Characterization of the Iraqi artisanal marine fisheries, northwest of the Arabian Gulf

ABSTRACT

The study described the characteristics of the Iraqi artisanal marine fisheries in the northwest Arabian Gulf between January 2020 and December 2021. The study aimed to update knowledge on the fish landings of the artisanal marine fisheries in the study area. A total of 19,877 t of fish were landed in 2020 and 13,784 t in 2021. A Student's *t*-test showed a significant difference between the species' landings over the two years. The main species exploited were mullets (10.5%), threadfin bream (10.4%) and spotted leatherskin (8.4%) in 2020, whereas threadfin bream (14.2%), mullets (9.6%) and tigertooth croaker (8.3%) were mainly landed in 2021. Unfortunately, the contribution of river shad catches has dropped to lower than levels over recent years, comprising 3.6-5.8% of the total landings during 2020-2021. Shrimps contributed 15.6 and 16.1% of the total landings during 2020 and 2021, respectively, and mixed fish contributed 11.8 and 15.3%, respectively. The trends of the landings of the main fish groups increased substantially from 2011 to 2021. Unfortunately, the contribution of river shad (*T. ilisha*) catches has dropped to lower levels over recent years, in contrast with the contributions of other species. Therefore, the study recommends the following management measures for the river shad stock: to protect the brood stock during the breeding season no fishing should be allowed in the Shatt Al-Arab River during the main spawning migration from May to June and small *T. ilisha* (<23.0 cm) should not be caught.

Keywords: Artisanal marine fisheries, shrimp landings, River shad, Arabian Gulf, Iraq.

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1. INTRODUCTION

The Iraqi marine waters are located at the northwestern tip of the Arabian Gulf. The Iraqi marine coastal area receives huge amounts of fluvial input via the Shatt Al-Arab River, which historically plays an important role in providing the northwestern Arabian Gulf with nutrient-rich freshwater [1]. The flow of the Shatt Al-Arab River into the Gulf supports the surface water flow direction towards the southwest, covering the northwestern edges of Kuwait Bay [2]. The region serves as a major spawning and nursery ground for several economically important marine species such as river shad, pomfret, mullets, shrimps, and other species. Generally, the average flow in the river was 70 m^3s^{-1}, and by 2009, the flow had decreased to 20 m^3s^{-1} due to the drought and upstream dams [3]. Decreased amounts of water from both Tigris and Euphrates rivers coupled with diverted discharge of Karun river inside the Iranian borders have allowed saltwater to move further upstream on the Shatt Al-Arab River, and without an increased flow of freshwater, this situation will worsen [4]. The yearly fish migration, spawning activity, recruitment, and hence, stock productivity will disrupt due to changes in the hydrological regime and marine environment that are associated with the freshwater flow system [5]. Jutagate *et al.* [6] stated that river engineering, such as dams, can adversely affect the fisheries in the region, both in terms of species compositions and fish yields.

The artisanal fishery or small-scale fishery is a traditional fishery involving both subsistence and commercial fishery, practiced by professional fisher folk directly, independently or in a household system, with their means of production or under a contractual partnership, using small vessels, making short fishing trips, close to shore, mainly for local consumption [7]. The Iraqi marine artisanal fishery sector has a longstanding tradition and includes a multi-species, multi-gear fishery directed towards various demersal and pelagic fish species. The fishing gears include drift and fixed gill nets, trawl nets, hand lines, traps (gargoor) and stake nets (hadra). Drift gillnets are dominant in inshore areas and especially for river shad, mullets and pomfret [8].

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Khayat [9] introduced a comprehensive socio-economic study of fish resources in Iraq and documented the marine artisanal and industrial landings from 1965 to 1973. Since that, several works have been published about fish landings or marketing at the main fish landing at Al-Fao port [10-12, 8, 13-15].

The main objectives of the present study are to describe the species composition, species and total landings and the general trends of species catches of the Iraqi artisanal marine fisheries during 2020 and 2021 to derive requisite information for the sustainable management of the fisheries, especially the river shad fishery.

