

Study of the Biodiversity of Fish in The Kufa River

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Abstract

This study was conducted to identify the types of fish and their spread in the Kufa River, and the effect of some environmental factors on their presence. The study samples were collected monthly and for a period of five months, from October 2021 to February 2022 at five stations, the physical and chemical environmental factors were measured such as temperature, pH, dissolved oxygen, the vital requirement for oxygen, nitrates, phosphates, conductivity, turbidity, salinity and conductivity as well as studying biodiversity indicators such as the relative abundance index and the Shannon-Wiener index. The water temperature ranged between (23.1 and 15) °C, the pH value ranged between (6.5 and 9), the dissolved oxygen was (4.2 and 7) mg/l, the biological requirement for oxygen was between (1.2 and 4.6) mg/l, while the salinity was Between (0.03 and 1.13) parts per thousand, as well as the electrical conductivity between (1271 and 1733) micro Siemens / cm, and the cloudiness was between (0.99 and 7) NTU, while the nitrates ranged between (0.004 and 0.12) mg / liter, while the phosphate was between (0.021 and 0.139) mg / liter. Through the current study, 14 species of fish were diagnosed. *Cyprinus Carpio*, *Spondylium cantharus*, *Aspirus vorax*, *Carassius carassius*, *Barbus kersin*, *Bagridae*, *Anguilliformes*, *Liza abu*, *Barbus luteus*, *Silurus trios' tegus*, *Mesopotamichthys sharpeyi*, *Barbus xanthopterin*, *alburnus mossulensis* and *Ctenopharyngodon idella*. The most common species were two *Spondyliosoma cantharus* and *Silurus triostegus* the least common species *Ctenopharyngodon idella*, *Mesopotamichthys sharpeyi*, *Barbus xanthopterin*, *Bagridae* and *Anguilliformes*.

Keywords: *cyprinus carpio*; *spondyliosoma cantharus*; *aspius vorax*; *carassius carassius*; *barbus kersin*

Introduction

Fish live in multiple environments, shallow hot springs, cold polar seas, and cold deep waters, it is differed in their types, shapes, and sizes, but they all share some characteristics that help them grow in their aquatic environment (Aguinaldo, 2018). All fish are cold-blooded that are able to maintain a body temperature higher than other species (Goldman, 1977), also many types of fish that are highly sensitive to change in temperature, so it exists at a certain temperature (Garey, 1973), other types are able to survive within a wider temperature range, so that the body temperature changes according to the temperature of environment, (Aguinaldo, 2018). There are many types of bony fish, more than 29,000 types of bony fish found in fresh and marine waters (Kenndy, 2019). The Aim of this study include evolution of the quantitative and qualitative composition of fish found in the Kufa river in Al-Najaf province, and the effect of some physical and chemical environmental factors on the presence and density of fish. Also applying the biodiversity rules, like relative abundance index (Ra), Shannon-Weiner

diversity index H, to identify the biological diversity in Kufa river.

Fish Biodiversity

The increase in biodiversity in any environment is attributed to the health of this environment (Deely and Paling, 1999). The study of the biological and environmental aspects is an important strategy to know the composition of the fish community (Al-Rudaini, 2010). It has an important role in understanding the fish communities in the water surface for the sake of their development and addressing the causes that lead to deterioration or lack of productivity (Hussain, 2008), as the dynamics Fish assemblages are regulated by abiotic and biotic factors, such as the interaction between species, which includes competition and predation (Siqueria-Souza, 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 (Kors're, 2001).

The importance of fishes

Fish is a staple meal for most people, and a rich source of high-quality protein, as it provides 16% of the

animal protein consumed around the world (Allan and Tidwell, 2001), and marine products contain high amounts of fat, and very micronutrients, Humans benefit in many ways from the presence of fish in the ecosystem, as fish have several important roles, including fish contribute significantly to the provision of essential nutrients that support the ecosystem, (Tailamy and samples, 2018), fish is generally low in sugar content and can be eaten by diabetics (Subedi, 2019). Fish proteins are essential in the diet of some densely populated countries where total protein intake is low, and are particularly important in the diets of SIDS (Peterson, 2009).

Environmental factors effect on fish presence

Temperature

The temperature is the main factor in controlling the distribution of living organisms also affects the population density of the community in the environment (Al-Rawi et al, 2002). the temperature directly affects the abundance and distribution of fish, which is clearer that is a negative correlation between the water temperature and the total density of zooplankton (Al-Khalidi 2004).

pH

The pH waters are of great importance to aquatic life through its impact on the natural physiological functions of aquatic organisms (Deebghazy, 2011). Weiner (2000) indicated, that the value of the pH of water affects the organisms, as crustaceans in acidic water suffer from a decline in growth and deformation in Exceeding the exoskeleton, pH hydrogen amount range from 4.5 - 10 impedes the growth of fish

Dissolved oxygen (DO)

Dissolved oxygen is one of the most important chemical variables in the aquatic ecosystem, The temperature, dissolved oxygen, and nutrient ratios in the water are among the most important factors that affect the lives of fish. The level of dissolved oxygen (DO) in the water is one of the important factors in the quality of the water in which fish are raised (Maria and Helen, 2000).

Electrical conductivity and Salinity

Electrical conductivity is a good indicator of productivity and refers to dissolved salts such as sodium chlorides (APHA, 1999), as ions differ in their ability to conduct electrically, but in general, conductivity in natural water is directly proportional

to the concentration of ions (Boyd and Tucker, 1988). The salinity value can be extracted from the electrical conductivity value (Angeler et al, 2010). Salinity has a major and direct role in determining the diversity and abundance of organisms in the aquatic environment (Wetzel, 2001).

Nitrates

Nitrogen compounds are one of the basic cellular components in living organisms (Wetzel and likens, 2000). Nitrate is the common form of inorganic nitrogen in the aquatic environment (Smith, 2004). And the presence of nitrates with phosphates in the water leads to rapid growth of algae, but in some aquatic ecosystems, nitrogen is the first determinant of algae growth (Smith, et al, 1999).

