Water Quality and Conservation Status of Fish Fauna of Main Outfall Drain, Al-Diwaniya City, Iraq

Kadhim J.L. Al-Zaidy

Department Animal production, College of Agriculture, University of Al-Qadisiyah, Iraq.
Email: jkadhim9@gmail.com

Abstract

Freshwater fish diversity, abundance, the ecological indices, and water quality from Main Outfall Drain (MOD) in Al-Diwaniya City / middle Iraq were studied monthly from January to December 2017 in two sites. The present study has shown that the third river (MOD) supported 15 fish species belonging to 7 families. As far as biodiversity status in fish community (IUCN-2019) is concerned, out of 15 species, eleven fish species are categorized into Lower risk least concern (LC or LR/lc), four Vulnerable (VU). Eight species were sensitive to salinity; seven species were tolerance. The results were concluded that the properties of water were tolerable for the fish community. Ultimately, it can be concluded that the sector of MOD supported the fish community. But it needs constant monitoring for the conserve and development of the diversity and the case of the healthy fish.

Keyword: Fish diversity, Main Outfall Drain, Diversity indices, Water quality

1. Introduction

The Southeastern Iraqi Marshlands represent one of the largest wetland ecosystems in all of Asia and covered about 15,000 square kilometers(km2) [1,2]. These marshes were formed by the confluence of the Tigris and Euphrates Rivers, so, all Iraqi water bodies depend in one way or another on the Tigris and Euphrates rivers [1]; also, these marshes are known for its high productivity; they are a natural shelter and the main source of fishing for local fisheries Iraq. Hawr Ad Dalmaj marsh is a largely isolated marsh located about 65 km northeast to Al-Diwaniya City and 35 km southeast of Kut city, at the heart of the Mesopotamian alluvial plain. The length of the Hawr Ad Dalmaj marsh ranges about 50 km and the width is about 10 km. This marsh was described [3] as a moist land of international importance. Despite the global importance of this area, unfortunately, it is not protected [4]. The present water supply of this area is obtained from Main Outfall Drain (MOD). Main Outfall Drain (MOD) is a river extended from north of Baghdad to Al-Basrah south of Iraq with a total length of about 565 km [5], and it is divided into three sectors (North, Mid, and South). The Mid sector of MOD (where the present study located in this sector) starts from the north of Hawr Ad Dalmaj marsh to the intersection of Main Outfall Drain with Euphrates River and within this section is 187 km long and discharge is 200 m3/s [6]. The important part in this section of the biological side, it is the part located in the northern part of Howr Ad Dalmaj marsh, because it is the only source of water to this water body. Knowledge of biodiversity and ecosystem of the fish species are important in understanding the stability of any fish community and are also essential in fundamental community analysis for studies of food webs, tropho-dynamics, and resource partitioning and ecological energetic [7,8]. So, the importance of Main Outfall Drain (MOD), is a matter of no controversy between authors as the indispensable factor to success to reach a full understanding of the environmental activities of this region, where the ecosystem and the stability and diversity of fish communities in this water body are mainly dependent on this river. Accordingly, study the installation of the fish community in MOD is an essential requirement that is indispensable for understanding the environmental changes that occur or the environmental changes that will occur to Hawr Ad Dalmaj marsh.

2. Material and Methods

The third river is a river used to the land reclamation on both sides of it, where two stations have been identified to obtain on the fish and water samples, during the study, which lasted from January to December 2017. First station was at 32°26′58.0″N 45°06′17.3″E near the salt bridge south-east of the city of Hilla, its represents the entrance to the city of Al Diwaniya north. The second location was at 32°11′12.5″N 45°19′33.9″E. Near the feeding gate, which is represents the main source of feeding water to Hawr Ad Dalmaj marsh. Fig (1). Water properties such as water temperature, salinity (Sal), pH and Dissolved oxygen concentration (DO) using the YSI sension 156 MUL TI METER. The water transparency was measured by using the Secchi Disc. The level of nutrients from nitrate (NO3) and phosphate (PO4) has been measured by using the...
cadmium column depending on the method described in [9]. The fish samples of both sexes were collected from January until December 2017 with the help of local fishermen by using different fishing gears (mainly: seine net, gill nets, cast nets and electric catch). The species were divided into three sections according to their repeated appearance in the monthly samples based on [10]. Common or regular of fish, it is meant by species that have emerged in the fish samples of 9 to 12 months during the study period. Seasonal or immigrant fish species, includes species are those present for (6-8) months in the samples. Occasional fish species, that appeared from (1-5) months during the year. Richness index (D), diversity index (H) and evenness index (J) were calculated from [11-13] respectively.