2. MATERIALS AND METHODS

2.1 Study area

The study was carried out in the Iraqi marine waters, the northwestern Arabian Gulf. Despite the short Iraqi coastline of 105 km, the continental shelf of 1034 km^2 and the territorial sea of 716 km^2 [16], the region is considered the most productive area in the Gulf due to running off the Shatt Al-Arab River [17]. Draining to the northern Arabian Gulf is also Khor Al-Zubair estuary which is a semi-land locked tongue extending from Khor Abdullah northward (Fig. 1). The surface water temperature values during 2018 ranged from 12.5°C in January to 33.5°C in August, and salinity varied from 28.1 to 47.3‰ [18]. The substratum of this region differs from the other parts of the Gulf, due to terrigenous sediments brought by the river. The sediments are mostly composed of fine mud consisting of 55% silt, 26% clay and 19% sand [18].

Figure 1 illustrates the main fishing grounds for the Iraqi artisanal marine fisheries, including the Shatt Al-Arab estuary, Khor Abdulla and Khor Al-Amaya [19]. The 64% of fishing boats have engines greater than 240 hp, though recently the tendency was toward a higher engine power per fishing vessel [14]. Al-Fao port is the main center of landing and auction of Iraqi marine resources located on the tip of the northwest Arabian Gulf.

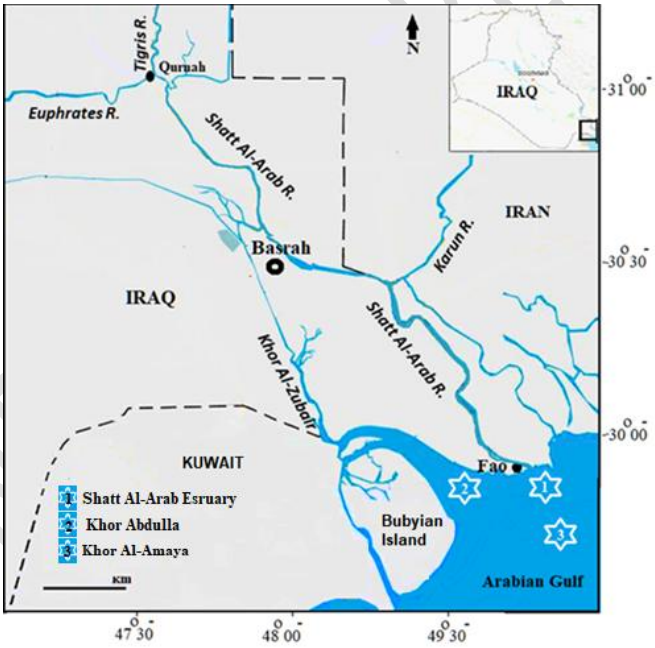

Fig. 1. Fishing areas in the Iraqi marine waters, northwest Arabian Gulf.

2.2 Data analysis

The data for this study were sourced from the daily raw data about the total and species landings at the Al-Fao port, south of Basrah, which were documented by the Basrah Agriculture Directorate for the period January 2020 to December 2021. Fish species were identified according to Fischer and Bianchi [20] and Carpenter *et al.* [21] and updated according to Fricke *et al.* [22]. Historical information about annual landings of the artisanal fishery provided in this paper was derived essentially from reviews of the

literature [9-10, 12, 8, 13-14]. These data were analyzed statistically through descriptive statistics and included in numerical results using Microsoft Excel 2010. The relative abundance (% by biomass) of each species was calculated according to the formula of Krebs [23]: Relative biomass (%)= $(W_i/W)*100$, where W_i is the total weight of fish the i^{th} species landed and W is the total weight of all the fish landed.

The similarity level between landing years (according to the weight per cent of each species) has been estimated using Morisita's index [24]: $C\lambda\% = 2\Sigma X_i Y_i / \Sigma X^2_i + \Sigma Y^2_i$, where Cλ is the similarity level, X_i and Y_i the weight per cent of ith species in each year of landing.

The difference in the total monthly catches of all species between 2020 and 2021 was analyzed using a t-test analysis. A trend line (technical analysis) within the linear regression analysis was engaged to demonstrate the general direction and describe the pattern of the landing of each fish species using Microsoft Excel 2010.

