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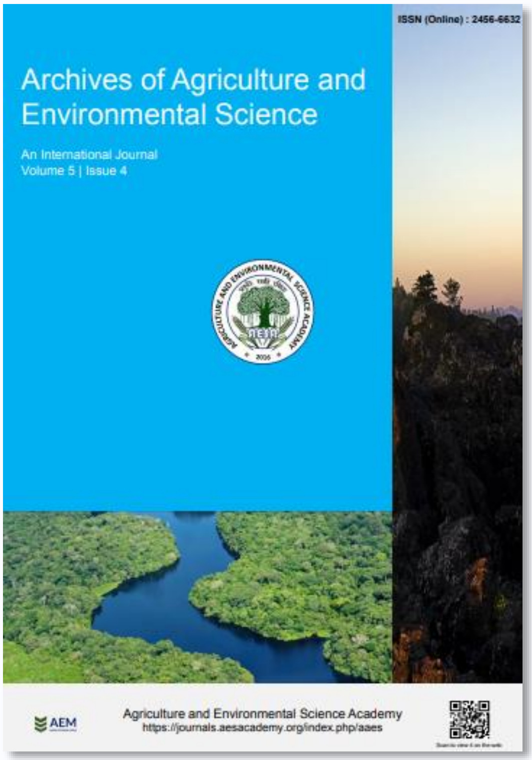

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ORIGINAL RESEARCH ARTICLE

Current status of Iraqi artisanal marine fisheries in northwest of the Arabian Gulf of Iraq

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ABSTRACT

The study was conducted to analyze the fish landings from Iraqi artisanal marine fisheries, northwest Arabian Gulf from January 2017 to December 2019. The monthly data of fish landings were collected from the main landing site at Al-Fao port, south Iraq and were analyzed using descriptive statistics. A total of 35 taxa in 18 families were identified in the artisanal catches, in addition to two species of shrimps. The highest total landings were 11,944 t in 2018 and 11,305 t in 2019. The annual total landing of the marine fisheries increased by 270% during 2017-2019 as compared with the annual landing during 2008-2016. Threadfin bream contributed 14.1%, followed by river shad (11.1%) and mullets (11.1%), whereas shrimps formed 15.2% to the total catch. The overall values of biomass diversity of fish ranged from 1.82 in 2017 to 2.85 in 2018. There were 320 registered fishing boats motorized by 65 to 950 hp. Multi gears fishing were observed. The trends of the landings of all fish groups were increased substantially, except river shad, threadfin bream and shrimps. The study suggests some of the management measures must be put into place, especially for the river shad in the regions of their migration reproductive and the nursery.

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INTRODUCTION

Historically, the Shatt Al-Arab River has played an important source in providing the north of Arabian Gulf by a high amount of nutrients with the freshwater outflow from Tigris, Euphrates and Karun Rivers which have an important role in decreasing a high salinity of this region by dilution of freshwater outflow (Poonian, 2003). Now, the discharge of the river was almost completely dependent on the freshwater influx from the Tigris River as a result of diverting the flow of Karun River inside the Iranian boundaries and cut off the Euphrates River before influx to the Basrah province (Mohamed and Abood, 2017).

The impacts of freshwater inflow to estuarine systems as well as the influence of natural and anthropogenic factors have been discussed by several scientists (Gillson, 2011; Taylor *et al.*, 2014; Ruiz-Barreiro *et al.*, 2019; Osadchiev *et al.*, 2020). Jesintha and Madhavi (2020) stated that the construction of dams diverts nutrient-rich water from entering into the sea, and obstruct the migratory path of some fish. The fish migration, spawning activity, recruitment, and hence, stock productivity will be disrupted due to changes in the hydrological regime and marine environment that are associated with the freshwater flow system (Al-Husaini, 2003). Jutagate *et al.* (2005) stated that the river engineering, such as dams, can potentially adversely affect the fisheries in the region, both in terms of species compositions and fish yields. Basurto *et al.* (2017) stated that the artisanal fishery refers to traditional fisheries involving fishing households, using relatively small amount of capital and energy, relatively small fishing vessels (if any), making short fishing trips, close to shore, mainly for local consumption.

