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Ecological Health Assessment of the Shatt Al-Arab River, Iraq

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Abstract: *The Shatt Al-Arab River suffered from deterioration in water quality due to seawater intrusion as a result of the decline in rate of discharge of freshwater during the recent years. Therefore, the ecological status of the river was evaluated by applying Fish Index of Biotic Integrity (F-IBI) during the period from November 2015 to October 2016. Fish were sampled monthly by different fishing gears from three sites on the river. The overall values of salinity in these sites were 1.2, 2.5 and 9.1‰, respectively. A total 111 fish species belonging to 50 families were collected, 15 of them were native, 13 exotic and 83 marine species. F-IBI scores were calculated from 16 separate assemblage metrics based on the species richness, species composition and trophic groups. Therefore, the F-IBI values showed clear longitudinal gradient in the river, its ecological health ranged from poor in the upper reaches to fair in the middle and lower reaches.*

Keywords: *F-IBI, ecological health, fish assemblage, Shatt Al-Arab River, Iraq*

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I. Introduction

Karr and Dudley (1981) mentioned that the Fish Index of Biotic Integrity (F-IBI) provides a tool for quantifying changes in ecosystem health as a result of habitat degradation or flow alteration, in addition to chronically poor chemical water quality.

Shatt Al-Arab River which originates from the confluence of Tigris and Euphrates rivers is the main surface water source in the region and serves around 3 million people, the majority living in Basra city. The river is widely used for human consumption, agricultural, trade and industrial activities, transportation, electric power plants and recreation. The main agricultural lands extend along the river banks with large date palm plantations.

The Shatt Al-Arab River suffered from massive regression in water quality related to the decline in rates of discharge from the Tigris and the Euphrates Rivers (Al-Mahmood *et al*., 2015) as a result of several hydrological projects constructed in the riparian countries (Partow, 2001), and the diversion of the Karun River into Iranian terrene (Hameed and Aljorany, 2011). 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 decreases of freshwater inflows into the estuary have allowed the saltwater to intrude about 80 km upstream the river mouth (Abdullah *et al.*, 2016). A decrease of river discharge into an estuary could increase the tidal range and the wave celerity, and consequent increase in salinity levels (Cai *et al*., 2012). The alteration of water discharge in the Shatt al-Arab River and the saltwater intrusion further upstream have been discussed by several authors (Al-Tawash, *et al.*, 2013; Hameed, *et al*., 2013; Yaseen, *et al*., 2016). Also, many channels are branched from Shatt Al-Arab pass through cultivated farmlands and carry huge amount of agricultural runoff wastes and untreated wastewater towards Shatt Al-Arab River (Eassa *et al.*, 2015). Several studies have been supportive of the deterioration of the Shatt al-Arab water quality under these conditions (Al-Tawash *et al.*, 2013; Brandimarte *et al*., 2015; Moyel and Hussain, 2015; Yaseen *et al*., 2016).

Other research efforts have been directed toward the fish assemblage structure in the Shatt Al-Arab River (Mohamed *et al.*, 2012a, 2015; Mohamed and Abood, 2017). However, there is no specific work is dealing with the fish index of biotic integrity (F-IBI) in the entire of the Shatt Al-Arab River. The aim of this work is to evaluate the ecological health of the fish assemblage in the Shatt Al-Arab River by applying the multimetric fish Index of Biotic Integrity (F-IBI).

II. Materials and Methods

The Shatt Al-Arab River forms from the confluence of the Tigris and Euphrates rivers at Al-Qurna town northern Basra Governorate, and flows to southeastern direction towards the Arabian Gulf (Fig. 1). It is about 204 km, and varies in width from 250 m at Al-Qurna to more than 1,500 m at the estuary. The River is affected by the tidal current of the Gulf (Al-Lami, 2009). Samples were collected monthly from the three sites on the river during November 2015- October 2016. Site 1 (upstream) is located near Al-Dair Bridge, site 2 (midstream) is sited in Abu Al-Khasib district and site 3 (downstream) is located north Al-Fao town (Fig. 1).

