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The current status of inland fisheries in Basrah province, Iraq

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Abstract
The current status of species composition, total catch, fishing effort and their landing trends in six fish landing locations in the inland waters of Basrah province, Iraq from 2017 to 2019 were assessed. A total of 15 species in 5 families were recognized in the inland fisheries. The maximum total catch was 2061.5 t in 2019, whereas 1740.7 t in 2017 and 1804.2 t in 2018. The total catches show a clear increasing trend from 2017 to 2019. *Cyprinus carpio* dominated the overall catch (29.2%), followed by *Planiliza abu* (16.2%) and tilapias (15.4%). There are positive trends in the catches of all species, except *P. abu* and *Luciobarbus xanthopterus*. The highest trends were for *Leuciscus vorax* and *Carasobarbus luteus*. The overall values of biomass diversity of each species ranged from 2.10 in 2017 to 2.01 in 2018, whereas 2.11 in 2019. About 75% of the fishing boats (2140 boats) was without engine propelled by paddles in the lengths of 3.5 to 5.0 m. The study suggests some management measures must be put into place include the enforce fish regulations in the Basrah inland fisheries, in particular, preventing illegal fishing methods, and increasing fish production by releasing fingerlings of cyprinid species to preserve them and protect them from extinction and overfishing.

Keywords: Inland fisheries, trend catch, fishing efforts, Basrah, Iraq

1. Introduction
The Basrah province is located at the southernmost part of the Mesopotamian Plain and is rich in water resources. It is bounded by the northwest corner of the Arabian Gulf and its northern borders by great Tigris and Euphrates Rivers and the water masses of the marshlands. There are two more main water bodies include 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. The Shatt Al-Arab River receives freshwater from the Tigris and Euphrates Rivers, as well as from the Karkheh and the Karun Rivers from Iran [1]. Therefore, there are two strictly different groups of fish were fished in the province, marine fish species from the northwest region of the Arabian Gulf (marine fisheries) and freshwater fish from the main rivers and the marshlands (inland fisheries). All the fisheries are generally artisanal with no large-scale industrial fisheries being undertaken in Iraq since 1990 [2]. 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 coming from the southern region [3].
Under this circumstance several studies on the Iraqi marine fisheries have been published [4-12] focused on species composition, fishing effort, total catch, marketing and stock assessment of different fish species. Additionally, some works have been published on the inland fisheries [13, 4, 14, 15] referred to the fish marketing conditions in Basrah province.
The discharge of Shatt Al-Arab River differed from what it was in last of the past century due to establishing and completing of hydropower dams projects in the headwaters of the Tigris and Euphrates Rivers and their tributaries in Turkey, Syria, Iraq, and Iran [3], besides the diverted the flow of Karun and Karkha Rivers into Iranian terrene [16, 17] and cut off the Euphrates River before influx to the Basrah province, which led to decreasing of water quality and quantity that entering the Shatt Al-Arab River and marshes areas, as well as supporting the saline arm to extended from the Arabian Gulf up to 100 km into Shatt Al-Arab and consequently resulting in high salinity levels in the river [18]. Also, the draining of the extensive marshes in southern Iraq by the diversion of major rivers around the marsh areas [19].

A comprehensive description of species, fishing efforts, catch rates and a total catch of the artisanal fisheries in the landing locations in Al-Qurna, Al-Midaina and Swab, north of Basrah province during 2005 was published by Mohamed *et al.* [20]. Nasir and Khalid [21] reviewed the annual species landings in the Basrah inland fisheries from 2005 to 2016.

The main purpose of this study is to describe the current status of fish species, total catches, fishing effort and their landing trends in six fish landing locations in the inland waters of Basrah province, Iraq from 2017 to 2019.

2. Materials and Methods

The study was carried out in several fish catch locations throughout the inland waters of Basrah province, Iraq to cover the period from January 2017 to December 2019. These catch locations were selected for the study because of their suitability for fishing activities as they are close to rivers (Tigris, Euphrates, Shatt Al-Arab, El-Eez and Swab Rivers) and marshes (Huwazah, Central and East Hammar) where fish are capture (Fig. 1). The raw data of total catches of each species, the number of fishers and the specifications of fishing boats and nets were collected from each of the following catch locations; Al-Qurna, Al-Midaina, Al-Dair,