The artisanal marine fishery sector has a longstanding tradition in Iraq and includes a multi-species, multi-gear fishery that is directed towards various demersal, pelagic fish species and shrimps. A total of 214 species from 75 families include 16 cartilaginous and 198 bony fish species were listed in the Iraqi marine waters (Al-Faisal and Mutlak, 2018). There are several works available regarding fish landings of Iraqi marine artisanal fisheries. The status of marine capture fisheries in Iraq during 1991-2004 was reviewed by Morgan (2006). Al-Dubakel (2011) described the fishing methods, landings and marketing of river shad *Tenualosa ilisha* at the Al-Fao fish landing port. A detailed account on the species and total landings, as well as the fishing effort of the Iraqi artisanal marine fisheries during 2007-2011, was reported by Mohamed and Qasim (2014a). A comprehensive description of species and total landings and their trends during 2008-2016 was published by Mohamed (2018). The aim of this study is to analysis the landings of Iraqi artisanal marine fisheries from 2017 to 2019 to determine the catch composition, the major species landings, the monthly and annual landings variations, the fishing efforts, and the annual trends of the total landings as well as of the major species caught to provide basic information for fishery management.

MATERIALS AND METHODS

The Iraqi marine waters occupy the most northwestern tip of the Arabian Gulf comprises the Shatt Al-Arab estuary and several open lagoons such as Khor Al-Khafga, Khor Al-Umaya, Khor Al-Rocka and Khor Abdullah (Albadran *et al*., 2016). Despite the restriction of Iraqi coastline 105 km, continental shelf 1034 km^2 and territorial sea 716 km^2 (EarthTrends, 2003), but considered the most productive area in the Gulf due to run off the Shatt Al-Arab River (Bibik *et al*., 1971). The surface water temperature values ranged from 12°C in January to 34°C in August and salinity varied from 6 to 40% (Mohamed *et al*., 2005). There are three fishing grounds for Iraqi marine fisheries include the Shatt Al-Arab estuary, Khor Abdulla and Khor Al-Amaya (Figure 1). Al-Fao port, southern Basrah is the main center of landings and auction of marine resources, then transported to the fish markets in Basrah city and other parts of the country by several marketing agencies.

The study was carried out for over 36 months from January 2017 to December 2019. The monthly raw data of the total and species landings were collected from the main landing site at Al-Fao port by employees of the Al-Fao Fisherman's Co-operative, as documented by the Basrah Agriculture Directorate which is responsible for the management of fisheries in the Basrah province. Data about the number of fishermen and the specifications of fishing boats and nets were assembled from the Basrah Agriculture Directorate records. The obtained data were analyzed through descriptive statistics and included in numerical results. The relative abundance of each species was assessed according to the formula of Krebs (1972). The similarity level between the landing's years (according to the weight percent of each species) has been estimated using Morisita's 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, Xi, and Yi the weight percent of ith species in each year of landing.

Diversity (Shannon–Wiener diversity index) of the catch of the species (H_b) was calculated for each year landing using the following formula of Shannon and Weaver (1964):

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

where P_i is the proportion of ith species represented in the present paper as the weight of each species.

The monthly variations between landing years were tested using a one-way analysis of variance (ANOVA) and the least-significant difference was used to analyse the difference between months and years. A trend line (technical analysis) was used to show the general direction and describe patterns of fish species landings. All statistical computation was carried out using Microsoft Excel 2010.