3. Results

The overall number of fish species caught by Iraqi artisanal marine fisheries during 2020-2021 was 33, belonging to 16 families (Table 1). Unmarketable fish from various small species were regarded as a single group, named mixed fish.

Table 1. Fish species caught in the Iraqi artisanal marine fisheries (2020-2021).

Family	English name	Scientific name
Nemipteridae	Threadfin bream	*Nemipterus japonicas*
Mugilidae	Mullets	*Planiliza subviridis, P. carinata, P. klunzingeri*
Lethrinidae	Emperor	*Lethrinus nebulosus*
Carangidae	Spotted leatherskin & Black pomfret	*Scomberoides commersonianus, Parastromateus niger*
Sciaenidae	Croakers	*Otolithes ruber, Johnius maculates, J. sina, Johnieops belangerii*
Sparidae	Seabreams	*Acanthopagrus arabicus, A. berda, Sparidientex hasta, Argyrops spinifer*
	River shad	*Tenualosa ilisha*
Clupeidae	Gizzard shad	*Nematolosa nasus*
Epinephildae	Spotted groupers	*Epinephelus tauvina, E. areolatus*
Stromateidae	Silver pomfret	*Pampus argenteus*
Pomadasyidae	Silvery grunts	*Scolopsis phaeops, Plectorhinchus schotaf, Pomadasys argentius*
Chirocentridae	Wolf herring	*Chirocentrus dorab, C. nudus*
Bothidae	Largetooth flounder	*Bothus pantherinus*
Cynoglossidae	Largescale tonguesole	*Cynoglossus arel*
Platycephalidae	Indian flathead	*Platycephalus indicus, Gramolites scaber*
Scombridae	Spanish mackerel	*Scomberomorus commerson, S. guttatus*
Penaeidae	Green tiger prawn	*Penaeus semisulcatus*
	Jinga shrimp	*Metapenaeus affinis*

The highest total landing was 19,877 t in 2020, and 1364 t in 2021 (Fig. 2). The landing by species revealed that the most dominant species in the annual landings shifted from mullets (2,082 t), threadfin bream (2,075 t) and spotted leatherskin (1,673 t) during 2020 to threadfin bream (1,950 t), mullets (1,321 t) and tigertooth croaker (1,137 t) during 2021. Shrimp landings during 2020 and 2021 were 3,107 and 2,221 t, respectively, whereas mixed fish were 2,340 and 2,105, respectively.

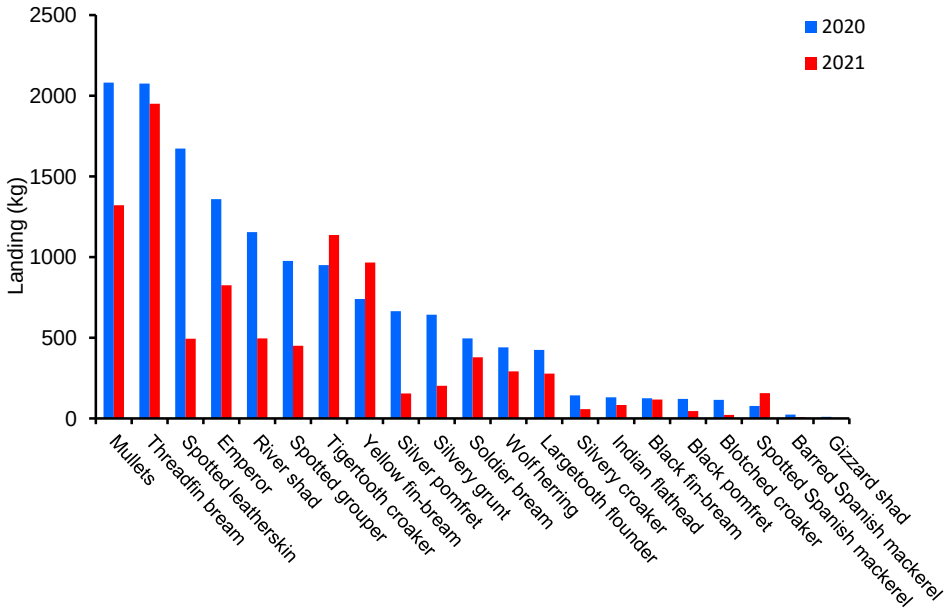

Fig. 2. Fish species landings of the Iraqi marine fisheries during 2020-2021.

