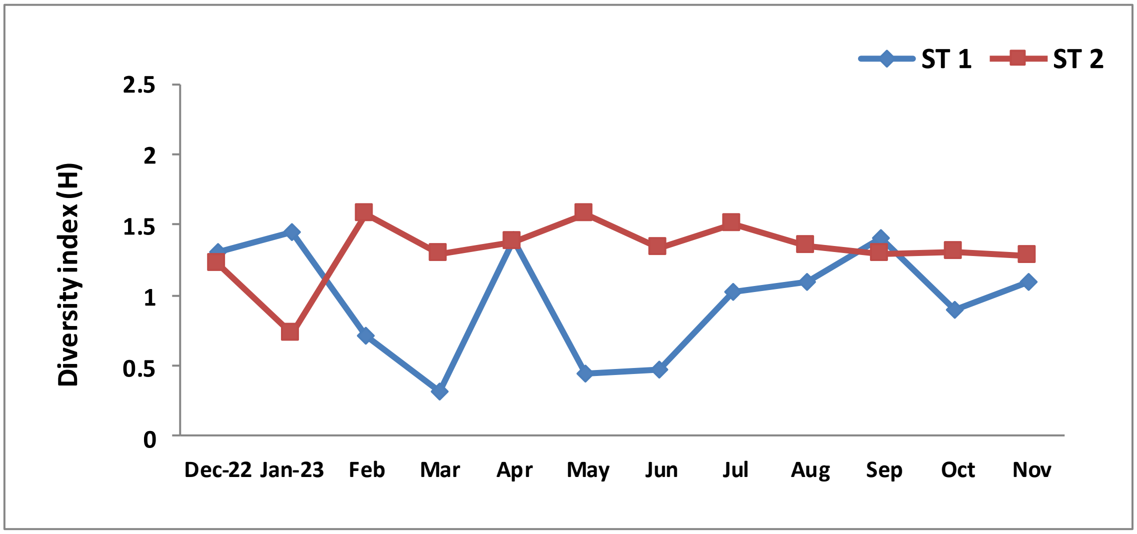

Fig. 17. Monthly variations in the diversity index values for the two study stations

DISCUSSION

Environmental factors overlap in their impact on aquatic organisms, as the effect of one factor cannot be separated from the other, and temperature is one of the environmental characteristics affecting the ecosystem and its impact on fish metabolism rates, nutrition, energy, movement, digestion, absorption of nutrients inside the digestive system and storage of excess energy **(Volkoff & Ronnestad, 2020).**

The slight variation in temperature between the study stations is due to the variation in location, the difference in sampling times, and the variation in the depth of the water; the results of the current study agree with those of previous studies **(Wahhab, 1986; Resen, 2011; Al-Thamili, 2020; Galo, 2023)**.

Salinity values varied during the study period in the Shatt al-Basrah Canal, recording high concentrations at the second station compared to the first station due to its great impact on tidal water coming from the Arabian Gulf through Khor Al-Zubair. The salinity concentrations recorded during the current research are higher than those detected in previous years, with ranges from 1.0-33.1‰ during 1985-1986 **(Wahhab, 1986)** and between 5.5-47.5‰ during 2008-2009 **(Resen, 2011)**; whereas, a range between 15-35‰ was recorded during 2011-2012 **(Abbas, 2015)**.

The current salinity range (20.2 – 47‰) is attributed to the increase in evaporation rates as well as the lack of fresh water revenues from the Euphrates River, as well as the establishment of the Earthen Dam, built on the upper part of the canal from the side of the Karma Ali River, while the lower part of the channel is affected on a daily basis by the phenomenon of tides and coming from the Arabian Gulf **(AL- Aesawi, 2010)**.

Remarkably, the continuous increase of salts result from human activities and untreated wastewater **(Hassan *et al*., 2018)** and irregular opening of regulator gates (personal contact).

The current study showed a rise in dissolved oxygen concentrations in the Shatt al-Basrah Canal during winter and autumn, while a decrease was determined during summer in at both study stations; the reason for the decrease in dissolved oxygen concentrations during the summer season is the increase in the rate of decomposition of organic matter oxygen consumption by aquatic organisms **(Moyel, 2014)** and inverse correlation between gases and temperatures **(Durmishi *et al*., 2008)**. Light penetration is one of the abiotic properties that have a direct impact on the presence and spread of fish species **(Hussein *et al*., 2000)**.

The values of low light penetration at the first station compared to the second station are ascribed to the low speed of current, as the regulator controls the speed of water movement at this station, which opens perhaps for a few hours of the day or month, which leads to the deposition of suspended matter and the difference in the density of phytoplankton, and this is consistent with previous research **(Wahhab, 1986; Galo, 2023)**.

