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The Impact of Household Pollutants and Fish Assemblages on the Environment of Some Internal Streams Fed by the Euphrates River, North of Basrah Province

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Abstract - This study was conducted in response to a lack of research in the region and aims to evaluate the impact of household pollutants and fish populations on the environment and investigate their role in the disappearance of some ancient phenomena that occur annually. The study was performed from January to December 2023 on the internal streams fed by the Euphrates River in Al-Sadiq District, north of Basrah Province. Some ecological parameters were measured: water temperature, salinity, hydrogen ion concentration, dissolved oxygen, biological oxygen demand, total nitrate, and phosphate. Out of the total of 17 fish species nine of them were native, and eight were exotic species belonging to 15 genera, nine families, and five orders, all of them affiliated with the bony fish Osteichthyes class. Four species recorded the highest values of numerical relative abundance and formed 78.01% of the overall number of species. The current study concluded that the region has moderate total nitrate and phosphate concentrations and that the fish assemblage contributes to the recovery from eutrophication by fish feeding on filamentous algae and aquatic plants.

تأثير الملوثات المنزلية والتجمعات السمكية على بيئة بعض الانهار الداخلية المتغذية من نهر الفرات شمال محافظة البصرة

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المستخلص - أجريت هذه الدراسة استجابة لنقص الأبحاث في المنطقة وتهدف إلى تقييم تأثير الملوثات المنزلية وتجمعات الأسماك على البيئة والتحقق من دورها في اختفاء بعض الظواهر القديمة التي تحدث سنويا. أجريت الدراسة خلال الفترة من كانون الثاني وحتى كانون الأول 2023 على الانهار الداخلية التي يغذيها نهر الفرات في قضاء الصادق شمال محافظة البصرة. قيست بعض العوامل البيئية: درجة الحرارة، وملوحة الماء، تركيز أيون الهيدروجين، الأوكسجين المذاب، المتطلب الحياتي للأوكسجين، النترات والفوسفات الكلية. كان مجموع الانواع 17 نوعًا من الأسماك، تسعة منها محلية، وثمانية أنواع دخيلة تعود إلى 15 جنسًا، وتسع عوائل، وخمسة رتب، وجميعها تنتمي إلى رتبة الأسماك العظمية. Osteichthyes سجلت أربعة أنواع أعلى قيم في الوفرة النسبية العددية بنسبة 78.01% من إجمالي عدد الأنواع. خلصت الدراسة الحالية إلى أن المنطقة فيها تراكيز إجمالية معتدلة من النترات والفوسفات وأن تجمع الأسماك يساهم في تعافي البيئة من الاثراء الغذائي عن طريق تغذية الاسماك على الطحالب الخيطية والنباتات المائية.

الكلمات المفتاحية: تجميع الأسماك، الملوثات المنزلية، شمال البصرة، المغذيات

Introduction

Fish assemblages have an important role in aquatic ecosystems. They organize the function, and overall health of water environments (Abdullah, 2020; Kim *et al*., 2021). Fish populations significantly contribute to the total biodiversity of aquatic habitats and ecosystems (Prakash, 2021). Fish in aquatic environments work to cycle nutrients by feeding on dead organisms,

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detritus, and other organic matter to result in the production of nutrients in aquatic ecosystems through the decomposition of these materials (Petranich *et al*., 2018; Le Mezo *et al*., 2022). Fish population has a major role in maintaining the environmental balance. For example, herbivore fish that consume plants prevent the increase in the density of aquatic plants, while predatory fish limit the growth of the prey community (Liu *et al*., 2019). Fish play an important role in the aquatic food web as both predator and prey, and thus directly affect the dynamics of the ecosystem. They make changes in fish populations can have negative repercussions on species via food webs (Reis *et al*., 2020; Traugott *et al*., 2021). Fish are characterized by being an important economic source of high, easily digestible protein that provides the food needs of human societies. Therefore, the management and maintenance of fish populations play a crucial role in the sustainability of this important resource (Gasco *et al*., 2020).

Small streams in freshwater habitats have been severely affected by human activities, especially after widespread communities and increased populations. Humans widely use water in several spaces for drinking, agriculture, industrial, hydroelectric, home uses, transport, and Aquaculture (Arthington *et al*., 2016; Chowdhary *et al*., 2020). The effect of exchange between terrestrial and aquatic habitats and the influxes of interaction between biotic and abiotic factors make the study of aquatic environments more complex (Gomes x *et al*., 2017). The modifications of ecological factors feature as a result of a change in land use by that increased turbidity due to the erosion process that takes place by activates of humans (Leitao *et al*., 2018).

