Evaluation of fish assemblage environment in east Hammar using Integrated Biological Index

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Abstract

An Index of Biotic Integrity (IBI) was used to assess the status of the fish assemblage of east Hammar marsh from October 2005 to September 2006. IBI scores were calculated from 16 separate assemblage metrics based on the species richness, species composition and trophic guilds. After more than two years of restoration activities and improved water quality, the state of the fish community in Hammar marsh was fair during 2005-2006 (IBI= 42.6%), and better than the same study marsh after four years of restoration (IBI=40.8%). The results revealed that no substantial improvements have been recorded during the late years of restoration, reflect that the environment is still fragile and need time to be recovering.

Introduction

The IBI is a quantitative measure that integrates a number of biological factors into a single value of ecosystem integrity, and the biological integrity was defined 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 (Karr, 1999). The original version of the IBI was first developed using fish in the USA by Karr (1981) and consisted of 12 fish community parameters, or metrics, divided into categories of species richness, trophic structure, and fish abundance and condition.

As the IBI became widely used, different versions were developed for different regions and ecosystems of the world (Minns, *et al.*, 1994; Bowen, *et al.,* 1996; Belpaire, *et al.*, 2000; Simon, *et al.,* 2000; Bozzetti and Schulz, 2004; Bhagat, *et al.*, 2007; Brousseau and Randall, 2008).

Minns *et al.* (1994) developed a fish-based IBI for marshes of Great Lakes areas which included metrics sensitive to impacts by exotic fishes, water quality changes, physical habitat alterations, and changes in piscivore abundance related to fishing pressure and stocking. Brousseau and Randall (2008) stated that the key to successful wetland restoration, mitigation, and conservation efforts is using an objective method to assess conservation effects, and the IBI is a recognized tool for doing so, and its use also allows managers to set realistic targets and evaluate the effectiveness of conservation practices.

Historically, Mesopotamian marshes were the largest wetlands in the Levant and South Western Asia, covered more than 15,000 km² representing about 44% of inland freshwater and oligo-saline water bodies of Iraq. These marshes were characterized by their high productivity (Al-Zubadi, 1985; Al-Mayah, 1992; Al-Hilli *et al.,* 2009) and considered as natural refuge for many aquatic organisms and major source of inland fisheries (60%) in Iraq (FAO, 1999). They were the permanent habitat for millions of waterfowls and a flyway for millions more migrating between Siberia and Africa (Evans, 2002).

Planned drainage processes started in early 1990s to divert the riverine water of Tigris, Euphrates and Shatt Al-Arab rivers away from the southern marshlands, resulted in catastrophic loss of native aquatic flora and fauna. Since mid 2003, great efforts have been made to restore the marshes and revive the wetlands environment. As of August 2007, the marshes had recovered almost 58% (3,500 km²⁾ of their former area in 1972 according to UNEP (2007).

Al-Hammar marsh is the biggest southern marshes extended in two provinces (Basrah and Nasiriyah). It is approximately 120 km long and 25 km wide. Maximum water depth in the marsh ranges from 1.8-3.0 m. The marsh narrowed about the middle consequently it could be divided roughly in two parts west and east. After inundation in 2003, large areas of Al-Hammar were reflooded by riverine water. Recently west Al-Hammar marsh is fed primarily from tributaries of Euphrates River, but the eastern part get a considerable mount of water from Shatt Al-Arab river, groundwater recharge is another source of replenishment.

Most previous studies have focused on water quality, plankton and plant communities and on biological aspects of fish in the Hammar marsh before desiccation (Maulood, *et al.*, 1979; Pankow, *et al*., 1979; Al-Saadi, *et al.*, 1981; Al-Saboonchi, *et al.*, 1982, 1986; Barak and Mohamed, 1982, 1983; Al-Zubaidy, 1985; Jasim 1988; Mohamed and Barak, 1988a, b; Al-Kanaani, 1989; Al-Rudainy 1989; Mohamed and Ali, 1994).

Since inundation in 2003, several studies have been focus on describe the fish assemblages in the southern marshes (ARID, 2006; Hussain, *et al.,* 2006, 2009; Mohamed, *et al.*, 2008, 2009). Some researches have been carried out attempting to evaluate water quality change as result of environmental alteration in east Hammar marsh by using Water Quality Index, WQI (Al-Saboonchi, *et al.*, 2011) or fish structure changes in the marshes by applying the Index of Biotic Integrity, IBI (Al-Shamary, 2008; Abd, 2010).

This work aims to evaluate changes in the fish assemblage of east Hammar, to assess the marsh "health" and to identify eventual recovery trends after two years of inundation, in comparison to other southern marshes of Iraq, like Huwazah marsh..

Materials and methods

Fish species composition, relative abundance and trophic groups data which were collected monthly from two selected sites, Mansoury and Burkah, at the east Hammar marsh (Fig. 1) during October 2005 to September 2006 (Hussain, *et al.*, 2006, Hussain, *et al.*, 2009, Mohamed, *et al.*, 2009; Mohamed and Hussain, 2012) are used in the present study.

We followed the approach of Minns *et al.* (1994) for standardizing metric (attribute) scores, formulating the IBI, and analyzing effects of individual metrics on the overall IBI score. IBI scores were calculated from 16 separate assemblage metrics based on the species richness, species composition and trophic characteristics of the fish community (Minns *et al.*, 1994; Table 1). Positive scoring metrics (i.e., those that should increase with increasing biological integrity) included numbers of native, common native and migratory fish species, proportion of sensitive native species, proportion of migratory species, proportion of herbivore, proportion of carnivore and proportion of piscivore, and species richness. The species richness was calculated monthly according to Margalef (1968). Raw positive metrics were standardized to a scale of 0 to 10. A value of 10 would be assigned to the highest value of each raw metrics, otherwise the standardized score was calculated as B x raw score, where B = 10/ highest value.

