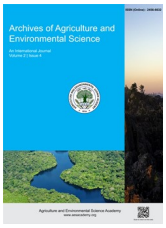
Archives of Agriculture and Environmental Science 8(2): 105-111 (2023)
https://doi.org/10.26832/24566632.2023.080202

e-ISSN: 2456-6632

This content is available online at AESA

Archives of Agriculture and Environmental Science

Journal homepage: journals.aesacademy.org/index.php/aaes



ORIGINAL RESEARCH ARTICLE

Evaluation of the inland fisheries in Basrah province in Iraq during 2020-2021

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ARTICLE HISTORY

Received: 18 February 2023
Revised received: 26 April 2023
Accepted: 17 May 2023

Keywords

Exotic species
Inland fisheries
Iraq
Landing trends
Native fish

ABSTRACT

The study was aimed to update the knowledge on the fish landings of the inland fisheries in Basrah province, Iraq. The species composition, species and total landings, and their trends in six landing sites throughout the study region were evaluated during the year 2020-2021. Species compositions were included seven cyprinids' species, three cichlids' species, three mullet's species, and two species from sparids and silurids. The exotic species, *C. carpio*, tilapias species and *C. auratus* dominated the landings constituting 44.2% of the total catch, whereas the highly valued native species (*M. sharpeyi*, *L. xanthopterus*, *C. luteus* and *A. grypus*) forming only 12.4% of the total catch. The total landing reached 2,427.78 t in 2020 and 2,365.15 t in 2021, and these values were higher than what was recorded during the past years since the year 2009. This is due to the prevalence of aliened species and the increase in the fishing effort, such as the numbers of fishermen and fishing boats. Therefore, in fisheries management point of view, it is essential to enhance the stocks of the native species, minimize the dispersal and impacts of some exotic species, and activate the national regulating fishing, exploitation and protection of aquatic organisms to improve the inland fisheries.

Citation of this article: Mohamed, A. R. M., & Abood, A. N. (2023). Evaluation of the inland fisheries in Basrah province in Iraq during 2020-2021. *Archives of Agriculture and Environmental Science*, *8*(2), 105-111, https://dx.doi.org/10.26832/24566632.2023.080202

INTRODUCTION

Inland fisheries are generally characterized as small-scale operations that typically harvest for household consumption and local barter or trade (Bartley *et al*., 2015), and exploit wild fishery resources in inland water environments including rivers, streams, floodplains, wetlands, lakes, inland seas, canals and reservoirs, especially where there are higher population densities of rural people able to exploit these resources (Funge-Smith and Bennett, 2019). FAO reported that the inland fisheries catch of 11.47 million tons in 2015, representing 12.2% of total global capture fishery production. Seventeen countries, led by China, India and Bangladesh, produce 80% of this inland fishery catch ranging between 0.15 and 2.3 million tons (Funge-Smith, 2018).

The southern part of Iraq is a potentially rich source of fish, FAO reported that over 60% of the total inland catch of fish in Iraq in 1990 came from the southern region (UNEP, 2001). But during the last years, the Basrah province has suffered from the deterioration of the water quality and quantity due to a series of anthropogenic activities such as agricultural runoff wastes, untreated wastewater, invasion of fish species and seawater intrusion further upstream up to 100 km into the Shatt Al-Arab River during dry years as a result of drastically decline in rates of the flow from the Tigris, the Euphrates and Karun Rivers (Hameed and Aljorany 2011; Abdullah *et al*., 2015; Brandimarte, *et al*., 2015; Eassa, *et al*., 2015; Yaseen, *et al*., 2016). Several works were published related to the inland fisheries of Basrah, such as Mohamed *et al.* (2008) who described the species, fishing efforts, catch rates and total catch of the artisanal fisheries in the landing locations in the north of Basrah province in 2005. Nasir and Khalid (2013) and (2017) defined the annual species landings in the Basrah inland fisheries during 2005-2016. Later, Abood and Mohamed (2020) investigated the species composition, total catch, fishing effort and landing trends in the inland waters of Basrah province during 2017-2019.

The objective of this paper is to introduce a fresh look at inland fisheries including the species composition, species and total catches and the landing fish trends in six fish landing locations throughout the inland waters of Basrah province from January 2020 to December 2021.