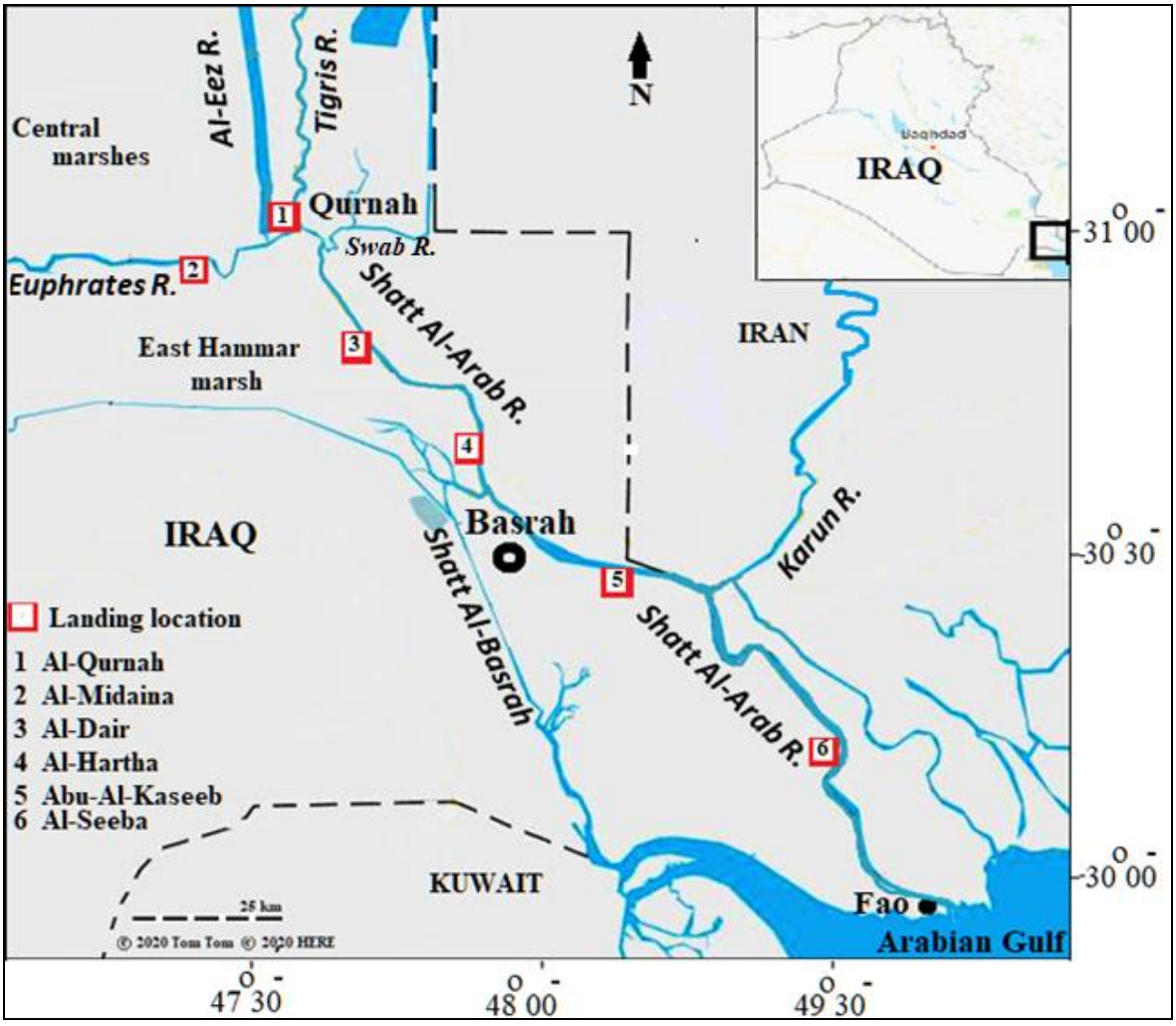

Fig 1: Fish landing locations in the Basrah inland fisheries

Al-Hartha, Abu-Al-Kaseeb and Al-Seeba by the fish staffs of the Basrah Agriculture Directorate, Ministry of Agriculture.

Data were analyzed through descriptive statistics and included in numerical and graphic results. The relative abundance of each species was calculated according to the formula of Krebs [22]. Similarity level between the catches years (according to the weight per cent of each species) has been estimated using Morisita's index [23]: $C\lambda\% = 2\Sigma X_i Y_i / \Sigma X^2_i + \Sigma Y^2_i$, where $C\lambda$ is the similarity level, X_i and Y_i the weight per cent of ith species in each year of catch.

The diversity index of catch (H_b) was calculated for each year catch using the following formula of Shannon and Weaver [24]: $H_b = - \sum P_i \log_e P_i$, where P_i is the proportion of ith species which represented in the present paper as the weight of each species. The monthly variations between catch years were tested using one-way analysis of variance (ANOVA) and the least-significant different were used to analyses the difference between months and years. A trend line was used to show the general direction and describe patterns of fish species catches. All statistical computation was carried out using Microsoft Excel 2010.