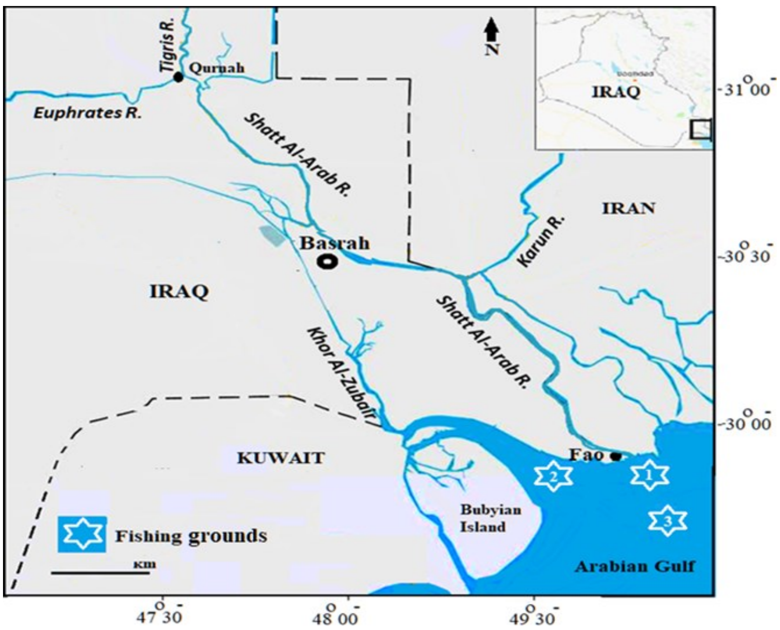

Figure 1. *Fishing areas in Iraqi marine waters, northwest Arabian Gulf in Iraq.*

RESULTS AND DISCUSSION

Table 1 showing the list of species landed by the marine fisheries during 2017-2019. A total of 35 taxa in 18 families were identified in the artisanal catches, in addition to two species of shrimps which belong to Penaeidae. Sciaenidae and Sparidae were represented by four species each, while Mugilidae and Pristigasteridae by three species each. The remaining families were represented by either two or one species. Table 2 given the annual landings of different species landed by marine fisheries in the Al-Fao port for the period 2017-2019. The highest total landings varied from 7988 t in 2017 to 11944 t in 2018. The analysis of variance between the species landings over the three years showed no significant differences between these years ($F= 2.829$, $P > 0.05$). Conversely, the similarity level between the weight per cent of the species in the landing years according to Morisita's index indicated a very high similarity level ($C\lambda= 96.5$) between the years 2018 and 2019, and the lowest value ($C\lambda= 87.6$) between 2017 and 2018.

According to the present results indicated that the inter-annual trends in the total landing of Iraqi marine fisheries increased obviously during the present investigated years and demonstrated good improvement compared with the landing figures since 2003 (Figure 2). The annual fish statistics of the marine fisheries of Iraq after 2003 has been reviewed by Al-Dubakel (2011), Mohamed and Qasim (2014) and Mohamed (2018). Al-Dubakel (2011) noted that the annual landing of the marine fisheries during 2003-2007 varied from 786 t in 2003 to 7,047 t in 2007, with an average landing of 3,792 t per year. The annual landings of the marine fisheries during 2008-2016 ranged from 2,587 t in 2008 to 5,449 t in 2014, with an average landing of 3,832 t per year (Mohamed, 2018). While, the current investigation exhibited a significant increase in the landings extended from 7,986 t in 2017 to 11,945 t in 2018, with an average value of 10,412 t per year. This steady increase in the landing is associated with an increase in the catches of all fish groups under exploitation. This increase may be attributed to the development of infrastructure, the upgrading of navigation technology and the increasing the mechanized power of fishing boats, despite the number of existing fishing boats were much lower than the previous periods.

Table 1. Fish species caught in the marine fisheries of Iraq (2017-2019).

Family	Scientific name	English name	Local name
Sciaenidae	*Otolithes ruber*	Tigertooth croaker	Newaiby
	Johnius maculates	Blotched croaker	Shmahy
	Johnius sina	Silvery croaker	Tataoo
	Johnieops belangerii		
Sparidae	*Acanthopagrus arabicus*	Arabian yellowfin seabream	
	Acanthopagrus berda	Goldsilk seabream	Shaem (Shanak)
	Sparidientex hasta	Sobaity seabream	
	Argyrops spinifer	King soldier bream	Andag
Mugilidae	*Planiliza subviridis*		
	Planiliza carinata	Mullets	Beyah
	Planiliza klunzingeri		
Pristigasteridae	*Ilisha megaloptera*	Big-eye shad	Abu-Owaina
	Ilisha Melostoma		(Sawayah)
	Ilisha elongate		
Clupeidae	*Tenualosa ilisha*	River shad	Sboor
	Nematolosa nasus	Gizzaed shad	Jafoot
	Scomberoides commersonianus	Spotted leatherskin	Dhal'a
Carangidae	*Parastromateus niger*	Black pomfret	Halwayah
Platycephalidae	*Platycephalus indicus*	Indian flathead	Wahra
	Gramolites scaber		
Epinephildae	*Epinephelus tauvina*	Spotted grouper	Hamoor
	Epinephelus areolatus		
Chirocentridae	*Chirocentrus dorab*	Wolf herring	Hiff
	Chirocentrus nudus		
Pomadasyidae	*Scolopsis phaeops*	Silvery grunt	Nagroor
	Plectorhinchus schotaf		
	Pomadasys argentius		
Scombridae	*Scomberomorus commerson*	Barred Spanish mackerel	Chanaad
Stromateidae	*Pampus argenteus*	Silver pomfret	Zobaidy
Scombridae	*Scomberomorus guttatus*	Spotted Spanish mackerel	Khobat
Nemipteridae	*Nemipterus japonicas*	Threadfin bream	Bassi
Bothidae	*Bothus pantherinus*	Flounder	Khofaah (Mezlag)
Soleidae	*Euryglossus orientalis*	Black sole	
Cynoglossidae	*Cynoglossus arel*	Largescale tonguesole	Lessan
Lethrinidae	*Lethrinus nebulosus*	Emperor	Sheiry
Penaeidae	*Penaeus semisulcatus*	Green tiger prawn	Robian
	Metapenaeus affinis	Jinga shrimp	