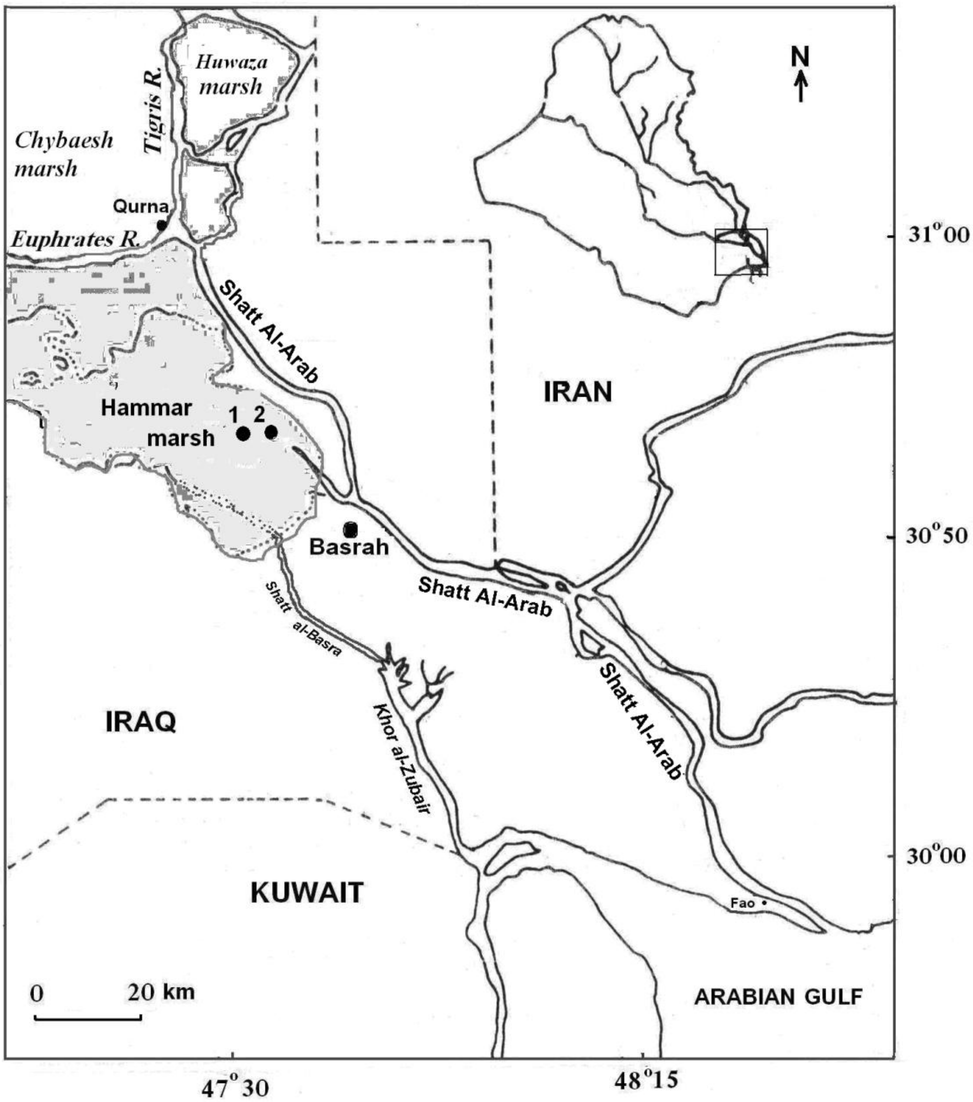

Fig. 1. Map of southern of Iraq, showing the location of Al-Hammar marsh

Negative metrics (i.e., those that should decrease with increasing biological integrity) included number and proportion of alien, and proportion of tolerance species, proportion of *Liza abu*, proportion of *Carassius auratus*, proportion of omnivore and proportion of detrivore fish (Table 1). Also, raw negative metrics were standardized to a scale of 0 to 10. A value of 0 would be assigned to the highest value of each raw metrics, otherwise the standardized score was calculated as 1- *B* x raw score, where *B* = 10/ highest value. Standardized IBI metrics were summed to obtain an IBI score that varied continuously from 0 to 100 for the marsh and the month, for each metric. 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 total variances (i.e., across marshes and months) of the differences were used to assess the sensitivity of the complete IBI to individual metrics.

Table 1. Species composition, geographic origin and trophic guild of fish captured from the Hammar marsh during 2005-2006 [N (native), A (alien), M (migratory), S (sensitive), T (tolerant), H (herbivore), C (carnivore), O (omnivore), D (detrivore) and P (piscivore)].

Species	Origin Status					Trophic Guild				
	N	A	M	S	T	H	C	O	D	P
Liza abu	*				*				*	
Carassius auratus		*			*	*				
Acanthobrama marmid	*				*		*			
Tenualosa ilisha			*					*		
Thryssa mystax			*		*		*			
Alburnus mossulensis	*				*		*			
Cyprinus carpio		*			*			*		
Aspius vorax	*			*						*
Barbus luteus	*			*		*				
Liza subviridis			*						*	
Silurus triostegus	*			*						*
Heteropneustus fossilis		*			*		*			
Poecilia latipinna		*			*			*		
Cyprinion macrostomum	*			*			*			
Aphanius dispar	*				*		*			
Boleophthalmus boddarti			*		*		*			
Aphanius mento	*				*		*			
Acanthobrama lissneri	*						*			
Bathygobius fuscus			*		*		*			
Barbus sharpeyi	*			*		*				
Acanthopagrus latus			*		*		*			
Barbus grypus	*			*				*		
Matacembelus matacembelus	*			*						*
Barbus xanthopterus	*			*				*		
Liza klunzingeri			*						*	
Scatophagus arqus			*		*	*				
Gambusia holbrooki		*			*		*			
Ctenopharyngodon idella		*			*	*				
Sparidentex hasta			*		*		*			
Hemiramphus georgii			*		*		*			
Synaptura orientalis			*		*		*			

The correlation coefficients between water temperature and salinity, and IBI scores were calculated (n= 12, p≤ 0.05), the correlation coefficient is significant at r ≥ 0.505. The similarity between the months based on their IBI score was calculated according to Schoener (1970). All statistical computations were made using SPSS software (version 11, 2001) statistical package.