3. Results

3.1. Annual trends in catch

The fish species caught by the inland fisheries in Basrah province during 2017-2019 are given in Table 1. A total of 15 species in 5 families were identified in the artisanal catches. Cyprinidae was represented by seven species, while Mugilidae and Cichlidae by three species each, The remaining families were Sparidae represented by *Acanthopagrus arabicus* and Siluridae by *Silurus triostegus*.

Table 1: Fish species in the Basrah inland fisheries (2017-2019)

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

The annual catches of different fish species caught by the Basrah inland fisheries for the period 2017-2019 are explained in Table 2. Mullets fish group refer to *Planiliza subviridis* and *P. klunzingeri*, while tilapias to *Oreochromis niloticus*, *O. aureus* and *Coptodon zillii*, and mixed fish to unmarketable fish which are caught together. The maximum total catch was 2061.5 t in 2019, whereas 1740.7 t in 2017 and 1804.2 t in 2018. No significant differences between the species catch over these years ($F= 0.505$, $P> 0.05$).

Table 2: Fish species catches (t) and their contributions in the Basrah inland fisheries

Fish	2017		2018		2019		Total	
	Catch	%	Catch	%	Catch	%	Catch	%
C. carpio	467.8	26.9	557.8	30.9	613.9	29.8	1639.5	29.2
L. abu	325.3	18.7	283.6	15.7	297.8	14.5	906.7	16.2
Tilapias	314.4	18.1	250.1	13.9	300.1	14.6	864.7	15.4
L. vorax	112.9	6.5	158.8	8.8	196.8	9.6	468.5	8.4
Mullets	133.2	7.7	113.5	6.3	146.7	7.1	393.4	7.0
C. luteus	77.8	4.5	104.8	5.8	121.0	5.9	303.6	5.4
C. auratus	81.2	4.7	48.0	2.7	87.8	4.3	217.0	3.9
M. sharpeyi	38.1	2.2	46.0	2.6	47.8	2.3	131.9	2.4
A. latus	30.5	1.8	38.0	2.1	32.5	1.6	104.86	1.9
L. xanthopterus	26.0	1.5	26.2	1.5	27.4	1.3	79.5	1.4
S. triostegus	20.9	1.2	18.6	1.0	25.2	1.2	64.7	1.2
A. grypus	10.0	0.6	9.0	0.5	11.9	0.9	30.9	0.6
Mixed fish	102.6	5.9	149.8	8.3	152.7	7.4	405.1	7.2
Total	1740.7		1804.2		2061.6		5610.4	

Conversely, the similarity level between the weight per cent of each species in the catch years according to Morisita's index indicated a very high similarity level ($C\lambda= 99.7$) between the years 2018 and 2019, and the lowest value ($C\lambda= 98.1$) between 2017 and 2018.

Cyprinus carpio was the most harvest species during the present study, its catch ranged from 467.8 t (26.9%) in 2017 to 613.9 t (29.8%) in 2019 (Table 2). The catch of *P. abu* varied from 283.6 t (15.7%) in 2018 to 325.3 t (18.7%) in 2017, while tilapias fluctuated from 250.1 t (13.9%) in 2018 to 314.4 t (18.1) in 2017. The maximum catches of *Leuciscus vorax*, Mullets, *Carasobarbus luteus*, *Carassius auratus*, *Mesopotamichthys sharpeyi*, *Luciobarbus xanthopterus*, *Silurus triostegus* and *Arabibarbus grypus* were 196.8, 146.7, 121.0, 87.8, 47.8, 27.4, 25.2 and 11.9 t happened in 2019, whereas *A. latus* was 38.0 t in 2017.

C. carpio consisted 29.2% of the overall total catches, followed by *P. abu* (16.2%) and tilapias (15.4%), whereas *L. xanthopterus*, *S. triostegus* and *A. grypus* contributed 1.42, 1.15 and 0.55% of the total catches, respectively. However, mixed fish formed 7.2% of the total catches (Table 2).

Figure 2 illustrated the most important fish group contributing ≥5.0% of the total fish catches during 2017-2019. Six fish groups comprised about 81.6% from the overall total catches, namely *C. carpio*, *P. abu*, tilapias, *L. vorax*, mullets and *C. luteus*.