Phosphates

It is one of the important elements in order to maintain the health of humans, animals, and plants (Motomizu, 2005). the increase in phosphorus in environmental media can contribute to overgrowth of some aquatic plants (Valderrama, 1981). Which in turn contributes to a decrease in the percentage of dissolved oxygen in the water and the lack of radiation, which negatively affects the organism (Dayton and Holloman and others, 2017), which affects the increase in the sun reaching the depths on fish and other aquatic organisms in the negative concentration of phosphorus in the human body Especially bone blindness, and this increase is one of the causes that can lead to cancer. Phosphorus is found mainly in the environmental media in the form of PO₄ phosphate. The method for the determination of phosphorus in aqueous samples in drinking water and industrial wastewater depends on the formation of a complex of molybdate with phosphate or a combined complex of molybdate and phosphate, which is returned using ascorbic acid or any other an amino acid (Lenoble and Dilchat and others, 2013).

Material s and Methods

The study area description

The Euphrates is one of the important rivers in Iraqi, there are several dams on this river, including the Al-Hindiya dam, which the river divided into two branches, the Al-Hindiya River, and the Hilla River, after which the river extends until it reaches the city of Al-Kifl, and in the city of Al-Kifl, the Euphrates River is divided into two branches, the Abbasiya River and the Kufa River, which extends from the city of Al-

Kifl to the city of Diwaniyah. The total length of the Kufa River is about 36 kilometers, and the flow is about 375 cubic meters / second. The depth of the water in the river fluctuates greatly and reaches its highest level during the flood seasons at the end of

March beginning of April and reaches the lowest water level in the summer months (Al-Haidarey, 2010). Five stations were selected using the Geographical Positioning System (GPS) (Figure 1).



Figure 1: Study stations in the Kufa River

Collection of Fish Samples

The samples were collected from October 2021, until March 2022. At eight in the morning until twelve in the afternoon, it is collected by a fishing net 30 meters long and 2 meters wide from the aforementioned areas, then the required measurements related to weight, length and morphological characteristics were taken.

Water samples collection

Which were collected in 5 liter polyethylene containers after washing with distilled water and homogenizing them with sample water several times before filling them for measuring the total hardness. Winkler bottles of 250 ml were used to collect water samples for measuring dissolved oxygen and the biological requirement for oxygen, 2 ml of manganese sulfate solution and 2 ml of basic azide iodide were added to stabilize the dissolved oxygen. Several environmental factors were studied at the study stations and during the study period in the field and laboratory.

Field Measurements

Including water temperature, pH, and electrical conductivity (MS/CM), using a portable digital multi-meter after calibration with standard solutions, and the depth of the water was measured using a plastic ruler divided from 0-400 cm at a depth of 100 cm.

Laboratory measurements

Including Salinity and conductivity which estimated according to the following equation Mackereth et al, (1978) (Salinity = Electrical Conductivity ($\mu\text{S}/\text{cm}$) x

640 x 10⁻⁶). and Dissolved Oxygen (DO) was estimated by following the Azid Modification Winkler method described by APHA, (2003). Also, Biological Oxygen Demand (BOD₅) was measured It calculates the BOD₅ value for the samples River water by equation: (DO₂-DO₁ = BOD₅)

DO₁ = dissolved oxygen concentration before incubation (mg/L).

DO₂ = dissolved oxygen concentration after incubation (mg/L).

In the other hand the Reactive Nitrate was measured using the indole method (Al-Hijami, 2007), the absorbance was measured at a wavelength of 395 nm using an ultraviolet and visible meter. While the Reactive Phosphate (PO₄) was measured at a wavelength of 690 and the absorption of phosphates is measured at a wavelength of 690 nm using a UV-visible spectrophotometer. Results are expressed in $\mu\text{g}/\text{L}$.

Diagnosis of fish

Many types of fish were diagnosed based on the scientific references, and the diagnosis was documented through photographs of each sample. Also, the biological indicators were studied of fish samples including two vital indicators First: Relative abundance index (Ra) this indicator was calculated based on the following equation (Ra = $N_s \times N \times 100$) (Omori and Ikeda, 1984). Second: Shannon-winner index (H) was calculated from the following Shannon and Weiner equation (H = $-\sum n_i/N \ln. n_i/N$), according to Folder and Sommer, (1999) (Proto Neto, 2003).

Results

Fish density

The highest density of fish was recorded in the fourth station, followed by the first, second and third stations respectively and the lowest density in the fifth station (Figure 2). Also 14 species of fish were diagnosed, including *Spondyliosoma cantharus*, *Aspirus vorax*, *Carassius carassius*, *Barbus kersin*, *Liza Abu*, *Barbus luteus*, *Silurus trio's tegu*, *Anguilliformes*, *Bagridae*, *Mesopotamichthys sharpeyi*, *Barbus xanthopterin*, *lburnus mossulensis*, *Ctenopharyngodon idella* and *cyprinus Carpio*.

(Table 1). In first station fish recorded the highest density in November and the lowest density in February. Also *Silurus trio's tegu* was recorded the highest density of all species in October which was 176 followed *Spondyliosoma cantharus* 140 in January, in the other hand *Spondyliosoma cantharus* revealed third rank of density in October and February which was 124 also *Silurus trio's tegu* revealed 123 in December, the lowest density was recorded in October, November, December, January and February which were zero (0) in *Anguilliformes*, *Bagridae*, *Mesopotamichthys sharpeyi* and *Ctenopharyngodon idella* respectively. (Table. 1) (Figure. 2).