Results

The species composition, geographic origin and trophic guilds of fish captured from the East Hammar marsh during the study period are given in Table 1. Thirty-one fish species were collected from the study marsh. IBI scores were calculated from 16 separate assemblage metrics as followed (Table 2):

The number of native fish species was fourteen, constituted 45.1% of the total number of species. The highest appearance of the species was 11 in July and the lowest was 4 in December (Table 2). IBI score of native fish species ranged from 3.6% in December to 10% in July (Fig. 2).

The alien species was six, formed 19.4% of the total number of species. The lowest number was one in December and the highest was four in March and July (Table 2). The highest score of alien fish species was 7.5% in December (Fig. 2).

The migratory species were eleven, comprised 35.5% of the total number of species. The lowest number was one appeared in November, December and February, and the highest was seven in July (Table 2). Therefore, the maximum IBI score of migratory species was 10% in July (Fig. 2).

The highest number of common native species was 6 recorded in May and the lowest was two recorded in October, April and June. The maximum IBI score of common native species was 10% in May (Fig. 2).

Of the total catch of 16,199 fish from the East Hammar marsh, 29.4% was alien fish, the highest proportion (46.3%) being in June and the lowest (7.1%) in September (Table 2). *C. auratus* was the most abundant alien species, which contributed 25.4% of the total catch. IBI score of proportion alien species attained the highest value 8.5% in September (Fig. 3).

The relative proportion of migratory fish was 10.8% of the total catch. Their proportion fluctuated from 0.2% in November to 55.1% in September (Table 2). *Tenualosa ilisha* was the most abundant marine species, comprising 10.1% of the total catch. The maximum IBI score of migratory fish was 10% in September (Fig. 3).

The species richness of fish assemblage was varied between 0.7 in December to 2.8 in July (Table 2). IBI score of species richness ranged from 2.6% in December to 10% in July (Fig. 3).

L. abu was the most abundant species comprising 37.5% of the total catch, followed by *C. auratus* (25.4%). The relative proportion of *L. abu* ranged from 20.8% in March to 60.8% in August, and C. *auratus* from 6.4% in September to 42.8% in October (Table 2). The maximum score of proportion of *L. abu* was 6.6% in March, and for *C. auratus* was 8.5% in September (Fig. 4).

The relative proportion of sensitive native species fluctuated from 0.3% in December to 9.6% in May, while the proportion of tolerant species ranged from 52.8% in August to 98.7% in October (Table 2). Three tolerant species (*L. abu*, *C. auratus* and *Acanthobrama marmid*) comprised 70.2% of the total catch. The highest score of proportion of sensitive native species was 10% in May, and for tolerant species was 4.6% in September (Fig. 4).

The trophic guilds metrics, which is composed of percent of individuals that are considered as herbivorous, carnivorous, omnivorous, detrivorous and piscivorous species, which constituted 26.5, 21.0, 11.5, 38.2 and 2.8% of the total catch, respectively. The highest proportions of them were 43.3%, 55.3%, 39.3%, 61.3% and 7.1%, respectively (Table 2). *C. auratus* was common in the catch and constituted 23.7% of herbivorous species, whereas, *A. marmid* consisted 10.8% of carnivorous species, *T. ilisha* 10.1% of omnivorous species, *L. abu* 35.9% of detrivorous species

Table 2. Monthly variations in the fish assemblage metrics used to calculate IBI scores of Hammar marsh during 2005-2006.

IBI metrics	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep
No. of native species	8.0	5.0	4.0	7.0	6.0	10.0	9.0	7.0	7.0	11.0	7.0	9.0
No. of alien species	3.0	2.0	1.0	3.0	3.0	4.0	3.0	3.0	3.0	4.0	2.0	3.0
No. of migratory species	6.0	1.0	1.0	2.0	1.0	3.0	6.0	4.0	3.0	7.0	4.0	3.0
No. of common native species	2.0	3.0	3.0	3.0	3.0	4.0	2.0	6.0	2.0	5.0	4.0	4.0
Proportion of alien species	43.1	41.2	20.5	29.1	24.2	22.3	31.4	38.7	46.3	33.1	16.3	7.1
Proportion of migratory species	25.8	0.2	6.3	2.4	1.6	2.8	2.6	1.4	1.4	19.6	10.7	55.1
Proportion of *L. abu*	23.9	47.9	30.6	47.1	38.5	20.8	43.4	37.8	41.7	32.1	60.8	25.2
Proportion of *C. auratus*	42.8	41.0	20.5	28.7	23.5	18.9	28.6	21.0	34.5	23.8	15.4	6.4
Proportion of sensitive native species	1.0	1.2	0.3	0.4	1.8	2.2	4.2	9.6	7.5	6.5	6.6	5.5
Proportion of tolerant species	98.7	93.5	96.4	96.6	95.3	94.5	90.1	91.8	72.7	91.4	52.8	76.5
Proportion of herbivores	43.3	41.1	20.8	28.9	25.3	19.8	30.1	23.5	35.6	28.3	19.1	8.8
Proportion of carnivores	9.5	9.7	42.4	20.4	34.5	55.3	22.2	14.1	4.5	11.9	14.5	22.0
Proportion of omnivores	18.9	-	-	0.2	0.1	0.5	0.4	17.3	11.1	25.2	2.3	39.3
Proportion of detrivores	27.6	48.1	36.9	49.3	40.1	23.2	44.8	38.0	42.6	32.9	61.3	26.8
Proportion of piscivores	0.6	1.2	-	1.0	-	1.1	2.7	7.1	6.4	1.8	2.9	3.1
Species richness	2.1	1.1	0.7	1.6	1.3	2.2	2.2	1.8	1.7	2.8	1.7	1.8

