Evaluation of Iraqi Marshlands Environment: Through Spatio - Temporal Differences of Fish Integrated Biological Index

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Abstract:

Restored environment of central and southern marshes were evaluated by applying fish integrated biological index (FIBI) on data collected during the period from October 2005 to February 2007. Monthly and yearly changes of FIBI were noticed in the three of the major restored marshes (Huwazah, Chebiyesh and East Hammar). Temporal FIBI scores in East Hammar was higher than the other two marshes , the scores were rated more than 50 (fair) in several months and in few months exceed 60 (fair). Spatial differences in FIBI scores were recorded between several restored central and southern marshes during summer 2007, variations existed even between local stations in the same marsh. The highest spatial scores were recorded in East Hammar ,followed by west Hammar and Chebiyesh. Low saptio-temporal scores obtained in most of the studied marshes reflect that the environment of marshes is still distributed and fragile, need more time and care to be fully recovered.

Introduction

Integrated Biological Index (IBI) was defined as an index to monitor the ecological integrity of water bodies and evaluate the degree of disturbance, degradation and imbalance environmental conditions. The assemblages consider integrated

if its composition and functions are comparable with those of natural habitat (Karr *et al* 1987) . Biological integrated is the best tool to monitor at the assemblage level (Ganasan and Hughes,1998 ;Hughes *et al.,* 1998) . IBI reflects the important components of the habitat ecology: taxonomy ,occurrence , tropic composition, individual abundance and assemblage health. Minns *et al.* (1994) developed a fish-based IBI for marshes of Great Lakes areas of USA which included metrics sensitive to the abundance of alien species, alterations of vegetation stand , water quality and modification in basin physical habitat. Brousseau and Randall (2008) stated that using the IBI is successful key to monitor wetland restoration and to evaluate the effectiveness of conservation practices. Hydrological disturbance like drought and flood play plays major role on spatio-temporal distribution of fish in wetlands considered as crucial ecological factors in existence of fishes as pointed out by Ruetz *et al.* (2005), However Rozas and Odum (1988) showed the major role played by aquatic vegetation as shelter and food resource for fishes in wetland. Recently the Integrated Biological Index using fish communities (FIBI) was reviewed by Simon (1999) to highlight its efficiency to evaluate the magnitude of disturbance of aquatic environment.

The restored environment of the Iraqi marshes were surveyed after inundation in 2003 by IMRP (2006), ARID(2006), CIMI(2006). Key Biological Area /Nature Iraq (KBA/NI project, 2006) concerned more specifically with the abundance of freshwater species and other migratory marine species to the marshes as one of the major tasks of the project (Abd *et al*. 2009). The abundance and ecological indices of fishes in three southern marshes was studied by Hussain *et al*. (2008). Few articles were traced deal with FIBI in southern marshes like Al-Shamary (2008), Al-Shamary and Younis (2009), Abd (2010) ; Mohamed and Hussain (2012).

The aim of this work is to evaluate the restored environment of the Iraqi marshes by applying modified FIBI

metrics in attempt to assess the environmental rehabilitation process of Iraqi marshland .

Materials and Methods:

The fish data were collected by the second author of KBA team from three major marshes (Huwayza , Chebiyesh and East Hammar) and from other marshes including central marshes.(Zichry, Abu Zarag, Al Wadah) and West Hammer (Fig. 1).Fishes were collected from these marshes during 2005,2006 and 2007 by several types of nets and methods as explained by Abd *et.al.*(2009) .