Table 1: Monthly changes in the density of fish in the first station

Species	February	January	December	November	October
cyprinus Carpio	79	72	51	47	50
<i>Spondyliosoma cantharus</i>	124	140	121	102	124
<i>Aspirus vorax</i>	84	79	88	77	73
<i>Carassius carassius</i>	58	41	53	42	53
<i>Barbus kersin</i>	64	76	57	60	63
<i>Liza abu</i>	89	69	80	72	61
<i>Barbus luteus</i>	72	81	73	64	87
<i>Silurus trio's tegu</i>	85	114	123	117	176
<i>Anguilliformes</i>	3	4	1	3	0
<i>Bagridae</i>	1	0	2	1	0
<i>Mesopotamichthys sharpeyi</i>	0	1	0	0	2
<i>Barbus xanthopterin</i>	5	2	1	2	3
<i>alburnus mossulensis</i>	40	33	40	36	20
<i>Ctenopharyngodon idella</i>	1	0	0	0	1

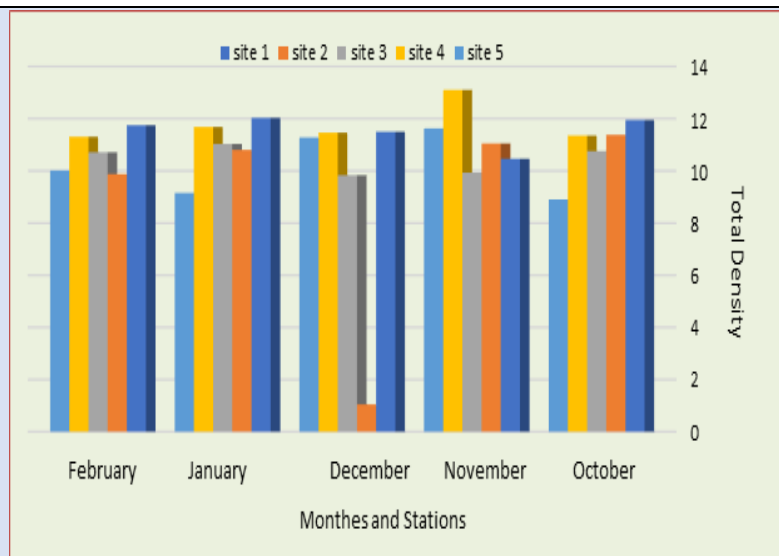


Figure 2: The total density of fish for all study stations during the study months.

In the second location, the highest density was recorded for *Spondyliosoma cantharus*, *Anguilliformes*, *Silurus trio's tegu*, and other species

appeared in all months except *Mesopotamichthys sharpeyi*, which disappeared in January and November, and *Bagridae*, disappeared in November

and December, and Anguilliformes, disappeared in November and January, also *Barbus xanthopterus* and

Ctenopharyngodon idella both disappeared in February (Table 2).

Table 2: Monthly changes in the density of fish in the second station

Species	February	January	December	November	October
cyprinus Carpio	52	63	74	59	62
Spondyliosoma cantharus	116	121	101	162	151
Aspius vorax	57	65	76	68	75
Carassius carassius	75	69	72	67	63
Barbus kersin	59	59	44	41	59
Liza abu	54	68	51	63	57
Barbus luteus	81	75	81	85	69
Silurus trio's tegu	77	98	102	128	113
Anguilliformes	2	4	0	1	4
Bagridae	5	3	1	0	0
Mesopotamichthys sharpeyi	1	0	0	0	3
Barbus xamthopterus	0	4	4	3	1
alburnus mossulensis	14	17	24	19	24
Ctenopharyngodon idella	0	2	4	3	2

Third location appeared the highest density which were recorded in species *Spondyliosoma cantharus*, *Anguilliformes*, *Silurus trios tegu*, other species, were appeared in all months, except *Mesopotamichthys sharpeyi* and *Anguilliformes* which both disappeared

in January and November, and *Bagridae*, disappeared in November and December, also *Barbus xamthopterus* and *Ctenopharyngodon idella* are disappeared in October and December (Table 3).

Table 3: Monthly changes in the density of fish in the third station

Species	February	January	December	November	October
cyprinus Carpio	55	45	37	40	48
Spondyliosoma cantharus	87	99	89	99	112
Aspius vorax	51	70	56	53	69
Carassius carassius	61	73	67	45	59
Barbus kersin	64	64	68	87	76
Liza abu	77	89	82	74	68
Barbus luteus	85	93	88	93	88
Silurus triostegu	116	99	75	69	104
Anguilliformes	1	0	1	0	1
Bagridae	4	3	3	1	2
Mesopotamichthys sharpeyi	3	2	5	4	1
Barbus xamthopterus	2	1	0	1	0
alburnus mossulensis	34	22	19	11	18
Ctenopharyngodon idella	2	2	0	1	0

In the other hand fourth location revealed the highest density for *Spondyliosoma cantharus*, *Anguilliformes*, *Silurus triostegu*, and the rest of the species, all of which appeared in all months, except for *Anguilliformes*, which appeared in some months and

disappeared in December, January, and November, and *Barbus xamthopterus* appeared in some months and disappeared in October. the second and February, as shown in Table (4).

Table 4: Monthly changes in the density of fish in the fourth station

Species	February	January	December	November	October
cyprinus Carpio	49	62	59	61	55
Spondyliosoma cantharus	109	89	98	176	163
Aspius vorax	68	79	65	74	62
Carassius carassius	52	49	65	63	44
Barbus kersin	48	48	52	47	55
Liza abu	89	83	77	81	70
Barbus luteus	97	121	101	99	107
Silurus triostegu	136	130	111	133	94
Anguilliformes	2	0	0	0	2
Bagridae	2	2	2	3	1
Mesopotamichthys sharpeyi	3	2	3	4	2
Barbus xamthopterus	0	3	3	0	3
alburnus mossulensis	22	31	50	44	21
Ctenopharyngodon idella	2	2	2	1	2

In the fifth location, the highest density was recorded for *Spondyliosoma cantharus*, *Anguilliformes*, *Silurus triostegu*, and all of which appeared in all months, except for *Mesopotamichthys sharpeyi*, which disappeared in November and October, and *Bagridae*,

which disappeared in February, and *Anguilliformes*, which disappeared in a month. February and the *Barbus xamthopterus* disappeared in February, (Table 5).