Table 2. Fish groups landed by Iraqi marine fisheries from 2017 to 2019.

Fish groups	2017		2018		2019	
	Landing (Kg)	%	Landing (Kg)	%	Landing (Kg)	%
Threadfin bream	1265	15.84	1920	16.08	1225	10.84
Mullets	753	9.43	1267	10.61	1439	12.73
River shad	1687	21.12	737	6.17	1028	9.09
Emperor	263	3.29	880	7.37	718	6.35
Yellow fin-bream	195	2.44	485	4.06	654	5.79
Wolf herring	177	2.22	665	5.57	315	2.79
Tiger tooth croaker	204	2.55	309	2.59	509	4.50
Spotted leather skin	58	0.73	377	3.16	553	4.89
Soldier bream	154	1.93	438	3.67	365	3.23
Spotted grouper	133	1.66	325	2.72	435	3.85
Silver pomfret	84	1.05	253	2.12	242	2.14
Silvery grunt	106	1.33	203	1.70	217	1.92
Large tooth flounder	116	1.45	135	1.13	195	1.72
Spotted Spanish mackerel	61	0.76	234	1.96	80	0.71
Black fin-bream	43	0.54	62	0.52	67	0.59
Silvery croaker	30	0.38	88	0.74	44	0.39
Indian flathead	56	0.70	50	0.42	29	0.26
Black pomfret	21	0.26	46	0.39	17	0.15
Blotched croaker	-	-	64	0.54	15	0.13
Barred Spanish mackerel	3	0.04	6	0.05	8	0.07
Tongue sole	10	0.13	-	-	-	
Gizzard shad	1	0.01	-	-	1	0.01
Mixed fish *	1045	13.08	1640	13.73	1674	14.81
Shrimps	1523	19.07	1760	14.74	1475	13.05
Total	7988		11944		11305	

*Refer to the small sizes of unidentified fish species and unmarketable fish from various species which are landed together.

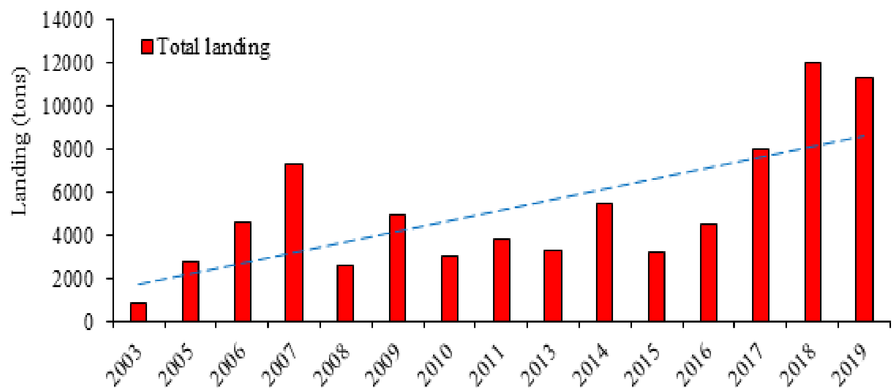

Figure 2. *Inter-annual trends in the total landing of Iraqi marine fisheries (2003-2019).*