Fish assemblage composition can be variable as are the son of shifting in the condition parameters, for instance, behavior, feeding, reproductive, migrations, and growth. Therefore, fish work as an indicator for ecosystem suitability and measure of environmental stress on fish assemblage (Georgian *et al.*, 2019). There is some theoretical and empirical evidence that verifies the role of the environment in the distribution and widespread of fish and other organisms in aquatic habitats e.g. hydrological characteristics, river topographic, type of substrate, plant vegetation, current and the amount of climate change (Radinge and García-Berthou, 2020).

The use of ecological indices to predict in nature of the relationship between fish assemblage composition and ecological condition. Evaluating the river status by analysis of fish assemblage structure, abundance with compared results with other fish communities have a good ecosystem (Akhi *et al*., 2020).

Household pollutants usually include chemicals from cleaners and pesticides, which cause a decline in water quality (Akhtar *et al*., 2021). The increased concentration of nitrogen and phosphorus in streams has caused the phenomenon of eutrophication, which depletes dissolved oxygen and suffocates and kills aquatic organisms (Diatta *et al*., 2020). Detergents cause poisoning of water and living organisms, including fish and invertebrates, which affect the food web. When humans eat these organisms, they may affect their health by changing environmental functions (Kenconojati and Azhar, 2020).

There are no studies dealing with the impact of household pollutants on fish assemblage composition in southern Iraq, but there are several studies that focused on fish assemblage structure and the conditions factors that affect distribution, abundance, and widespread. Mohamed and Abood (2017) studied compositional change in fish assemblage structure in the Shatt Al-Arab River. Mohamed and Hameed (2019) investigate the impacts of saltwater intrusion on the fish assemblage in the middle part of Shatt Al-Arab River, Abdullah *et al*., (2023) studied the influence of some ecological factors on fish diversity and abundance in the Al-Huwyzah marsh south of Iraq.

The current study seeks to assess the environmental impact of household pollutants and fish assemblages by evaluating anthropogenic activity and explaining the disappearance of some annual phenomena in internal streams feeding the Euphrates River north of Basrah province.

