Fish Community Structure in Greater Zab River Near Aski-Kalak-Erbil

A Research

Submitted to the Fish Resource and Aquatic Animals dept. College of Agricultural Engineering science-Salahaddin University, Requirements for the Degree of Bachelor Science

By:

Sara Yassen Aziz

4th stage Fish Resources and Aquatic Animals dept. College of Agricultural Engineering Science- Salahaddin University

Supervised by:

Dr. Safeen Othman Sediq

Fish Resource and Aquatic Animals dept. College of Agricultural Engineering Science

April 2024

List of contents

Title	Pages
Introduction	1
Collection of Fish	2
Ecological and Biological Index	2
Results and Discussion	3
Conclusions	14
References	15

List of tables

No	Title	Pages
Table (1)	**Ranges of Values of Physico - Chemical Properties of Water in the Study Sites (Sediq, 2023).**	**5**
Table (2)	**Scientific and Common Name of Fish Collected at Greate Zab River from November 2020 to October 2021(Sediq, 2023).**	**8**
Table (3)	**Fish Collected from Greater Zab River According to Their numbers and Weights from November 2020 to October 2021(Sediq, 2023).**	**9**
Table (4)	**Monthly Changes of Species, Numbers and Weights of Fish Caught at Greater Zab River from November 2020 to October 2021(Sediq, 2023).**	**10**
Table (5)	**Number and Weight of Commercial and Non-Commercial Fish Caught at Greater Zab River from November 2020 to October 2021(Sediq, 2023).**	**11**
Table (6)	**Monthly Changes in The Total Catch Amount, Commercial and Non-Commercial in The Unit Effort for Fish Caught from Greater Zab River from November 2020 to October 2021(Sediq, 2023).**	**13**

Introduction

The river is widely used for human consumption, agricultural, trade and industrial activities, transportation, electric power plants and recreation. The main agricultural lands extend along the river banks (Mohamed and Al-Jubouri., 2017). Rivers are increasingly exposed to many changes in water quality due to climatic conditions and human interventions such as pollution, agricultural and industrial activities and other abnormal changes that have directly or indirectly affected the fish assemblage structure through changing the water quality (Parks and Pierce., 2014).

Aquatic resources play an important role in developing countries, because they not only contribute to the daily livelihood of the population, but also provide significant nutrition for the local communities, as in Southeast Asia (Viet and Kazumi., 2012). Fish are a major source of protein for many people all over the world, as they are at the top of the aquatic food chain (Nurgul and Selda., 2016). In a comparative study of the parasites that infect some species of fish in the Greater Zab River (Abdullah and Mhaisen., 2010). Indicated that the presence of 25 species of fish. While indicated in study that conducted of the Greater Zab River in Aski-Kalak City, presence of 27 species of fish (Agha., 2017).

Whereas in a study conducted of Greater Zab River in Deralok Hydropower Plant indicated the presence of 11 species of fish (Mizory and Abdulrahman., 2019).Temperature, salinity, pH and nutrient concentration affect the structure of fish communities and lead to increase bioactivity of fish interactions. The importance of these factors has led to differences in control and conservation of these communities (Ibarra et al, 2005).

All studies on fish distribution, abundance, composition, and population dynamics are critical for providing a very clear phenomena on ecological and nature of fish structure in environment (Abbas et al, 2017). These studies were showed and gave information's on fish stock assessments, commercial and non-commercial fishes, as well as, this information which support us to take care of

fishes as rich national resources and to be as a basic for our planning for future to reserve this fortune (Sediq and Abbas., 2013).

The local studies were characterized by their limitations, those that dealt with evidence of diversity to assess the composition of fish communities. Due to the lack of fish ecological studies on the Greater Zab River near Aski- Kalak the present study aims to give an example for describing the nature of the fish community, dominant and abundance of species in the Greater Zab River through the use of biological indices. as well as, study of the environmental changes in the region to identify their impact on the presence of species.