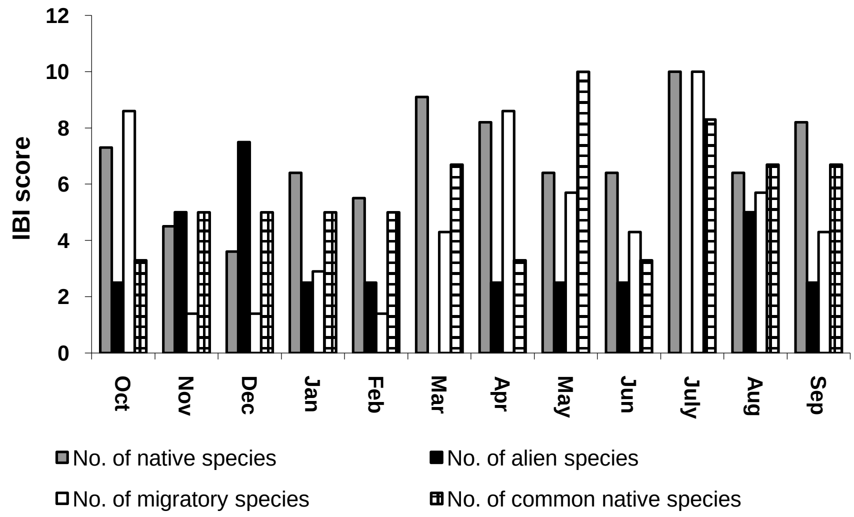

Fig. 2. Monthly variations in IBI scores metrics of numbers of native, alien, migratory and common native species in Hammar marsh

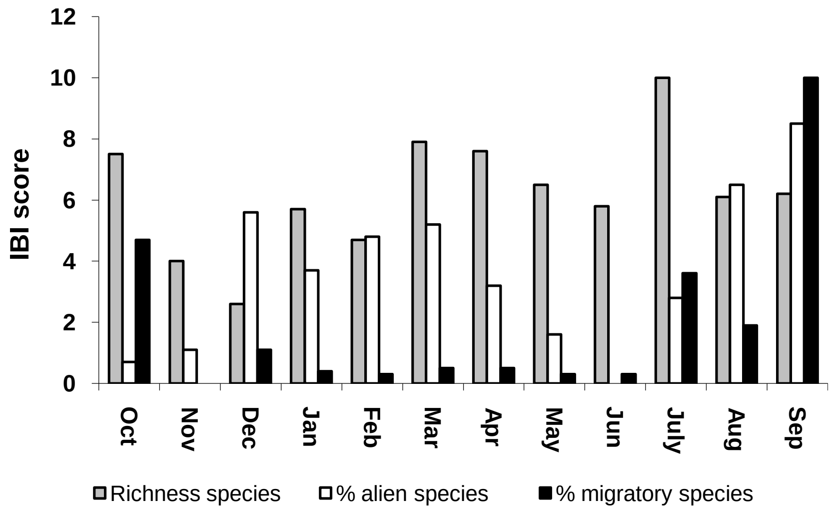

Fig. 3. Monthly variations in IBI scores metrics of richness and % of alien species in Hammar marsh

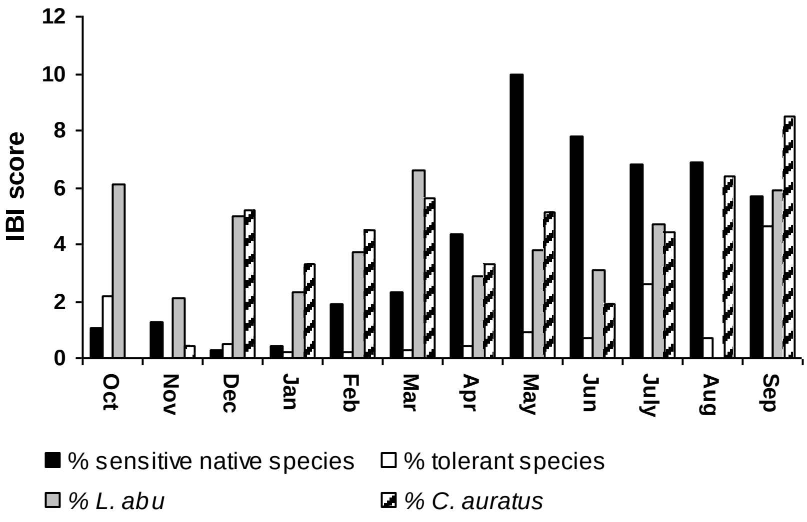

Fig. 4. Monthly variations in IBI scores metrics of some species in Hammar marsh (2005-2006)

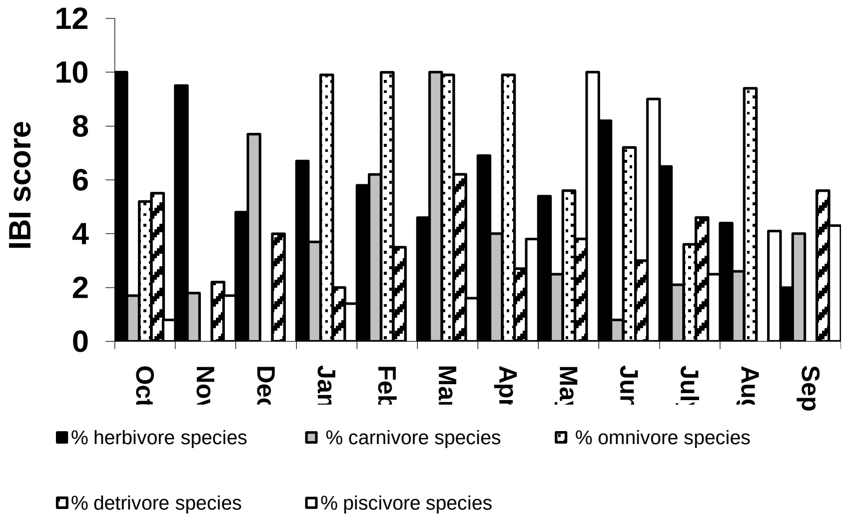

Fig. 5. Monthly variations in IBI scores metrics of the trophic guilds in Hammar marsh (2005-2006)