MATERIALS AND METHODS

Study area

The Basrah province is located in the southernmost part of the Mesopotamian Plain and is rich in water resources. It is northern bordered by the great Tigris and Euphrates Rivers and the water masses of the marshlands, and it is southern is limited by the northwest corner of the Arabian Gulf and. There are two more main water bodies including the Shatt Al-Arab River running through Basrah City to the Arabian Gulf, and the Shatt Al-Basrah Canal connecting to the Arabian Gulf through Khor Al-Zubair. Basic fishing activities in several fish landing sites throughout the inland waters of Basrah province (Figure 1) were investigated from January 2020 to December 2021, while March and April were the closed times for fishing. Official data from the Ministry of Agriculture, Basrah Agriculture Directorate was used to analyze the inland fisheries of Basrah. This data included the monthly total catch of each species, the number of fishers and the specifications of fishing gears in the following landing sites; Al-Qurna, Al-Midaina, Al-Dair, Al-Hartha, Abu-Al-Kaseeb and Al-Seeba.

Data analysis

These raw data were computerized, analyzed through descriptive statistics and included in numerical and graphic results. The monthly relative abundance (%RA) of each species from the total catch was calculated for the two years according to the formula of Krebs (1978):

$$\%RA = C_i/TC * 100$$

Where C_i is the catch of i^{th} species and TC is the total catch.

The similarity between the catches for the two years, according to the weight per cent of each species estimated using the Morisita index (Morisita, 1959):

$$C\lambda\% = 2\Sigma X_i Y_i / \Sigma X^2_i + \Sigma Y^2_i,$$

Where $C\lambda$ is the similarity level, X_i and Y_i the weight per cent of i^{th} species in each year of catch.

The monthly biomass diversity index (Hb) was calculated for each year by the following formula by Shannon and Weaver (1964):

$$H_b = - \sum P_i \log_e P_i$$

Where P_i is the proportion of i^{th} species as the weight of each species for each month.

The monthly variations in the weight of each species between the two years were tested using Student's t-Test to inspect the difference between the years.

The trend line technique was used to illustrate the general direction and describe the pattern of each species' catch. All computations and analyses were carried out using Microsoft Excel 2010 program.

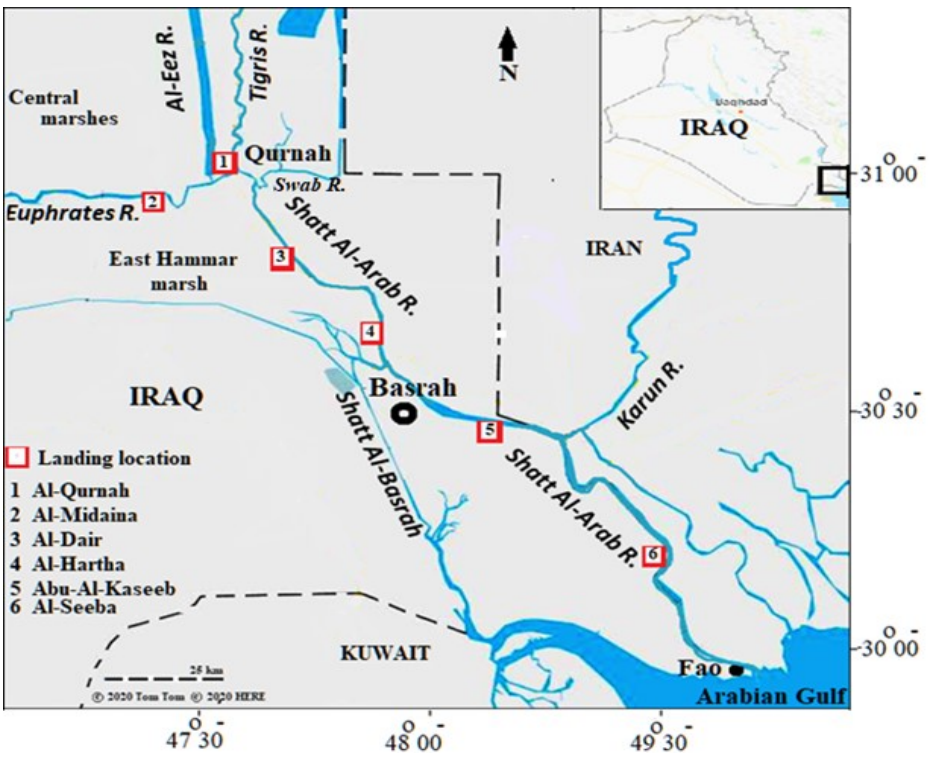

Figure 1. *Location of the landing sites of data collection in the Basrah inland fisheries.*