Collection of Fish

Fish samples were collected from three sites of Greater Zab River at Aski-Kalak City near Khabat sub-district. Samples of fishes were collected using gill nets of 90m in length, 5 m in depth and mesh size of 1.5 x 1.5, 3 x3, 4.5 x 4.5, 5 x 5 and 6 x 6 cm. Also, using cast net (or selia as a local name) were used with mesh size of 1 x 1, 1.5 x 1.5 and 2 x 2. Monthly fish catches havebeen done during the period from November 2020 to October 2021. Fish were examined nearest 0.1 cm and 0.1gm for both Total Length (TL) and Weight (TW) respectively, and identified according to Beckman (1962) and Coad (2010).

Ecological and Biological Index

Water samples were collected from three sites of Greater Zab River at Aski-Kalak City near Khabat sub-district. The samples were collected during the morning hours at the middle of each month. Some properties of water quality measured as water temperature (°C) were using an ordinary mercury thermometer, ranging from 0-100, according to the monthly reading rate, dissolved oxygen was measured using Dissolved Oxygenmeter of Romanian origin, type Hanna 2012, and measured in (mg/l), salt concentration (gm/l) Use a device HANNA HI2300 Romanian origin type Hanna 2010 To measure electrical conductivity it is measured in units of (µS/cm). To calculate salinity, pH Using

pH-meter Romanian origin after calibration (titration) with regulated solutions (7, 4, 9) and Transparency was measured by Secchi disk diameter 28 cm.

Results and Discussion

1- Physical and Chemical Characteristics

Table (1) exhibited the monthly changes in the water temperature at the studied sites (Sediq, 2023), the lowest temperature degrees were 9.2, 9.8 and 9.5°C in January 2021 at the three sites respectively. whereas water temperature increased gradually to reach highest of 28.5, 30 and 29.6°C during July 2021 at the three sites respectively. Water temperature is an important factor in any aquatic environment that effects on biological processes. In this study, this variation may be due to changes in air temperature, differences in collecting times and water depth variation, and this result was similar to previous studies done by Abdullah and Mhaisen (2002) and Ali (2010). The seasonal changes of water temperature in the river were within narrow ranges in the winter season and expanded during the summer, which are the appropriate ranges that fish tolerate in the environment of water bodies interior (Al-Temimy, 2004).

Table (1) indicated the monthly changes in water salinity concentration during the study period (Sediq, 2023), the lowest values of salinity were recorded in November 2020 (0.21, 0.26 and 0.24 ppt) at the S.1, S.2 and S.3 while the highest salinity values were recorded in July 2021 (0.45, 0.49 and 0.46 ppt) at the S.1, S.2 and S.3. The fluctuation of the salinity of the river water between decreasing and relieving may be due to rain in the winter season, and a rise of salinity due to the evaporation of water during the summer.Generally, salinity value was showed very slight changes period in sites and the results came in accordance with the known salinity value for Iraqi inland water (Abdullah., 2002; Ali., 2010). The river is classified as a freshwater in which the water salinity concentration does not exceed 0.50 gm/l according to the Reid (1961) divisions,

and it is very suitable for the presence of freshwater fishes such as the Cyprinidaefamily in the current study.

Table (1) revealed the monthly changes in dissolved oxygen of the study sites (Sediq, 2023), the lowest oxygen values were recorded 7.8 mg/L in August 2021 for the first site, 5.2 mg/L in July 2021 for the second site and 7 mg/L in September 2021 for the third site. The highest oxygen values were 12.5 mg/L in December 2020 for the first site, 7.9 mg/L in January 2021 for the second site and 10.2 mg/L in December 2020 for the third site. Oxygen content of water is one of the important factors, and it is very necessary for all living organisms (WHO, 2006). The study showed a significant increase in the dissolved oxygen values.This is due to low temperatures and continuous mixing of water and the capacity of the surface area. This is consistent with many previous local studies that confirmed the nature of good ventilation in the inland waters (Abdullah., 2002; Al-Temimy., 2004).