![Figure 1. Location of study area Main Outfall Drain (MOD) in Al-Diwaniya City / middle Iraq.](image)

### 3. Results

The present study of fish fauna in study area showed that the most of the fish species recorded were widely distributed in this waterbody. A total of 15 species of fishes belongs to seven families were recorded. The family of Cyprinidae was dominated other families, eight species were recorded within this family through the study period. followed by order Cichlidae with two species, order Mugilidae, Siluridae, Bagridae, Heteropneustidae and Mastacembelidae with one species (table1); also, the percentage of relative abundance for the fish population shown that order Planiliza abu was most dominant constituting 19.45% followed by order Carassius uratus constituting 16.81%, order Coptodon zillii constituting 12.25% of the total fish species recorded (table1).

#### 3.1. Biodiversity status

The present investigation of fish fauna showed that all of the dominant species recorded were economic. As far as biodiversity status [22] for the fish community, is concerned, out of 15 species recording through the study period, eleven fish species are categorized into Lower Risk: Conservation Dependent (LC or LR/lc) and four species Vulnerable (VU), only one species of them was dominant, which is the common carp (table1).

#### 3.2. The physical and chemical properties of the water

In the current study, the physical and chemical properties of the water showed clear variations. The highest average temperature of the water was 27.79 °c during the summer, and the lowest average recorded in the through the study period was 11.03 °c in the winter. pH values showed a tendency towards a weak basal trend and saw a rise warm month of this study, the lowest average value recorded was 7.41 during the winter and the highest was 7.84 in the summer. The Winter months during the months of the study showed a marked reduction in the salinity as compared to the Summer months. The lowest average concentration was recorded 4.94 (Gram/L), while the highest average value recorded was 7.30. In the same direction the rest of the studied water quality characteristics showed a contrast in the values of the rates during the study period, as showed in the table (2).
3.3. Diversity indexes

The Shannon-Weiner fish diversity index ranged from 1.77 to 2.05, also, the evenness index (J) values fluctuated between 0.68 to 0.78. Whilst, richness index (D) values were ranges from 2.02 to 2.35 as recorded in table (2) and fig. (2). The results in this study differed in the total values of environmental indexes with Shatt Al-Arabi River. The average values of environmental indexes were lower in the study area than in the Shatt al-Arab, where an overall, value was to the fish diversity index ranged in Shatt Al-Arabi River from 1.62 to 2.22, richness from 2.23 to 4.63 and evenness from 0.40 to 0.64 [30]. Perhaps this is due to the absence of marine species in the study area, as no presence to marine species was recorded during the study period.

Table 1. Fish abundance and biodiversity status in the (MOD) in Al-Diwania City / middle Iraq of January to December 2017.

| Family    | Fish Species | Origin | Percentage | Abundance | Habitat | Red List Criteria | Biodiversity | Threats | Use and Trade | Salinity Tolerance | Trophic Guild |
|-----------|--------------|--------|------------|-----------|---------|------------------|--------------|---------|---------------|-------------------|---------------|
| Mugilidae | Planiliza abu | Native | 19.45      | Resident nt | W, MI, MC, AM | Stable | LC | Plu., Cli. | Food - human | Tolerance | Detrivore |
|           | Carassius uratus | Alien | 16.81      | Resident nt | W | Unknown n | LC or LR/lc | In. | Sport, Food - human | Tolerance | Omnivore |
|           | Cyprinus carpio | Alien | 11.25      | Resident nt Seasonal | W | Unknown n | VU | Tr., Nat., In. | Tolerance | Omnivore |
|           | Mastacembelus sharpeyi | Native | 4.57 | Seasonal | W, AM | Decreasing | VU | En., Bio., Nat., In. | Food - human | Sensitive | Herbivore |
| Cyprinidae| Carasobarbus luteus | Native | 6.32 | Seasonal | W, AM | Stable | LC or LR/lc | none | Food - human | Sensitive | Omnivore |
|           | Leuciscus vorax | Native | 5.44 | Seasonal | W, AM | Unknown n | LC or LR/lc | Bio., Pol. | a commercial species. | Sensitive | Piscivore |
|           | Arabibarbus gypsius | Native | 0.1 | Occasional | W | Decreasing | VU | Bio., Nat., Pol., Cli. | Food - human | Sensitive | Omnivore |
|           | Luciobarbus xanthopterus | Native | 0.1 | Seasonal | W, AM | Decreasing | VU | Nat., Pol. | Food - human | Sensitive | Omnivore |
| Cichlidae | Acanthobrama marmid | Native | 3.89 | Occasional | W | Stable | LC or LR/lc | none | a low value commercially valuable fish | Tolerance | Omnivore |
|           | Coptodon zillii | Alien | 12.25 | Resident nt Seasonal | W | Unspecified | LC or LR/lc | Bio. | Food - human | Tolerance | Herbivore |
|           | Oreochromis aureus | Alien | 7.48 | Seasonal | W, MC | Unknown n | LC or LR/lc | Nat., Pol. | Food - human | Sensitive | Herbivore |
| Siluridae | Silurus triostegus | Native | 10.11 | Resident nt | W, AM | Decreasing | LC or LR/lc | None | Food - human | Tolerance | Piscivore |
| Bagridae  | Mystus pelusi | Native | 1.36 | Occasional | W | Unknown n | LC or LR/lc | Nat., Pol., Cli. | non | Tolerance | carnivorous |
| Heteropneustidae | Heteropneustes fossilis | Alien | 0.58 | Seasonal | W | Stable | LC or LR/lc | Res., Bio., Nat., Pol., Geo., Cli. | Food - human, Medicine - human | Tolerance | Piscivore |
| Mastacembelidae | Mastacembelus mastacembelus | Native | 0.29 | Occasional | W, AM | Stable | LC or LR/lc | None | Food - human | Sensitive | Piscivore |