RESULTS AND DISCUSSION

Catch composition

The fishermen caught 15 fish species belonging to 5 families in the Basrah inland fisheries during 2020-2021 (Table 1). Species composition was seven cyprinids' species, three cichlids' species, three mullet's species, and two species of sparids and silurids. In terms of original, seven native fish species were observed during the study including *Leuciscus vorax*, *Carasobarbus luteus*, *Mesopotamichthys sharpeyi*, *Luciobarbus xanthopterus*, *Arabibarbus grypus*, *Planiliza abu* and *Silurus triostegus*, five aliened species involved *Cyprinus carpio*, *Carassius auratus*, *Oreochromis niloticus*, *O. aureus* and *Coptodon zillii*, and three marine species comprised *P. subviridis*, *P. klunzengeri* and *Acanthopagrus arabicus*. Moreover, *O. niloticus*, *O. aureus* and *C. zillii* are referred to as Tilapias and *P. subviridis* and *P. klunzingeri* as mullets. Mixed fish is unmarketable species sold together.

The stocked fish (*C. carpio*) and the invasive fish (*O. niloticus*, *O. aureus*, *C. zillii* and *C. auratus*) dominated the landings fish species and constituted 44.2% of the total catch in the present study (Table 2), whereas the highly valued native fish (*M. sharpeyi*, *L. xanthopterus*, *C. luteus* and *A. grypus*) formed only 12.4% of the total catch, where they were classified as threatened by the International Union for the Conservation of Nature and included on the Red List (Jawad, 2013; Freyhof, 2014a, b). Mohamed *et al.* (2008) recorded 22 fish species belonging to 12 families in the artisanal fisheries of the lower reaches of Tigris, Euphrates and Swab Rivers at Qurna town, north of Basrah in 2005, and they mentioned that the species, *M. sharpeyi*, *L. xanthopterus*, *C. luteus* and *A. grypus* formed 13.4% from the total catch and the aliened species, *C. auratus*, *C. carpio* and *C. idella* instituted 12.2% of the total catch during 2005 (Table 2). Nasir and Khalid (2017) documented fourteen freshwater fish species in the Basrah province including some species recorded in the present study in addition to *Hypophthalmiehthys molitrix* and *C. idella*, and they stated that native species like *M. sharpeyi*, *L. xanthopterus*, *C. luteus* and *A. grypus* formed 15.7% of the total catch and the aliened species, *C. carpio*, *C. auratus* and *C. zillii* constituted 29.5% of the total catch during 2005-2016 (Table 2). This may be due to habitat degradation, the stocking of alien species and the invasion of exotic species. The southern region of Iraq suffered from a substantial reduction in water quality and quantity due to the construction of hydropower dam projects in the headwaters of the Tigris and Euphrates Rivers and their tributaries (Garstecki and Amr, 2011). Dams on major rivers worldwide have adversely affected fisheries, primarily by altering the seasonal floods to which many fish species and fisheries are adapted, especially in the downstream reaches (Scudder and Connelly, 1985). Britton, *et al.* (2011) stated when a non-native fish is established in the environment and then dispersed, potential negative consequences include suppression of native fish populations through competition, predation and hybridization, and disruptions to habitats and ecosystem function. Also, different species of carp have been stocked in Iraqi natural waters and continue to be stocked annually by the Ministry of Agriculture, whereas, there was a deficiency in the stocking of indigenous species. In addition, several fish species invaded Iraqi waters in various ways and expanded rapidly and became one of the most dominant species in various water bodies of Basrah (Mohamed and Abood, 2020). So far about thirteen exotic fish species have been reported in the Shatt Al-Arab River (Mohamed and Abood, 2017). The impacts of cyprinids and cichlids introduced upon native fish and their habitats were well documented in several countries (Canonico *et al.*, 2005; Leunda, 2010; Innal, 2011; Morgan *et al.*, 2014).