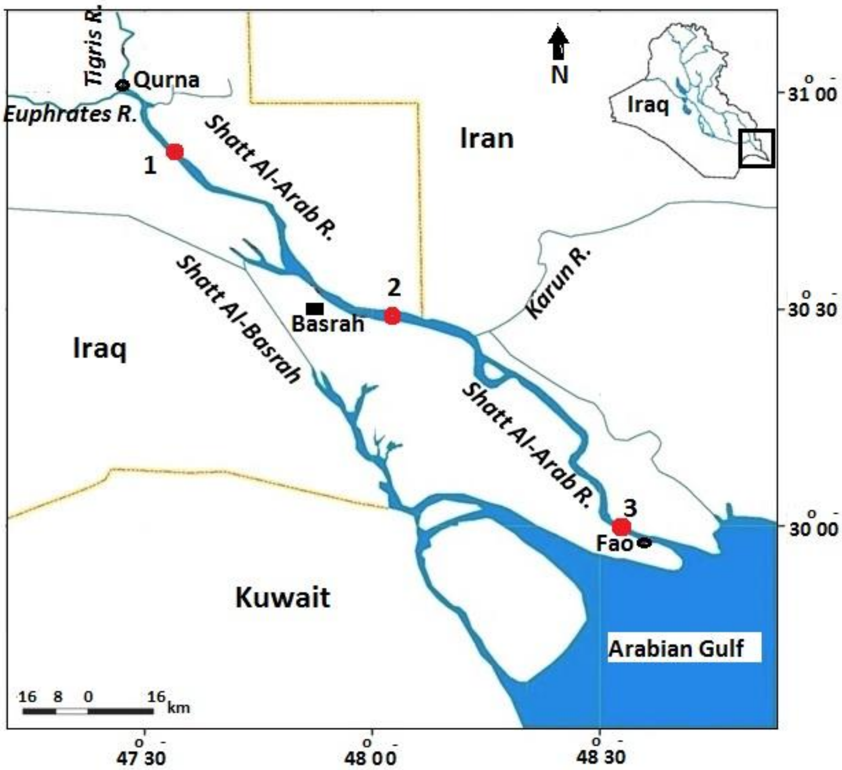

Fig. 1. Map of Shatt Al-Arab with locations of study sites.

Fish samples were regularly collected from each site by using gill nets (200 m length with 15- 35 mm mesh size), cast net (9 m diameter with 15x15 mm mesh size) and electro-fishing by generator engine (provides 300-400V and 10A). Fishes were counted and classified to species following Carpenter *et al.* (1997) and Coad (2016). Water temperature and salinity were measured *in situ* using WTW portable instrument model 556 MPS. The monthly rates of discharge in the upstream of the Shatt Al-Arab River were obtained from Water Resources Directorate in Basrah. Fish samples from different species were preserved in a formalin solution (10%) for diets analysis. Various analytical methods were used to analyze stomach contents of the species (Windell and Bowen, 1978).

To each fish species, geographic origin (native or marine or exotic), trophic guilds and environmental degradation tolerance were assigned by using a variety of references (Mohamed *et al.*, 2012; Coad, 2016; Mohamed and Hussain, 2012a, b) and professional judgment.

Sixteen metrics were chosen to calculate the fish integrated biological index depending on species richness, species composition and trophic guilds, most them already applied successfully in other studies (Karr, 1981; Minns *et al.*, 1994; Belpaire *et al.,* 2000; Younis *et al.*, 2010; Mohamed and Hussain, 2012a; Mohamed *et al.*, 2012b).We standardized metrics to score from 0 to 10 by using a technique similar to Minns *et al*. (1994) that was based on threshold limits and a linear equation. IBI scores are rated as very poor (0-20), poor (20-40), fair (40-60), good (60-80) and excellent (>80) (Minns *et al.* 1994). The species richness index (D) is defined by (Margalef, 1968): D= S-1 / loge N, where, S= number of species and N= number of individuals. All statistical computations were made using SPSS software (ver. 16) statistical package.