and *Aspius vorax* 1.8% of piscivorous species. The maximum score of proportions of herbivorous, carnivorous, omnivorous and piscivorous were 10% in October, March, February and May, respectively, and for detrivorous species was6.2%in March(Fig. 5).

The monthly variations in the overall IBI score of fish assemblage in the marsh during the study period is shown in Figure 6, together with monthly changes in water temperature and salinity. Water temperature ranged from 12.5 ^{o}C in February to 29 ^{o}C in July. Salinity changed from 1.2 ‰ in August to 2.0 ‰ in July. The lowest value of IBI was 25% in November and the highest value 54.4% in September. Water temperature showed significant positive correlation (r= 0.604, p≤ 0.05) with the IBI score, while salinity exhibited non-significant correlation (r= 0.025, p≤ 0.05). Also, species richness showed significant positive correlation (r= 0.726, p≤ 0.05). In general, the values of IBI were poor during the period from November to February and fair during from March to October. The annual IBI value of east Hammar marsh during 2005-2006 was evaluated to be fair (42.6%).

Similarity dendrogram between the months based on their IBI score is presented in Fig. 7. Five main groups were distinguished. Group I, consists of four subgroups, first includes January and February, second includes April, third includes August and fourth includes March. Group II includes October and July. Group III includes May and June. Group IV, includes November and December. Group V includes September.

Discussion

The IBI was recognized as a key to successful wetland restoration, improvement, and management efforts (Brousseau and Randall, 2008). During the last three decades, the Mesopotamian marshlands were suffering from various problems amongst them new hydrological projects, more than 30 large dams in Turkey, Syria, Iran, and Iraq have diverted water from the Tigris and Euphrates and their tributaries. The constructions of drainage systems by diversions of major rivers surrounding the marsh areas, and drainage processes in the 1990s drained the southern marshlands. In 2002, 85% of permanent marshes described in 1973 had been environmentally destroyed. Only 14.5% of the East Al-Hammar marshes and 35% of the Huwazah marshes near the Iranian border, remained (Richardson and Hussain, 2006).

Different versions for calculating IBI have been developed for different ecosystems of the world and all of them calculate IBI scores by comparing against reference sites or historical data on fish assemblage composition. Because of more than a decade of intensive desiccation and multiple burning of soils and plants during the nineties of the study marsh, we located no reference sites, and historical information about fish assemblage composition did not exist. Instead, we compared the status of study marsh with the adjacent marshes, such as Huwazah marsh which suffered from drainage less than other southern marshes (Richardson and Hussain, 2006), and also with the same study marsh after four year of inundation (Al-Shamary, 2008).

After more than two years of restoration activities and improved water quality (2005-2006), the state of the fish community in Hammar marsh was fair (IBI= 42.6%), but IBI value was lower than at Hawazah marsh (IBI= 53.2%), and better than the same study marsh after four years of restoration, IBI= 40.8% (Table 3). In view of positive IBI scores, although the restriction of migratory species and high number of native species in Hammar marsh, these fish proportions comprised about 70.6% of the total individuals in this marsh, whereas proportion of native individuals

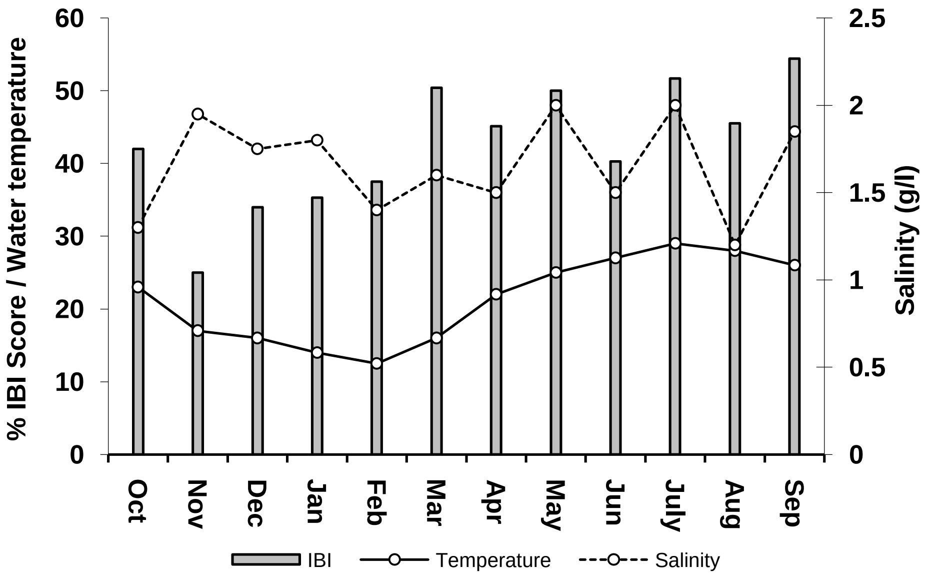

Fig. 6. Monthly variations in water temperature, salinity and IBI values of Hammar marsh (2005-2006)