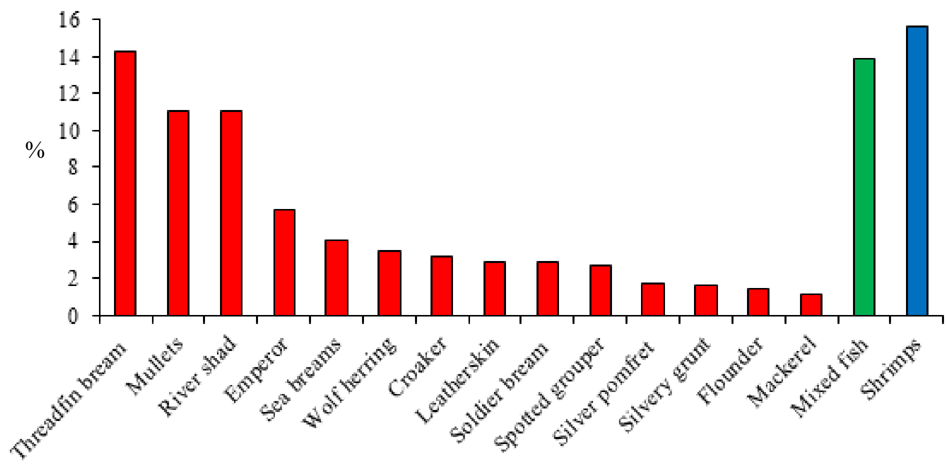

Figure 3. *Composition of Iraqi marine fisheries by species (2017-2019).*

At the time of the study, there were 320 registered fishing boats operated in Iraqi marine waters, of which 246 were made from steel (steel-hulled dhows), 67 from fiberglass and 7 from wooden motorized by 65 to 950 hp (Table 3). About 53.4% of the fishing boats (171 boats) with engines of 240 hp of which 152 steel, 17 fiberglass and 2 wooden boats, followed by 69 boats with engines of 120 hp and 35 boats with engines of 150 hp. However, there were 10 boats with engines from 825 to 950 hp. Further, about 64% of the fishing boats have engines greater than 240 hp. The artisanal marine fisheries are characterized by the use of several fishing gears include gill nets (drift and fixed), trawl nets (fish and shrimp), hand lines, and wire traps (Gargoor traps). Drift gillnets are dominant in inshore areas and especially for river shad species, mullets and pomfrets. Mohamed and Qasim (2014b) stated that 57% of the fishing boats in 2013 have engines between 15-120 hp and sizes of 6 to 30 m, whereas in the present study about 64% of the fishing boats have engines greater than 240 hp and sizes of 8 to 44 m. In general, the fishing gears and techniques used by fishermen in the marine fisheries along the investigated period did not differ from those previously described by other authors (Khayat, 1978; Ali *et al.*, 1998; Jawad, 2006; Mohamed and Qasim, 2014b).

The landing by species revealed that the most dominant species in the annual landings shifted from river shad, threadfin bream and mullets in 2017 towards threadfin bream, mullets and river shad in 2018 and towards mullets, threadfin bream and river shad in 2019 (Table 2). River shad was the most dominant landing species during 2017 (about 1687 t) contributed 21.1% of the total landings in this year, followed by threadfin bream (15.8%) and mullets (9.4%). In 2018, threadfin bream was the most significant landing species accounted for about 1920 t (16.1%) followed by mullets (10.6%) and river shad (6.2%). Conversely, mullets have predominated the landing during 2019 accounted for about 1439 t (12.7%) followed by threadfin bream (10.8%) and river shad (9.1%). However, shrimps contributed 19.1% of the total landings in 2017 and 14.7% in 2019, whereas mixed fish formed 13.1% in 2017 and 14.8% in 2019.