Table (1) indicates the monthly changes in the pH values for the studied stations (Sediq, 2023), whichwere recorded during the study period. The lowest values of pH were recorded in July 2021 (6.8, 6.1 and 6.6) at the three sites respectively, while the highest pH values were recorded in February 2021 (8, 7.6 and 7.8) at the three sites, respectively. The pH value of Greater Zab River in study sites during of most studied period was alkaline, this result agreed with Ali (2017), the results are agree with the finding that recorded by Ali (2007) and Shekha (2008) in the same river, who both claimed that Iraqi interior water is thought to be on the alkaline side of neutrality and represent local geological formations.

Table (1) presents the monthly changes in transparency values during the water column at the studied sites (Sediq, 2023), the lowest permeability of the light was (17, 23 and 19) cm in March 2021 at the three sites, respectively, while the highest values were (51, 62, and 57) cm in July 2021 at the three sites respectively. Water transparency is one of the most important physical factors

affecting the variation and composition of the fish community, especially those that depend for their feeding on sight or the sense of smell (Karve *et al*, 2008). Among the most important factors that affect the transparency of water (light transmittance) are the amount of discharge, current velocity, nature of the bottom, quality of the soil on the coast of the water body, density of vegetation, size of the basin on that surface, climate changes, topography of the region and various human activities (BRC, 2008). Nickolisky (1963) showed that the transparency of the water is inversely proportional to the increase in the presence of suspended solids within the water column, such as silt, mud, fine organic and inorganic materials, phytoplankton and zooplankton. Also, high values of water transparency for any water body indicate a low productivity in it (Al-Lami, 1998).

Table (1): Ranges of Values of Physico - Chemical Properties of Water in the Study Sites (Sediq, 2023).

Factors	Sites		
	S.1	**S.2**	**S.3**
Water temperature (°C)	9.2 - 28.5 18.9 ± 9.5	9.8 – 30 19.7 ± 10	9.5 - 29.6 19.3 ± 9.7
Salt concentration. (PPT)	0.21 - 0.45 0.30 ± 0.13	0.26 - 0.49 0.36 ± 0.12	0.24 - 0.46 0.33 ± 0.10
Dissolved oxygen (mg/L)	7.8 - 12.5 9.9 ± 2.5	5.2 - 7.9 6.6 ± 1.1	7 - 10.2 8.1 ± 2.0
pH	7.0 - 9.5 7.9 ± 0.4	6.0 - 7.5 6.8 ± 0.9	6.6 - 8.0 7.5 ± 0.4
Transparency (Cm)	17 – 51 32.3 ± 17.9	23 – 62 40 ± 19.5	19 – 57 35.3 ± 15.5

2- Fish catches

Tables (2 and 3) shows the species of fish caught in the Greater Zab River for the period from November 2020 to October 2021(Sediq, 2023). A total of 2368 of fishes with a total weight of 848.97 kg were collected.These fish were represented by 28 fish species belonging to nine families, including 16 species of fish of the Cyprinidae family, five fish species of the Leuciscidae and one species for each of the Mugilidae, Siluridae, Heteropneustidae, Bargridae, Sisoridae, Mastacembelidae and Xenocyprididae. The highest numbers of fish recorded were represented by Chondrostoma regium reached 11.9 % from total fish cached in the study sites, followed by Capoeta truttawhich recorded 11.8 % then come Arabibarbus grypus11.1% from total number. The lowest values were recorded by A. sellal which represented 0.2% followed by Garra rufa represented 0.3% from total fish number. Also, the fish species of Luciobarbus kersincome first in total weight of fish catches and formed (18.1%), then followed by Arabibarbus grypus(16.1%), Cyprinus carpio (7.9%). Finally, the lowest values were recorded by Garra rufa within 0.01% of total weight fish catches in the study sites (Table 2).