Table 1. Fish species in the Basrah inland fisheries (2020-2021).

Family	Scientific name	English name	Local name
Cyprinidae	*Cyprinus carpio*	Common carp	Samti
	Leuciscus vorax	Tigris asp	Shalig
	Carasobarbus luteus	Himri barble	Hemri
	Mesopotamichthys sharpeyi	Binni	Bunni
	Luciobarbus xanthopterus	Yellowfin barbell	Gattan
	Arabibarbus grypus	Shabout	Shaboot
	Carassius auratus	Crucian carp	Kaezmeh
Mugilidae	*Planiliza abu*	Abu mullet	Khishni
	Planiliza subviridis	Greenback mullet	Beyah
	Planiliza klunzingeri	Klunzinger's mullet	
Cichlidae	*Oreochromis niloticus*	Nile tilapia	Bultee (Tilapia)
	Oreochromis aureus	Blue tilapia	
	Coptodon zillii	Redbelly tilapia	
Sparidae	*Acanthopagrus arabicus*	Arabian yellowfin seabream	Shanak
Siluridae	*Silurus triostegus*	Tigris catfish	Jerry

Table 2. A comparison of species composition in the Basrah inland fisheries (1975-2021).

Species	Sharma (1980) 1975-1977	Mohamed *et al.* (2008) 2005		Nasir and Khalid (2017) 2005-2016	Present study 2020-2021
		Tigris	Euphrates		
C. carpio	0	2.4	3.8	17.6	26.7
Tilapia species	0	0	0	7.9	14.5
P. abu	5.7	6.3	8.1	16.4	14.5
L. vorax	2.2	1.1	2.1	9.6	14.1
Mullets	3.2	0.5	0.9	7.2	5.4
C. luteus	12.6	1.3	2.8	11.5	5.1
M. sharpeyi	24.8	0.3	0.7	3.2	3.9
C. auratus	0	11.0	10.2	4.0	3.0
A. grypus	0.16*	0.2	0.04	0.2	2.2
L. xanthopterus	24.1	0.7	0.4	1.0	1.6
A. latus	1.1			0.6	1.1
Silurus triostegus	-	70	53	20.7	-

Table 3. Fish species landings (t) and their contributions to the Basrah inland fisheries during 2020-2021.

Species	2020		2021	
	Landings	%	Landings	%
C. carpio	582.83	24.01	693.95	29.34
L. vorax	465.26	19.16	214.45	9.07
P. abu	369.10	15.2	326.30	13.8
Tilapias	298.20	12.28	394.85	16.69
Mullets	153.43	6.32	107.09	4.53
C. luteus	133.14	5.48	113.83	4.81
Mixed fish	130.68	5.38	216.51	9.15
C. auratus	91.87	3.78	50.70	2.14
A. grypus	71.62	2.95	32.57	1.38
M. sharpeyi	59.60	2.45	125.58	5.31
S. triostegus	32.22	1.33	0.00	0.00
L. xanthopterus	29.90	1.23	48.02	2.03
A. latus	9.95	0.41	41.30	1.75

Monthly and annual catches

The monthly variations in the inland fisheries during 2020-2021 are presented in Figure 2. The law forbids freshwater fishing in the Basrah province from the middle of February to the middle of April yearly. The total landings fluctuated from 139.07 t in May to 467.8 t in November 2020 and from 187.35 t in February to 273.67 t in December 2021. There is an indication of a positive trend in the total catch during the present study (slope (b)= 0.68). The catch of *C. carpio* varied from 40.70 t in March 2020 to 67.80 t in January 2022 and from 8.80 t in November 2022 to 79.50 t in 2022. There is a positive trend in the catch of *C. carpio* during the study period (b= 1.12). The landings of *P. abu* ranged from 22.00 t in February to 50.25 t in December 2020 and from 28.25 t in September to 47.1 t in January 2021. The landings of *P. abu* show a slightly declining trend during 2020-2021 (b= -0.30). In 2020, the landing of tilapias varied from 7.27 t during July to 39.00 t during November and from 27.50 t during February to 56.50 t during December 2021. The catch of *L. vorax* fluctuated from 17.00 t in March to 31.50 t in December 2020 and from 14.50 t in February to 25.50 t in November 2021. The landing of mixed fish ranged from 7.27 t in March to 19.75 t in December 2020 and from 14.81 t in January to 23.95 t in September 2021. There are positive trends in the catches of tilapias and mixed fish (b= 0.74 and 0.59, respectively), while is a negative trend in the catch of *L. vorax* (b= -0.18).