III. Results

Ecological factors

Monthly changes in water temperature, salinity and discharge rate in the three sites Shatt Al-Arab River are presented in Figure 2. Values of water temperature varied from 13.6^{o}C in January to 34.5^{o}C in July in site 1, from 14.1 ^{o}C in January to 34.6^{o}C in August in site 2 and from 12.3 ^{o}C in January to 35.3 ^{o}C in August in site 3.

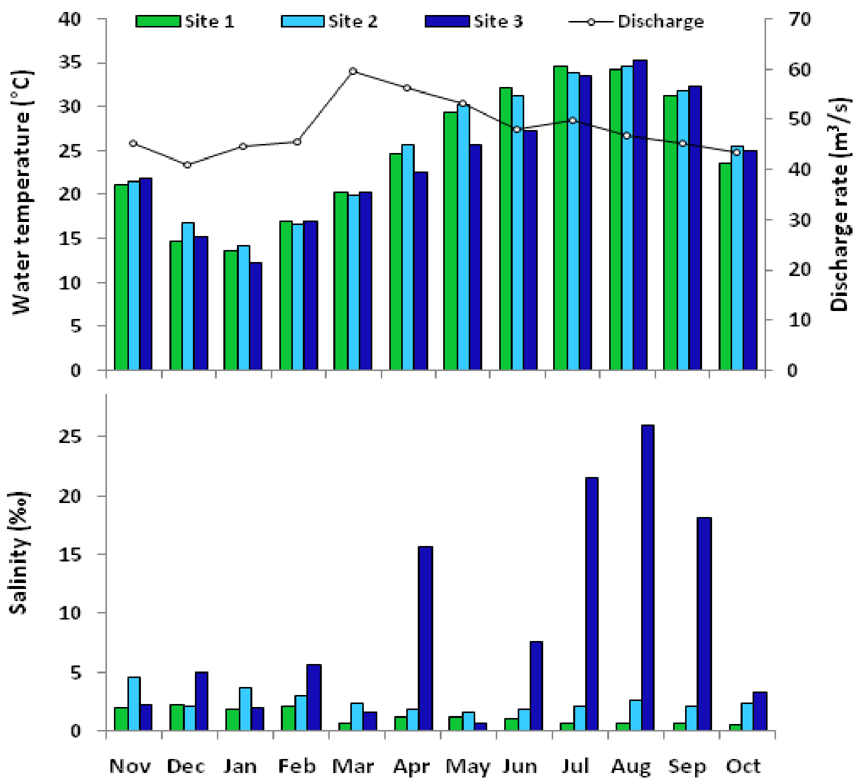

Fig. 2. Monthly variations in some ecological factors of Shatt Al-Arab River

Variations among sites in water temperature were insignificant differences (F= 0.74, P>0.05). The discharge rate in the Shatt Al-Arab River varied from 40.88m³/s in December to 59.75m³/s in March, with overall value was 48.25m³/s. Salinity values fluctuated from 0.5‰ in October to 2.2‰ in December in site 1, and in site 2 from 1.6‰ in May to 4.6‰ in November, whereas in site 3 from 0.6‰ in May to 25.9‰ in August. Significant differences in salinity (F= 8.08, P>0.05) was detected between sites. The overall values of salinity in the three sites were 1.2, 2.5 and 9.1‰, respectively.

Fish assemblage structure

The fish species were arranged according to families, stations, geographic origin, trophic guilds and environmental degradation tolerance (Tables 1 and 2). During the study, 95,347 fish comprising 50 families, 88 genera and 111 species of bony and cartilaginous fish were captured from the Shatt Al-Arab River. One hundred and eight bony species were composed, 15 of them were native, 83 marine and 13 exotic species. Numerically the most abundant family in the Shatt Al-Arab River was Mugilidae represented by 27.9% of the total individual followed by Cichlidae with 21.3% and Cyprinidae with 21.1%. Taxonomically, the most abundant family in the river was Cyprinidae which was represented by 17 species followed by Carangidae by 9 species and Sciaenidae by 6 species. The silver crucian carp, *Carassius auratus* was the most abundant species constituting 13.24% of the total numbers followed by the blue tilapia, *Oreochromis aureus* (12.58%) and the Klunzinger's mullet, *Planiliza klunzingeri* (10.56%).