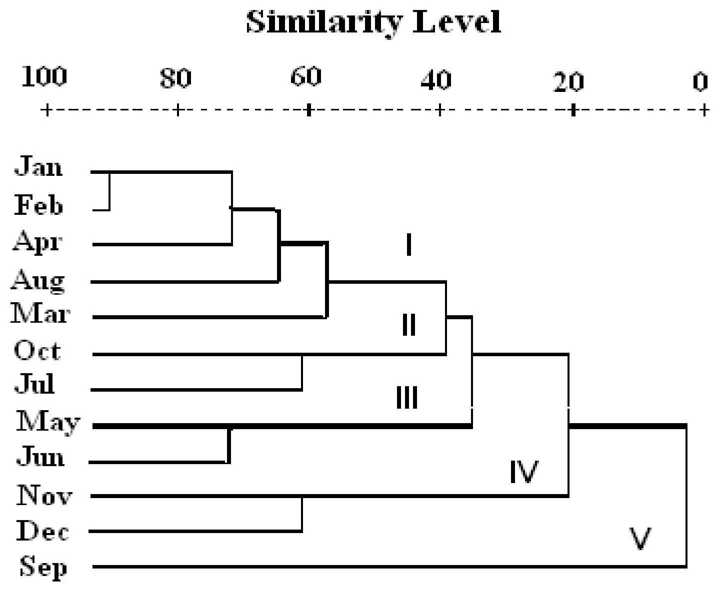

Fig. 7. Similarity dendrogram between the months based on their IBI scores in Hammar marsh

Table 3. Comparison of IBI scores metrics between Hammar and Huwazah marshes.

IBI metrics	**Hammar (present study)**	**Huwazah (Mohamed, *et al.*, 2008)**	**Hammar (Al-Shamary, 2008)**
No. of species	31	15	37
No. of native species	14	11	13
% of native species	45.2	73	35
% of native individuals	59.8	81.2	51
No. of alien species	6	4	9
% of alien species	19.4	27	24
% of alien individuals	29.4	18.8	42.3
No. of migratory species	11	0	15
% of migratory species	35.5	0	40.5
% of migratory individuals	10.8	0	6.5
% of *L. abu*	37.5	32.8	28.4
% of *C. auratus*	25.4	11.5	26.4
% of sensitive native species	3.9	45.4	24.3
% of tolerant species	87.5	53.3	83.2
% of herbivores	27	47.7	1.2
% of carnivores	21.8	8.2	17.3
% of omnivores	11.5	1.3	45
% of detrivores	39.3	32.8	29.5
% of piscivores	2.3	8.6	7.0
Species richness	0.7-2.8 (1.8)	0.7-2.4 (1.7)	

in Hawazah marsh was higher (about 80.2%). Also, large proportions of the herbivores, carnivores and piscivores individuals have made up 65% of the trophic guilds in Hawazah marsh, compared to about 51% for those in Hammar marsh. However, the proportions of aliened, *L. abu* and *C. auratus* individuals, as negative IBI scores, were higher in Hammar than at Hawazah marsh. Despite the two marshes had similar species richness values, Huwazah marsh has achieved a more balanced trophic structure (i.e. more piscivores and fewer generalists) over time that is most likely related to water quality and fish habitat improvements (Brousseau and Randall, 2008).

Huwazah marsh is non tidal freshwater marsh and representing the best remaining natural marsh in the original Mesopotamian wetlands, less harshly degraded of the other southern marshes due to drainage. According to Al-Abbawy and AI-Mayah (2010), the highest number of aquatic plants was registered in Huwaiza marsh (35) in comparison with Hammar marsh (24), and the aquatic macrophyte species restoration percentages during 2006 were 97.2% in Huwaiza, whereas, 63.2% in Hammar. Also, the density and biomass of the major macrophytes species in Hawazah marsh during July 2006 were 423 g/m² and 21,452 g/m² dry wt., respectively, while for Hammar marsh were 308 g/m² and 11,367 g/m² dry wt., respectively (ARADI, 2006).

Several authors reported that water quality, water level fluctuation and macrophyte coverage were among the most influential factors affecting fish IBI in wetland ecosystems (Minns *et al*., 1994; Brazner and Beals, 1997; Uzarski *et al.,* 2005; Bhagat, *et al*., 2007). Brazner and Beals (1997) stated that increased fish species richness and abundance were often correlated with increased macrophyte species richness and density. Uzarski *et al.* (2005) determined that fish community composition in Great Lakes wetlands could be predicted more effectively by stratifying with respect to plant zones rather than by ecoregion, Great Lake, or wetland hydrogeomorphic type.

When the IBI scores from Hammar marsh were compared to those from the same marsh after four years of inundation, 2006-2007 (Al-Shamary, 2008), four metrics were found to be great different. Despite the high number of species (37) in Hammar marsh during 2006-2007, the proportions of migratory and native species comprised about 56.5% of the total individuals in this marsh, whereas proportions of these individuals during 2005-2006 was higher (about 70.6%). Also, the proportion of the herbivores declined sharply from 27% in 200-2005 to only 1.2% in 2006-2007 (Table 3). The proportions of aliened and omnivores individuals, as negative IBI scores, were higher after four year from restoration compared with the proportions of these scores for the years immediately following restoration (2005-2006).

We speculate that the observed differences in IBI scores were related to differences in discharge and quality of water between years, and could be related to the heavy fishing pressure by the marsh dwellers inflecting serious damages especially by using illegal methods (electrofishing and poisons). During the first years of restoration, the western and northern sides of Hammar marsh received water from Euphrates River and also influenced by semi tidal brackish water flowing from the Shatt-Al-Arab River through Garmat Ali (Iraq Foundation, 2003; Taher, *et al.,* 2008). The discharge from Euphrates River was declined after that and water came from Shatt Al-Arab only which affected the water level and declined in the water quality of the marsh. The flow speed of Hammar marsh was declined from 1.2-5.2 m/s in 2005-2006 (ARDI, 2006) to 0.11-0.75 m/s in 2006-2007 (Al-Shamary, 2008). Odum (1969) reported that specialist species are quickly replaced by opportunists ones when there is environmental alteration. 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).