W= Wetlands, MI= Marine Intertidal, AM= Artificial/Aquatic & Marine, MC= Marine Coastal/Supratidal, VU = Vulnerable, LC or LR/lc = Least Concern, En. = Energy production & mining, Cli. = Climate change & severe weather, In. = Invasive and other problematic species, genes & diseases, Tr.= Transportation & service corridors, Nat.= Natural system modifications, Bio. = Biological resource use, Pol.= Pollution, Res.= Residential & commercial development, Geo.= Geological events.

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Table 2. The seasonal averages for the physical and chemical properties of the water and the ecological indices in the study area of the third river of January until December 2017.

| Trait studied                      | Winter        | Spring        | Summer        | Autumn       |
|------------------------------------|---------------|---------------|---------------|--------------|
| Temperature of water °C            | 11.03 ± 1.91  | 26.66 ± 2.33  | 27.79 ± 2.04  | 26.40 ± 6.82 |
| pH                                 | 7.41 ± 0.12   | 7.7 ± 0.22    | 7.84 ± 0.19   | 7.70 ± 0.59  |
| Salinity ppt                        | 4.94 ± 0.85   | 5.22 ± 0.79   | 7.30 ± 0.68   | 5.37 ± 0.43  |
| (DO) mg/l                           | 9.13 ± 0.77   | 7.01 ± 0.19   | 7.34 ± 0.56   | 7.83 ± 0.39  |
| Light penetration cm                | 67.42 ± 8.12  | 45.78 ± 4.29  | 40.39 ± 1.11  | 51.91 ± 7.86 |
| NO 3 µg N /L                        | 20 ± 2.43     | 21 ± 1.55     | 22 ± 1.06     | 23.23 ± 2.76 |
| PO 4 µg N /L                        | 0.61 ± 0.58   | 0.69 ± 0.08   | 0.71 ± 0.09   | 0.66 ± 0.19  |
| Diversity index (H)                | 1.87 ± 0.32   | 1.77 ± 0.21   | 2.05 ± 0.24   | 1.84 ± 0.21  |
| Evenness index (J)                 | 0.68 ± 0.2    | 0.76 ± 0.13   | 0.72 ± 0.08   | 0.78 ± 0.03  |
| Richness index (D)                 | 2.16 ± 0.72   | 2.35 ± 1.21   | 2.02 ± 0.36   | 2.07 ± 0.27  |

Figure 2. Seasonal variations in ecological indices of fish assemblage in the study area during the period from January to December 2017.