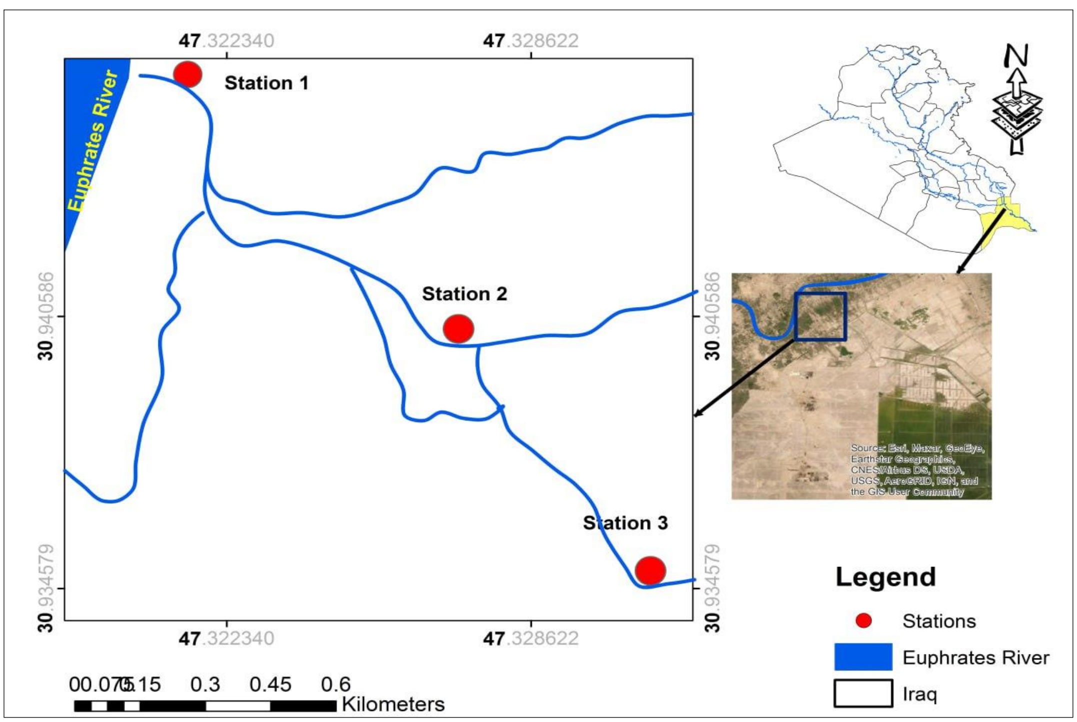
Materials and Methods

Description of Study Area

The present investigation studies the structure and abundance and impact of household pollutant of fish communities in some internal streams feeding from the Euphrates River north of Basrah province. The current study area consists of a large network of internal streams confined between the Euphrates River's west bank and the central street in Al-Sadiq District, north of Basrah Governorate. Streams have varying widths and lengths between 3 to 6 meters and an area of 15 kilometers in length, with depths between one meter to three meters. The area is flooded all year because it is fed by massive electric pumps. The samples were obtained monthly from January to December 2023. For data collection, three stations were chosen: station 1 was at the near the bank of the Euphrates River (N 30°55' 48″, E 47° 17' 42″); station 2 at (N 30°55' 12″, E 47°18' 54″); station 3 at (N 30°54' 18″, E 47° 17' 42″) (Figure 1).

Some ecological factors were measured at the same time as the sampling: water temperature (-10 to 100 °C) was measured with a thermometer. Salinity and hydrogen ion were measured using a Lovibond-Sensor Direct 150, Germany. Dissolved oxygen (DO) and biological oxygen demand (BOD) were measured according to Welch (1964). Total nitrate (NO3) and nitrites (NO_2) estimated due to Parsons *et al*. (1984), and total phosphate was determined according to Murphy and Riley (1962). Bicarbonate (HCO3) and sulfates (SO_4) according to (APHA 1995).

Fish samples were collected monthly from the three stations using fixed and draft gillnets, cast nets, and electro-fishing with an electric generator (400–500 volts, 10 amps). Fricke *et al*. (2022) and Froese and Pauly (2022) were used to classify the fish species. The ecological indices used to evaluate the fish assemblage in the present study region. Relative abundance was estimated according to Walag *et al*., (2016). Occurrence by Tyler (1971). Fish diversity was measured by Huang *et al.*, (2019), and richness and evenness followed Nyitrai *et al*., (2012).