The result of the t-test indicated a significant difference in the total monthly catches of all species between 2020 and 2021 (t= 2.289, n-2= 22, P> 0.05). Conversely, the Morisita index showed that dispersal distribution patterns of species landed during 2020 and 2021 was uniform (Cλ= 95.1).

The five most dominant species were mullets, threadfin bream, spotted leatherskin, emperor and river shad constituting 10.5, 10.4, 8.4, 6.8 and 5.8%, respectively of the total landing in 2020 (Fig. 3), while threadfin bream, mullets, tigertooth croaker, yellow fin-bream and emperor formed 14.2, 9.6, 8.3, 7.0 and 6.0%, respectively in 2021 (Fig. 3). Shrimps contributed 15.6 and 16.1% of the total landings during 2020 and 2021, respectively, and mixed fish contributed 11.8 and 15.3%, respectively.

The landings of total species, threadfin bream and mullets are explained in figure 4. The total landings were subject to monthly fluctuations in both years when the landings varied between 926 t in March and 3070 t in May 2020 with an average of 1656.6 t, while ranging from 517 t in April to 2263 t in March 2021 with an average of 1149.9 t (Fig. 4). There was an indication of a negative trend in the total landings during the study period (slope of the regression line (b)= -35.1). The lowest landings of threadfin bream occurred in April with 120 t in 2020 and 100 t in 2021, while the highest catches happened in December 2020 with 250 t and in March 2021 with 300 t. The landings of threadfin bream show an increasing trend during the study period (b= 0.12). The landings of mullets fluctuated from 61 t in April to 307 t in November 2020, whereas from 3 t in August to 217 t in January 2021. The catches of mullets show a clear declining trend during 2020-2021(b= -3.15).

The lowest landings of river shad happened in February with 3 t in 2020 and 1 t in 2021, while the highest landings occurred in May with 257 t in 2020 and 158 t in 2021 (Fig. 5). The landings of this species exhibited a clear declining trend from 2020 to 2021(b= -3.25). The landings of shrimps varied from 61 t in February to 532 t in October 2020 and from 120 t in April to 272 t in May 2021. The shrimps' landings displayed a clear declining trend from 2020 to 2021 (b= -3.98). The mixed fish landings changed from 135t

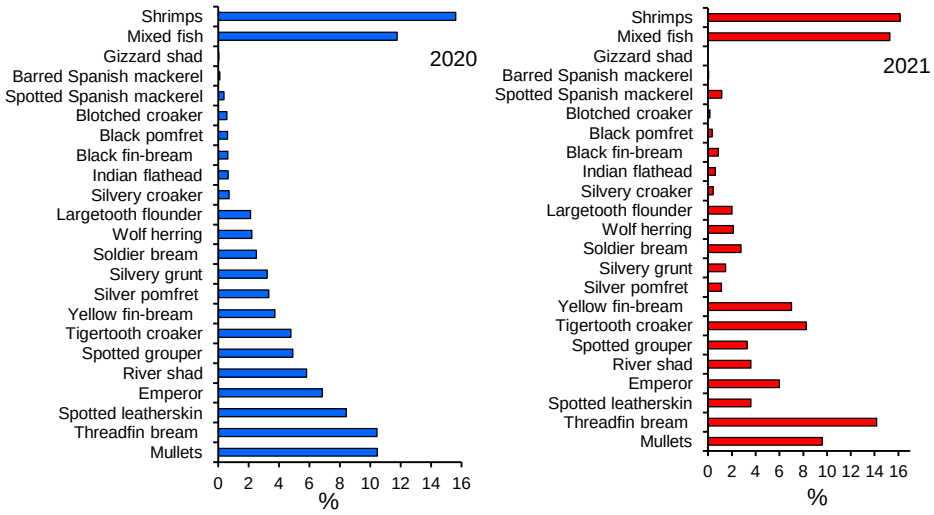

Fig. 3. The percentage contribution of each species from the total landing during 2020-2021.