Forty five fish species were collected from site 1, 14 of them were native, 12 exotic and 19 marine species. *C. auratus* was the most abundant species comprising 21.48% of the total catch, followed by *O. aureus* (19.52%) and *P.* a*bu* (18.99%). A total of 51 fish species were collected from site 2, including 11 native, 11 exotic and 29 marine species. *C. auratus* was the most abundant species in this site, comprised 19.74% of the total catch, followed by *O. aureus* 19.33% and *C. zillii* 12.42%. The fish fauna in site 3 was comprised of one native, four exotic and 82 marine species. *P. klunzingeri*, *Planiliza subviridis*, and *Tenualosa ilisha* were most abundant species in site 3, comprising 17.40%, 12.79%, and 11.55% of the total catch, respectively.

Table 1. Relative abundance (%) of marine species caught in the Shatt Al-Arab River (1, 2, 3= Sites, H= Herbivore, O= Omnivore, C= Carnivore, D= Detritivore, T= Tolerant, S= Sensitive)

Family	Marine species	%	Family	Marine species	%
Mugilidae	*Planiliza klunzingeri* [1-3,D,T]	10.56	Sillaginidae	*Sillago attenuata* [1-3,C,T]	0.008
Clupeidae	*Tenualosa ilisha* [1-3,O,T]	6.553	Dussumieriidae	*Dussumieria acuta* [3,C,T]	0.008
Mugilidae	*Planiliza subviridis* [1-3,D,T]	6.087	Carangidae	*Rastrelliger kanagurta* [3,C,T]	0.007
Sparidae	*Acanthopagrus arabicus* [1-3,C,T]	4.182	Sphyraenidae	*Sphyraena obtusata* [3,C,T]	0.006
Sciaenidae	*Johnius dussumieri* [2,3,C,T]	3.775	Haemulidae	*Pomadasys kaakan* [3,C,T]	0.005
Engraulidae	*Thryssa whiteheadi* [1-3,C,T]	2.878	Nemipteridae	*Scolopsis taeniata* [3,C,T]	0.005
Mugilidae	*Osteomugil speigleri* [3,D,T]	2.311	Gerreidae	*Gerres macracanthus* [3,C,T]	0.004
Sciaenidae	*Johnius belangerii* [2,3,C,T]	2.213	Soleidae	*Solea elongate* [3,C,T]	0.004
Clupeidae	*Nematalosa nasus* [1-3,O,T]	2.201	Mullidae	*Upeneus sundaicus* [3,C,T]	0.004
Engraulidae	*Thryssa vetrirostris* [1-3,C,T]	1.775	Serranidae	*Epinephelus coioides* [3,C,T]	0.004
Pristigasteridae	*Ilisha melastoma* [2,3,C,T]	1.495	Plotosidae	*Plotosus lineatus* [3,C,T]	0.004
Sillaginidae	*Sillago sihama* [1-3, C,T]	1.154	Carangidae	*Parastromateus niger* [3,C,T]	0.003
Pristigasteridae	*Ilisha compressa* [2,3,C,T]	0.798	Haemulidae	*Diagramma pictum* [3,C,T]	0.003
Sillaginidae	*Sillago arabica* [1-3,C,T]	0.697	Siganidae	*Siganus canaliculatus* [3,C,T]	0.003
Sparidae	*Sparidentex hasta* [1-3,C,T]	0.482	Haemulidae	*Pomadasys stridens* [3,C,T]	0.003
Leiognathidae	*Photopectoralis bindus* [1-3,C,T]	0.451	Scombridae	*Scomberomorus guttatus* [3,C,T]	0.002
Sciaenidae	*Johnius sp.* [1-3,C,T]	0.428	Gerreidae	*Gerres limbatus* [3,C,T]	0.002