Table 5: Monthly changes in the density of fish in the fifth station

Species	February	January	December	November	October
cyprinus Carpio	75	42	65	63	37
Spondyliosoma cantharus	93	102	107	131	107
Aspius vorax	66	55	71	67	39
Carassius carassius	70	68	48	50	49
Barbus kersin	51	51	70	55	35
Liza abu	50	47	61	62	48
Barbus luteus	79	72	95	102	82
Silurus trios tegus	96	89	121	126	115
Anguilliformes	0	1	2	4	2
Bagridae	0	1	3	2	1
Mesopotamichthys sharpeyi	1	4	1	0	0
Barbus xamthopterus	0	1	2	1	1
alburnus mossulensis	19	14	30	34	17
Ctenopharyngodon idella	1	2	1	1	1

Fish identification

Fourteen species of fish were diagnosed in Kufa river from October 2021 to February 2022 in five locations, which were *Cyprinus carpio* its feeding on grass mainly, its movement in groups. The weight ranges from 1 kg to 5 kg. *Spondyliosoma cantharus* its length may reach a meter for an adult fish, but we diagnosed with a length of 20- 25 cm and a weight of about 7-10 fish per kg. *Aspius vorax* it is distinguished by long head and tapering forward, and the mouth is elongated and reaches the front half of the eye. its length reaches 65 cm, and its weight passed 5 kg.

Carassius carassius its cylindrical shape and small head. The weight was 1.5 - 3 Its length 30 - 75 cm. *Barbus kersin*: it is distinguished by the mouth is directed downwards, the tentacles are large, the head is cylindrical and arched, the fins are yellowish, and it lives near the rocks. *Liza Abu* It is a small fish, its length is about 10 cm, and one kilogram of it is about 9-12 fish. it contains two radial fins that cause luster in its body at night. *Barbus luteus* it is the height of the body, usually about a third of the length. The eyes are small, and the snout is prominent for a small mouth in a medium-sized head. The dorsal fin has

three primary rays and 11 secondary rays, and the body color is reddish-brown with dark glasses on the back, while the abdomen is silver in color, its length does not exceed 50 cm. *Silurus triostegus* its large size fish and without scales that do not excrete waste and toxins outside the body. *Anguilliformes* it is distinguished by shape close to snakes, hiding among rocks and grass. It feeds on garbage and any living creature that can enter its mouth. *Bagridae* A small type of fish that is not eaten and has a thorn in its fins and small in size. It is believed that it is one of the fish that lives on eating insect larvae in rivers, and it is one of the incoming fish. *Mesopotamichthys sharpeyi* It is length of about 60 cm and reproduces during the spring. It is characterized by the presence of small squibs on the mouth. It is very strong and fast fish. Its color is silver. *Barbus xanthopterus* the mouth in this species is facing forward, and the fins are dark. It is a medium-sized fish, up to 80 cm long. *Alburnus mossulensis* It is a type of fish characterized by the luster of its distinct body and its length is about 30 cm. the weight it is about 12-15 fish per kg, and it is characterized by very clear and large eyes. *Ctenopharyngodon idella*: It is a species that has the ability to eat grass and cleanse riverbeds and canals of weeds It is grows in large size and quickly, its color is golden-green or brown, its scales are strong, and it is large in size, cylindrical in shape and long.

The total number of fish caught was (16,414) fish during the study period. The highest value of the relative abundance index was recorded in the first location in December. The second rate increased by 21.99% due to the availability of a good environment in that station for the growth of fish, where the physical and chemical environmental factors and the value of nutrients were also present. Also, in the fifth location, it recorded the lowest abundance in the month of October, reaching 16.36%. This means that the composition of the fish population is in a state of great changes in light of the changes in the current aquatic environment as a result of changes in some environmental factors such as high and low temperature, salinity and other factors. This is what (Horn & Allen, 1985) found.

The results of the Shannon Wiener fish index showed that its value ranged between the highest value (0.14) in the first site for each of October, January and

February, where the first site is characterized by being an area that contains many plants and good nutrients for fish breeding, as well as positive values for the physical and chemical factors favorable for breeding. And the diversity of fish in it. The lowest value was in the third location (0.02) in October. The third location is distinguished and is located near the drain of Maysan after the confluence of the side branch of the Kufa River. It is one of the largest buffalo breeding areas in the city of Kufa, where some environmental factors were not suitable for the reproduction and diversity of fish. Diversity index values approached a relatively wide range, which reflects the use and exploitation of the area by fish. Quarterly basis and this are the same as indicated by (Allen, 1985).

Environmental Measurements

Water temperature

In the current study, it was recorded that the water temperature in the first station ranged between 17 °C in February and 21.4 °C in October, while in the second station the temperature was 15 °C in January and October, while the temperature was recorded in the third station between 15.5°C in January and 23.1°C in October, also a temperature was recorded in the fourth station between 15°C in January and 22.2°C in November, finally in the fifth location The temperature ranged between 15°C in January and 21°C in November, (Figure 2). The results of the current study showed that the water temperature changes according to the months, and few relative changes in temperature are observed. This is due to the high heat capacity of water compared to other liquids, which is defined as the amount of heat required to raise the temperature of one gram of water by one degree Celsius. The large increase in temperature results in a relatively small rise in the water temperature (Al-Saadi, 2006). The difference in temperature between the study stations may be due to the time of sampling, as temperatures are low at the beginning of the morning and then rise when the time approaches midday. The temperature variation that occurred in the study areas is considered a natural variation as a result of the change in the weather throughout the year, and this is fully consistent with Al-Zurfi, (2010).

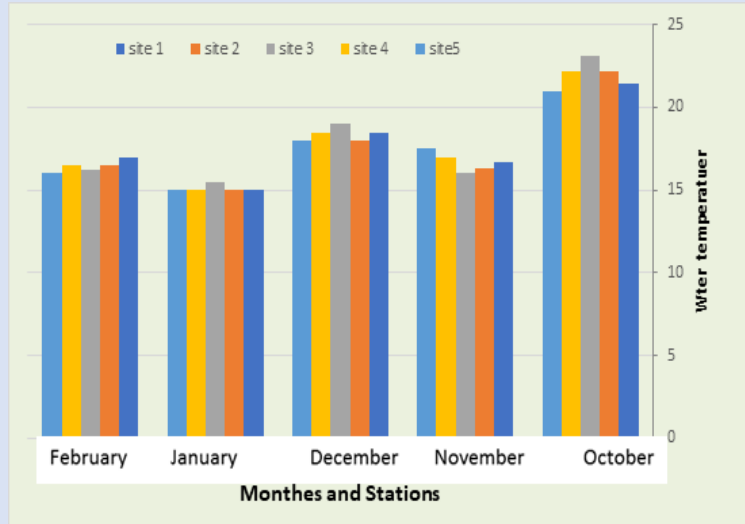


Figure 3

pH (Potential of Hydrogen Ion)