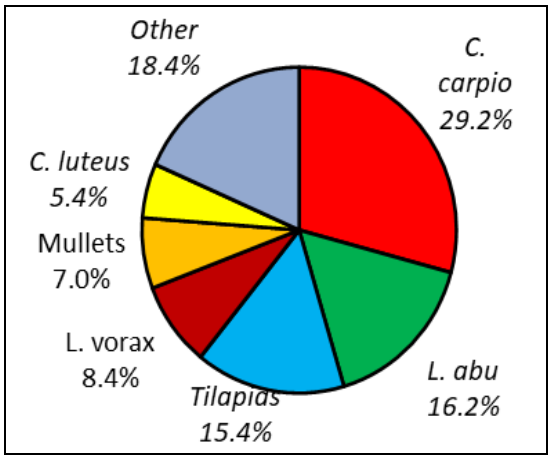

Fig 2: The major fish groups contributions in the Basrah inland fisheries

3.2. Monthly trends in catch

Due to fishing close season under the Act of Regulating Fishing and Aquatic Exploitation and Protection No. 48,

1976, the fish catch data are not existing during March and April each year. Figure 3 illustrates the monthly variations in the total, *C. carpio* and *P. abu* catch in the Basrah inland fisheries during 2017-2019. The total catches were subject to monthly and annual variability where the minimum catches were 146.8, 154.4 and 151.1 t in February 2017, October 2018 and February 2019, respectively, whereas the maximum catches were 195.5, 247.8 and 230.2 t in October 2017, January 2018 and September 2019, respectively. The total catches show a clear increasing trend from 2017 to 2019. The lowest catches of *C. carpio* were 36.3, 32.1 and 50.5 t in March 2017, January 2018 and February 2019, respectively, while the highest catches were 49.7, 61.1 and 67.0 t in December 2017, August 2018 and September 2019, respectively. There is an indication of a positive trend in the catches of *C. carpio* during the present study. The catch of *P. abu* varied from 27.9 t in June to 37.8 t in January 2017, while from 21.3 t in November to 33.8 t in May 2018 and from 17.6 t in February to 36.0 t in November 2019. The catches of *P. abu* show a clear declining trend from 2017 to 2019.

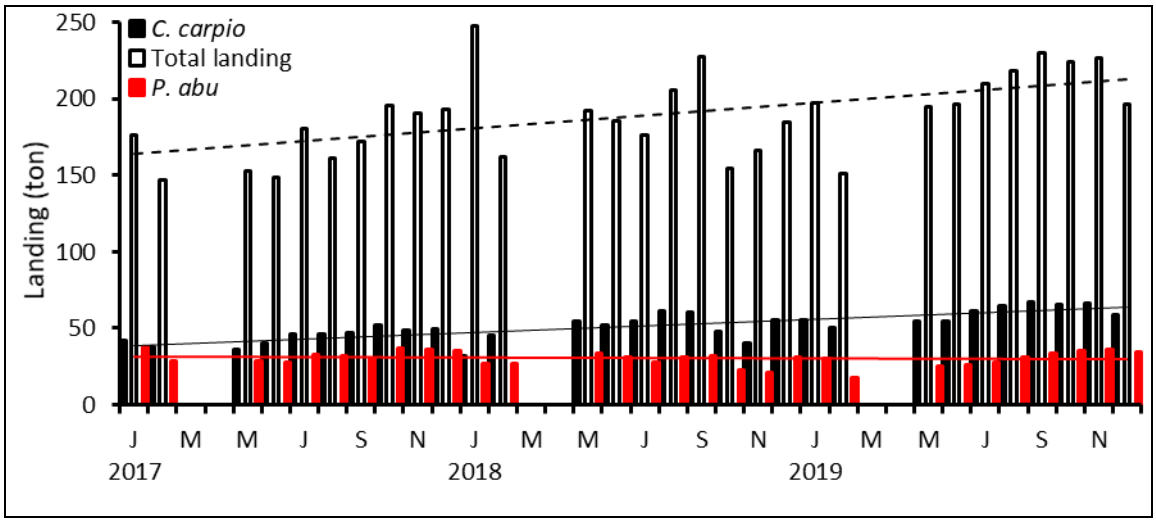

Fig 3: The monthly variations in the total, *C. carpio* and *P. abu* catches

Figure 4 shows the monthly fluctuations in the catches of tilapias, mullets and *L. vorax* in the Basrah inland fisheries from 2017 to 2019. The lowest catch of tilapias was 20.0 t in February 2017, 21.0 t in July 2018 and 22.0 t in December 2019, while the highest catch was 38.2 t in July 2017, 32.5 t in September 2018 and 35.5 t in December 2019. The catches of mullets varied from 8.5 t in May to 17.1 t in October 2017, while in 2018 from 8.3 t in July to 137 t in January, and from 9.3 t in June 2019 to 17.2 t in September 2019. The lowest catches of *L. vorax* were 8.1 t in May 2017, 12.9 t in January 2018 and 15.2 t in January 2019, while the highest catches were 14.5 t in October 2017, 18.9 t in August 2018 and 22.9 t in September. There is an indication of positive trends in the tilapias, mullets and *L. vorax* catches, but the highest trend was for *L. vorax* along the investigated period.