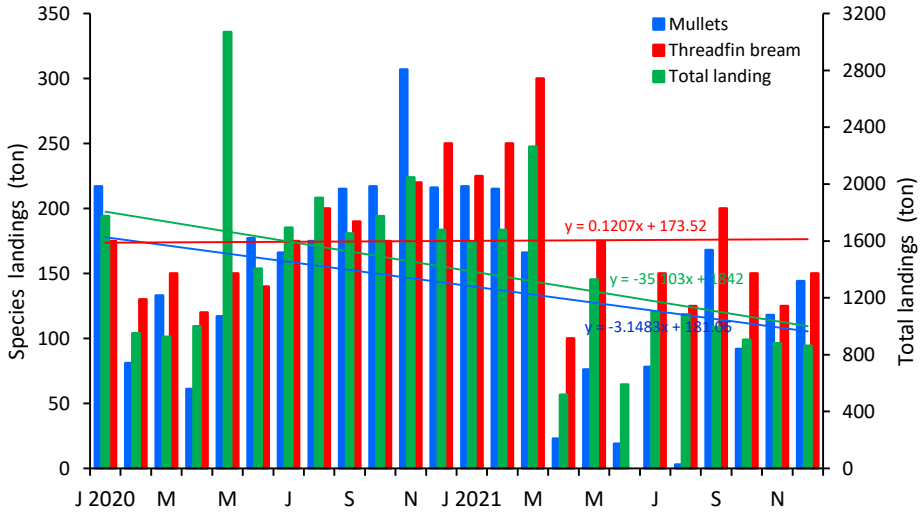

Fig. 4. The monthly variations in the total, threadfin bream and mullet landings with their trend lines in Iraqi marine fisheries from 2020 to 2021.

in March to 251 t in November 2020 and from 100 t in April to 251 t in May 2021. There was a positive trend in the mixed fish catches during the study period (b= 0.42).

The landings of the emperor varied from 60 t in March to 200 t in May 2020, and from 2 t in April to 150 t in August 2021 (Fig. 6). The catches of the emperor display a clear declining trend during 2020-2021(b= -2.41). The landings of tigertooth croaker ranged from 29 t in March to 134 t in December 2020 and from 10 t in April to 610 t in March 2021 (Fig. 6). The landings of tigertooth croaker show a clear declining trend during 2020-2021(b= -1.34). The landings of sea breams fluctuated from 75 t in January to 298 t in May 2020, whereas from 19 t in April to 557 t in March 2021. The landings of sea breams demonstrate a clear declining trend during 2020-2021(b= -1.86). The landings of spotted leatherskin varied from 33 t in March to 400 t in May 2020 and from 1 t in April to 100 t in January 2021 (Fig. 6). The catches of spotted leatherskin show a clear decreasing trend during 2020-2021(b= -6.23).

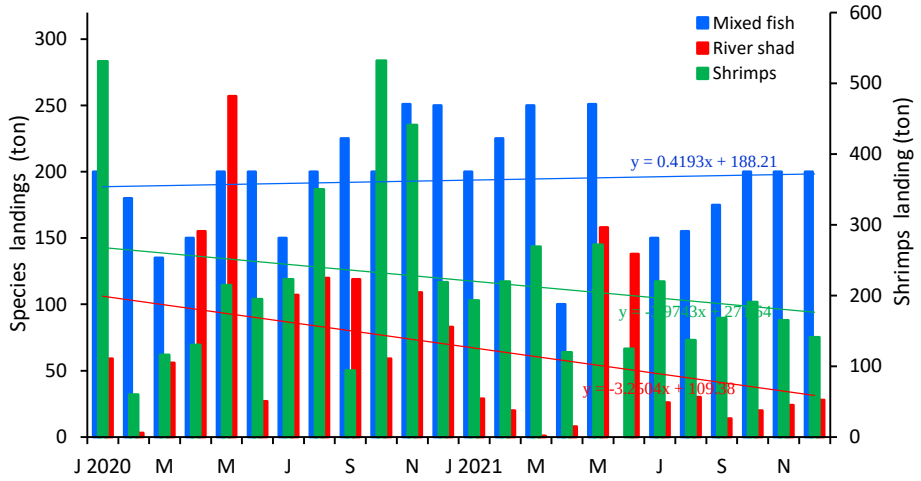

Fig. 5. The monthly fluctuations in the landings of river shad, shrimps and mixed fish with their trend lines in Iraqi marine fisheries from 2020 to 2021.