Figure 3 illustrated the most important species contributing ≥1.0% to the marine fisheries catches during 2017-2019. Threadfin bream made up 14.1% of the total landed, followed by river shad (11.1%) and mullets (11.1%). Moreover, shrimps and mixed fish contributed 15.2% and 14.0% of the total landings, respectively. The species landed by marine fisheries were arranged into fish groups and Figures 4-6 show the monthly landings for those fish groups contributed to ≥ 5% of the total landings during the investigation years. The total landings were subject to monthly and inter-annual variability where the highest landings varied from 1441 t in May 2017 to 1979 t in May 2018, whereas the lowest landings from 237 t in February 2017 to 478 t in April 2019 (Figure 4). There is an indication of a positive trend in the total landings during this study. Threadfin bream was the main species landed during the study period and caught throughout the year, but show a clear decreasing trend in its landings during the study (Table 2). The landing of threadfin bream ranged from 15 t in November to 200 t during March-May 2017, 70 t in December to 620 t in January 2018 and 60 t in November to 150 t in August 2019. The landings of threadfin bream show a clear declining trend in the study. River shad is commercially most important marine fish in Iraq and is anadromous fish, migrating up into the Shatt Al-Arab River during the breeding season which starts from March, therefore, it is clear from Figure 4 that the landing of this species exhibit a seasonal pattern starts in March each year. The river shad was the second most landed species in this study, its landings fluctuated from 2 t during January-March to 315 t in May 2017, while from 2 t in January to 275 t in May 2018 and from 1 t in February to 287 t in June 2019 (Figure 4). The landings of river shad display a clear declining trend in this study.

The monthly fluctuations in the landings of mullets, sea breams and emperor from 2017 to 2019 are demonstrated in Figure 5. Among mullets, *Planliza subviridis*, *P. carinata* and *P. klunzingeri* were the important representatives of this group. These are mostly marine or estuarine, landed by Iraqi fishermen throughout the year. The landings of mullets varied from 4 t in July to 154 t in January 2017 to 70 t in April 2019 to 178 t in August 2019. Among sea breams, *Acanthopagrus arabicus*, *A. berda*, *S. hasta* and *A. spinifer* were the representatives of this group. The lowest catches of sea breams ranged from 14 t in August 2017 to 30.5 t in July 2018, while the highest catches varied from 53 t in December 2017 to 266 t in December 2019 (Figure 5). The lowest landings of the emperor fluctuated from 8 t 10 t in July 2018 to 4 t in March 2019, while the highest landings ranged from 40 t in June 2017 to 250 t in May 2018 (Figure 5). There is an indication of positive trends in the mullets, sea breams and emperor landings along the investigated period. The monthly variations in landings of shrimps and mixed fish from 2017 to 2019 are illustrated in Figure 6. The landing of shrimps ranged from 47 to 207 t during 2017, 96 to 310 t during 2018, and 50 to 200 t during 2019. The mixed fish landing changed from 20 to 160 t in 2017, from 100 to 200 t in 2018, and from 100 to 180 t in 2019. There is a positive trend in the mixed fish catches during the study period, whereas a clear declining trend in the shrimps catches.

The biomass diversity "H_b" for the species in each year of landing are illustrated in Figure 7. The diversity varied from 1.14 in February to 2.6 in April during 2017, 2.26 in February to 3.72 in May during 2018 and 1.84 in April to 4.00 in December during 2019. The overall values of biomass diversity of the species ranged from 1.82 in 2017 to 2.85 in 2018, whereas 2.70 in 2019. The results also revealed a shift in dominant species over landings over time. Three fish species dominated total landings during the study period, but each species dominated during a specific year. So, the river shad prevailed in 2017 (21.1%), threadfin bream in 2018 (16.1%), mullets in 2019 (12.7%) and again threadfin bream dominated the overall period (14.1%). Mohamed (2018) stated that the most abundant species in the Iraqi marine fisheries from 2008 to 2016 were mullets, river shad and carangids constituted 22.1% 14.2% and 11.8%, respectively.

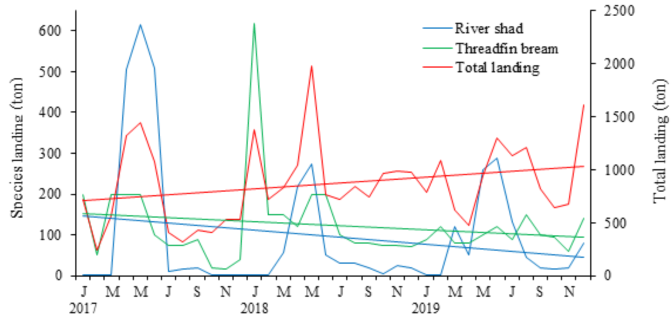

Figure 4. *The monthly variations in the total, threadfin bream and river shad landings.*