The results of present study, agree with research occured of same river by Abdullah & Mhaisen (2010), same species registered and Cyprinidae family was dominant, In the study of Agha (2017) which was conducted in Greater Zab River 27 species of fish were recorded and the Cyprinidae family was prevalent while Abdullah et al. (2007) recorded 26 species of fish in Darbandikhan Lake, the Cyprinidae family was dominant.The present results agree with some of past local research that found Cyprinidae fish species were the dominant (Abbas and Sediq., 2012; Abbas et al., 2015). The present results agree with research occuredin some inland water bodies about the dominance of the Cyprinidae family (Al-Temimy., 2004) and (Al-Rudainy, 2010).

Indicated Al- Daham (1982) that the dominance of fish species of this cyprinidae family is due to their being freshwater fish that prefer cold and warm water and have good ventilation, and this is close to the current results. However, the different numbers and weights of fish in water bodies may be due to the different environmental conditions of those water bodies, as well as reductions in the quality and quantity of available food and river sediment structure and the seasons of fishing locations and methods, and finally the vertical distribution of fish (Mayo and Jackson ., 2006).

Table (4) shows the monthly changes in the species, numbers and weights of fish caught in the Greater Zab River throughout the study period (Sediq, 2023). The fish species in the catch samples fluctuated throughout the year, with a decrease in the number of fish species caught to 12 in November 2020 and a rise to 20 species in August of 2021 .It is also noted that the lowest percentage of fish in the total catch was 5.9% in January 2021, and the highest percentage was 11.8% in August 2021 .As for the weight, it decreased by 4.2% in December 2020 and returned to increase by 14.1% of the total catch in the month of August of the year 2021.

It is noted from it that there is a decrease in the presence of fish species, numbers and weights in the cold months and an increase in their abundance during the warm and hot months. The abundance of fish species, their numbers and weights with the rise in water temperature may be due to the presence of large fish for the purpose of reproduction, as well as the presence of all types of resident fish prevalent as a result of the increased feeding activity (Al-Temimy., 2004; Al-Rudainy., 2010; Sediq and Abbas., 2013).

Table (2): Scientific and Common Name of Fish Collected at Greater Zab River from November 2020 to October 2021(Sediq, 2023).

Scientific name	Local name	Family
**Arabibarbus grypus* (Heckel, 1843)	Shaboot	Cyprinidae
Barbus lacerta Heckel, 1843	Shabout moraqqat	Cyprinidae
**Capoeta damascina (Valenciennes, 1842)*	Demashqii	Cyprinidae
**Capoeta trutta (Heckel, 1843)*	Touyeni	Cyprinidae
**Carassius auratus (Linnaeus, 1758)*	Samak zahabi	Cyprinidae
**Carassius Carassius (Linnaeus, 1758)*	Carsin	Cyprinidae
Carasobarbus kosswigi (Ladiges, 1960)	Kosswigi barb	Cyprinidae
**Carasobarbus luteus (Heckel, 1843)*	Himri	Cyprinidae
Cyprinion kais Heckel, 1843	Bunni saghir	Cyprinidae
Cyprinion macrostomum Heckel, 1843	Bunaini kabir	Cyprinidae
**Cyprinus carpio Linnaeus, 1758*	Common carp	Cyprinidae
Garra rufa (Heckel,1843)	Karkur ahmar	Cyprinidae
**Luciobarbus barbulus (Heckel, 1843)*	Abu-barattum	Cyprinidae
**Luciobarbus esocinus Heckel, 1843*	Bizz	Cyprinidae
**Luciobarbus kersin (Heckel, 1843)*	Gatan	Cyprinidae
**Luciobarbus subquincunciatus (Günther, 1868)*	Abou khazzama	Cyprinidae
**Ctenopharyngodon idella* (Valenciennes, 1844)	Carp Oshaby	Xenocyprididae
Acanthobrama marmid Heckel, 1843	Semnan arrez	Leuciscidae
Alburnus sellal Heckel, 1843	Semnan	Leuciscidae
**Chondrostoma regium* Agassiz, 1832	Baloot muluki	Leuciscidae
**Leuciscus vorax* (Heckel, 1843)	Shiliq	Leuciscidae
Squalius cephalus (Linnaeus, 1758)	Qashash	Leuciscidae
Glyptothorax kurdistanicus (Berg, 1931)	Saqanqwr	Sisoridae
Heteropneustes fossilis (Bloch, 1794)	Abu- hakkam	Heteropneustidae
**Silurus triostegus* Heckel, 1843	Jirri	Siluridae
Mystus pelusius (Solander, 1794)	Abu-zummair	Bargridae
Planiliza abu (Valenciennes, 1836)	Khishni	Mugilidae
Mastacembelus mastacembelus (Banks & Solander, 1794)	Marmarij	Mastacembelidae