The high turbidity of the second station is due to the large number of side branches on both sides of the canal, from which water is discharged into the islands, disturbing the station, in addition to the detrimental effect of fishing boats and their movement, tidal currents and the nature of the bottom, as well as the direct release of household waste and untreated sewage **(Charles *et al*., 2019)**.

The pH results indicated a clear homogeneity across all study stations and were within the light base direction throughout the study period, This reflects a distinctive of Iraqi waters, which exhibit high regulatory capacity due to its content of carbonates and bicarbonates **(stirling, 1985)**.

Fish populations composition

The studies that dealt with the composition of fish populations in the Shatt al- Basrah canal are relatively few, as the total number of species in the current study reached 45 species, the Dorosomatidae and Mugilidae families topped the number of species, and this is consistent with many studies that dealt with the composition of fish populations. As Table (4) shows a comparison between the composition of fish populations in the Shatt al-Basrah Canal and previous studies, it is clear that there is a decrease in the number of species compared to that detected in previous studies. This decrease may be traced back to the lack of water releases, an increase in the number of boats, and the multiplicity of fishing methods **(AL-Shamary, 2020).**

In addition o the previous factors, closing the canal with the earthen dam from the side of Karma Ali, opening and closing the gates of the regulator irregularly, and directly subtracting untreated sewage and industrial water are to be considered.

Table 4. Comparison of the composition of fish populations in the Shatt al-Basrah Canal with previous studies

References	**Species**
(AL-Daham and Yousif, 1990)	47
Jassim (2007)	44
(Younis and AL-Shamary, 2011)	53
Resen *et al*. (2014)	33
Present study	45

The study results shows differences in the populations of endemic, marine, and exotic fish compared to previous studies in the Shatt al-Basrah Canal. In the current study, the number of endemic, exotic, and marine species reached 1, 4 and 40 respectively. The findings of the current study differ from those of **Younis and AL-Shamary (2011)** in the number of endemic and Marine species and may be due to hydrological variations and change in the amount of water flow of the canal, which has a role in the formation of the composition of fish populations **(Whiterod *et al*., 2015)**.

Any disturbances in the nature of the water body lead to a decline in endemic species and an increase in invasive species in addition to causing problems that are harmful to other species **(Kumar & Pandey, 2013)**. The numbers of endemic species were close and identical at the two study stations, while there was a clear sovereignty in the number of marine species during the study period covering the two stations due to the fact that they are affected by marine waters. On the other hand, the second station continues to be linked to the upper branches of Khor Al-Zubair, as well as to the high concentrations of salinity in it, unlike the first station, where the water was stagnant and static in most of the province and the lack of water flow received regularly from the source and the non-operation of the Shatt al- Basrah regulator for technical reasons or according to the instructions issued from the General Estuary Department **(AL- Mahmoud *et al*., 2023)**.

The study showed the predominance of three types of fish at the first station and varied in their numerical and relative abundance and constituted 79.02% of the total number. *C. zilli* ranked first with 45.16% of the total catch, and *B. fuscus* came in second place by 17.96%, while *B. dussumieri* ranked third by 15.91%, as the study **(Galo, 2023)** confirmed the abundance of *C. zilli* through a study on some fish off the Shatt al-Basrah canal. *C. zilli* is a widespread invasive species with a high ability to withstand environmental conditions, which has accidentally entered through shared waters with neighboring countries **(Al-Faisal & Mutlak, 2009)**.

They tolerate high salinity, low oxygen concentrations, high reproduction capacity, rapid adaptation to new environments **(Ridha, 2006)**, and have the ability to resist adverse and polluted environmental conditions, and resist diseases and have a reproductive activity throughout the year, and its peak is in March to June **(Qadoory, 2012)**.

The results of the current study agree with the study of **Al-Thamili (2020)** which indicated the abundance of fish of the (Gobiidae) family due to the ability of this species to withstand environmental conditions and revealed the ability to live in a wide range of salinity in rivers and lakes with poor water specifications **(Haney & Walsh, 2003; Vasagam *et al*., 2005)**. Four species accounted 66.95% of the total number at the second station, and the *T. whiteheadi* ranked first with 22.56%, *P. subviridis* came in second with 21.48%, and *N. nasus* came in second with 13.13% of the total number, *B. fuscus* ranked fourth with 9.78% of the total number.

The results of the current study showed that the marine species registered in the Shatt Basrah canal are the closest species recorded in the northern part of the Arabian Gulf more than the southern part through the species registered in the study and agree with the study of **Younis *et al*. (2016)**. The presence of species may return significantly in the southern part as a result of the tide coming from the sea and through Khor Al-Zubair and the high values of salinity concentrations from the previous, and this is confirmed in the research work of **Ali (1985)** investigating Khor Al-Zubair.