In the current study, it was recorded that pH in first station ranged between 6.3 in January and 8.17 in February. In second station, ranged between 8.1 in October and 8.6 in January, while the pH was recorded in the third station between 6.9 in December and 8.6 in February, in the fourth station recorded an average between 6.5 in January and 8.7 in February, and finally in the fifth location the pH ranged between 6.7 in December and 9 in February, (Figure3). The pH is one of the most important environmental characteristics that have an impact on the metabolism, physiology, and growth of organisms that live in different aquatic environments (Lawson, 2011). Hydrogenation with photosynthesis et al, 2009

(Cupsas). The pH values are a reflection of several life and chemical processes and are of great importance, as several life activities occur only within a narrow range of pH, so any variation outside the acceptable range is fatal for some organisms (Iqbal et al., 2004), in the current study the values were The recorded pH ranged between (9-6.3) as natural waters tend in general to be alkaline, and this is consistent with the study (Al-Haidarey, 2012), as it was noted that the waters of Shatt al-Kufa tend to be alkaline. The highest value of pH was in the second station, due to the excretion of waste in the area, and this is consistent with Al-Zubaidi (2012). Studies have indicated that Iraqi water is alkaline water, including Al-Kinzawi, (2007) and Al-Haidarey, (2009).

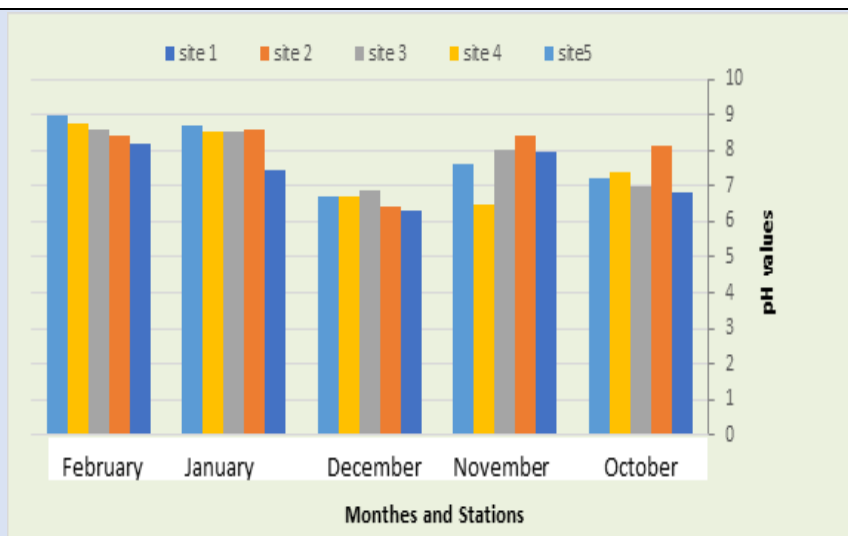


Figure 4

Dissolved Oxygen (DO).

It was recorded that the amount of DO in the first station ranged between 4.6 mg/L in November and

6.6 mg/L in October, in the second station its ranged between 4.2 mg/L in December and 6.6 mg/L In October, while in the third station were 3.5 mg/L in

December and 7.4 mg/L in October, while in the fourth station a rate ranging between 4.2 in December and 7.3 in October was recorded. Whereas, in the fifth location, the dissolved oxygen ranged between 4.9 mg/L in February and 7.4 in October, (Figure 4). The values of dissolved oxygen in the current study where the highest value was 6.4 mg / L in December 2021 and the lowest value was 2.5 mg / L in November 2021. It is noted that the values of DO changed monthly as they began to rise in the winter

season. This is consistent with Al-Shibli (2014), and the reason for this is due to the decrease in the solubility of gases at higher temperatures, as well as the increase in the activity of microorganisms in the processes of decomposing organic matter, which leads to an increase in oxygen consumption (Al-Zurfi, 2010). And Mahmoud (2008) indicated that the high value of DO is due to good ventilation and continuous mixing, as well as the great role of aquatic plants and phytoplankton.