The data mainly

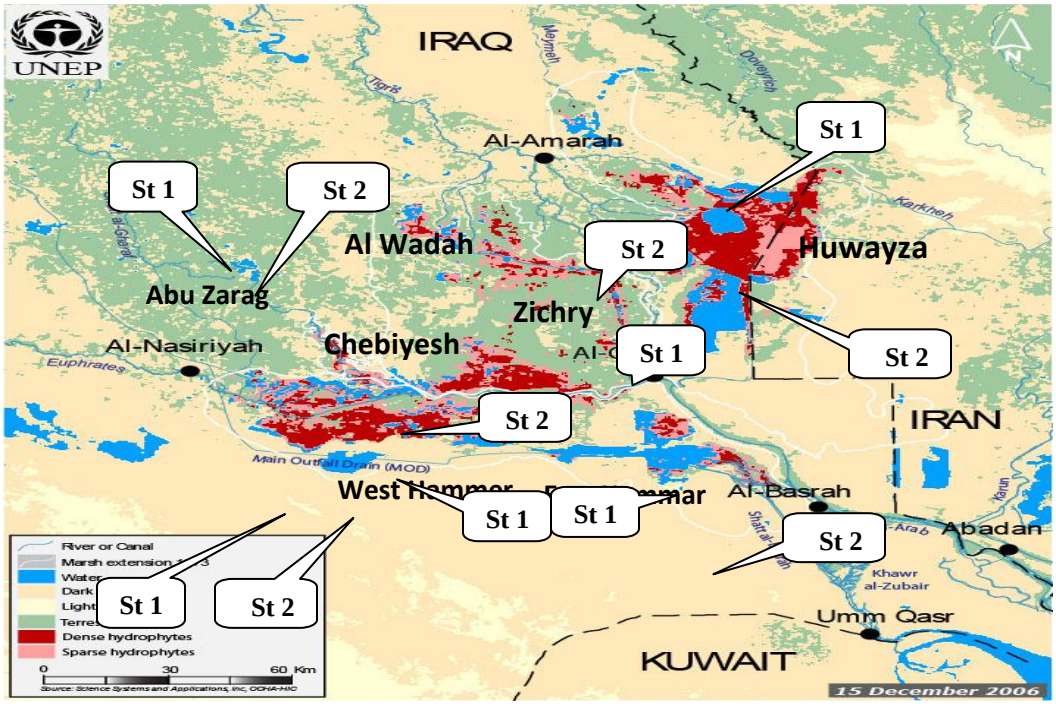

Fig (1) The Map of South Iraq showing the studied marshes .

Ecological indices were calculated according to the following ;

Diversity index H´=1-∑ni /Nl ln ni /N (Shanon;Wiener , 1949),

Evenness index J =(H/ln N) (Pielou ,1977),

Richness index D = S-1 / ln N (Margalef, 1968)

FIBI metrics were modified to applicable the Iraqi marshes. Ten metrics were scored and then summed into an IBI value on monthly basis (Karr 1981 ; Karr *et al.* 1986). Basic ecological information on fish species

either native or alien, tolerant or intolerant and their trophic level and nature depend on Hussain *et al*, (2001) and Hussain and Ali (2006).The modified FIBI measured ten metrics of marsh fish community to assess the integrity of these marshes. Each metric was rated three points (worse), five (medium) and ten (good), in comparison with expected values of that attributed values of fish community before massive drainage. Rating metrics were summed to yield a numerical score ,to assign to one of the five qualitative levels equals quantities rates of modified FIBI , as follows:

Qualitative levels	Quantities rates
Disturbed	35-49
Fair	50-64
Normal	65-74
Natural	85-90
Excellent	≥91

Results:

Metrics choose and designated to involve resident fish species including both native and alien were demonstrated in Table (1), in attempt to evaluate the status of the restored marshes environment by using occurrence , abundance , ecological indices and trophic nature and level of fish species.

Table(1) Criteria of metrics used to evaluate monthly FIBI in the southern marshes.