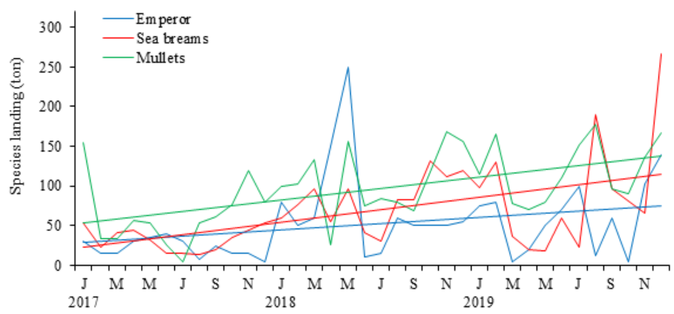

Figure 5. *The monthly fluctuations in the landings of mullets, sea breams and emperor.*

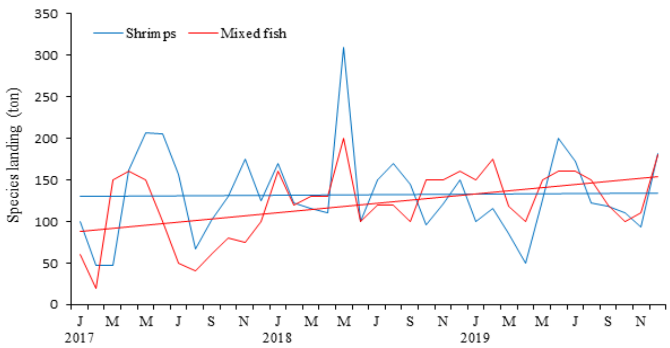

Figure 6. *The monthly variations in the landings of shrimps and mixed fish (2017-2019).*

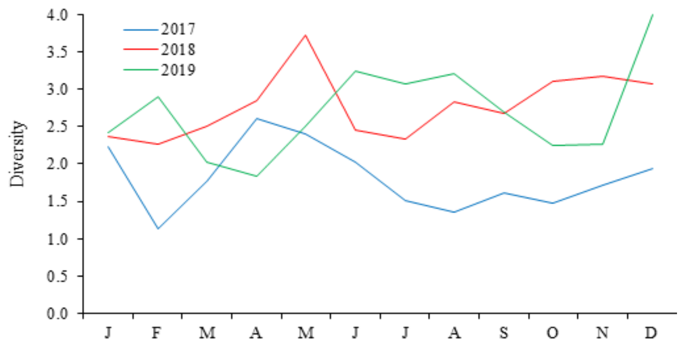

Figure 7. *The monthly variations in the biomass diversity (H_b) values of fish landings.*

The study showed increased trends in landings values for all fish groups except the river shad landings and to some extent threadfin bream during the current period. The landing of river shad compared to other resources still continuously decreasing throughout the years. Previously, this species had dominated the Iraqi marine fisheries for a long time, as it constituted 90% of total landings during 1965-1973 (Khayat, 1978), 52.9% during 1990-1994 (Ali *et al.*, 1998), 30.7% during 2000-2006 (Al-Dubakel, 2011) and 14.2% during 2008-2016 (Mohamed, 2018). Mohamed and Qasim (2014a) reported that the river shad landings were responsible for determining the general trend of Iraqi marine fisheries from 1965 to 2005. The abundance of river shad has fallen to the point where it was classified as threatened by the International Union for the Conservation of Nature and included on the Red List (Freyhof, 2014). This may be attributed to reduced flow of the Shatt Al-Arab River (a result of damming on the upper reaches of Tigris and Euphrates Rivers and the diverted of Karun River), extensive loss of marsh habitat, heavy exploitation of the species and the lack of the regulations to protect and manage the marine resources. The river shad stock in the north Arabian Gulf is certainly shared among Iraq, Iran and Kuwait (Morgan, 2006) and several studies revealed that the stock of river shad suffered from heavy exploited in the waters of these countries (Al-Baz and Grove, 1995; Al-Sabbagh and Dashti, 2009; Hashemi *et al.*, 2010; Roomiani and Jamili, 2011; Mohamed and Qasim, 2014c). Al-Husaini *et al.* (2015) reported that the river shad landings in Kuwaiti waters decreased from 1197 t in 1995 to 137 t in 2013, and their contributions from the total landings were declined from 17.05% in 1995 to 4.39% in 2013. The landing of threadfin bream exhibited suddenly rise from 21.3-565 t during 2008-2016 (Mohamed, 2018) to 1920 t in 2018 then dropped to 1225 t in 2019. This can be attributed to the targeted fishing by trawlers in the last years.