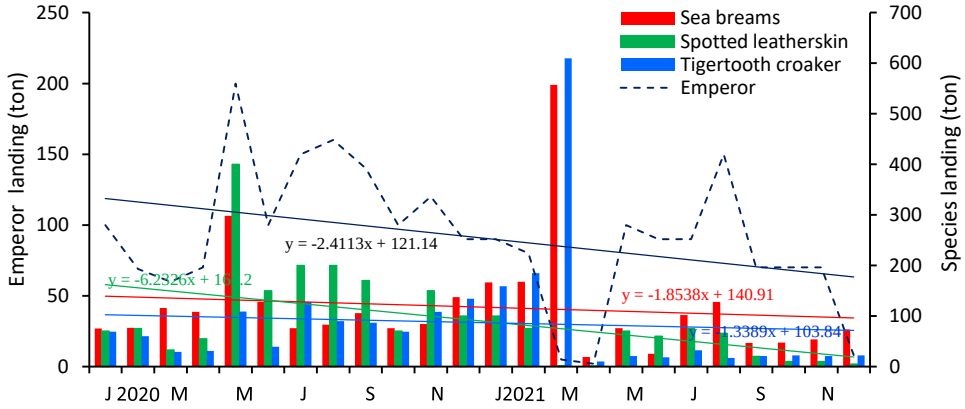

Fig. 6. The monthly variations in the landings of the emperor, tigertooth croaker, sea breams and spotted leatherskin with their trend lines in Iraqi marine fisheries from 2020 to 2021.

4. DISCUSSION

During the present study, the multi-species nature of the Iraqi marine artisanal fishery was well demonstrated by the high diversity of species caught consisting of various fish species and shrimps. Despite the large number of the species caught during the study period, the overall catch was dominated by seven species groups, namely threadfin bream, spotted leatherskin, tigertooth croaker, sea breams, river shad, emperor and shrimps. These findings are typical for Iraqi marine fisheries and confirm the previous results of other authors [10, 8, 13-14].

The exact state of fish stocks in Iraqi marine waters was unknown. The trend analysis in this study may still indicate the need for management measures to sustain fishing activities in the long term. The successions of published papers about the marine artisanal fisheries of Iraq for the period 2011-2021 [18, 14] as well the current results are not enough for a maximum sustainable yield (MSY) analysis. It was decided instead to study the trends in species landings during this period to provide a comprehensive overview of the fishery.

It was clear from Figure 7 that despite the landing in 2021 was less than in 2020, the overall yearly trend in the total landings increased obviously toward the present years. Also, this steady increase in the total landings was associated with the rise in the catches of all fish groups under exploitation. According to Mohamed and Abood [14], these increases in the total landings of the species from Iraqi marine waters may be attributed to the development of infrastructure, the upgrading of navigation technology and the increasing mechanized power of fishing boats. Generally, the fishing effort (number of registered fishing boats) in the present study was higher than that stated by Mohamed and Abood [14], in which 320 registered fishing boats operated in Iraqi marine waters during 2017-2019.