Metrics contributors				
No. of native species	All native species estimated to be 17 as base line (Hussain *et al*. 2008)			
No . of alien species	*Cyprinus carpio*	*C. aruatus*	*H. fossilis*	Marine species
Relative abundance of herbivores fish	*Carassius aruatus*	*Barbus sharpeyi*	*B. luteus*	*Ctenophryngodon idella*
Relative abundance of carnivorous individual	*Heteropneustes fossilis*	*Cyprinus carpio*	*B.xanthopterus*	*Gambusia holbrooki*
Relative abundance of predators individual	*Aspius vorax*	*Mastacembelus mastacembelus*	*Silurus triostegus*	*Aphanius dispar*
Relative abundance of intolerant Cyprinidae species	*B . grypus*	*Cyprinion microstmum*	*B. xanthopterus*	*B. kersen*
Relative abundance of tolerant native species	*Acanthobrama marmaid*	*Alburnus mossulensis*	*L.abu*	*B, luteus*
Diversity index				
Evenness index				
Richness index				

Temporal Variations :

Monthly changes of FIBI scores in the three major restored marshes (Huwaza , Chebiyesh and East Hammar) were exhibited in Fig (1). In general, FIBI of East Hammar was higher than the other two marshes, the scores were more than 50 in several months and in limited months exceed 60 . Huwaza was better than Chebiyesh, only in Oct.2005,Nov.2006 and March exceed 50 scores . Chebiyesh was the worse restored marsh only in February 2007 exceed 50 score. In general, the score February in 2006 was the lowest score recorded during 18 months sampling program in the three marshes. FIBI

scored highest values in April 2006, February 2007 and November 2006 in East Hammar, Chebiyesh and Huwayza respectively.

Seasonal variations of FIBI were displayed in Table (2) .Winter season score the lowest values than other seasons spring ,summer and autumn in the three monitored marshes .In average East Hammar score the highest level (53.8)followed by Huwayza (45.5) and the last was Chebiyesh (43.3)

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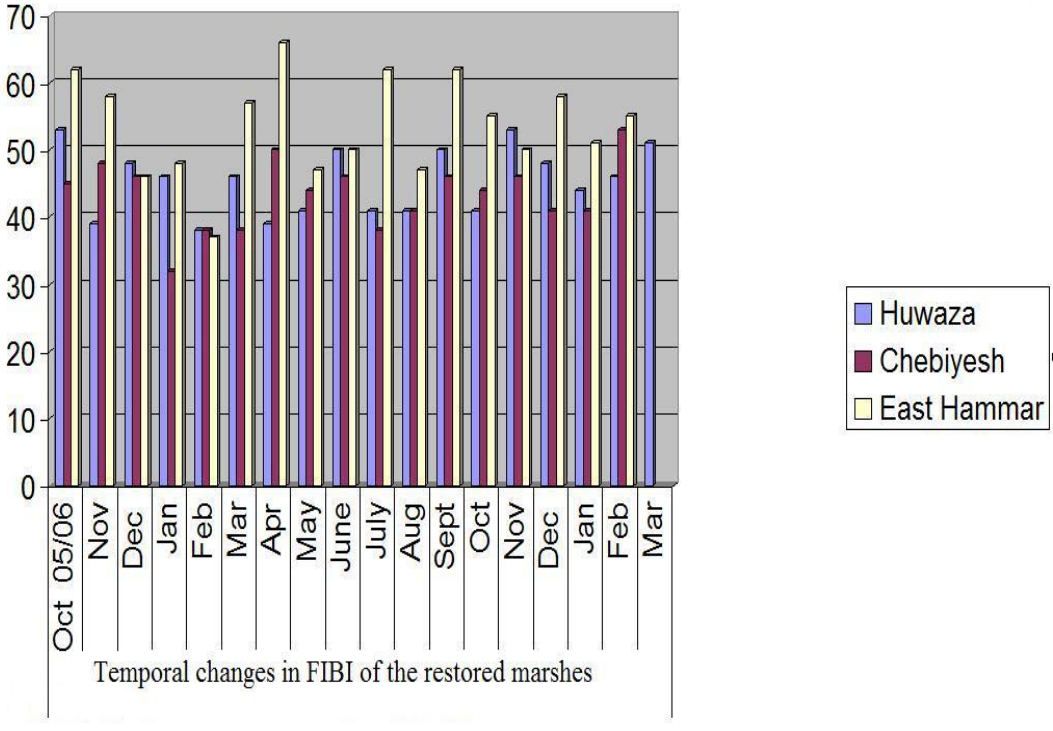
Table (2) Seasonal variations in FIBI at the monitored Iraqi marshes (Chebiyesh, Huwayza and East Hammar) during the period from 2005 to 2007.