Gobiidae	*Bathygobius fuscus* [1-3,C,T]	0.130	Sparidae	*Argyrops spinifer* [3,C,T]	0.002
Soleidae	*Brachirus orientalis* [1-3,C,T]	0.107	Mullidae	*Upeneus doriae* [3,C,T]	0.002
Ariidae	*Netuma bilineata* [2,3,C,T]	0.095	Belonidae	*Strongylura leiura* [3,C,T]	0.002
Mugilidae	*Planiliza carinata* [1-3,D,T]	0.077	Rhinobatidae	*Glaucostegus granulates* [3,C,T]	0.002
Platycephalidae	*Platycephalus indicus* [2,3,C,T]	0.077	Terapontidae	*Terapon puta* [3,C,T]	0.002
Carangidae	*Alepes kleinii* [3,C,T]	0.063	Terapontidae	*Terapon theraps* [3,C,T]	0.002
Gobiidae	*Boleophthalmus dussumieri* [1-3,C,T]	0.061	Apogonidae	*Apogonichthyoides taeniatus* [3,C,T]	0.001
Cynoglossidae	*Cynoglossus arel* [2,3,C,T]	0.059	Hemiscylliidae	*Chiloscyllium arabicum* [3,C,T]	0.001
Hemiramphidae	*Hyporhamphus limbatus* [1-3,C,T]	0.058	Batrachoididae	*Austrobatrachus dussumieri* [3,C,T]	0.001
Sciaenidae	*Otolithes ruber* [3,C,T]	0.044	Cepolidae	*Acanthocepola abbreviata* [3,C,T]	0.001
Ariidae	*Netuma thalassina* [3,C,T]	0.038	Carcharhinidae	*Rhizoprionodon acutus* [3,C,T]	0.001
Clupeidae	*Nematalosa persara* [1-3,C,T]	0.034	Polynemidae	*Polydactylus sextarius* [3,C,T]	0.001
Carangidae	*Alepes vari* [3,C,T]	0.028	Belonidae	*Tylosurus crocodilus* [3,C,T]	0.001
Carangidae	*Scomberoides commersonnianus* [2,3,C,T]	0.027	Carangidae	*Carangoides malabaricus* [3,C,T]	0.001
Scatophagidae	*Scatophagus argus* [2,3,C,T]	0.025	Carangidae	*Alepes melanoptera* [3,C,T]	0.001
Stromateidae	*Pampus argenteus* [3,C,T]	0.024	Carangidae	*Selar crumenophthalmus* [3,C,T]	0.001
Belonidae	*Strongylura strongylura* [2,3,C,T]	0.022	Carangidae	*Carangoides chrysophrys* [3,C,T]	0.001
Sparidae	*Crenidens crenidens* [3,C,T]	0.020	Triacanthidae	*Triacanthus biaculeatus* [3,C,T]	0.001
Polynemidae	*Eleutheronema tetradactylum* [2,3,C,T]	0.020	Synanceiidae	*Pseudosynancei melanostigma* [3,C,T]	0.001
Engraulidae	*Thryssa dussumieri* [3,C,T]	0.016	Platycephalidae	*Grammoplites suppositus* [3,C,T]	0.001
Chirocentridae	*Chirocentrus nudus* [3,C,T]	0.014	Lutjanidae	*Lutjanus russellii* [3,C,T]	0.001
Nemipteridae	*Nemipterus bipunctatus* [3,C,T]	0.013	Sciaenidae	*Pennahia anea* [3,C,T]	0.001
Synodontidae	*Saurida tumbil* [3,C,T]	0.012	Ariidae	*Carangoides chrysophrys* [3,C,T]	0.001
Gobiidae	*Periophthalmus waltoni* [3,C,T]	0.010	Rachycentridae	*Rachycentron canadum* [3,C,T]	0.001
Sciaenidae	*Protonibea diacanthus* [3,C,T]	0.009			

Table 2. Relative abundance (%) of native and alien species caught in the Shatt Al-Arab River (1, 2, 3= Sites, H= Herbivore, O= Omnivore, C= Carnivore, D= Detritivore, T= Tolerant, S= Sensitive)