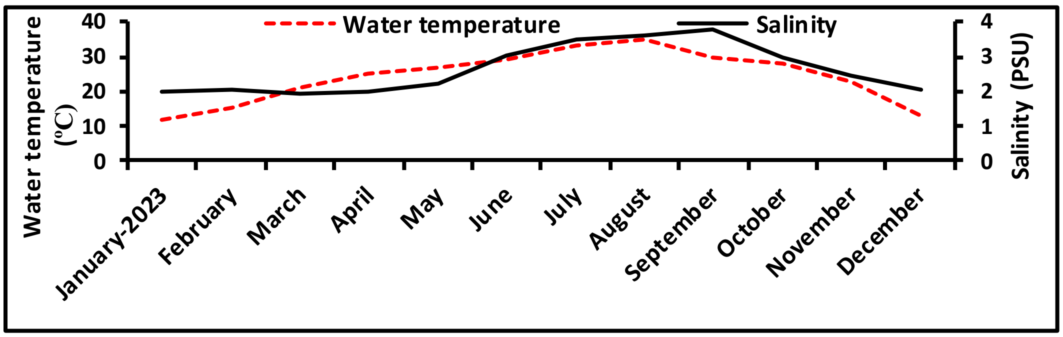


(Figure 1) Map of the study area

Results

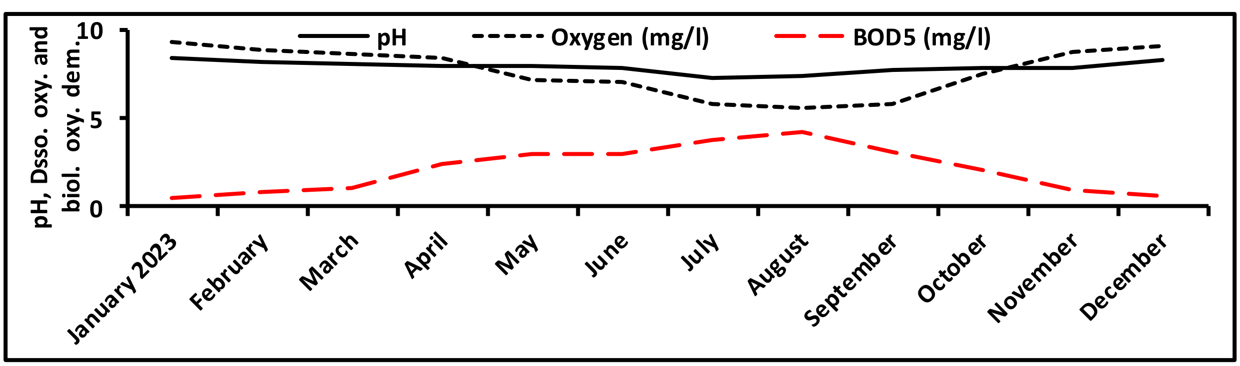
Ecological Factors

Water temperature rates ranged from 14℃ in January to 34℃ in July, with the mean ± SD 24.25 ± 7.653, while the salinity varied from 1.91 in March to 3.76 psu in September, with the mean ± SD 2.63±0.707. (Figure 2). No significant correlation (r = 0.071) was recorded between temperature and the number of species. A weak negative relationship (r = -0.14) was shown between salinity and the number of species. The monthly variations in the means of water temperature and salinity showed no significant differences (P> 0.05) among the present three stations.



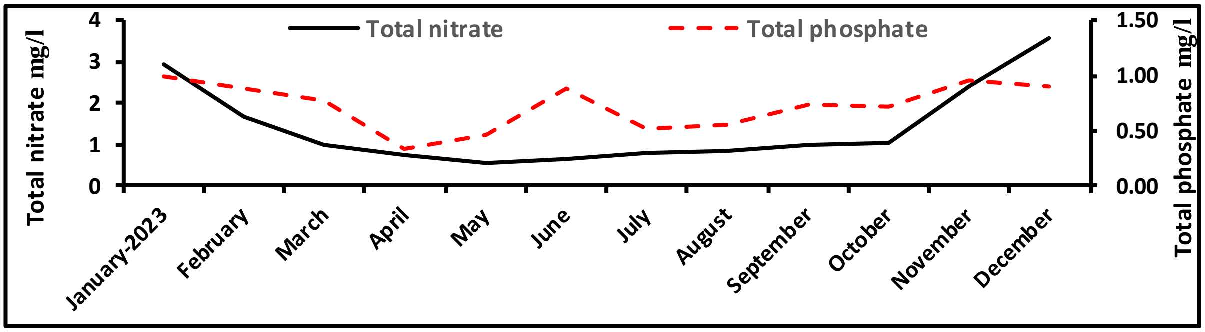
(Figure 2) Monthly variations in the water temperature and salinity in the study area from January to December 2023.

The hydrogen ion values ranged from 7.32 in July to 8.43 in January, with a mean ± SD of 7.92 ± 0.323. A negative correlation was recorded (r = -0.025) between hydrogen ions and the number of species. The dissolved oxygen values ranged from 5.61 mg/l in August to 9.34 mg/l in January, with a mean ± SD 7.69 ± 1.37. Biological oxygen demand (BOD5) varied from 0.52 mg/l in January to 4.21 mg/l in August, with a mean ± SD of 2.13 ± 1.29 (Figure 3). No significant differences were detected in the monthly fluctuations of the means of hydrogen ion, dissolved oxygen, and biological oxygen demand (P> 0.05) among the present three stations.



(Figure 3) Monthly variations in hydrogen ion, dissolved oxygen, and biological oxygen demand in the current study area from January to December 2023.

There is obvious variation in concentrations of total nutrients in the study area during the study period (Fig. 3). The lowest value of total nitrate ranged from 0.54 mg/l in May to 3.58 mg/l in December (mean ± SD 1.43 ± 1.01), while the concentrations of total phosphate fluctuated from 0.34 mg/l in April to 0.99 mg/l in January (mean ± SD 0.73± 0.21). A negative relationship was found between total nitrate and the number of species (r = -0.384) in the study area. A negative correlation (r = - 0.157) was detected between total phosphate and the number of species. The monthly fluctuations in the means of nitrate and phosphate concentrations in the present study region showed no significant differences (P > 0.05) among the present three stations (Fig. 4).



(Figure 4) Monthly variations in the concentrations of total nitrate and total phosphate in the present study area from January to December 2023.