Marsh	Winter 2005-2006	Spring 2006	Summer 2006	Autumn. 2006	Winter 2007	Average (18 months)
Chebiyesh	38.6	44	41.6	45.3	45	43.3
Huwayza	44	42	44	48	46	45.5
East Hammar	43.6	56.6	53	54.3	54.6	53.8

Comparing score of FIBI of multiple seasons winter and summer 2005-2006 and 2006-2007 represent different environmental conditions and extreme weather prevailing on the marshes region (high, low temperatures, changing water levels, low productivity and scarcity of food resources), showing improvements in the scores between winter 2005-2006 and 2006-2007 (Table 3) in the three marshes studied. Summer scores didn't reflect the same improvements in Huwayza and East Hammar, lower values could be to the increase in fishing activities. Chebiyesh was on the contrary of the other two marshes and score slightly higher value in summer than winter. In general, East Hammer score, was higher seasonal FIBI values. Table (3) showed an improvement in 2007 in comparison with 2006 especially in Chebiyesh and East Hammar. Winter season 2007 in all marshes score higher values than that of 2006 .

Table (3) Comprison of FIBI scores of multiple seasons in the three monitored marshes (Chebiyesh, Huwayza and East Hammar) during the period from 2005 to 2007.

Marsh	**season**	**2005-2006**	**2006-2007**
Chebiyesh	winter	38.6	45
	summer	41.6	44
Huwayza	winter	44	46
	summer	44	40.5
E.Hammar	winter	43.6	54.6
	summer	53	48.5



Fig(2) Temporal changes in IBI scores in three major restored marshes (Huwaza ,Chebiyesh and East Hammar).

Spatial differences:

Spatial differences in FIBI between several restored marshes during summer 2007 were illustrated in Fig.(3), indicate that East Hammar was different from other marshes and with minor differences between local stations Sada (St1) and Burkha (St2) ,followed by West Hammar with second highest score with moderate differences between Amia (St1) and Al-Wenns (St2) , then Chebiyesh marsh with meaningful difference between Abu- sobat (St1) and Baghdadea (St2). In Huwaza and Abu Zarg marshes the differences also existed between stations but St1 have higher score than St2 the same was in St1 in Huwaza (Um al-Naaj) a wide openness marsh and St2 was Al-Taraba shallow vegetation marsh ,the same in Abu Zarag.The score of FIBI was the same in both station in Zachrey marsh. In general differences in score of FIBI between marshes and related stations reflected the spatial variations in environment situations existed between marshes and even the stations .The higher scores recorded by East and West Hammar than the rest of marshes, indicated that resorted environment was better in the southern marshes than the central marshes.