It can be concluded that no substantial improvements has been recorded in IBI scores of Hammar marsh during the late years of restoration, reflect that the environment is still fragile and need time to be recover.

References

Abd, I. M. 2010. Ecological assessment of Chybayish marsh using water quality index and index of biological integrity of fish and phytoplankton assemblages. Ph D. thesis. Basrah University, Iraq.

Al-Abbawy, D. A. H. and A. A. AI-Mayah. 2010. Ecological Survey of Aquatic Macrophytes in Restored Marshes of Southern Iraq during 2006 and 2007. Marsh Bulletin 5: 177-196.

Al-Hilli, M. R., B. G. Warner, T. Asada and A. Douabul. 2009. An assessment of vegetation and environmental controls in the 1970s of the Mesopotamian wetlands of southern Iraq. Wetlands Ecol. Manage.17: 207-223.

Al-Kanaani, S. M. 1989. Diet overlap among the common carp *Cyprinus carpio* L. and three native fish species in Al-Hammar marsh, southern Iraq .M.Sc. thesis Basrah University, Iraq.

Al-mayha, A. R. A., 1992. Aquatic plants in marsh of south of Iraq,127-14, In Hussain, N.A.(editor) Ahwar of Iraq environmental approach, Marine Science Center Publ. (18) 1994, 299pp.

Al-Rudainy, A. A. J. 1989. Morphometric study of four cyprinid fish and it's related to food in Hammar marsh, south Iraq. M.Sc. thesis. Basrah University, Iraq.

Al-Saadi, H. A., S. R. Antoine and A. K. M. Nurl Islam. 1981. Limnological investigation in Al-Hammar marsh area in Southern Iraq. Nova Hedwig cramer 35: 157-166.

Al-Saboonchi A. A., A. R. M. Mohamed and N. A. Barak. 1982. Astudy of phytoplankton in the Garma marshes, Iraq. Iraqi J. of Marine Science, 1:67-78.

Al-Saboonchi, A. A., N. A. Barak, and A. R. M. Mohamed. 1986. Zooplankton of Garma Marshes, Iraq. J. Biol. Sc. Res., 17: 33-39.

Al-Saboonchi, A., A. R. M. Mohamed, A. H. M. Alobaidy, H. S. Abid and B. K. Maulood. 2011. On the current and restoration conditions of the southern Iraqi marshes: Application of the CCME WQI on East Hammar marsh. Journal of Environmental Protection, 2: 316-322.

Al-Shamary, A. C. 2008. Ecological assessment for South-East Al-Hammar marsh, north of Basrah. M.Sc. thesis. Basrah University, Iraq.

Al-Zubaidy, A. J. M. 1985. Ecological study on Algae (Phytoplankton) to the marshes near Qurna, Southern Iraq. M.Sc thesis Basrah University, Iraq.

ARDI (Agriculture, reconstruction and development program for Iraq). 2006. Final report, marshlands monitoring team. Development Alternative International. 172pp.

Barak, N. A. A. and A. R. M. Mohamed. 1982. Food habits of Cyprinid fish, *Barbus luteus* (Heckel). Iraqi J. Mar. Sci. 1: 59-67.

Barak, N. A. A. and A. R. M. Mohamed. Biological study of the cyprinid fish, *Barbus luteus* (Heckel) in Garma Marshes. J. Biol. Res. 14: 53-70.

Bhagat, Y., J. J. H. Ciborowski, L. B. Johnson, D. G. Uzarski, T. M. Burton, S. T.A. Timmermans, and M. J. Cooper. 2007. Testing a Fish Index of Biotic Integrity for Responses to Different Stressors in Great Lakes Coastal Wetlands. J. Great Lakes Res. 33: 224-235.

Belpaire, C., R. Smolders, I. V. Auweele, D. Ercken1, J. Breine1, G. V. Thuyne and F. Ollevier. 2000. An Index of Biotic Integrity characterizing fish populations and the ecological quality of Flandrian water bodies**.** Hydrobiologia, 434**:** 17-33.

Bowen, Z. H., M. C. Freeman, and D. L. Watson. 1996. Index of Biotic Integrity Applied to a Flow-Regulated River System IN Proceedings of the 50th Annual Conference of the Southeastern Association of Fish and Wildlife Agencies, 1996: U.S. Fish and Wildlife, p. 26-37.

Brazner, J. C., and E. W. Beals. 1997. Patterns in fish assemblages from coastal wetland and beach habitats in Green Bay, Lake Michigan: a multivariate analysis of abiotic and biotic forcing factors. Can. J. Fish. Aquat. Sci. 54: 1743-1761.

Bozzetti, M. and U. H. Schulz, 2004. An index of biotic integrity based on fish assemblages for subtropical streams in southern Brazil. Hydrobiologia, 529: 133-144.

Brousseau, C. M., and R.G. Randall. 2008. Assessment of long-term trends in the littoral fish community of Hamilton Harbour using an Index of Biotic Integrity. Can. Tech. Rep. Fish. Aquat. Sci. 2811: ii + 85 p.

Evans, M. I. 2002. The ecosystem. In: Nicholson, E., Clark, P. [Eds] .pp. 201–219. The Iraqi Marshlands: A human and environmental study. The Amar appeal international charitable foundation, 299pp.

FAO .1999. Fishery country profile. FID/CP/IRQ Rev. 2.

Hussain, N. A., A. R. M. Mohamed, S. S. Al-Noor, B. Coad, F. M. Mutlak, I. M. Al-Sudani, A. M. Mojer, A. J. Toman and M. A. Abdad. 2006. Species composition, ecological indices, length frequencies and food habits of fish assemblages of the restored southern Iraqi marshes. Annual Report, Basrah University, Iraq. 114p.