Composition of Fish Assemblage

A total of 17 fish species were caught in the present study region; nine of these species were native, and eight were exotic species. All species belonged to 15 genera, nine families, and five orders, all of them affiliated with the bony fish Osteichthyes class. Cyprinidae, the most abundant family, included four species. The families Leuciscidae and Cichlidae consisted of three species each. Poeciliidae are formed of two species, whereas the families Heteropneustidae, Mastacembelidae, Siluridae, Xenocyprididae, and Mugilidae contain one species each (Table 1).

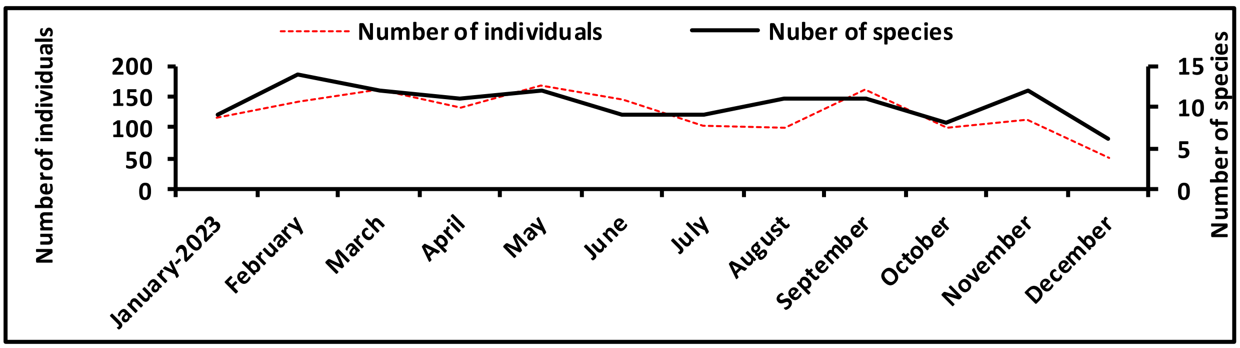
(Table 1) Fish species, families, and orders in the present study area with refer to native and exotic fish species

Order	Family	species	Native	Exotic
Cypriniformes	Cyprinidae	*Carassiu gibelio**		+
		Carasobarbus luteus	+	
		Carasobarbus sublimus	+	
		*Cyprinus carpio**		+
	Leuciscidae	*Acanthobrama marmid*	+	
		Alburnus mossulensis	+	
		Leuciscus vorax	+	
	Xenocyprididae	*Hemiculter leucisculus**		+
Siluriformes	Siluridae	*Silurus triostegus*	+	
	Heteropneustidae	*Heteropneustes fossilis**		+
Synbranchiformes	Mastacembelidae	*Mastacembelus mastacembelus*	+	
Percifomes	Cichlidae	*Coptodon zillii**		+
		*Oreochromis aureus**		+
		*Oreochromis niloticus**		+
Mugiliformes	Mugilidae	*Planiliza abu*	+	
Cyprinodontiformes	Poeciliidae	*Gambuzia holbrooki**		+
		Aphanius dispar	+	

*= Exotic species

Number of Species and Individuals

The data show evident changes in the number of species among the study months in the current study area. The number of species varied from six species in December to 14 species appearing in February, with the mean ± SD 10± 2.19. The number of individuals in the present study region1487 individuals differed from 50 individuals in December to 169 individuals in May, with a mean ± SD of 123.92 ± 34.48 (Figure 5.). The analysis of the data detected a significant positive correlation (r = 0.702*) between the number of species and individuals. The analysis of the data showed no significant differences (P> 0.05) in the number of species and individuals among the three stations.



(Figure 5) Monthly changes in the number of species and individuals in the current study area from January to December 2023.

Relative Abundance

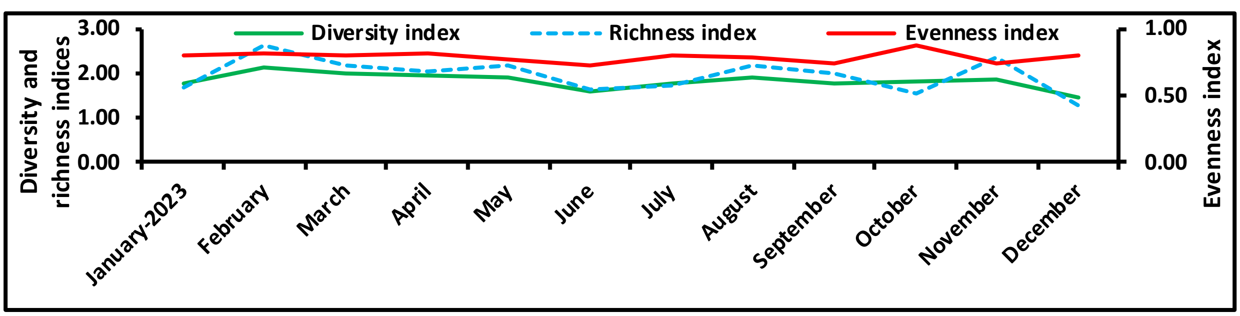
Four species recorded the highest values of relative abundance in the present study region, forming 78.01% of the overall number of species in the current work. The species *O. aureus* is the most abundant species formed 27.98% of the total number of species. Species *P. abu* was the second most abundant species recorded, accounting for 20.24% of the total caught, whereas the fish *C. gibelio* harvested 15.47%. The species *O. niloticus* formed 14.32% of the overall catch (Table 2).