* Commercial species

Table (3): Fish Collected from Greater Zab River According to Their Numbers and Weights from November 2020 to October 2021(Sediq, 2023).

Scientific Name	Fish No.	(%)	Total Weight (Kg)	(%)	Total Length Ranges (cm)	Total Weight Ranges (gm)
Acanthobrama marmid	156	6.6	9.55	1.1	8.5 - 45.0	11 90
**Arabibarbus grypus*	263	11.1	136.9	16.1	10.0 80.0	10.5 – 4000
Alburnus sellal	5	0.2	1.25	0.14	10.0 18.0	12 100
Barbus lacerta	22	0.9	11.0	1.3	14.0 50.0	30 550
**Capoeta damascina*	30	1.2	6.87	0.8	8.2 30.5	22.5 275
**Capoeta trutta*	280	11.8	59.50	7.0	10.8 50.0	15.5 500
**Carassius auratus*	119	5.0	22.90	2.7	8.3 27.5	16.5 375
**Carassius Carassius*	65	2.7	20.36	2.4	6.1 23.5	7.5 175
Carasobarbus kosswigi	26	1.0	0.56	0.06	5.2 14.5	5.5 25
**Carasobarbus luteus*	63	2.7	8.93	1.0	9.5 25.0	12.5 205
**Chondrostoma regium*	282	11.9	35.61	4.2	8.6 29.3	10.5 200
**Ctenopharyngodonidella*	16	0.7	30.95	3.6	25.5 57,0	195 2100
Cyprinion kais	112	4.7	10.34	1.2	13.6 29.5	40.5 180
Cyprinion macrostomum	40	1.7	3.4	0.4	6.3 18.5	5.5 120
**Cyprinus carpio*	88	3.7	67.51	7.9	6.4 50.0	7.5 3250
Garra rufa	6	0.3	0.14	0.01	10.0 19.5	15.0 52.5
**Leuciscus vorax*	70	2.9	46.06	5.4	15.0 57.5	120 1200
**Luciobarbus barbulus*	164	6.9	49.36	5.8	20.0 75.5	50 2500
**Luciobarbus esocinus*	126	5.3	55.78	6.6	13.0 85.5	190 5500
**Luciobarbus kersin*	197	8.3	154.13	18.1	11.0 85.0	85 4500
**Luciobarbussubquincunciatus*	25	1.0	43.10	5.0	20.0 40.0	950 2500
Squalius cephalus	29	1.2	15.35	1.8	13.5 42.0	85 580
Glyptothoraxkurdistanicus	33	1.4	0.22	0.4	12.5 18.0	50 80
Heteropneustes fossilis	8	0.4	0.32	0.03	17.0 20.0	30 50
**Silurus triostegus*	48	2.0	37.5	4.4	17.5 58.0	150 1100
Mystus pelusius	23	0.9	0.63	0.07	12.0 19.5	20 40

Planiliza abu	36	1.5	4.07	0.5	15.0 23.5	40 150
Mastacembelusmastacembelus	36	1.5	13.59	1.6	40.0 65.5	240 550
Total	2368		848.97			

* Commercial species

Table (4): Monthly Changes of Species, Numbers and Weights of Fish Caught at Greater Zab River from November 2020 to October 2021(Sediq, 2023).