The monthly fluctuations in the catches of *C. luteus*, *C. auratus* and *M. sharpeyi* in the Basrah inland fisheries from 2017 to 2019 are illustrated in figure 5. The catch of *C. luteus* ranged from 2.5 to 10.2 t in 2017, 2.5 to 13.6 t in 2018 and 4.5 to 15.1 t in 2019. The harvest of *C. auratus* varied from 6.7 to 10.0 t in 2017, 2.5 to 11.1 t in 2018 and 1.8 to 10.8 t in 2019, while *M. sharpeyi* catch changed from 2.1 to 5.7 t in 2017, 2.8 to 5.8 t in 2018 and 4.1 to 5.7 t in 2019. There are positive trends in the three species caught, but the highest trend was for *C. luteus* along the investigated period.

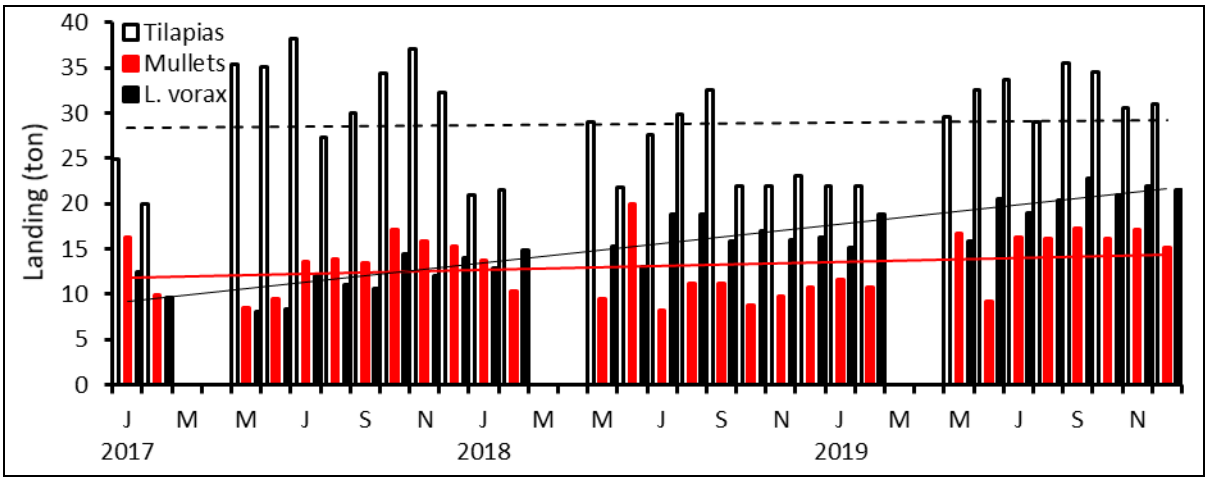

Fig 4: The monthly fluctuations in the catches of tilapias, mullets and *L. vorax*

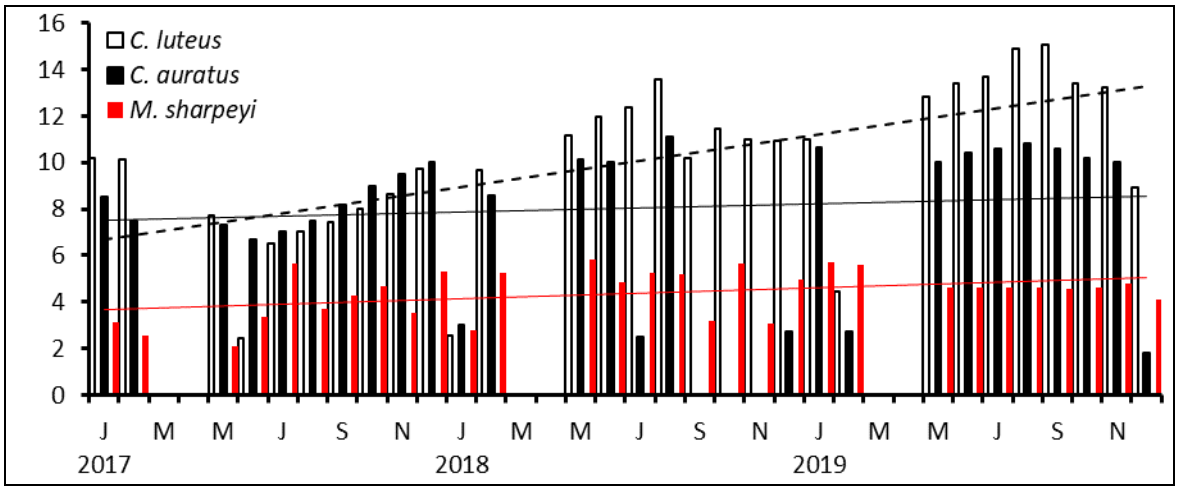

Fig 5: The monthly fluctuations in the catches of *C. luteus*, *C.auratus* and *M. sharpeyi*

