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Fish Species Composition, Distribution and Abundance in Shadegan Wetland

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Abstract

Composition, distribution and abundance of fish species was carried out from April 2012 to Mars 2013 in the Shadegan wetland. Samples were collected from five stations; Mahshar, Rogbe, Khorosy, Salmane and Ateish in this local in Khuzestan provinces (Iran). A total of 3312 fish individuals comprising 26 species from 6 families were sampled throughout the entire study period. The most abundant species was *Carasobarbus luteus* (Cyprinidae) comprising 28.20% of the total fish caught. The mean CPUE (catch per unit effort) for all species was 29 nu/day and maximum and minimum CPUE values were 47.60 ± 11.61 nu /day (spring) and 18.40 ± 5.94 nu /day (winter), respectively. Maximum and minimum Shannon-Weinner values were 2.21 (spring) and 2 (autumn), respectively. The Shannon-Weinner value differ significantly between different station ($P<0.05$) and Margalef's, Evenness, Simpson's index didn't differ significantly between different station ($P>0.05$). A comparison of value salinity is significant between different station ($P<0.05$) and other parameters is no significant different station ($P<0.05$). The Wetland Fish Index (WFI) calculated for the entire wetland using total abundance was 2.99. The WFI should prove to be an effective tool to aid in the management and protection of important fish habitat in Shadegan wetlands.

Keywords: Shannon-weinner values; Wetland fish index; Shadegan wetland

Introduction

It is important to know the fish species diversity, abundance and distribution in the reservoirs in order to develop management and conservation programs. Studies of spatial and temporal patterns of diversity, distribution and species composition of freshwater fishes are useful to examine factors influencing the structure of the fish community [1]. Biodiversity is the quantity, variety and distribution across biological scales ranging through genetics and life forms of populations, species, communities and ecosystems [2]. Biodiversity is important for the future sustainability of natural resources that include commercial fisheries. While it is axiomatic that biodiversity is essential for sustainable productive fisheries there is surprisingly little supporting evidence. Fish species are also an important indicator of ecological health. The abundance and health of fish will show the health of water bodies [3]. This is supported by Zainudin [4] who claimed that fish species diversity can be used as a biological indicator to show the level of aquatic pollution contributing to environmental quality. Biodiversity affects the capacity of living systems to respond to changes in the environment, underpins ecosystem function and provides the ecosystem goods and services that support human well-being [5,6]. This has led to the development of some management programs to conserve and to increase needs for the freshwater fish population.

Wetlands are invaluable ecological resources that serve many human needs and therefore, enhance our lives by providing a lot of opportunities. Many depend heavily on the resources of such water bodies as their main source of animal protein and family income [7]. Wetlands in the world was included about 7 to 9 million km^2 (4-6 percent of Earth surface). Iran wetlands are approximately 1853762 ha and between Middle East wetland was contained 25% [8]. Shadegan Wetland in Khuzestan province is one of the 18 international wetlands registered on UNESCO's Natural Heritage List. Located 52 km from Abadan and 105 km from Ahvaz, it is Iran's largest wetland and by Linking Jarahi River connect with Persian Gulf waters, the wetland is considered one of the most wonderful natural landscape of the world because of it is unique biodiversity [9]. In 2006, fish landings in Shadegan wetland reached a peak of 3700 tons, which corresponds to more than 10 billion$ [10]. The wetland is a unique natural asset for the province of Khuzestan, supporting a rich biodiversity, including threatened and endemic species. water resources development for agricultural intensification in the upstream catchment which would reduce the volume of the inflows, and change the seasonality of flooding development of heavy industries and infrastructures around and within the wetland pollution from industrial, urban and agricultural (including aquaculture) wastes oil spills [9].

In this study, we examined the fish species composition, distribution and abundance in shadegan wetland. Our main aims were to: (i) Estimation of fish species composition, distribution and abundance, (ii) different distribution and abundance in stations and seasons. Maramazi [11], Ansari and Mohamadi [12,13] and Ansari et al., Hashemi et al., were searched fish survey, stock assessment and capture conditions of shadegan wetland. Lotfi et al., [9] were considered human activity and effect on shadegan wetland and also diversity and capture situation of shadegan wetland. However, one study so far has been made on fish distribution and abundance in shadegan wetland. For rational and sustainable management of this exploited resource, information on the species composition, abundance, distribution, and growth are provided. These data can be used to better fisheries stock management for these valuable fish.