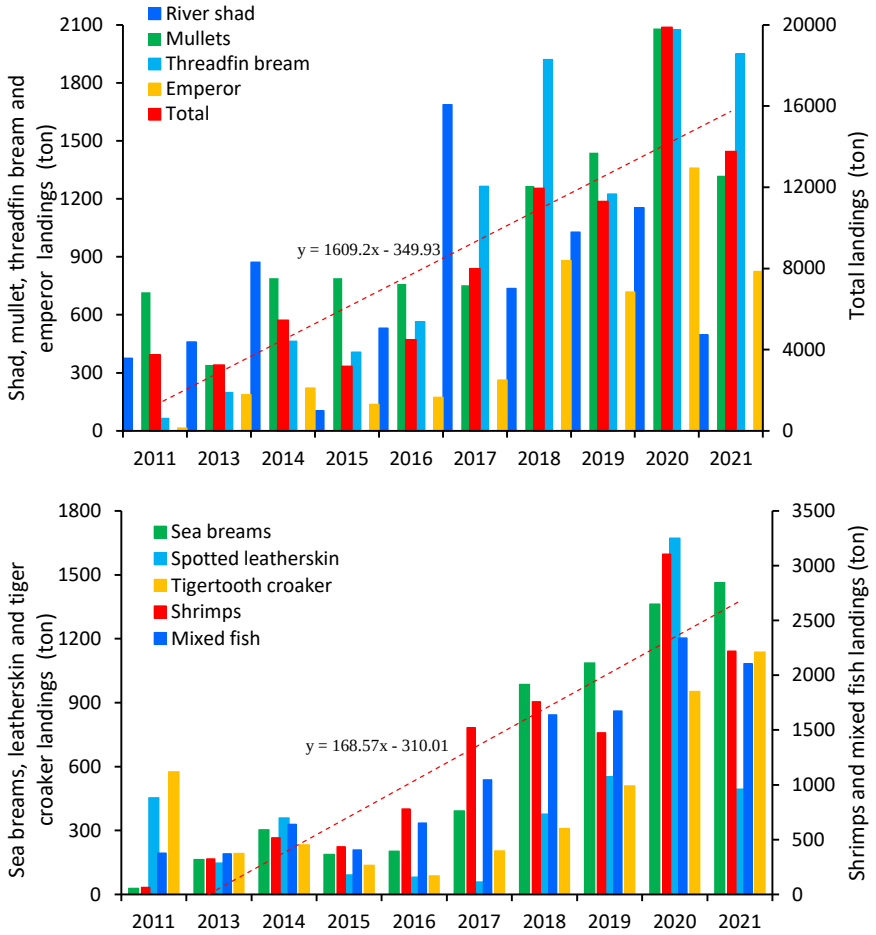

Fig. 7. A comparison between the species' landings by artisanal marine fisheries of Iraq from 2011 to 2021.

The study revealed a shift in dominant fish species over landings over time (Table 2). The three most dominant fish species during 2020 were mullets, threadfin bream and spotted leatherskin, whereas threadfin bream, mullets and tigertooth croaker in the second year. According to Mohamed and Qasim [8], the most landed species during 2007 were tigertooth croaker, river shad and wolf herring, whereas, river shad, mullet and wolf herring during 2008, and mullet, river shad and spotted leatherskin during 2009. Mohamed and Jawad [15] stated that the most abundant species in Iraqi marine fisheries during 2011 were mullets, croakers and carangids, while river shad, mullet and threadfin bream were during 2014, by contrast, threadfin bream, mullet and river shad during 2016. Mohamed and Abood [14] (2020) found that

Table 2. The dominant fish species (%) in the landings of Iraqi marine fisheries over time.

	Species (%)						
Year	Mullets	River shad	Threadfin bream	Leather skin	Croakers	Wolf herring	Reference
2007	-	18.2	-	-	21.7	14.9	Mohamed and Qasim (2014)
2008	16.2	24.3	-	-	-	10.4	=
2009	37.2	14.6	-	11.4	-	-	=
2011	22.6	-	-	-	18.1	-	Mohamed and Jawad (2021)
2014	14.5	16.0	11.3	-	-	-	=
2016	17.0	11.9	18.8	-	-	-	=
2018	10.6	6.2	16.1	-	-	-	Mohamed and Abood (2020)
2020	10.5	-	10.4	8.4	-	-	Present study
2021	9.6	-	14.2	-	8.3	-	=

the threadfin bream made up 16.1% of the total landings during 2018, followed by mullets (10.6%) and river shad (6.2%).

Unfortunately, the contribution of river shad catches has dropped to lower levels over recent years, in contrast with the contributions of other species such as threadfin bream, mullets, emperor, spotted leatherskin, tigertooth croaker and sea breams which have improved considerably. We have reviewed both the old and recent findings on the river shad fishery in Iraq to document the status of the knowledge and the potential gaps necessary to comprehend for formulating a more effective fishery management plan. Previously, the river shad had dominated the Iraqi marine fisheries for a long time and was responsible for determining the general trend of this fishery during 1965-2005, Fig. 8 [8]. It constituted 90.2% of total landings during 1965-1973 [9], 52.9% during 1990-1994 [10], 51.0% during 1995-1999 [8], 30.7% during 2000-2006 [12], 16.9% during 2007-2011 [8], 14.2% during 2008-2016 [13], 11.1% during 2017-2019 [14] and 4.9% in the current study.