(Table 2) Monthly changes in the relative abundance in the present study area from January to December 2023.

Species	Jan. 2023	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
O. aureus	20.69	22.14	19.88	15.04	37.87	36.30	12.75	19.39	38.51	33.67	37.17	46.00	27.98
P. abu	27.59	15.00	31.68	8.271	16.57	28.77	33.33	9.18	14.29	18.37	17.70	24.00	20.24
C. gibelio	27.59	20.71	4.35	36.09	7.69	17.81	18.63	31.63	4.35	12.24		12.00	15.47
O. niloticus	12.07	17.14	18.63	12.03	14.79	6.85	7.84	11.22	23.60	15.31	19.47	-	14.32
C. zillii	-	3.57	6.83	9.02	8.28	5.48	20.59	17.35	6.83	9.18	8.85	-	7.94
C. luteus	1.72	3.57	4.35	6.77	3.55	-	-	1.02	2.48	-	-	-	2.29
C. carpio	-	2.14	3.73	3.76	3.55	-	1.96	-	1.24	3.06	1.77	-	1.95
S. triostegus	-	1.43	2.48	4.51	3.55	1.37	0.98	3.06	-	-	0.88	-	1.68
L. vorax	3.45	5.71	1.86	-	-	0.68	-	2.04	-	-	1.77	10.00	1.68
A. mossulensis	2.59	3.57	-	-	1.18	-	-	-	3.73	4.08	-	2.00	1.41
G. holbrooki	2.59	-	3.73	1.50	-	-	-	-	2.48	-	2.65	-	1.21
P. latipinna	-	1.43	-	2.26	0.59	-	-	-	1.86	-	4.42	-	0.94
H. leucisculus	1.72	-	1.24	-	-	0.68	2.94	2.04	-	-	0.88	6.00	0.94
C. sublimus	-	1.43	1.24	-	-	2.05	-	-	0.62	-	1.77	-	0.67
A. dispar	-	0.71	-	-	1.18	-	0.98	-	-	4.08	-	-	0.54
M. mastacembelus	-	1.43	-	-	1.18	-	-	1.02	-	-	2.65	-	0.54
H. fossilis	-	-	-	0.75	-	-	-	2.04	-	-	-	-	0.20

Ecological Indices

The ecological indices fluctuated during the study months in the present study region. The diversity index values ranged from 1.43 in December to 2.13 in February, with a mean ± SD of 1.81 ± 0.18. The richness index fluctuated between 1.28 in December and 2.63 in February, with a mean ± SD of 1.94 ± 0.38, while the evenness index varied from 0.72 in June to 0.87 in October, with a mean ± SD of 0.78 ± 0.78 ± 0.04 (Fig. 6).



(Figure 6) Monthly variations in the ecological indices among the study months in the present study region.