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Material and Methods

Study area

Composition, distribution and abundance of fish species was carried out from April 2012 to Mars 2013 in the Shadegan wetland. Samples were collected from five stations; Mahshar (48˚,45′ E,30˚,33′ N), Rogbe (48˚,33′ E, 30˚,41′ N), Khorosy (48˚,40′ E, 30˚,39′ N), Salmane (48˚,28′ E, 30˚,40′ N) and Ateish (48˚,40′ E, 30˚,54′ N) in the Shadegan wetland in Khuzestan provinces (Figure 1). In each month, 5 stations were selected for sampling. Fish species was carried out by using gill net with 45 mm mesh and then Sampling transported to lab with dry ice. The gill nets were set at dusk and hauled the next morning. All fish caught were identified to species using standard taxonomic keys following Nelson and Coad [14,15].

Data collection

Habitat monitoring and fish sampling were carried out seasonally from September 2012 to September 2013. Fishing gears set for sampling at study sites were sometimes destroyed by other fisherman in this wetland. In such cases, data collection was repeated in the next year at the same place and the same time period. Sampling started at a random point and then proceeded at evenly distributed intervals along the shoreline of the water body. Seasonally water samples for analysis of environmental parameters were collected from each station using a Nansen bottle sampler and analyses as per standard analytical procedures [16]. Eighteen environmental parameters (Table 1) were considered in this research and included water temperature (WT), water depth (WD), water salinity (WS) phosphorus (TP), nitrate (TN), PH, biological oxygen demand (BOD) and dissolved oxygen (DO).

Diversity of fish species

The diversity of fish species was estimated in terms of species evenness, using Margalef's D index, Shannon Wiener, Evenness