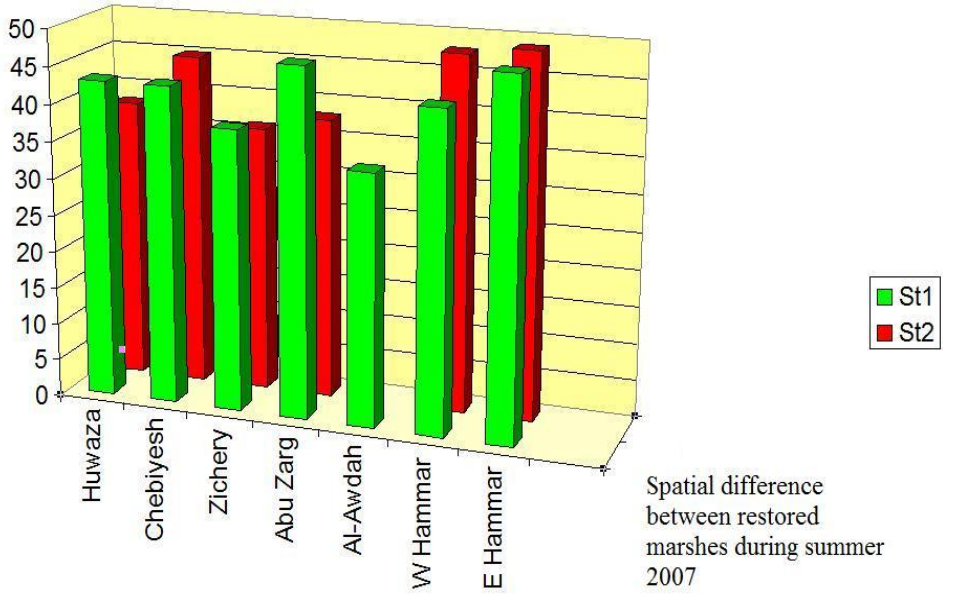


Fig (3) Spatial differences between southern and central restored marshes in general and local stations (stations 1 and 2), during summer 2007.

Evaluation of Iraqi marshes by FIBI:

Table (4) showing the average numerical scores and status description of the surveyed marshes in central and southern Iraq. Only East. Hammar reach the level to be rated as fair (53.8), Abu Zarak in central marshes coming in second rank with score 48 and Huwayzah in third placed with scored of 45.5. Chebiyesh marsh scored the lowest rate with value of 43.3 . The low score of less than 50 for most studied marshes reflect the disturbed environment in the restored marshes .

Table (4) Average FIBI rating of monitored marshes as scored position (numerical value) and status description during the study period.

Description Status	Numerical Range	Huwayza	Chebiyesh	East Hammar	Zichry	Abu Zarak	west Hammar
Disturbed	35-49	45.5	43.3		45	48	45
Fair	50-64			53.8			
Normal	65-74						
Natural	85-90						
Excellent	≥91						

Discussion:

Fishes known to occupied different trophic levels like being herbivorous, carnivorous,dertiovorous and as predators beside exist in various habitat (freshwater, estuarine and marine),consequently consider as prefect organism to monitor the integration of aquatic environment .

Thirteen years of desiccation of Iraqi marshes brought a catastrophic damages to the wetland environment of southern Iraq , changing the vast green marshes to be a desert terrain (Richardson *et al.* 2005). Desiccation of marshes and multiple burning of reed stands alter the nature of soil to be hard to recolonize again by benthic organisms (Flitzpatric, 2004) and destroy the productivity cycles and prevailing food webs (Richardson and Hussain , 2006). Drought and

desiccation were forms of hydrological disturbance as considered by Ruetz *et al.* (2005) plays a crucial ecological role in distribution and survival of fishes in wetlands. The collapse of original trophic pyramids in the restored marshes was clear in KBA data perhaps due to the absence of herbivorous species and increase of omnivorous and predators species like C*arasisus aruatus , Barbus luteus,Silurus triostegus* and *Aspius vorax*. Increase numbers of individuals of alien and exotic species (*C.aruatus* and *Cyprinus carpio*) led to decrease the relative abundance of other native species, total number of species and relative abundance of intolerant (mostly cyprinid), since these alien and exotic species were opportunistic species feed on available resources, while native species were more restrict and specialized in their diet (Hussain *et al.*, 2008b;2009b).

FIBI rating of East Hammar marsh was higher than other mashes could be due to several reasons, first it is mesosaline marsh known worldwide by its higher productivity, second offering huge food resources due to the existence of mixed communities of freshwater and estuarine organisms and third migration of estuarine / marine fish species will increase number of species and individual in comparison with other freshwater and oligosaline marshes (Hussain *et al.*, 2009b ;Mohamed *et al.*, 2009). Due to the mention reasons, East Hammar was the only marsh to score 53.8 (fair) while the rest were scored less than 50 (disturbed).

Lower winter score values of FIBI in comparison with other seasons especially summer and autumn due to the reduced activity of fishes due to low temperatures, sacristy of food resources and third to emigration of marine species back to the Arabian Gulf (Mohamed *et al*.,2009)

Spatio-temporal deviation in FIBI score were noticed between the marshes showing that the environmental restoration rates were different between the marshes and also in same marsh as exhibited between local stations.