Hussain, N. A., A. R. M. Mohamed, S. S. Al-Noor, F. M. Mutlak, I. M. Abed and B. W. Coad. 2009. Structure and ecological indices of fish assemblages in the recently restored Al-Hammar Marsh, southern Iraq. BioRisk, 3: 173–186.

Iraq Foundation. 2003. Physical characteristics of Mesopotamia marshland southern Iraq Report, 45pp

Jasim, A. A.W. 1988. Reproductive biology of *Barbus sharpeyi* Gunther 1874 (Pisces, Cyprinidae), South Al-Hammar marsh, Iraq. M.Sc. thesis, University of Basrah, Iraq..

Karr, J. R. 1981. Assessment of biotic integrity using fish communities. Fisheries, 6: 21-27.

Karr, J. R. 1999. Defining and measuring river health. Freshwater Biology, 41: 221-234.

Karr, J. R., K. D. Fausch, P. L. Angermeier, P. R. Yant and I. J. Schlosser, 1986. Assessing biological integrity in running waters: A method and its rationale. Illinois Nat. Hist. Surv. Spec. Publ. 5. 28 pp.

Margalef, R. 1968. Perspectives in ecology. University of Chicago Press.111p

Maulood, B. K., G. C. Hinton, H. S. Kamees, F. A. Saleh, A. A. Shaban and S. M. Al-Shahwani. 1979. An ecological survey of some aquatic ecosystems in southern Iraq. Tropical Ecology.20: 27-40.

Mohamed, A. R. M, T. S. Ali. 1994. The biological importance of Iraqi marshes in fish growth . In: Hussain, N.A. [Ed.] Ahwar of Iraq environmental approach. Marine Science Center. Publ. 18: 205-215.

Mohamed, A. R. M. and N. A. Barak. 1988a. Seasonal variations in some limnological features of the Garma marshes. Basrah J. Agric. Sci. 1: 56-62..

Mohamed, A. R. M. and N. A. Barak. 1988b. Growth and condition of a cyprinid fish, *Barbus sharpeyi* Gunther in Al-Hammar marsh. Basrah J. Agric. Sci. 2: 18-25.

Mohamed A. R. M., N. A. Hussain, S. S. Al-Noor, F. M. Mutlak, I. M. Al-Sudani, A. M. Mojer and A. J. Toman. 2008. Fish assemblage of restored Al-Hawizeh marsh, Southern Iraq. Ecohydrology & Hydrobiology. 8: 375-384.

Mohamed A. R. M., N. A. Hussain, S. S. Al-Noor, B. Coad and F. M. Mutlak. 2009. Status of diadromous fish species in the restored East Hammar marsh in southern Iraq, Status of diadromous fish species in the restored East Hammar marsh in southern Iraq. American Fisheries Society Symposium 69: 577-588.

Mohamed, A. R. M. and N. A. Hussain. 2012. Trophic strains and diet shift of the fish assemblage in the recently restored Al-Hammar marsh, southern Iraq. Journal of University of Duhok, 15(1): 119-127.

Minns, C. K., V. W. Cairns, R. G. Randall, and J. E. Moore. 1994. An index of biotic integrity (IBI) for fish assemblages in the littoral-zone of Great-Lakes areas of concern. Can. J. Fish. Aquat. Sci. 51: 1804-1822.

Odum, E. P. 1969. Ecologia. Sao Paulo, Pioneira, 201p.

Pankow, H., H. A. Al-Saadi, M. F. Hug and R. A. M. Hadi. 1979. On the algal flora of the marshes near Qurna southern Iraq. Willdenowia 8: 493-506.

Richardson, C. J., and N. A. Hussain. 2006. Restoring the Garden of Eden: An ecological assessment of the marshes of Iraq. BioScience 56: 477-489.

Schoener, T.W. 1970. Non synchronous spatial overlap of lizards in patchy habitats. Ecology, 51: 175-181.

Simon, T. P., R. Jankowskib and C. Morris. 2000. Modification of an index of biotic integrity for assessing vernal ponds and small palustrine wetlands using fish, crayfish, and amphibian assemblages along southern Lake Michigan. Aquatic Ecosystem Health and Management 3: 407-418.

Tahir, M. A., A. K. Risen and N.A. Hussain. 2008. Monthly variations in the physical and chemical properties of the restored southern Iraqi marshes. Marsh Bulletin 3: 81-94.

UNEP. 2007. Iraqi marshland observation system (UNEP/IMOS) Website: //imos. grid. unep.ch/

Uzarski, D. G., T. M. Burton, M. J. Cooper, J. W. Ingram, and S. Timmermans. 2005. Fish habitat use within and across wetland classes in coastal wetlands of the five Great Lakes: development of a fish-based index of biotic integrity. J. Great Lakes Res. 31: 171-187.

تقييم بيئي لتجمع أسماك هور شرق الحمار باستخدام دليل التكامل الحياتي IBI

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الخلاصة

قيمت بيئة تجمع أسماك هور شرق الحمار للفترة من تشرين الأول 2005 ولغاية أيلول 2006 باستخدام دليل التكامل الحياتي Integrated Biological Index (IBI). تم انتخاب 16 وحدة لقياس دليل التكامل الحياتي اعتمادا على غنى وتركيبة وطبيعة غذاء أنواع تجمع الأسماك. كانت حالة تجمع أسماك هور شرق الحمار مقبول (IBI= 42.6%) خلال عام 2005–2006، أي بعد السنتين الأولى من فعاليات إعادة المياه وتحسن نوعيته وهي أفضل من حالة الهور بعد مضي أربعة سنوات من ذلك، اذ بلغت قيمة IBI خلال عام 2007–2008 (40.8%). يتبين من النتائج عدم حصول تحسن جوهري في حالة الهور خلال السنين الأخيرة مما يعكس بان البيئة لازالت هشة وتتطلب وقتا لاستعادة حالتها الطبيعية.