Food Items of Most Abundant Species

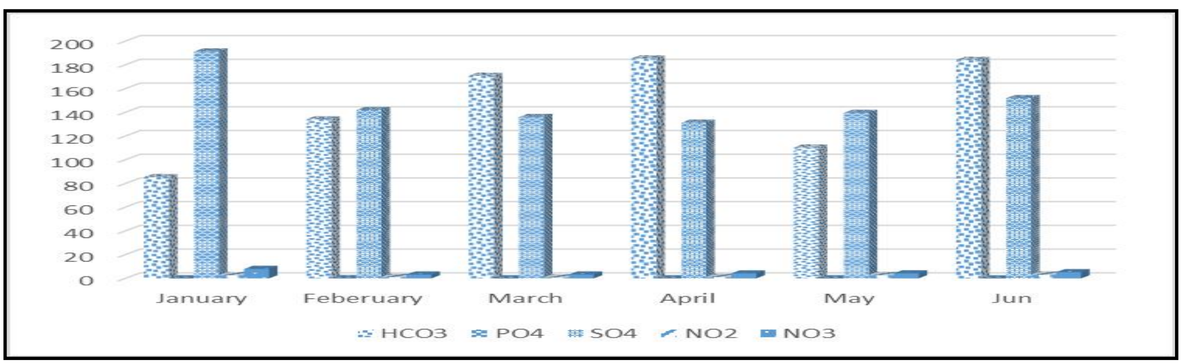
The present study deals with the five most abundant species of food items in the study area. To highlight the role of these species in stream habitats, the results show that five species consume large amounts of water plants and filamentous algae, represented by *C. zillii*, which feeds 58.90% of macrophytes and 24.55% of filamentous algae and water plants from genera (*Ceratophyllum*). The species *O. niloticus* feeds on 49.63% of macrophytes and 25.75% of algae, whereas O. aureus feeds on 43.48% of macrophytes and 33.36% of algae and other species (Table 3).

(Table 3) Food elements of the five most abundant species in the internal streams feeding from the Euphrates River in the present study region.

Species	**Food elements**					
	Macrophytes	filamentous algae	Organic detritus	Diatoms	Water insects	Snails
O. aureus	43.48	33.36	18.13	5.03	-	-
P. abu	11.46	40.12	39.45	8.97	-	-
C. gibelio	37.29	28.09	14.32	6.65	7.20	6.45
O. niloticus	49.63	25.75	20..38	4.24	-	-
C. zillii	58.90	24. 55	10.55	5. 61	-	-

Organic Pollutants

An increase in concentrations of nutrients (NO3, PO4) in the stream water was noticed. The study detected a high ratio of organic materials (HCO3) which was 180 µg/l and sulfate feeding from the Euphrates River in Al-Sadiq District, north of Basrah Governorate, concentration reached 191 in the µg/l in the stream waters (Fig.7).



(Figure 7) Organic pollutants measurements (HCO3, PO4, SO4, NO2, and NO3) in internal streams.

Discussion

The temperature has a vital role in shaping the composition of the fish assemblages in rivers and streams (Vieira and Tejerina-Garro, 2020). Fish are ectothermic animals, and their body temperature varies with the temperature of the surrounding environment (Nakamura and Sato, 2020). Fish species differ in their preferences and thermal tolerance, and the presence or absence of certain species is strongly related to temperature (Payne *et al*., 2021). The results revealed that temperatures increased beyond their limits in July and August, generating some stress, which can weaken fish immunity systems and increase potential susceptibility to diseases (Mugwanya *et al*., 2022). Temperature influences some biological functions: reproduction, spawning, level of oxygen, metabolic rates, patterns of migration, and changes in behavior (Servili *et al*., 2020; Durtsche *et al*., 2021). Salinity is an important factor that can affect fish assemblages in aquatic ecosystems; it has a significant impact on the distribution, abundance, and composition of fish assemblages (Asha *et al*., 2015). Salinity variations force freshwater species to leave upstream, and reductions in salinity lead marine species downstream and have a significant impact on the distribution of invertebrate and vegetation that are used as food and refuge for fish. Salinity fluctuations have significant impacts on fish reproductions and distribution of fish (Whitfield, 2017; Lauchlan and Nagelkerken, 2020). The salinity concentration in the present study area is within the tolerance range of freshwater.

The concentrations of pH in the waters bodies south of Iraq tend to be in the Alkaline trends due to existence of carbonate and bicarbonate in the rivers bottoms, so finding of hydrogen ion values corresponds with (Abdullah *et al*., 2019).

Detergents are materials used for washing and cause a decrease in the surface tension of water, which negatively affect the dissolved oxygen in water. Dissolved oxygen (DO) and biological demand (BOD) are important factors in evaluating water quality. There is a negative correlation between dissolved oxygen and biological demand, which is significantly affected by temperature and organic pollutants in the water. Our results refer to moderately polluted water (2–5 mg/l) and agree with Alewi *et al*., (2021).