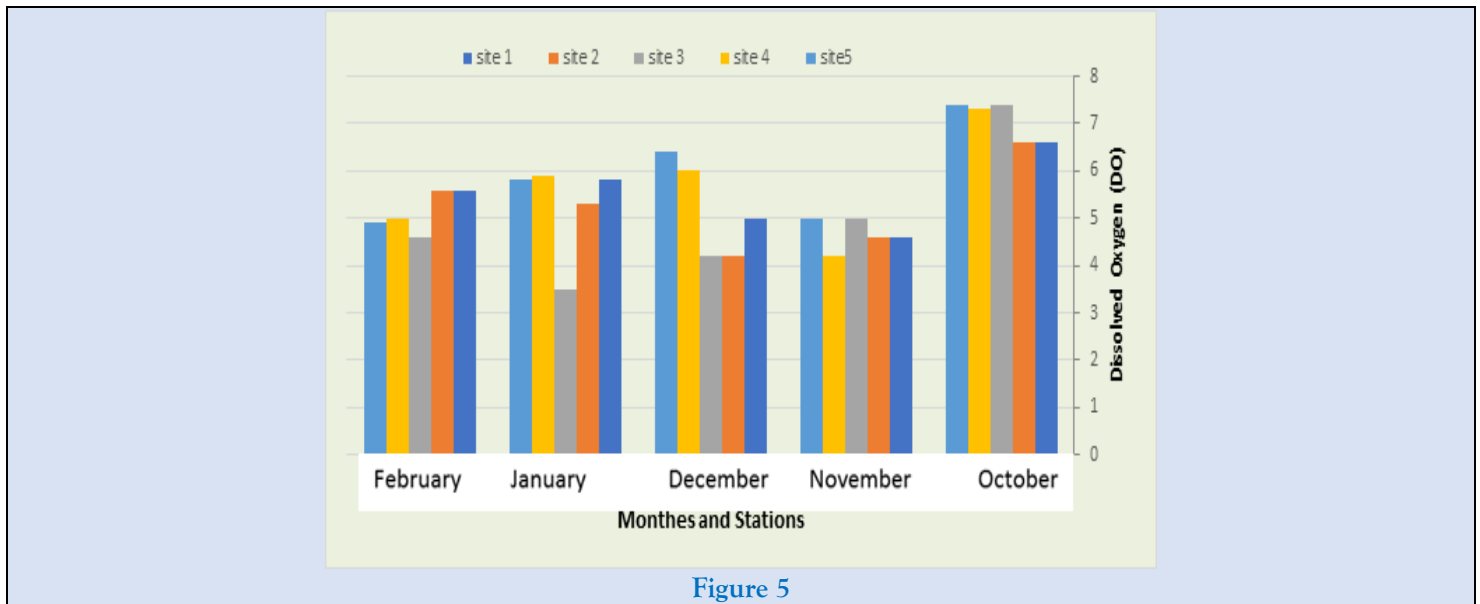


Figure 5

Biological Oxygen Demand (BOD5)

In the current study, it was recorded that BOD in the first station were 1.2 mg/L in October and 5 mg/L in February and January, while in the second station the amount of BOD were 0.8 mg/L in December and 5 mg/L in February, while the BOD recorded in the third station were between 1.9 mg/L in October and 3.8 mg/L in February, while it was recorded in the fourth station an average between 1.7 mg/L in October and 4.6 mg/L in February, while in the fifth location, BOD ranged between 1.6 mg/L in October and 4 mg/L in February, as shown in Figure (5). In the current study, it was recorded that the lowest value was 0.8 mg / L in November in the second station, due to the absence of any industrial activity in that region, as well as the increase in water resources

during the winter compared to the summer. The current study showed that the value of the vital requirement for oxygen is low. In winter, the reason for this may be due to the lack of solubility of gases when the temperature rises, and the current study agreed with the study of Al-Khalidi (2012) and Al-Gharabi (2014) in the Diwanayah River. While the highest value of 5 mg / liter was recorded in January in the third and fourth station in February, and the reason for the water thrown out by the municipality of Kufa may be due to the river water, which contains many organic substances, in addition to the great activity of cafes on the river, which throws out all the owners Food and human excreta directly into the river without any treatment, and this is consistent with the study (Muhammad, 2012), which found that the BOD value is high.

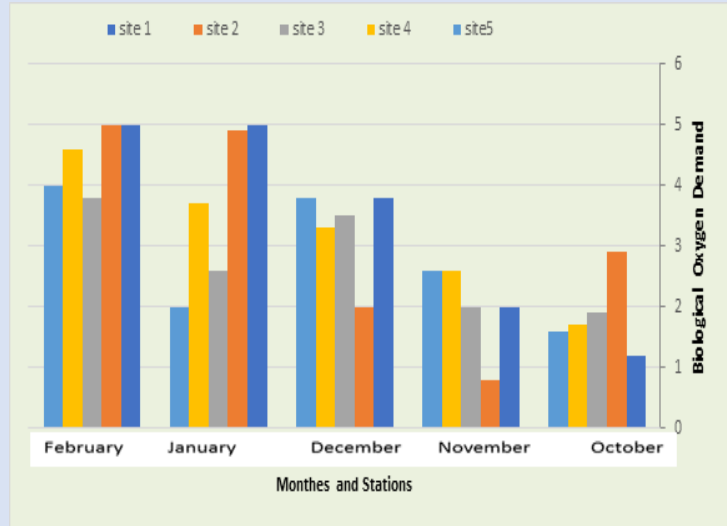


Figure 6

Electrical Conductivity

The results revealed that the amount of electrical conductivity in the first station were 1271 micro-Siemens/cm in November and 1812 micro-Siemens/cm in December, while in the second station the amount of electrical conductivity ranged between 1271 micro siemens/cm in November and 1933 micro siemens/cm in November. /Cm in December, while the electrical conductivity recorded in the third

station was between 1375 micro siemens / cm in November and 1698 micro siemens / cm in December, while it was recorded in the fourth station a rate ranging between 1375 micro siemens / cm in October the first and 1672 micro siemens/cm in January, also in fifth location the electrical conductivity ranged between 1395 micro siemens/cm in October and 1733 micro siemens/cm in December, as in Figure (6).

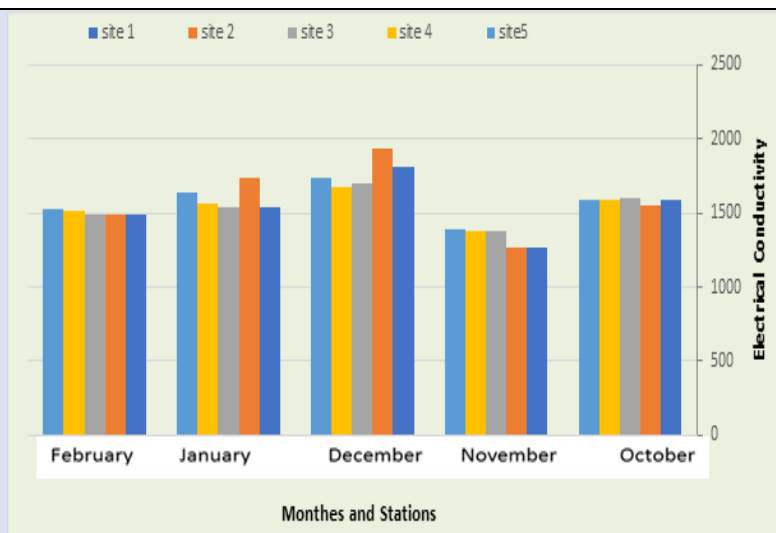


Figure 7

Salinity

The salinity was recorded in the first station were ranged between 0.5 parts per thousand in December and February and 0.5 parts per thousand in October. As for the second station, the amount of salinity ranged between 0.6 parts per thousand in December and February and 0.99 parts per thousand in December. October, while the salinity recorded in the third station ranged between 0.5 parts per thousand

in December and February and 1.02 parts per thousand in October, while a salinity recorded in the fourth station ranged between 0.03 parts per thousand in October and 0.88 parts per thousand. In the month of November, while in the fifth site, the salinity ranged between 0.5 parts per thousand in December and 1.02 parts per thousand in the month of October, as in Figure No. (7). One of the water systems most affected by salinity is fresh water, and

this may happen due to low water levels or as a result of rising groundwater, as well as to increase evaporation processes in the hot months, and human activities have a significant impact on increasing the concentration of salts (Nielsen et al., 2003). The lowest value (0.5) was recorded in February 2021 in the third and first stations, and in December in all stations except the second, as well as in March. All stations except the fifth and the highest value (0.7) in

the month of January 2021 in the second station, as an increase in the salinity value was observed in this month, and the reason may be due to the high temperatures that lead to an increase in evaporation processes, and as a result an increase in the concentration of salts, and as for a decrease in the salinity value in the winter months It is due to the rise in the water level in those months, and thus the increased dilution of salts.