Month	**No.of species**	**Total no. of fish**	**(%)**	**Total weight of fish (Kg)**	**(%)**
November 2020	12	163	6.9	65.8	7.8
December	13	172	7.3	35.9	4.2
January 2021	15	140	5.9	47.2	5.6
February	16	145	6.1	50.9	6.0
March	18	154	6.5	56.8	6.7
April	18	151	6.4	55.5	6.5
May	15	204	8.6	55.2	6.5
June	16	231	9.7	83.3	9.8
July	15	271	11.4	105.6	12.4
August	20	280	11.8	120.0	14.1
September	18	276	11.6	114.0	13.4
October	18	181	7.6	62.5	7.4
Total		2368	848.9		

Table (5) shows the commercial and non-commercial fish species according to their numbers and weights caught in the Greater Zab River throughout the study period (Sediq, 2023). The distribution of the total catch among commercial species (15 species) is characterized by clear dominance in terms of the number

of fish with a total number of 1810 fish with a total weight of 770.58 Kg, and among non-commercial fish (13 species) with a total number of 558 fish with a total weight of 78.39 Kg. noted that the lowest number of commercial fish was 90 fish during February 2021 and the lowest weight of commercial fish was 32.81 during December 2020, while an increase in the number was recorded by 228 fish during July 2021 and the weight was 109.33 Kg in August of the same year. As for non-commercial fish, the lowest number of five fish and weighing 0.30 Kg, was recorded in November 2020, while the highest numbers were 62 fish in May 2021 and the weights were 15.40 Kg in June of the same year.

Table (5): Number and Weight of Commercial and Non-Commercial Fish Caught at Greater Zab River from November 2020 to October 2021(Sediq, 2023).

Month	**Commercial**		**Non-commercial**	
	Fish No.	**Fish Weight (Kg)**	**Fish No.**	**Fish Weight (Kg)**
November 2020	158	65.48	5	0.30
December	126	32.81	46	3.12
January 2021	99	44.27	41	2.96
February	90	41.90	55	8.99
March	101	43.82	53	12.92
April	117	49.81	34	5.73
May	142	46.77	62	8.44
June	172	67.86	59	15.40
July	228	102.10	43	3.44
August	219	109.33	61	6.93
September	225	108.48	51	5.59
October	133	57.95	48	4.57
Total	1810	770.58	558	78.39

A fluctuation in the amount of catch per unit effort during the study period was seen, the lowest value was recorded at 11.97 Kg/hour for total catch, 10.93 Kg/hour for commercial catch in December 2020 and a value of 0.1 Kg/hour for non-commercial catch in November of the same year (Table 6), While the amount of catch increased in the subsequent months the highest amount of total catch was recorded, with a value of 38.75 Kg / hour, for commercial catch with a value of 36.44 Kg/hour in August and for non-commercial catch with a value of 5.13 Kg/hour in June of the year 2021.

Expresses catch per unit effort (CPUE) the number (individuals) or weight of fish (Kg) caught during the unit time / hour (Paully, 1984), it is one of the most important indicators for the condition of the fish community and includes the number of fishermen, the number of boats, the number of fishing days, the types of nets and the number of their throws, as well as the lunar of their throws, as well as (the lunar phase) is very important during night fishing(Chisnall *et al*., 2007). Similar results were recorded for the decrease in the amount of fish caught in the cold months, the peak of which increased with the rise in water temperature with the beginning of spring and during the summer, which may be due to the increased feeding activity of the fish or their movement during or after spawning (Sediq and Abbas., 2013). The fluctuation in the amount of fish caught may be attributed to many factors, including catch effort intensity and the movement of fish for feeding and reproduction, in addition to various other environmental influences that play a major role in the distribution and spread of fish especially the increase in water temperature (Abbas and Sediq., 2012). The current results indicate a decrease in the amount of fish caught in the cold months and its peak increased with the rise in water temperature with the beginning of spring and duringthe summer. The current results are close to the above in some previous local studies (Al-Temimy., 2004; Sediq., 2009). The fluctuation in the quantity of fish caught may be attributed to several factors, including the catch effort intensity and the movement of fish for feeding or reproduction, in addition to

other important environmental influences in the distribution and spread of fish, it is consistent with the current results.