Figure 3 illustrates the monthly fluctuations in the landings of *M. sharpeyi*, *C. luteus*, mullets, *C. auratus*, *L. xanthopterus*, *A. grypus* and *A. latus* from 2020 to 2021. The harvest of *M. sharpeyi* varied from 1.45 t in August to 8.00 t in June 2020 and from 8.63 t in August to 16.95 t in May 2021. The catch of *M. sharpeyi* shows a clear increasing trend during 2020-2021 (b= 0.45). The landing of *C. luteus* ranged from 5.15 t in February to 18.95 t in December 2020 and from 9.30 t in February to 14.3 t in November 2021, while the landing of mullets fluctuated from 5.00 t in May to 22.26 t in November 2020 and from 1.65 t in January to 12.00 t in September 2021. The landings of *C. luteus* and mullets demonstrate clear declining trends during 2020-2021 (b= -0.40 and -0.06, respectively), however, the declining trend of *C. luteus* was sharper during the study period. The catch of *C. auratus* fluctuated from 0.67 t in February to 17.55 t in November 2020 and from 2.7 t in January to 7.00 t in July 2021. The landing of *C. auratus* shows a clear decreasing trend during 2020-2021 (b= -0.22). The harvest of *L. xanthopterus* varied from 0.05 t in August to 7.73 t in December 2021 and from 2.85 t in October to 7.30 t in January 2021, whereas *A. grypus* landing changed from 1.22 t in November to 4.10 t in May 2020 and 2.07 t in December to 5.51 t in January 2021. There are positive trends in the landings of *L. xanthopterus*, *A. grypus* and *A. latus* (b= 0.06, 0.03 and 0.06, respectively) along the investigated period.

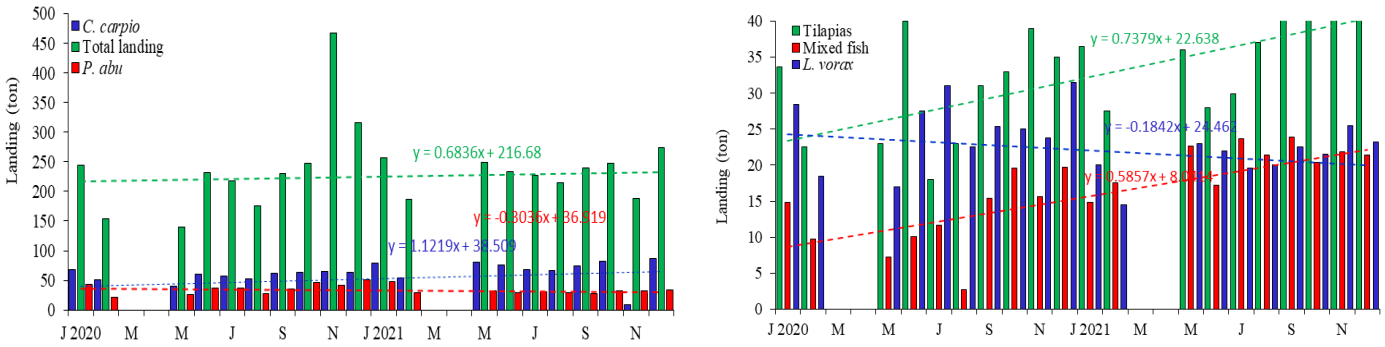

Figure 2. *The monthly fluctuations in the landings of the total, C. carpio, P. abu, tilapias, L. vorax and mixed fish.*

The monthly value of the biomass diversity "H_b" for each species in each year of the catch is illustrated in Figure 4. The diversity ranged from 1.94 in August to 2.16 in June 2020 and from 2.03 in January to 2.25 in February 2018. The overall values of the biomass diversity index of each species were 2.07 in 2020 and 2.12 in 2021. Abood and Mohamed (2020) found that the overall values of biomass diversity of each species ranged from 2.10 in 2017 to 2.11 in 2019. The total landings of various fish species and their contributions to the inland fisheries during 2020 and 2021 are presented in Table 3. The total landing in 2020 was 2,427.78 t, whereas 2,365.15 t in 2021, and there is no significant difference was found between the total landing in the two years (t= 1.02, P> 0.05) at the level of 0.05. Also, the similarity between the weight per cent of each species in 2020 and 2021, according to the Morisita index was a very high similarity level (Cλ= 93.8).