Family	Native species	%	Family	Alien species	%
Mugilidae	*Planiliza abu* [1,2,D,T]	8.825	Cyprinidae	*Carassius auratus* [1,2,O,T]	13.24
Cyprinidae	*Carasobarbus luteus* [1,2,O,S]	1.808	Cichlidae	*Oreochromis aureus* [1,2,3,H,T]	12.58
Cyprinidae	*Leuciscus vorax* [1,2,C,S]	0.252	Cichlidae	*Coptodon zilli* [1,2,3,H,T]	8.201
Cyprinidae	*Alburnus mossulensis* [1, 2,O,T]	0.187	Cyprinidae	*Cyprinus carpio* [1,3,O,T]	3.235
Cyprinidae	*Acanthobrama marmid* [1,2,O,T]	0.138	Cyprinidae	*Carasobarbus sublimus* [1,2,O,6]	0.706
Bagridae	*Mystus pelusius* [1,2 ,C,T]	0.069	Cyprinidae	*Hemiculter leucisculus* [1,2, O,T]	0.481
Siluridae	*Silurus triostegus* [1,2,C,T]	0.041	Cichlidae	*Oreochromis niloticus* [1,2,H,T]	0.474
Cyprinidae	*Mesopotamichthys sharpeyi* [1,2,H,S]	0.014	Poeciliidae	*Poecilia latipinna* [1,3,H,T]	0.404
Cyprinidae	*Luciobarbus xanthopterus* [1,2, O, S]	0.009	Poeciliidae	*Gambusia holbrooki* [1,C,T]	0.056
Cyprinidae	*Garra variabilis* [1,6,,D,S]	0.009	Cyprinidae	*Hypophthalmichthys molitrix* [1,2,O,T]	0.007
Mastacem-belidae	*Mastacembelus mastacembelus* [1,2,,C,S]	0.006	Cyprinidae	*Ctenophryngodon idella* [1,2,H,T]	0.006
Cyprinidae	*Chondrostoma regium* [1,C,S]	0.006	Heteropneu-tidae	*Heteropneustes fossilis* [1,C,T]	0.003
Cyprinidae	*Cyprinion kais* [1,O,S]	0.004	Cyprinidae	*Hypophthalmichthy nobilis* [2,O,T]	0.002
Cyprinidae	*Arabibarbus grypus* [1,2,O,S]	0.003			
Cyprinod-ontidae	*Aphanius dispar* [1,3,C,T]	0.009			

Fish integrated biological index

All the fish assemblage metrics used to calculate the fish integrated biological index (F-IBI) scores in the three sampling stations are given in Figure 3. The native species constituted 13.5% of the total number of species, with the highest appearance of the species was 14 in site 1 and the lowest was one species in site 3. The exotic species formed 11.7% of the total number of species, its lowest number was 4 in site 3 and the highest was 12 in site 1. The highest proportions of native and exotic individuals were 27.0 and 62.7% in site 1, respectively and the lowest proportions were 0.02 and 0.2% in site 3, respectively. The marine species comprised 74.8% of the total number of species and its lowest number was 19 appeared in site 1 and the highest was 82 in site 3. The highest proportion of marine fish was 99.8% in site 3 and the lowest 10.3% in site 1. The highest proportions of *C. auratus* and *P. abu* individuals were 21.5 and 19.0% in site 1, respectively and the lowest proportions (*O. aureus, C. zillii* and *Oreochromis niloticus*) varied from 0.2% in site 3 to 32.9% in site 1. The percentage of intolerant species fluctuated from 0.0% in site 3 to 9.3% in site 1, while the tolerant species ranged from 90.7% in site 1 to 100% in site 3. The highest proportions of herbivorous and omnivorous individuals were 34.4 and 36.7% in site 1, respectively and the lowest were 0.2 and 21.0% in site 3, respectively. The highest percents of carnivorous and detrivorous individuals were 43.1 and 35.7% in site 3, respectively and the lowest were 2.3% in site 1 and 21.1% in site 2. The species richness of fish assemblage was varied between 3.1 in site 1 to 4.6 in site 3.

The monthly variations in the total IBI scores of fish assemblage in the three sites during the study period are shown in Figure 4. The F-IBI value in site 1 varied from 25.0% in January and classified as poor to 49.6% in September and considered as fair. The lowest value of F-IBI in site 2 was 27.7% in January and classified as poor and the highest value was 64.6 in May and considered as good. The F-IBI value in site 1 ranged from 39.2% in January and classified as poor to 65.1% in November and considered as good. Significant differences in the IBI values ($F= 9.46$, $P>0.05$) was detected between the sites. The overall F-IBI values of the three sites were 39.4, 45.9 and 54.4%, respectively and evaluated to be poor in site 1 and fair in sites 2 and 3 during 2015-2016.