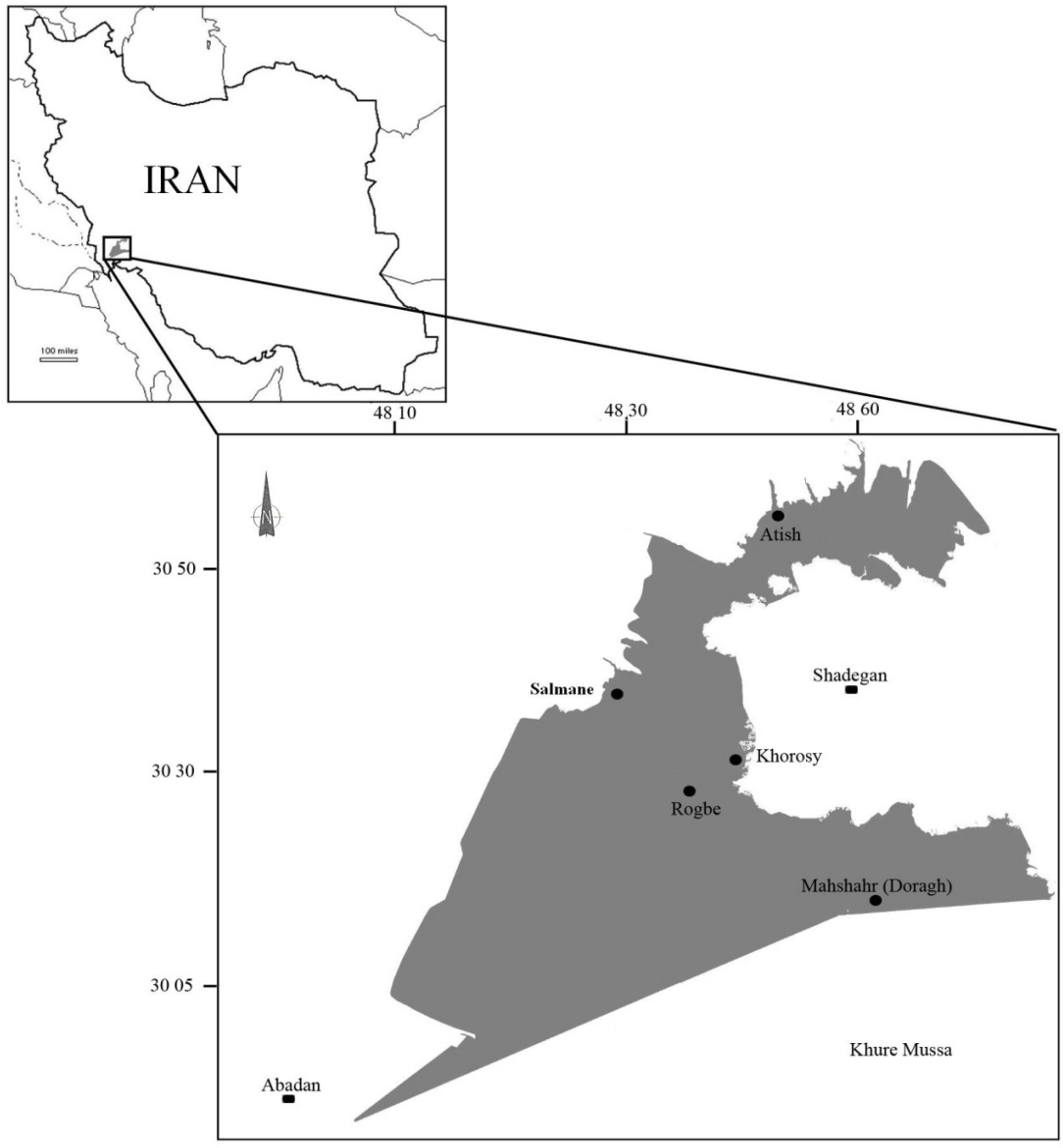

Figure 1: The map of Iran, Location of five Capture sites was sampled in Shadegan wetland (Khuzestan province, South West of Iran).

Family	Species	status	N	%N	W (Kg)	%W	Y	U	T
Cyprinidae	*Carasobarbus luteus*	native	934	28.20	73.78	15.74	2.97	4	4
Cyprinidae	*Cyprinus carpio*	native	613	18.50	58.23	12.42	2.78	4	4
Cyprinidae	*Carasius carasius*	native	437	13.19	44.57	9.51	2.64	3	4
Mugilidae	*Liza abu*	native	399	12.04	13.56	2.89	2.60	2	2
Cyprinidae	*Mesopotamichthys sharpeyii*	native	336	10.14	56.78	12.11	2.52	2	3
Cyprinidae	*Aspius vorax*	native	191	5.76	29.98	6.39	2.28	2	3
Cyprinidae	*Hypophthalmichthys molitrix*	introduce	75	2.26	6.01	1.28	1.80	2	3
Cyprinidae	*Barbus grypus*	native	74	2.23	11.32	2.41	1.87	2	3
Siluridae	*Silurs triostegus*	native	61	1.84	154.49	32.97	1.78	3	4
Cyprinidae	*Hypophthalmichthys nobilis*	introduce	50	1.50	5.7	1.21	1.69	2	2
Sparidae	*Acantupagrus lutus*	exotic	47	1.41	2.25	0.48	1.67	1	2
Cyprinidae	*Ctenopharingodon idella*	native	25	0.75	2.6	0.55	1.39	2	3
Mastacembelidae	*Mastacembuls mastacembuls*	native	20	0.60	4.09	0.87	0.84	2	3
Cyprinidae	*Luciobarbus pectoralis*	native	13	0.39	1.59	0.33	1.11	2	2
Mugilidae	*Ellonchelon vaigiensis*	exotic*	6	0.18	1.21	0.25	0.77	1	1
Mugilidae	*Chelon subviridis*	exotic*	6	0.18	0.81	0.17	0.77	1	1
Engraulidae	*Thrssa hemiltoni*	exotic*	5	0.15	0.2	0.04	0.69	1	1
Siluridae	*Heteropenusti fossili*	native*	3	0.09	0.6	0.12	0.47	1	1
Cyprinidae	*Luciobarbus xantropetrous*	native*	3	0.09	0.4	0.08	0.47	1	1
Cyprinidae	*Acanthobra mamarmid*	native*	2	0.06	0.2	0.04	0.3	1	1
Clupeidae	*Sardinellas indensis*	exotic*	2	0.06	0.05	0.01	0.3	1	1
Cyprinidae	*Alburnoides bipunctatus*	native*	2	0.06	0.04	0.008	0.3	1	1
Cyprinidae	*Cyprinion macrostumus*	native*	2	0.06	0.04	0.004	0.3	1	1
Cyprinidae	*Cyprinion kais*	native*	2	0.06	0.02	0.004	0.3	1	1
Cyprinidae	*Barbus luciobarbus*	native*	2	0.06	0.01	0.002	0.3	1	1
Clupeidae	*Tenualosa ilisha*	exotic*	2	0.06	0.01	0.002	0.3	1	1

Table 1: Table showing the list of fish species caught and the percentage composition for fish population in shadegan wetland and Water-quality optimum (U) and tolerance (T) values for 26 fish species from abundance (AB) data. (*Species occurring in <5% of wetlands were automatically assigned a T value of 1).

ratio and Simpson's. Species diversity, abundance and richness are determined by following May (1993) and used following diversity indices:

- Margalef's Index

MD= S-1/LogN

Where S= total number of species, N=total density and Ni=density of individual species.

- Shannon-Weinner Index

H= -{ni/Nlog2 ni/N}

- Evenness ratio

The species evenness ratio is the ratio of the observed species diversity (H') to the maximum possible for the same number of species in the sample (log S). It is expressed as:

J'=H'/log S.

If J'=1, the biomasses of the individual species are evenly distributed among all of the species in the sample [17].