Four species were the mainstay of the inland fisheries in 2020 and 2021, involved *C. carpio*, *L. vorax*, tilapias species and *P. liza*. *C. carpio* dominated the overall catch, and its landing ranged from 582.83 t (24.0%) in 2020 and 693.95 t (29.34%) in 2021 (Table 3). The harvest of *L. vorax* fluctuated from 465.26 t (19.2%) in 2020 to 214.45 t (14.1%) in 2021, followed by tilapias species varied from 298.20 t (12.3%) in 2020 to 394.85 t (16.7%) in 2021. The catch of *P. abu* ranged from 369.10 t (15.2%) in 2020 to 326.30 t (13.8%) in 2021. These species formed 69.8% of the overall total landings in 2020-2021. The contributions of historically important economic species such as *C. luteus*, *A. grypus*, *M. sharpeyi*, and *L. xanthopterus* were 5.5, 3.0, 2.5 and 1.2%, respectively in 2020, while in 2021 constituted 4.8, 1.4, 5.3 and 2.0%, respectively in 2021 (Table 3). These four species instituted 12.8% of the overall total landings in 2020-2021. Moreover, mixed fish composed 5.4% of the total landing in 2020 and 9.2% in 2021.

Nasir and Khalid (2017) stated that the total catch of the Basrah inland fisheries during 2005-2016 varied between 256.290 t in 2009 and 1978.395 t in 2015, with an overall catch of 11,094.940 t, including *S. triostegus* with 1740.2 t (20.7%), *C. carpio* with 1508.7 t (17.6%), *P. abu* with 1400.8 t (16.4%), *C. luteus* with 978.2 t (11.5%) and tilapia 817.7 t (7.9%), and these five species constituted 74.1% of the total catch. The increase in fish landing during the period 2020-2021 was about eightfold when compared to the period 2009-2010. However, the total landings from this fishery during 2017-2019 ranged from 1,740.7 t in 2017 to 2,061.6 t in 2019 with an overall landing of 5,610.4 t, consisting of *C. carpio* with 1639.5 t (29.2%), *P. abu* with 906.7 t (16.2%) and tilapia with 964.7 t (15.4%), and these three species comprised 60.8% of the total catch (Abood and Mohamed, 2020).

Some factors may have contributed to the improvement of the total catch during the last years. Out of these, the prevalence of exotic species such as *C. carpio* and tilapia species, i.e., these species were successful in colonizing the waters of Basrah province and becoming the most abundant large freshwater fish in this region. *C. carpio* was introduced into Tharthar, Habbaniya and Hammar lakes, Iraq in 1960 (Al-Hamed, 1966), and then after, Al-Hassan *et al.* (1989) recorded its presence in the Shatt Al-Arab River, while tilapia species invaded Iraqi waters and first recorded in the Euphrates River near Musaib City, the middle of Iraq during 2007 (Saleh, 2007) after that they recorded in Basrah waters during 2009 and 2015 (Al-Faisal and Mutlak, 2015). *C. carpio* and tilapia species catch showed steady increasing trends in the last years in Basrah province (Nasir and Khalid, 2017; Abood and Mohamed, 2020). During the last few years, the Basrah Agriculture Directorate has released large numbers of young carp from its hatcheries (Personal communication). However, several studies referred that these species were considered a problem because of their perceived impacts on water quality, aquatic plants and native fish populations through competition and lowering habitat quality (Koehn *et al.*, 2000; Canonico *et al.*, 2005).