Figure 6 explains the monthly variations in the catches of *A. latus*, *L. xanthopterus* and *S. triostegus* in the Basrah inland fisheries from 2017 to 2019. *C. luteus* catch extended from 2.0 to 6.0 t in 2017, 2.5 to 5.5 t in 2018 and 2.0 to 5.0 t in 2019. The catch of *L. xanthopterus* ranged from 2.1 to 3.5 t in 2017, 1.1 to 4.1 t in 2018 and 1.4 to 3.2 t in 2019, while *S. triostegus* catch varied from 1.0 to 2.5 t in 2017, 1.5 to 2.8 t in 2018 and 2.5 to 3.0 t in 2019. There are positive trends in catches of *A. latus* and *S. triostegus*, but the highest trend was for *S. triostegus*, while *L. xanthopterus* showed a declining trend along the investigated period.

The biomass diversity "H_b" for each species in each year of the catch is given in Table 3. The diversity varied from 2.00 to 2.19 in 2017 and from 1.35 to 2.16 in 2018, while from 1.97 to

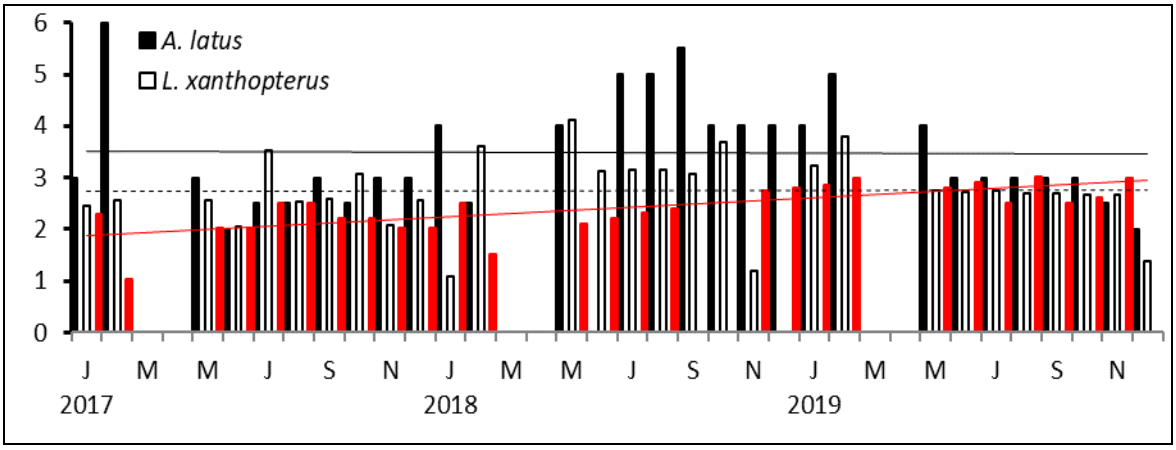

Fig 6: The monthly variations in the catches of *A. latus*, *L. xanthooterus* and *S. triostegus*

Table 3: Biomass diversity (Hb) values of the monthly inland fish catch during 2017-2019

Year	J	F	M	A	M	J	J	A	S	O	N	D	Overall
2017	2.14	2.19	-	-	2.07	2.00	2.10	2.07	2.12	2.10	2.08	2.12	2.10
2018	1.35	2.16	-	-	2.14	2.09	2.06	2.14	1.98	2.04	2.08	2.06	2.01
2019	2.18	2.09	-	-	2.17	2.14	2.12	2.13	2.11	2.10	2.11	1.97	2.11

2.18 in 2019. The overall values of biomass diversity of each species ranged from 2.10 in 2017 to 2.01 in 2018, whereas 2.11 in 2019.