The F-IBI showed significantly positively association with water temperature in both sites 1 and 2 ($r= 0.861$ and 0.737, respectively), while showed significantly negative correlation with salinity in these sites ($r= -0.613$ and -0.674, respectively). The F-IBI values in site 3 exhibited weak positive correlation with water temperature ($r= 0.294$) and no correlation with salinity ($r= 0.048$).

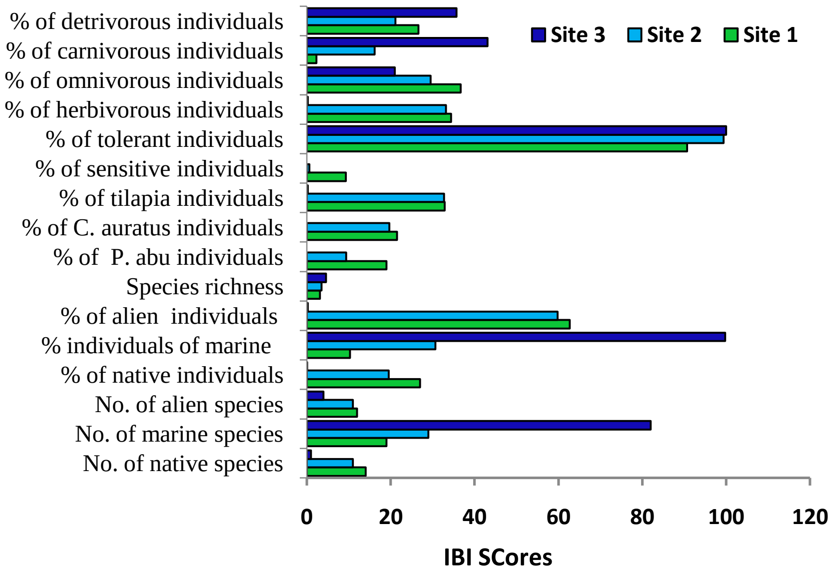

Fig. 3. F-IBI scores of fish assemblage metrics used to calculate IBI values of Shatt Al-Arab

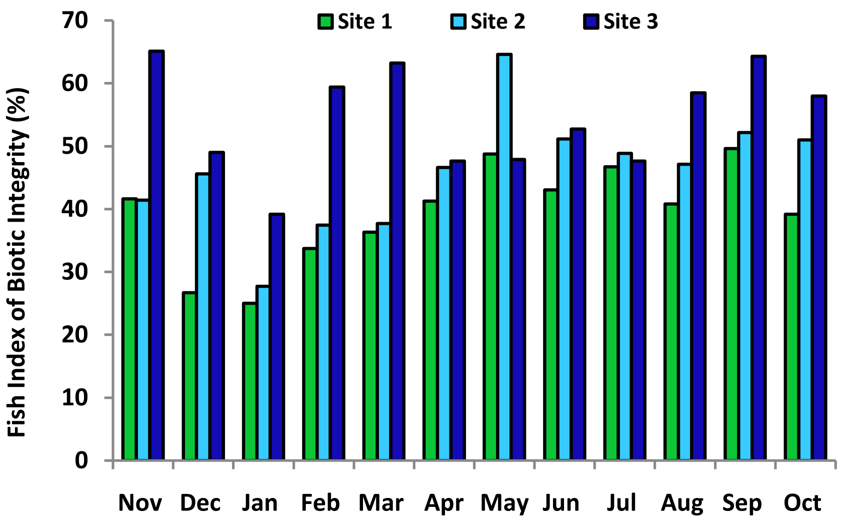

Fig. 4. Monthly variations in the fish index of biotic integrity values of Shatt Al-Arab River

IV. Discussion

Karr *et al.* (1987) defined IBI as the ability to support and maintain a balanced, integrated, adaptive community of organisms having species composition, diversity, and functional organization comparable to that of natural habitat of the region.