Also, the artisanal inland fisheries have undergone a progressive change in the fishing effort, like the numbers of fishermen and fishing boats may be further responsible for this improvement in the total catch of the Basrah inland fisheries. At the time of the study, there were 2140 non-motorized fishing boats (3.5-5.0 m length), with one to three fishermen employed in each boat. Also, there were 1160 motorized fishing boats (5.5-10.5 m length), which involved 573 made from fiberglass, 497 wooden and 90 aluminum, with two to three fishermen working on each boat. While earlier studies such as Nasir and Khalid (2017) stated about 1283 fishing boats are operating in the Basrah inland waters during 2005-2016, and most of these boats were less than 10 m in length with small outboard motors with an estimated 1490 fishermen. Generally, the main fishing gears and techniques used by fishermen in the Basrah inland fisheries during the investigated period included gill nets of various mesh sizes, seine and cast nets, and electro-fishing, which did not differ from those previously described by other authors (Jawad, 2006; Mohamed *et al.*, 2008).

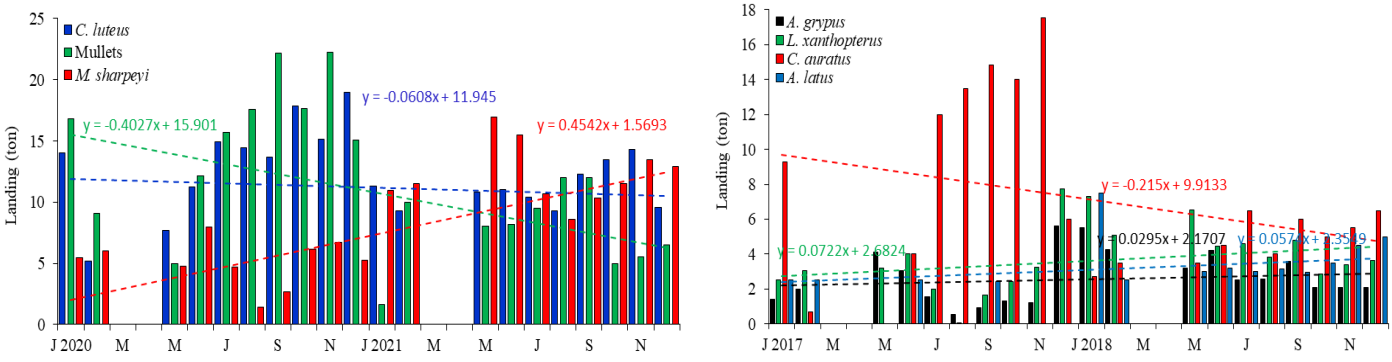

Figure 3.*The monthly variations in the catches of C. luteus, mullets, M. sharpeyi A. grypus, L. xanthopterus, C. auratus and A. latus.*

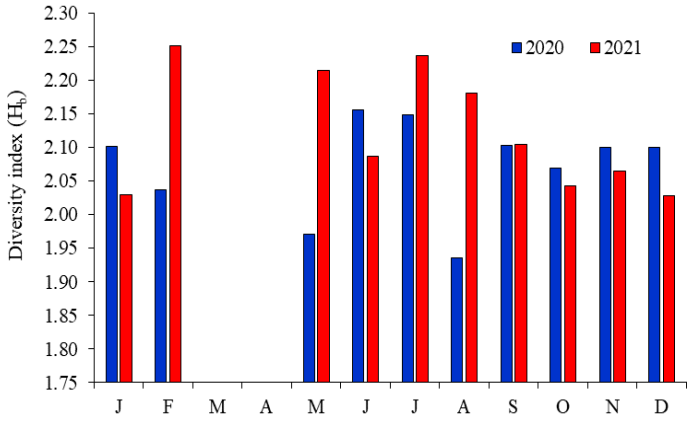

Figure 4. *Biomass diversity (H_b) values of the monthly inland fish catch during 2020-2021.*

Conclusion

The study exhibited that the annual total landing by the fishers in the Basrah inland fisheries improved during the last years as compared with the landings since 2009. This increase in the catches was mainly due to the prevalence of exotic species, while the contributions of the highly valued native fish (*M. sharpeyi*, *L. xanthopterus*, *C. luteus* and *A. grypus*) were below the historical levels. Consequently, proper fisheries management is urgently needed, such as enhancing the stocks of native species, minimizing the dispersal and impacts of some exotic species and activating the national regulating fishing, exploitation and protection of aquatic organisms, No. 48 for 1976 to improve the inland fisheries.

ACKNOWLEDGEMENT

We are very grateful to the Basrah Agriculture Directorate, Ministry of Agriculture for providing the raw fisheries data and other valuable information.

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