3.3. Fishing efforts

The characteristics of fishing efforts in the Basrah inland fisheries are summarized in Table 4. The number of fishing boats used in their activities in this fisheries was about 3,300 boats out of which 1203 boat were made from fiberglass, 1247 from wooden and 850 boats from aluminum in the range of lengths 3.5 to 10.5 m. About 75% of the fishing boats (2140 boats) was without engine propelled by paddles in the lengths of 3.5 to 5.0 m, which included 760 aluminum boats, 630 fiberglass boats and 750 wooden boats. There were 1160 boats (35.3%) with engines of 2 to 55 hp, in which 261 boats (7.9%) with engines of 11 to 15 hp and 259 boats (7.8%) with engines of 2 to 10 hp. However, there were 48 boats (1.5%) with engines of 50 to 55 hp.

Several fishing gears were identified in the Basrah inland fisheries during the study period included gill nets (drift and fixed), seine nets, cast nets, electrical fishing and hand lines.

Table 4: Specifications of the fishing efforts used in the Basrah inland fisheries (2017-2019)

Engine power (hp)	No. of boats	Type of boats			Size of boats (m)	No. of fishermen
		Fiberglass	wooden	Aluminum		
Without motor	2140	630	750	760	3.5-5	1-3
2-10	259	113	111	35	5.5-7	1-2
11-15	261	130	106	25	5.5-8	2-3
16-18	59	34	20	5	6-8.5	2-3
20-25	216	110	91	15	6.5-9	2-3
30-35	112	55	47	10	6-9.5	2-3
40-45	144	64	75	-	6.5-10	2-3
48	61	34	32	-	7-10	2-3
50-55	48	33	15	-	7.5-10.5	2-3
Total	3300	1203	1247			

These fishing gears were varied among boat type and size, and the location of the fishing condition.

4. Discussion

From this study, it was observed that the annual total catches by the Basrah inland fisheries exhibited improvement during the present years compared with the annual catches since 2009 (Fig. 7). The total catch in this study ranged from 1740.7 t in 2017 to 2061.5 t in 2019. Nasir and Khalid [21] reviewed the annual catch of the Basrah inland fisheries during 2005-2016 and found that the catches fluctuated from 256 t in 2009 to 1,978 t in 2015. It means that the catch during the present study equated to 7 to 8 times the catch during 2009. The fishing gears and techniques used by fishermen in the Basrah inland fisheries along the investigated period did not differ from those previously described by other authors [4, 25, 20].

In earlier reports, Al-Nasiri and Sharma [13] stated that the wholesale of freshwater fish in the Ashar fish market in Basrah handled 1,557 t per year in the mid-1960s and the mid-1970s. Moreover, Sharma [15] reported that the total landing in the Basrah main fish market from October 1975 to June 1977 was 3118.939 t, out of which 2172.810 t during 1976. per year during that decade.

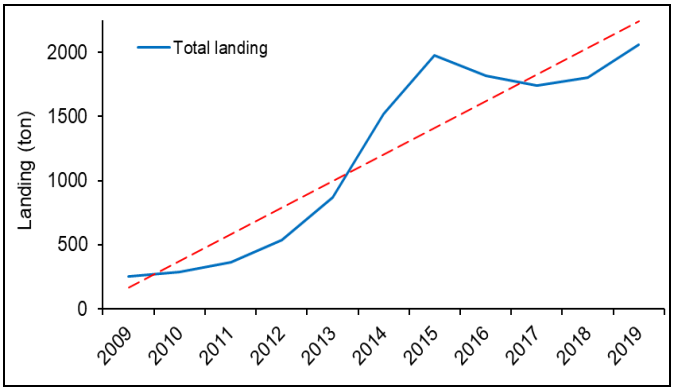

Fig 7: The annual total catch trend of Basrah inland fisheries (2009-2019)

Furthermore, although the total fish catch improved during the current study after years of declines due to reasons we will discuss, which can be compared with the fish landings in Basrah during the seventies of the last century, although the early reports dealt with fish brought to the Basrah fish market from only three locations, which were Al-Sinafi, Al-Midaina and Al-Qurna [15], dramatically shifted has been happened in the species structure and their dominance.

Historical the most economically important freshwater fish in the Basrah province were native cyprinid species like *M. sharpeyi, L. xanthopterus, C. luteus, A. grypus* and *L. vorax* and have high yield [13, 4]. Cyprinid family occupied the first place in terms of the number of species in all fishery sites, a situation common in inland waters of Iraq [26, 27]. Sharma [15] found that the contributions of major cyprinid species to the landings in the Basrah main fish market from October 1975 to June 1977 were *M. sharpeyi* (24.8%), *L. xanthopterus* (24.1%), *C. luteus* (12.6%) and *L. vorax* (2.2%). Moreover, he stated that *A. grypus* contributed only 0.16% of the total landing throughout the same period due to some enforcement not to catch it at least for some years in the marshes to allow a maximum of fish to breed and flourish.