P. subviridis showed clear dominance in terms of numerical abundance at the second station, and this is consistent with the findings of many researchers during their study on the Shatt al-Basrah Canal **(Al-Dubakel, 1986; Wahhab, 1986; Jassim, 2003; Resen, 2011)**. This is due to the entry of these fish into the downstream waters to spend a period of their life cycle and then return to the marine waters for reproduction in addition to the possibility of this type to withstand high concentrations of salinity.

It was noted that fishing rates are high during the summer and spring seasons and low during winter, and this is due to the movement of most species during the winter months from cold shallow waters to warm deep waters in the rest of the Arabian Gulf regions, as well as the Iraqi marine species migrating during summer and winter to and from those waters in order to stay away from the unsuitable environmental conditions. This behavior is frequently seen in many species found in this area since it is considered an incubation, reproduction and feeding area for the young **(Ahmed & Hussien, 2000; Taher, 2010)**.

A sharp decrease in the abundance of freshwater fish was observed due to the lack of fresh water releases from the source, and these fish were directly affected by high salinity values and the deterioration of the quality of the canal water as a result of the direct dumping of sewage, household waste and sewage without treatment **(Moyel and Hussain, 2015).**

The results of this study agree with the study of **Resen *et al*. (2014)**, and the study did not agree with that of **Younis and AL-Shamary (2011**) who recorded 8 species of the Cyprinidae family, and this is due to the difference in the physical and chemical factors of the Shatt al-Basrah Canal, which led to the entry of freshwater types coming from the Shatt al-Arab and the Hammar marsh, especially in the southern part of the canal, and this is confirmed by the studies of **Dubakel (1986)** and **AL-Shamary (2010)**.

Table (5) shows the comparison of the number of common, seasonal and occasional species in the Shatt Al-Basrah Canal with previous studies. It is noted through the table that the highest number of occasional and seasonal species, and this is consistent with the previous studies **(Dubakel, 1986; Younis & AL-Shamary, 2011; Resen *et al*., 2014)**. The lowest number of species observed in the current study is attributed to environmental changes, which influence the composition of fish populations times of emergence and presence of species **(Tyler, 1971)**.

It was noted that there is a difference in productivity between the Shatt al-Arab River and the Basrah Canal, and this difference is due to the fact that the Shatt al-Arab environment is more stable and contains a wide spectrum of neighborhoods, unlike the environment of the Shatt al-Basrah Canal, which has fast flow currents, and this is in a cycle that does not allow non-living to settle **(Jassim, 2003)**.

Table 5. Comparison of common, seasonal, and occasional species at the addressed stations with those recorded in previous studies

Reference	Station	Occasional species	Seasonal species	Common species
Dubakel (1986)	Shatt al-Basrah Canal	24	17	6
(Younis and AL-Shamary, 2011)	Station 1	8	17	3
	Station 2	26	5	7
Resen *et al*. (2014)	Shatt al-Basrah Canal	22	6	5
Present study	Station 1	14	0	4
	Station 2	32	3	6

Biodiversity indicators are of great importance in knowing fish populations, as they reveal diversity values of evidence on assessing the number of species that naturally thrive in various river locations. Additionally, these indicators reflect the stability of fish populations in these areas **(Sandu & Oprea, 2013)**. The results of the current study showed changes in the values of the diversity index which coincide with previous studies considering the minimum values of the diversity index, as in Table (6). The results of the current study do not agree with those of previous research **(Al-Shammari, 2020; Yaseen *et al*., 2024a, b)**, and this may be due to the difference in the study area, fishing pressure, and the high number of species recorded upon addressing 159 species and 86 species, respectively, compared to the current study's 45 species. This is reflected in the values of the diversity index as they are affected by the abundance of species in the aquatic environment as well as the abundance and dominance of species and their high percentage of total catch **(Hasan & Resen, 2019; Mohamed *et al*., 2017b)**.

Table 6. Comparison of the diversity index (H) between the current study stations and previous studies

Reference	Place	Diversity index
Ali (1985)	Khor Al Zubair	1.77-3.46
Dubakel (1986)	Shatt al-Basrah Canal	0.4-2.8
Jassim (2003)	Shatt al-Basrah Canal	0.28-2.87
Younis and AL- Shamary (2011)	Shatt al-Basrah Canal	0.95-3.05 st_1 1.45-3.06 st_2
Resen *et al* . (2014)	Shatt al-Basrah Canal	0-2.31
Al-Shammari (2020)	Iraqi marine waters	2.73-9.3
Yaseen *et al.* (2024)	Iraqi marine waters	1.5-3.5
Present study	Shatt al-Basrah Canal	0.31-1.45 st_1 0.73-1.57 st_2

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