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As a result of the reduction of river shad (Fig. 8) in Iraqi marine waters, the fishers have tended to capture other fish species to cover the cost of fishing trips and to make a living, for this reason, the landings of other species increased steadily. Several possible reasons that may have contributed to the decline in the river shad landings over recent years are such as the great drop in the discharge rate of the Shatt Al-Arab River, overfishing, indiscriminate harvesting of broods in migration routes and juveniles, use of fishing nets with small mesh sizes and degradation of habitats [8,14].

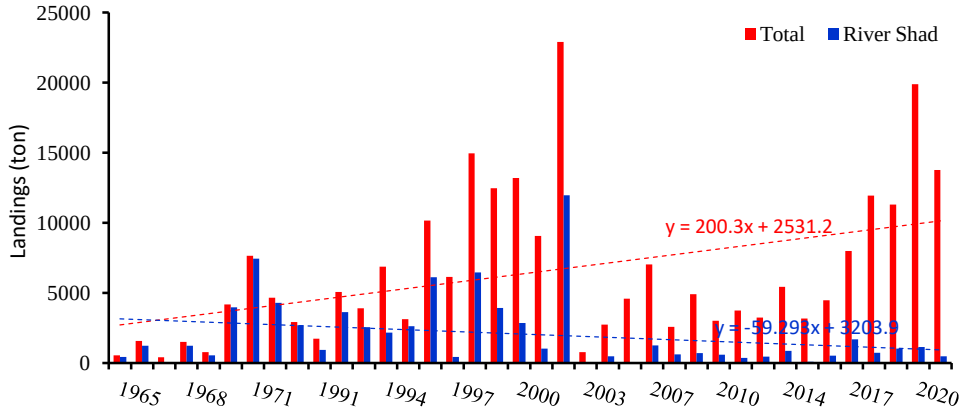

Fig. 8. Annual fluctuations in total and shad landings by Iraqi marine fisheries from 2011 to 2021.

River shad are widely distributed in the northwest Arabian Gulf and certainly shared among Iraq, Kuwait and Iran [11]. Therefore, any actions on this stock by any country's fleet may affect the landings in other countries [25]. Several studies indicated that the species harvested in large quantities and the catches declined seriously over the past decades in these countries. The information about the status of river shad in Kuwaiti and Iranian waters indicated that the stock suffered from heavy exploitation [26-29]. 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 [30].

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Alqattan *et al.* [31] stated that fish production in Kuwaiti waters increased from 1983 onwards until it reached a peak in 1995 of 8,500 t, but later gradually declined (with a few temporary spikes) to an average of between 4,000-5,000 t, the density of nine fish stocks declined by 53% between 2013 and 2014, and the decline was particularly severe in two main species: an 87% decline in river shad production and an 85% decline in silver pomfret production. The main causes of declining stocks in Kuwaiti waters were overfishing, pollution from factories, the discharge of sewage directly into the sea and the high levels of salinity caused by the construction of several large dams in the neighboring countries of Iraq, which have greatly reduced the amount of fresh water pouring into the Arabian Gulf through Shat Al-Arab River [31, 1, 32].

4. CONCLUSIONS

The river shad dominated the Iraqi marine fisheries for a long time and was responsible for determining the general trend of this fishery, but its contributions declined to lower levels over the recent years, whereas the contributions of other species improved considerably. There was a general agreement that multispecies fisheries should be managed through regulations, such as catch quotas and minimum legal-size limits to avoid the species targeted being overexploited [26, 28, 29, 33].

Comment [WU5]: Explain about different of it

Consequently, the study proposes the following administrative points to preserve the river shad stock at least in the migration routes and nursery areas, such as the establishment of the closed areas (Shatt Al-Arab River and Sindbad Island) and season (May-June), minimum size limit (more than 25 cm long), reduction of pollution in the Shatt Al-Arab and the regional coordination in the management of water systems and fisheries resources.

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