Mullets contributed to an average of 11.1% to the total catches in the present study and exhibited an increasing trend, their catch increased steadily from 753 t in 2017 to 1439 t in 2019. The average contribution of mullets to the catches reported by Ali *et al.* (1998) during 1990-1994 was 12.3%, while Mohamed (2018) found that mullets were the most dominant species during 2008-2016 constituted 22.1% of the total catches. The trend of sea breams landing increased gradually over the years from 391 t in 2017 to 1086 t in 2019. Their contribution in total catches also increased from 4.9% to 9.6%. However, Mohamed (2018) reported that the highest annual landing of sea breams during 2008-2016 was 150 t in 2014.

Emperor fish species contributed to an average of 6.4% to the total catches in the present study and revealed an increasing trend, their catch increased from 263 t in 2017 to 880 t in 2018. According to Mohamed (2018), during 2008-2016, emperor landing ranged from 5.9 t to 221 t. The trend of shrimps landing increased marginally over the years from 1523 t in 2017 to 1760 t in 2018. Their contribution in total catches also increased from 13.1% to 19.1% with an overall value of 15.2%. The shrimps landing increased in this decade as compared to 5.2 -131.7 t recorded by Ali *et al.* (1998) during 1990-1994, and 54.7-780.0 t documented by Mohamed (2018) during 2008-2016. The shrimp catch represented 25-45% of the total fishery landings from Kuwaiti waters (Chen *et al.*, 2013).

The Shatt Al-Arab River is the main source of freshwater, nutrients and fluvial inputs into the Iraqi marine waters, and this was impacted to a significant extent in the mid-late 1990s by the reduced flow of the Tigris and Euphrates Rivers, as a result of hydropower dams projects in the headwaters of the Tigris and Euphrates Rivers and their tributaries in Turkey, Syria, Iraq, and Iran (Partow, 2001), which the substantial reduction in water quality and quantity, and effective absence of the flood pulses (Garstecki and Amr, 2011), and later by diverted the flow of Karun River into Iranian terrene (Hameed and Aljorany 2011). The Karun River discharges about 52% monthly to the total discharge of the Shatt Al-Arab River into the Gulf (Albadran *et al*., 2016). 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 (Alaidani, 2014). The freshwater inflow has a strong impact on the biological, chemical and physical characteristics of estuaries which in turn affect the distribution and abundance of estuarine organisms, also can adversely impact commercially and recreationally important fisheries as many fish species utilize estuaries during a portion of their life (Scudder and Connelly, 1985, Nodo *et al*., 2017; Zhang and Zimba, 2017).

As a result of the reduction of discharge and deteriorated habitat several fish species have been impacted particularly the riverine migratory species. So, the river shad population in Iraqi waters was dropped to lower levels compared with the catches of the species during the seventieth of the last century. It is almost certain that annual fish migration and breeding will be disrupted due to the modification of downstream river flow regime by an impoundment through the loss of stimuli for migration, loss of migration routes and spawning grounds, decreased survival of eggs and juveniles, diminished food production (Salman, 1983, Larinier, 2001; van Puijenbroek *et al*., 2019). Accordingly, the fishermen have tended to catch other fish species to cover the cost of fishing trips and to keep their lives by developing the infrastructure and increasing the mechanized power of fishing boats, so the landing trends of other marine resources were steady increased during the last years.

Conclusion

The study revealed that the annual total landings increased by 270% during 2017-2019 as compared with the landings during 2008-2016. Threadfin bream was the main species landed, followed by river shad and mullets. The trends of the landings of all fish groups increased substantially, except river shad, threadfin bream and shrimps. The study suggests some management measures must be put into place especially for the river shad in the regions of their migration reproductive and the nursery such as restricted fishing areas, closed seasons, minimum size limits and legislation governing fishing.

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