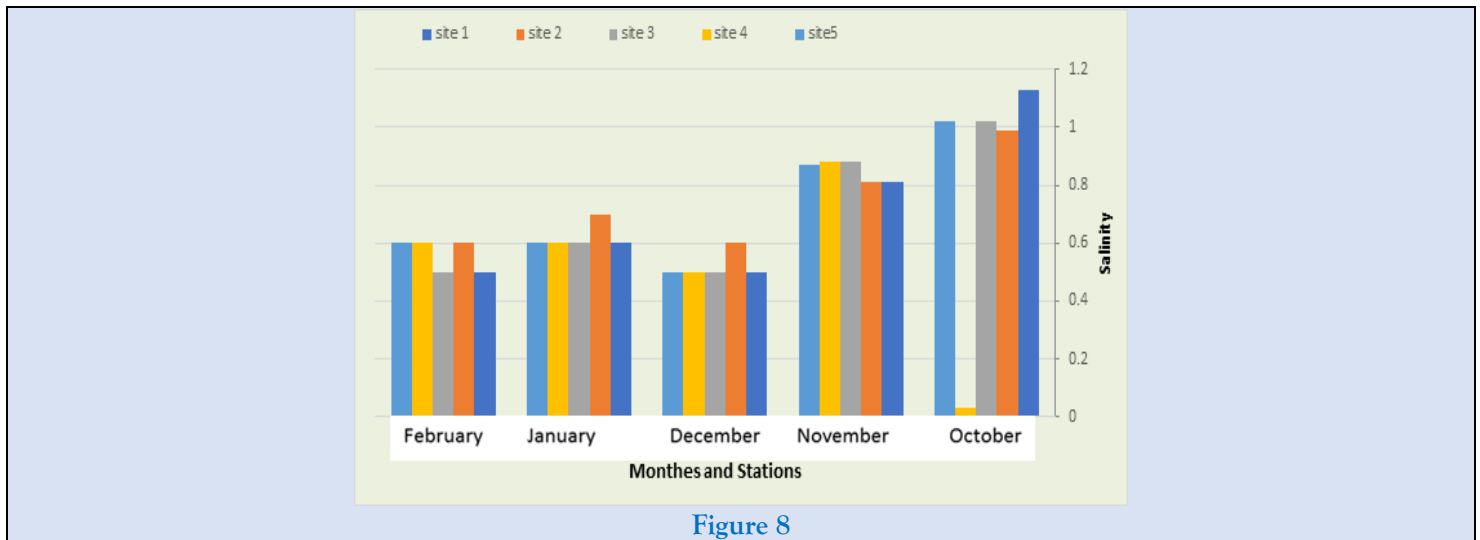


Figure 8

Turbidity (NTU)

In the current study, it was recorded that the amount of cloudiness in the first station ranged between 1.1 in November and 4.4 NTU in October. As for the second station, the amount of cloudiness ranged between 0.99 NTU in October and 4.8 naphthalene in November, while the recorded cloudiness was in the third station, it ranged between 1.31 NTU in February and 6 in October, while in the fourth station an average between 1.33 in February and 7 naphthalene in October was recorded, while in the fifth location the cloudiness ranged between 6.6 in

February and 1.34 NTU in the month of October, as in Figure (8). Muddyness is defined as the state of water resulting from the presence of suspended solids such as soil particles, sand, mud, and suspended organic and inorganic materials. It can also be due to the presence of microscopic living bacteria and floating plants, as muddyness increases in running water, as a result of the movement of sediment with the water stream, and this is what happens in Rivers and their value decreases in relatively stagnant waters, as is the case in the marshes and groundwater (Abbawi and Hassan, 1990).

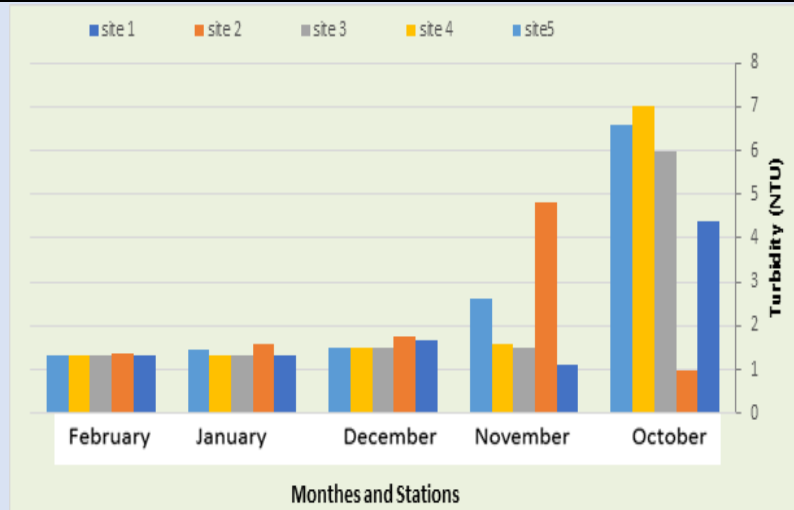


Figure 9

NO₃ Nitrates

In the current study, it was recorded that the number of nitrates in the first station ranged between 0.004 mg/l in January and 0.07 mg/l in October, while in the second station the number of nitrates ranged between 0.004 mg/l in January and February and 0.07 in the month of January. October, as shown in the table, while the recorded nitrates in the third station ranged between 0.012 mg / liter in February and 0.099 mg / liter in December, while the fourth station recorded an average between 0.014 mg in February and 0.087 mg in the month November, while in the

fifth location, nitrates ranged between 0.012 mg/l in February and 0.087 mg/l in October, as shown in Figure (9). The value of nitrates recorded in the current study ranged between (0.004-0.138) micrograms / liter, which is a low concentration compared to what was recorded by Alkinzawi, (2009) in three marshes in southern Iraq. This may be due to the density of phytoplankton and zooplankton, which leads to the consumption of the largest amount of nutrients, and this was confirmed by AL-Kenzawi, (2007), and this was confirmed and consistent with Al Maulood et al., (1979).