High concentrations of organic carbon pollutants (HCO3) were recorded in the current study (Figure 7), which affected the livelihood of fish and biodiversity. Under the pressure of organic pollutants, ecosystems have become vulnerable to environmental degradation that has negatively affected river fish health, water quality, and biological integrity (Lee *et al*., 2023). The concentration of total nitrate in the present study region varies significantly depending on some conditional factors, such as wastewater effluent from houses, agriculture runoff, organic matter decomposition, atmospheric deposition, and nitrogen fixation bacteria. The results indicate elevated nitrate concentrations in November, December, and January due to the above reasons; these consequences are computable and decreased in subsequent months due to the growth and bloom of algae plants (Israa and Neran, 2021; Maaroof *et al*., 2023). Total phosphate concentrations vary due to a variety of factors, including the influence of household cleaning flows, organic matter decomposition, agricultural runoff, rainfall, and biological activity. The current findings show that phosphate concentrations are elevated from November to February, with a decrease in subsequent months due to the abundance of phytoplankton, algal, and aquatic plants that consume phosphate. These results agree with (Al-Saeedi and Al-Salman, 2022).

Studying fish assemblages coexisting in specific habitats has highlighted important knowledge of aquatic ecosystems' health, ecological balance, biodiversity, and the interactions between fish and the ambient environment (Kim *et al*., 2021).

The present work collected 17 fish species, while the previous works were found different results such as Al Noor *et al*., (2009) recorded fish species these changes attributed to spatial and temporal variation between the two studies and to the variations in the using of fishing methods (Ngor *et al.*, 2018). In other work Abdullah *et al.*, (2017) listed 23 species of fish near the current work and the number of species of fish is larger than in the present region due to inhabitant of some marine species.

Notably, absence-sensitive local fish like *Luciobarbus xanthopterus*, *Mesopotamichthys sharpeyi*, *Arabibarbus grypus*, and *Luciobarbus kersin*, which are not even found in the Euphrates River from which they get their water feeding (Abdullah, 2017; Abdullah *et al*., 2022).

The present consequences show that the most abundant species are similar to those in other aquatic habitats in the south of Iraq due to the prevalence of *O. aureus*, *P. abu*, and *C. gibelio*. These results are consistent with all recent studies conducted on the southern end of the Euphrates River (Hussein *et al*., 2015; Abdullah, 2017; Abdullah *et al*., 2022). Most of these species are characterized as highly tolerant species, possess high fecundity, their individuals are reproductive at a small age or size, and their food is available, which is represented by plants, algae, and organic detritus (Alwan and Mohamed, 2019; Abdullah *et al*., 2021).
Ecological indices are essential tools for evaluating the aquatic ecosystems of fish by giving digital estimating that can provide information to researchers about the ecosystem dynamics and understanding of resource management and conservation (*Holsman et al*., 2017). The ecological indices of the current study are within the range of all previous studies conducted on the southern end of the Euphrates River; the values of diversity indices refer to poor status, while richness indices indicate half an integrated, and evenness index values point as semi-balanced. The finding corresponds with most studies done in the present part of the Euphrates River (Abdullah *et al*., 2021; Abdullah *et al*., 2022) (Table 4).

(Table 4) Comparisons values of the ecological indices in the present study with the previous studies conducted on the lower parts of the Euphrates River

The study	Diversity index	Richness index	Evenness index
Al-Noor *et al*., (2009)	1.65	--	0.53
Hussein *et al*., (2015)	1.51-1.69	1.26-1.70	0.67-0.85
Abdullah (2017)	1.11-1.92	1.15- 2.33	0.53-0.90
Abdullah *et al*., (2022)	1.43-3.20	1.48-3.57	0.37-0.75
Present study	1.43-2.13	1.48-2.63	0.72-0.87

The present results indicate that these species feed on a high percentage of filamentous algae, macrophytes (aquatic plants), and organic detritus. These results are consistent with (Salih *et al*., 2019; Mohamed and Al-Wan, 2020). The availability of sunlight in the study area throughout the year supports the growth of aquatic plants and algae, making food available for fish (Shihab *et al*., 2023). The investigation region has a high abundant of some alien species represented by *C. gibelio*, *C. zilii*, *O. niloticus*, and *O. aureus* that feed on the aquatic plant and algae such as the genus *Ceratophyllum* which grow in the high density. Therefore, in the last year's notable absence these water plants are due to consume of fish species this aquatic plants.

Conclusion

In this work, the researchers observed that the rivers habitats were clear and nonattendance of the high growth of aquatic plant and algae in the nets of the rivers in the study region, with the disappearance of the dance growth of the aquatic plant which attributed to the inhabitant the alien species that majorly consume the aquatic plants. The household effluent helps the aquatic plant to grow in high abundant, but occurrence of fish species prevents plants to grow which makes the habitat more suitable and continuously recovery.

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