4. Discussion

The current fish fauna study in the study region revealed that the majority of the fish species reported were extensively dispersed across the waterbody. Maybe this gives a good index, on the assumption, that the greater the number of species that return to the same proportions in the region, the more likely to accept that region to the measures taken to develop ecosystems. The total number of species recorded in this study is similar to the number of species recorded in Al-Hudirah area / Iraq by [15], and less than the number of species registered in Al-Hilla River/Iraq; where registered [16] 23 fish species 17 species of them belong to Cyprinidae family. The decline in the number of species constituent to the fish community in the study area of MOD may be due to the non-correlation of this river directly with the Tigris and Euphrates rivers. On the other hand, the decline in the number of fish species is a problem facing of most of Iraq water bodies, as result resource exploitation, climate change, habitat modification, and pollution. The collective effects of these factors led to a loss of populations and species, Which led to the collapse of fully to some of the functional groups in the Iraqi water bodies [17], where disappeared several species like *L. esocinus* in most Iraqi marshes, While other species suffered of have suffered a clear reduction in the proportion of its presence such as *L. xanthonopetra*, *A. grypus*, *M. sharpeyi* and *C. luteus*. The results of the current study showed the existence of *M. sharpeyi* species in a remarkable numerical abundance. Mesopotamia water bodies have historically been an important spawning ground for the species of *M. sharpeyi*, which is one of the most important local economic species, and as a result of the deterioration of water quality decreased numbers of this species in Iraqi water bodies are striking, where the ratios of the numbers of this species of fish reached to 0.1% and 0.15% only of the
total number of fish species that were caught in Chybayish marsh and Al Hammar Marsh respectively [18,19]. The increase in recorded numbers of this species in the study area may be due to direct contact between the third river with Hawr Ad Dalmaj marsh, where Hawr Ad Dalmaj is seen as one of the few hatcheries recognized to produce M. sharpeyi in Iraq, and large numbers of M. sharpeyi are released after they hatch at the same region [20,21].

The current study of fish fauna revealed that all of the top species found were economically important. These results are generally consistent with the assumption that the fish community in the natural direction tends to be highest dominance ratio in the fish species within the fish communities are those occupied by the Least Concern species (LC); where pointed each of [23, 24, 25] to the same result. On the other side, fish of C.carpio was registered as vulnerable in Iraq (table1), but in fact, that does not mean it vulnerable in all Iraqi water bodies, where the individuals of this species prefer warm water because relatively high temperatures are proportional to their physiological and vital activities [26, 27]. Of course, this factor is available in the central and southern regions of Iraq, which includes the study area. So, it seems too early to judge that species of C. carpio are as vulnerable in this region of the river. Perhaps this removes the vagueness which happened because of the fact that the case of this species of fish, is vulnerable in Iraq, according to [22], with the dominion of this species throughout the study period.

The physical and chemical characteristics of water were found to differ significantly in the current study. Physical and chemical properties of water are the determining factors for the spread of aquatic organisms and fish in particular through their impact on metabolic activities, growth, nutrition, reproduction, diversity and migration behavior [28]. The results showed that the water in the study region of the studied were wobbling within the study seasons, temperature, salinity and turbidity, it had a high value during the summer. Temperature is a key factor of water density, which is directly related to salinity that determines the distribution of organisms in the water body [29]. Rising temperatures reduce dissolved oxygen values and the values of pH leading to a decrease in the species number, especially since, the water column does not have a fixed level in MOD and as is known, The low water levels in any water body increase the salinity values, electrical conductivity and hardness, and decrease dissolved oxygen and pH values leading to a decrease in the species number [21]. Therefore, it seems that the biological diversity of fish communities is unstable in this area due to the changes in physical and chemical characteristics of the ecological habitats.

Diversity indexes are based on measuring the distribution of the number of individuals among different species and it is apparent that the diversity index (H) showed a positive correlation with the water temperature during the study period. This guide Values range from (0.0-5.0) to generally accepted results between (1.5-3.5) and values above 3.0 indicate that the environment is stable and balanced; values under 1 indicate contamination and degradation in the installation of the environment [31]. The third river which is a river used to discharge the effluents of agriculture activities from and its length about 565 km [5]. Hence, water quality varies according to the amount of water flowing through year seasons. Therefore, based on the results recorded, it is acceptable to conclude that the fish community in the study area within acceptable limits, but it is not stable; where [32] reported that the alteration in physical and chemical properties of water in any water surface for long periods may result in not clear landmarks changes in the biodiversity of fish.

Conclusion

The present ichthyofaunal study references that the study area was contains a variety of freshwater fish consists of native and alien species fishes. Several sensitive and commercial species that deserve special attention have been identified from decision-makers since they are presently classified within risk categories by (IUCN). Changes in environmental variables, directly or indirectly affect the fish community. Thus, this river directly affects the ecosystem including the composition of the fish community in Hawr Ad Dalmaj marsh. The third river in this section provides, an acceptable environment for the development of fish but it is unstable.

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