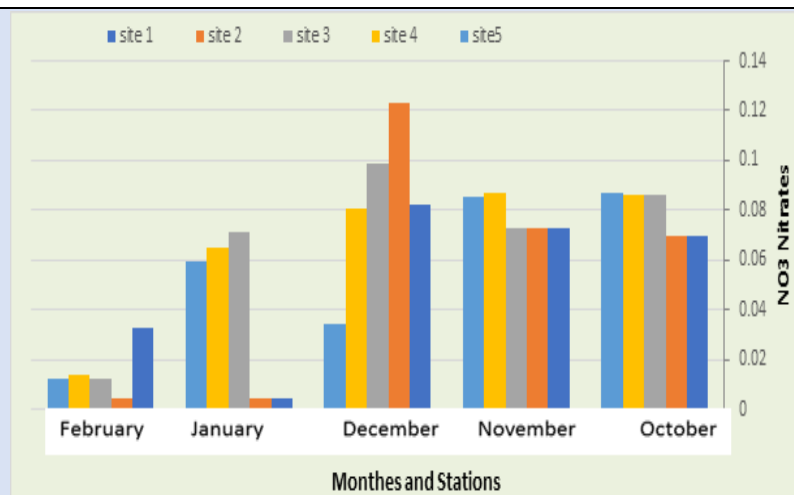


Figure 10

PO₄ phosphate

In the current study, it was recorded that the amount of phosphate in the first station ranged between 0.022 mg/liter in December and January and 0.055 mg/liter in February, while in the second station the amount of phosphate ranged between 0.021 mg/liter in December and 0.067 mg/liter. In February, while the

phosphate recorded in the third station ranged between 0.021 mg/liter in February and 0.056 mg/liter in October, while it was recorded in the fourth station, a rate ranging between 0.032 mg/liter in January and 0.058 mg in January. February, while in the fifth location, phosphate ranged between 0.45 mg/L in January and 0.07 mg/L in October, as shown in Figure (10). The highest value was 0.167 in

November, which is high for phosphorus at the station, and the lowest value was 0.021 in December due to what is discharged from various sources such as residential complexes that contain detergents and wastewater Industrial. Fertilizer run-off, water treatment, tributaries, rainwater, urban waste, agricultural landfills, groundwater, animal waste and

its decomposition and the process of nitrogen fixation in the atmosphere (Al-Saadi, 2002). The value of phosphate decreases in the second station due to the spread of phytoplankton and aquatic plants that consume phosphate in large quantities and store it inside their bodies (Al-Essa, 2004; Al-Yasiri, 2009).

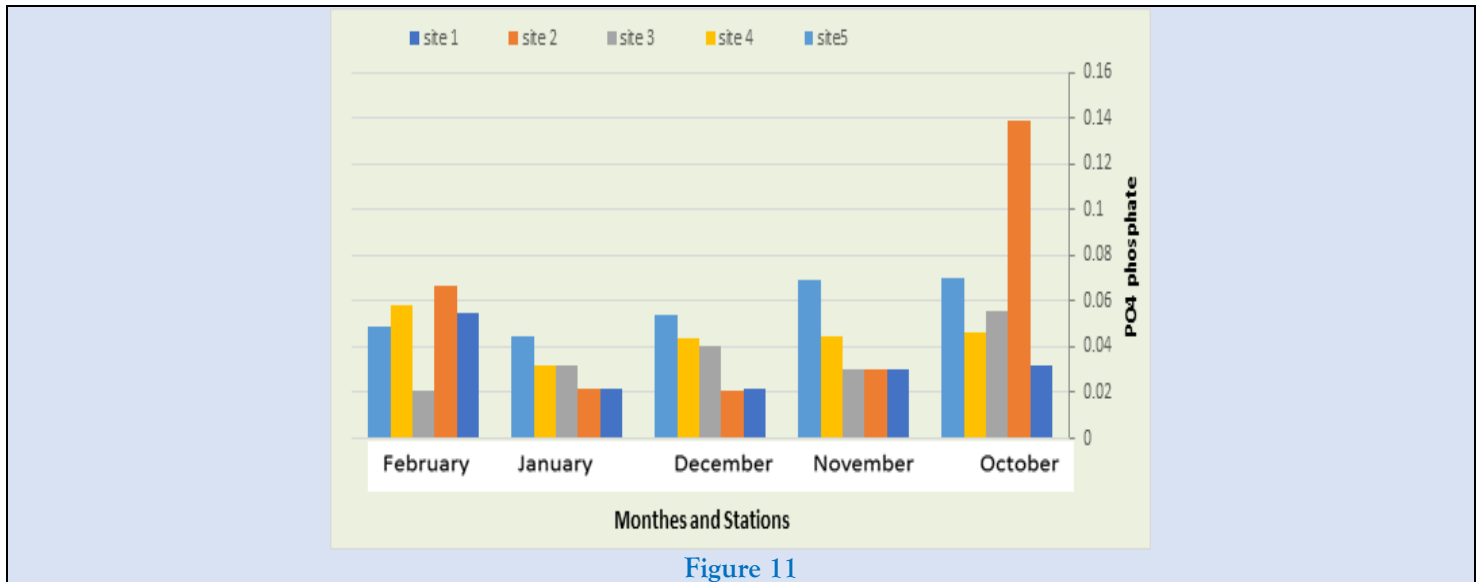


Figure 11

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