The results supported that the physical properties, especially salinity may provide some possible causes for the differences in the distribution, abundance and species composition along Shatt Al-Arab River. The salinity showed dissimilarity across a longitudinal gradient in the Shatt Al-Arab River, the mean values of salinity in the upper, middle and lower reaches were 1.2, 2.5 and 9.1‰, respectively. These results were similar to the previous studies on the river (Mohamed *et al.*, 2012a, 2015; Mohamed and Abood, 2017). The discharge of Shatt Al-Arab rivers differed from what it was in last of past century due to establishing and completing of many of a massive irrigation projects and dams by the countries participating in the basin of Tigris and Euphrates basin and its tributaries, which led to decreasing of water quality and quantity that entering the Shatt Al-Arab river (Patrow, 2001). Several studies have been supportive of the deterioration of the Shatt Al-Arab water quality which attributed to reduced freshwater discharges from Tigris and Euphrates Rivers and the negative impact of salt intrusion from the Arabian Gulf (Al-Tawash *et al.*, 2013; Brandimarte *et al.*, 2015; Yaseen *et al.*, 2016).

The longitudinal salinity variation and the distance of the salinity intrusion is controlled by natural mechanisms, such as tidal range, river flow, geomorphologic features of the estuary, sea level change, among others, as well as human activity interferences, like changes in the drainage basin, drainage channels, water intakes for urban water supply, land use and others (Prandle, 2009).

So, the fish assemblage of Shatt Al-Arab River showed important variation across the longitudinal gradient and can be divided into three ecological fish guilds. The first represent the upper reaches which characterized by highest numbers of native and exotic species, and lowest numbers of fish species and migratory species. The exotic individuals (*C. auratus* and *O. aureus*) and detrivorous individuals (*P.* a*bu*) were the most dominant species. The second guild represents a middle state between the other two guilds and considered as transitory area for several fish species. The third guild at the lower reaches differentiates by highest values of fish richness and migratory species, and lowest numbers of native and exotic species, and the most widely distributed species were *P. klunzingeri*, *P. subviridis* and *T. ilisha.* Al-Hassan *et al.* (1989) stated that marine species are limited to the middle and the lower regions of Shatt Al-Arab River and their number decreased toward the upper reaches of the river, and freshwater fauna exhibited a reverse trend of distribution in the river. Longitudinal changes in local assemblage richness have long been noted along the length of temperate streams and rivers (Angermeier and Karr, 1983; Matthews, 1998; Esselman *et al*. 2010; Vardakas *et al*., 2015), and along the Shatt Al-Arab River (Mohamed *et al.*, 2012, 2015).

Accordingly, the F-IBI values were clearly varied among the studied sites, showed clear longitudinal differentiation in the river. The higher scores recorded in the lower reaches, which correspond to hydrological differences and then fish species composition and richness. The high IBI scores in the lower reach was associated with highest value of fish richness, highest proportions of marine and carnivores individuals, in addition to a decrease or absent the exotic and native species in this site. Conversely, the low IBI scores in the upper reaches was attributed to the high proportions of exotic and omnivorous individuals, besides low down in the proportion of migratory individuals and species richness, regardless the presence most native species in this site. The extremely tolerant species are the last to disappear in response do environmental degradation (Bozetti and Schulz 2004; Costa and Schulz 2010). The number of fish species supported by an undisturbed aquatic ecosystem decreases with environmental degradation, as intolerant species will disappear with increasing disturbance (Karr *et al.,* 1986).

Therefore, the ecological health of the Shatt Al-Arab showed longitudinal gradient, poor in the upper reaches and fair in the middle and lower reaches during 2015-2016.The overall F-IBI values of the three sites were 39.4, 45.9 and 54.4%, respectively and evaluated to be poor in site 1 and fair in sites 2 and 3 during 2015-2016.

V. Conclusion

The overall study reveals that the fish-based IBI integrated biological index is positively correlated with the species richness, species composition and trophic characteristics of the fish community in the river. Therefore, the F-IBI values showed clear longitudinal differentiation in the river and its ecological health ranged from poor to fair during 2015-2016.

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