Mohamed *et al.* [20] described the harvests of fish species in the landing locations in Al-Qurna, Al-Midaina and Swab, north of Basrah province during 2005. *S. triostegus* dominated the overall catch with the percentages of 69.7, 53.0 and 44.8% in the three locations, respectively, followed by *C. aureus* (11.0 and 10.2% in the first two locations, respectively) and *M. sharpeyi* (24.5%) in Swab location, then *P. abu* ranked third in the first two locations by 6.3% and 8.1% respectively, while *L. vorax* constituted 10.4% in Swab location. Other records were *C. luteus* represented 1.3%, 2.8% and 8.6%, and *C. carpio* 2.4%, 3.8% and 3.3% of the overall catch in the three locations, respectively. The least species were *L. xanthopterus* and *A. grypus* formed 0.4 to 0.7% and 0.04 to 0.2%, respectively of the catches in the three locations.

Nasir and Khalid [21] reviewed the annual species landings in the Basrah inland fisheries during 2005-2016 and found that the overall catch comprised from *S. triostegus* (20.7%), *C. carpio* (17.6%), *P. abu* (16.4%), *C. luteus* (11.5%), *L. vorax* (9.6%) and *C. zillii* (7.9%). The least species were *M. sharpeyi* and *L. xanthpterus* constituted 3.2 and 0.96%, respectively.

In the present study, *C. carpio* dominated the overall catch with the percentage composition of 29.2%. This was followed by *P. abu* (16.2%) and tilapias (15.4%), *L. vorax* (8.4%), *C. luteus* (5.4%), *C. auratus* (3.9%), *M. sharpeyi* (2.4%), *A. latus* (1.9%), *L. xanthopterus* (1.4%) and *A. grypus* (0.6%).

From these studies, it was cleared that the cyprinid species, *M. sharpeyi*, *L. xanthopterus* and *C. luteus* which were highly valued has been greatly reduced and has been replaced by less valued species like the exotic species (i.e. *C. carpio* and tilapias species). The abundance of cyprinid species such as *M. sharpeyi*, *L. xanthopterus* and *L. vorax* has fallen to the point where they were classified as threatened by the International Union for the Conservation of Nature and included on the Red List [28-31].

There are a variety of potential threats to the Basrah inland fisheries during the last decades. These include hydropower dams projects in the headwaters of the Tigris and Euphrates Rivers and their tributaries, which the substantial reduction in water quality and quantity, and effective absence of the flood pulses that sustained wetland ecosystems in the lower Tigris-

Euphrates basin [32], besides the diverted the flow of Karun and Karkha Rivers into Iranian terrene and cut off the Euphrates River before influx to the Basrah province. Therefore, the main source of freshwater for the rivers and marshes of Basra province has become dependent exclusively on the freshwater influx from the Tigris River. The average rate of discharge in the upstream of the Shatt-Al-Arab River was declined from 207m^3/s during 1977-1978 to 60m^3/s during 2014 [33]. Dams on major rivers worldwide have adversely affected the fisheries, primarily by altering the seasonal floods to which many fish species and fisheries are adapted, especially in the downstream reaches [34]. Furthermore, using illegal fishing tools such as explosives, poisons and long-term use of illegal small-meshed nets [28]. During the last decades, several exotic fish have been stocked in Iraqi inland waters, the most important being *C. carpio* and continue to be stocked annually by the Ministry of Agriculture and through the Animal Resources Department. Others which were the majority have been invaded Iraqi waters in different ways, such as tilapias species [28, 35]. Mohamed and Abood [37] reported thirteen exotic fish species distributed along the Shatt Al-Arab River.

Tilapia species are invasive fish in Iraqi waters, and the early recorded was from the Euphrates River near Musaib City, Centre of Iraq [37]. Later, they were documented in inland waters of Basrah in 2009 [38], and expanded rapidly and became one of the most dominated species in various water bodies of Basrah [39]. The impacts of tilapias introduced on native fish and their habitats were well documented [40].

The study suggests some management measures must be put into place include the enforce fish regulations in the Basrah inland waters and this can be achieved by activating the national law of fishing, exploiting and protecting aquatic resources, in particular preventing illegal fishing methods, restricting fishing areas, closed seasons and minimum size limits, in addition to increasing fish production by releasing fingerlings of cyprinid species (*M. sharpeyi*, *L. xanthopterus* and *L. vorax*), as well as, carp species to preserve them and protect them from extinction and overfishing. Also, more yields could be obtained by increasing the fishing activities on tilapia species, such as increasing the number of fishing boats and decreasing the mesh-size for substantial harvest for use as animal forage or export.

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