Table (6): Monthly Changes in The Total Catch Amount, Commercial and Non-Commercial in The Unit Effort for Fish Caught from Greater Zab River from November 2020 to October 2021(Sediq, 2023).

Month	Total catches (Kg /hour)	Commercial catches (Kg /hour)	Non- commercial catches (Kg /hour)
November 2020	21.92	21.82	0.1
December 2020	11.97	10.93	1.04
January 2021	15.74	14.76	0.99
February	16.96	13.97	2.99
March	18.90	14.60	4.30
April	18.51	16.60	1.91
May	18.40	15.59	2.81
June	27.75	22.62	5.13
July	35.17	34.03	1.14
August	38.75	36.44	2.31
September	38.02	36.16	1.86
October	20.83	19.31	1.52
Total	282.92	256.83	26.1

CONCLUSIONS

1) **Water temperatures and dissolved oxygen concentration are very suitable for the presence and spread of different fish species in the river.**
2) **The waters of Greater Zab River tend to be slightly alkaline.**
3) **The present study area is an important reservoir for commercial fish species.**
4) **Most species recorded in this study belong to thefamily Cyprinidae thus no different from the rest of the water bodies in Iraq.**

REFERENCES

ABBAS, L. M., ABU-ELHINE, A. J., RADHY, A. G., and HASSAN, A. H. (2017). Evaluating the Fish Structure Community at Euphrates River near Al-Hindyah Barrier, Babylon Province/Iraq. *Journal Tikrit University for Agriculture Sciences*, (17): p. 28-29.

ABBAS, L. M. & SEDIQ, S. O. (2012). Some biological indexes of fish community at dukan lake, north of Iraq. *Basrah J. Agric. Sci.* 25(SpecialIssue2). p. 228-241.

ABBAS, L. M., ABU-ELHENI A.J. and RADHY A. G. (2015). Fish community of Tigris River before Al-Kut Barrier, Southern Baghdad, Iraq. Journal of Chemical, Biological and Physical Sciences (JCBPS); Section B, 5(2): 1639 – 1645.

ABDULLAH, S. M. A. (2002). Ecology, Taxonomy and Biology of some Parasites of Fishes from Lesser Zab and Greater Zab Rivers in North of Iraq. Ph.D. Thesis, Coll. Edu. (Ibn Al- Haitham), Univ. Baghdad: 153p.

ABDULLAH, S. M. A. & MHAISEN F. T. (2002). Some physico chemical properties of waters of Lesser Zab and Greater Zab rivers in north of Iraq. *J. Basrah Res*. 28 (4). p. 13-23.

ABDULLAH, S. M. A., & MHAISEN, F. T. (2010). Comparative study on the parasitic infections of some sympatric fish species in Greater Zab and Lesser Zab rivers, north of Iraq. *Basrah J. Agric. Sci*. 23 (2). p. 70-80.

AGHA, G.F. (2017). Morphological and Molecular Identification of Some Inhabitant Fishes in Greater Zab River/ Aski-Kalak in Kurdistan Region, Iraq. M.Sc. Thesis, College of Agriculture, University of Salahaddin – Erbil:113 p.

ALI, L. A. (2010). Seasonal variation in physico-chemical properties and zooplankton biomass in Greater Zab River – Iraq. *Jordan Journal of Biological Sciences*.3(3). p. 115 – 120.

ALI, A. L. (2007). A study of Macro Invertebrates Community in the Middle Sector of Greater Zab River, Iraq. Ph.D. Thesis. Univ. Baghdad: 156 p.

ALI, I. S. (2017). Water Quality Assessment for Greater Zab River and Bioaccumulation of Toxic Heavy Metals in Some Local Fish Species, Erbil, Kurdistan Region of Iraq. M.Sc. Thesis, College of Agriculture, University of Salahaddin–Erbil:120 p.