Improvement in quantity and quality of water reached to the marshes in

2007, resulted an increase in FIBI score and consider better year than 2005 and 2006. Hussain *et al*. (2010) showed that the water quality index (WQI) of the restored marshes was marginal (45-65) from scale of five categories. The highest Water quality index of marshes was recorded during 2007, East Hammar marsh showed highest average WQI during the survey period (2005-2008).

The lower scores of FIBI in most of Iraqi marshes, could be attributed to several factors. The massive drainage led to vanish of the local ecological habitat and original biological communities, disappearance of the local (marsh) fish population , deterioration of water quality especially increase of salinity, nutrients ; other perturbations from the resources (Tigris and Euphrates) and increase of fishing pressure by the marsh dwellers inflecting serious damages especially by using poisons. These factors play a fundamental role in lowering scores and ratings (values) of FIBI through removing several species and a lot of individuals (IMRP,2006 and ARDI,2006).

The disappearance of intolerant cyprinid species like *B. xanthopterus* , and *B.grypus* could be related to the vanish of their diets like insect and small invertebrates beside unfavorable environmental conditions like higher salinity(Ali*et al*.,2007;Al-Saffar 2006) The low abundance of *C. carpio* could be due this species became unable to suck the muddy substratum to extract the benthic organisms or disappearance of these organisms (Ali *et al*. 2007 and Al-Saffar, 2006) , to be forced to alter its diet to become omnivorous instead previously known as carnivorous. The same could be true for several species like *B. luteus* known to be previously as omnivorous , change diet to be herbivorous. species like *A. vorax* and *S. triostegus* before desiccation depend on insect, shrimps and small fish on their diet changed to be predators depend on small fishes (Mohamed and Hussain ,2012b).

The low abundance of *A. mossulensis* and *A. marmid* could be related to sacristy of insect, and alter to depend more on organic detritus (Hussain *et al*., 2008a and 2009a).

The change in trophic nature of fish species in marshes shift their categorization from certain level to another, as in cases of *C. carpio* and *B. luteus.* The improvement of ecological situation in the restored marshes help these species to switch back to their natural trophic diet, consequently different set of criteria will be appear resulted in higher FIBI scores .

Huge occurrence of alien species *C. aruatus* effect the marsh fish population through the competition with native species like *B. sharpeyi* and *B. luteus*. It was known that the occurrence of exotic species like C. carpio affect the abundance of other native species like *B. xanthopterus* and *B. kersin.*(Hussein *et al.*, 2000 and Mohamed *et al.* 2012) .

In general the Low values of FIBI scores of the studied marshes reflect the slow improvement of restored environment, need more time, care, effort and comprehensive monitoring to be fully recovered .

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تقيم بيئة الاهوار العراقية : من خلال الاختلافات المكانية والزمانية للدليل التكامل الحياتي للاسماك .

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الملخص:

قيمت بيئة الاهوار العراقية المسترجعة وذلك باستخدام الدليل التكمال الحياتي للاسماك (FIBI) .جمعت البيانات خلال الفترة الممتدة من تشرين الاول 2005 ولغاية شباط 2007. لوحظت اختلافات شهرية وسنوية في قيم الدليل لثلاثة من الاهوار الرئيسية وهي الحويزة والجبايش وشرق الحمار.سجلت اعلى القيم للدليل في هور شرق الحمار وكانت بحدود المقبول (50) وتجاوزت في اشهر معدودة مستوى المتوسط (60) ..لوحظت اختلافات مكانية في قيم الدليل بين الاهوار المختلفة وحتى بين المحطات الفرعية في ذات الهورز سجلت .اعلى القيم المكانية في هور شرق الحمار يليه غرب الحمار ثم الجبايش.. بينت القيم الزمانية والمكانية المستحصلة للدليل ان بيئة الاهوار المسترجعة لازالت مضطربة وهشة وتحتاج الى مزيد من الوقت والرعاية للعودة الى حالتها الطبيعية مجددا .