AL-RUDAINY, A. J. (2010). Ecology and Nature of Fish Structure in Al-Rathwania Lake, West of Baghdad. *Iraq Academic Scientific Journals*. 15(1). p. 1-11.

AL-TEMIMY, L. M. A. (2004). Ecology, Biology and Assessment of fishes Community in Euphrates, River near Al-Mussaib Power Station. Ph.D. Thesis, College of Agriculture, University of Basrah: 147p.

CHISNALL, B.L., WEST, D.W. and LAKE, M.D. (2007). Fish communities of Lake Whangap - February 2001 survey. Science and Technical Publ., Wellington, New Zeal., 15p.

IBARRA, A. A., PARK, Y. S., BROSSE, S., REYJOL, Y., LIM, P., and LEK, S. (2005). Nested patterns of spatial diversity revealed for fish assemblages in a west European river. Ecology of Freshwater Fish. 14(3). p.233-242.

KARVE, A.D., VON HIPPEL, F.A. and BELL, M.A. (2008). Isolation between sympatric anadromous and resident three spine stickleback species in Mud Lake, Alaska. Envi. Bio. Fish. 81(3). p. 287-296.

MIZORY, F. A. & ABDULRAHMAN, N. M. (2019). Survey and ichthyofauna of Great Zab River in Deralok hydropower plant. *Journal of Duhok University*. 22(s2). p. 69-79.

MOHAMED, A.R.M. & ABOOD, A.N. (2017). Compositional change in fish assemblage structure in the Shatt Al-Arab River, *Iraq Asian Journal of Applied Sciences*. 5(5). p. 944-958.

NURGUL, S. & SELDA, K.O. (2016). The histomorphological changes in Carassius carassius (Linnaeus, 1758). liver and kidney tissues of some heavy metals. *Indian journal of Goe-Marine Science*. 45(9): p.1123-1127.

PARKS, T.P., QUIST, M.C. and PIERCE, C.L. (2014). Historical Changes in Fish Assemblage Structure in Midwestern Nonwadeable Rivers. Am. Midl. Nat., 171, p. 27-53.

PAULLY, D. (1984). Length-Converted Catch Curves: A Powerful Tool for Fisher. Research in the Tropics (Part 11). ICLARM Fishbyte. 2(1). p. 9-17.

SEDIQ, S.O. (2009). Nature of Fish Community Assemblage in Dukan Dam Lake, M.Sc. Thesis, Coll. Agriculture, Univ. Salahaddin–Erbil: 81 p.

SEDIQ, S.O. (2023). Some of Ecological and Biological Aspects for Fish Structural at Greater Zab River in Aski-Kalak, Kurdistan Region – Iraq. Ph.D. Thesis. Coll. Agricultural Eng. Sci., Univ. Salahaddin–Erbil: 163 p.

SEDIQ, S.O. and ABBAS, L. M. (2013). Fish Community Structural in Dukan Dam Lake, Northern Iraq, *Jor. of Iraqi Veterinary Medicine*. 37(1). p.6-12.

SHEKHA, Y. A. (2008). The Effect of Erbil City Waste water Discharge on Water Qua lity of Greater Zab River, and the risks of irrigation. Ph.D. Thesis. Coll., Sci. Univ. Baghdad. 122 p.

VIET, T.V. & KAZUMI S.K. (2012). Population Dynamics of Metapenaeus ensis (Decapoda: Penaeidae) in a Coastal Region of the Mekong Delta, Vietnam. Asian Fisheries Science 25: p.1-14.

WORLD HEALTH ORGANIZATION (WHO) (2006). Guide lines for the Safe Use of Waste water, Excreta and Gray Water: Waste water Use in Agriculture. Volume II. France. 222p.

WRIGHT, H. E. (2007). Pleistocene Glaciation of Iraq. Developments in Quaternary Science. 3 (2). p. 215–216.