- Simpson's Index

D=1-Ni(n) – I/N(N-1)

In order to test for differences in diversity among fishes in different seasons of the year, pair wise randomization tests were carried out, abundance data following May (1993). The analyses were performed as per the method of May [18] using Species Diversity and Richness software and Microsoft Excel sheet.

Wetland fish index (WFI)

To develop the WFI, each species was assigned U and T values according to the following equation [19].

$$WFI = \frac{\sum YiTiUi}{\sum YiTi}$$

Where Yi is the presence or log10 abundance (log[x + 1]) of species i, Ti is the value from one to three (indicating niche breadth), and Ui is the value from one to five (indicating tolerance of degradation).

CANOCO 4.5 [19] was used to run canonical correspondence analysis (CCA) as in Seilheimer and Chow-Fraser [19,20]. Canonical correspondence analysis (CCA) was used to explore the distribution of the fish communities in relation to the environmental variables. If a species occurred only once, it was excluded from the CCA analysis. Environmental variables selected for the CCA analysis included continuous variables, such as water quality data (e.g., pH and COD). All continuous environmental variables were log (1 + x) transformed and standardized to have a zero mean and unit variance. Comparison of *environmental parameters* and species diversity, abundance, richness during different spatial and temporal carried out by analysis of variance (ANOVA). Statistical analyses were performed with SPSS 21 software package and a significance level of 0.05 was adopted.

Result

A total of 3312 fish individuals comprising 26 species from 6 families were sampled from Shadegan wetland throughout the entire study period (Table 1). The most abundant species was *Carasobarbus luteus* (Cyprinidae) comprising 28.20% of the total fish caught, followed

by *Cyprinus carpio* (Cyprinidae) (18.50%) and *Carasius carasius* (Cyprinidae) (13.19%). The most total weight fish was Silurs *triostegus (Siluridae) and Carasobarbus luteus* (Cyprinidae) comprising 32.97% and 15.74% respectively. Maximum and minimum abundant family were Cyprinidae (82.91%) and Engralidae (0.5%) respectively (Figure 2).

CPUE (catch per unit effort)

The mean CPUE (catch per unit effort) for all species was 29 nu/day and maximum and minimum CPUE values were 47.60 ± 11.61 nu /day (spring) and 18.40 ± 5.94 nu /day (winter), respectively. The mean depth of fishing was 1 m and ranged from 0.5 m to 2.5 m. Value CPUE in each Station (Figure 3) and this value in different season was showed (Figure 4). A comparison of value CPUE is significant between different season (ANOVA, F=16.09, P<0.05) and there is significant different station them (ANOVA, F=73.49, P<0.05).

Environmental parameters and diversity of fish species

Physic-chemical parameters and diversity of fish species are shown in Tables 2-4. A comparison of value salinity is significant between different station (ANOVA, F=18.21, P<0.05) and other parameters is no significant different station (P<0.05).

In different station, Maximum and minimum Shannon-Weinner values were 2.04 (Atish) and 1.61 (Rogbe), respectively. The Shannon-Weinner value differ significantly between different station (ANOVA, P<0.05) and Margalef's, Evenness, Simpson's index didn't differ significantly between different station (ANOVA, P>0.05). Maximum and minimum Shannon-Weinner values were 2.21 (spring) and 2

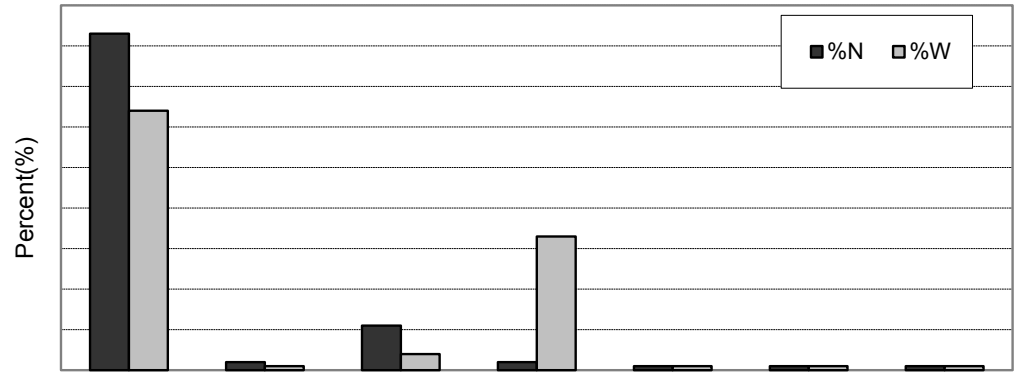

Figure 2: Fish abundant family was sampled in Shadegan wetland (%N=percent of fish number and %W= percent of fish weight).

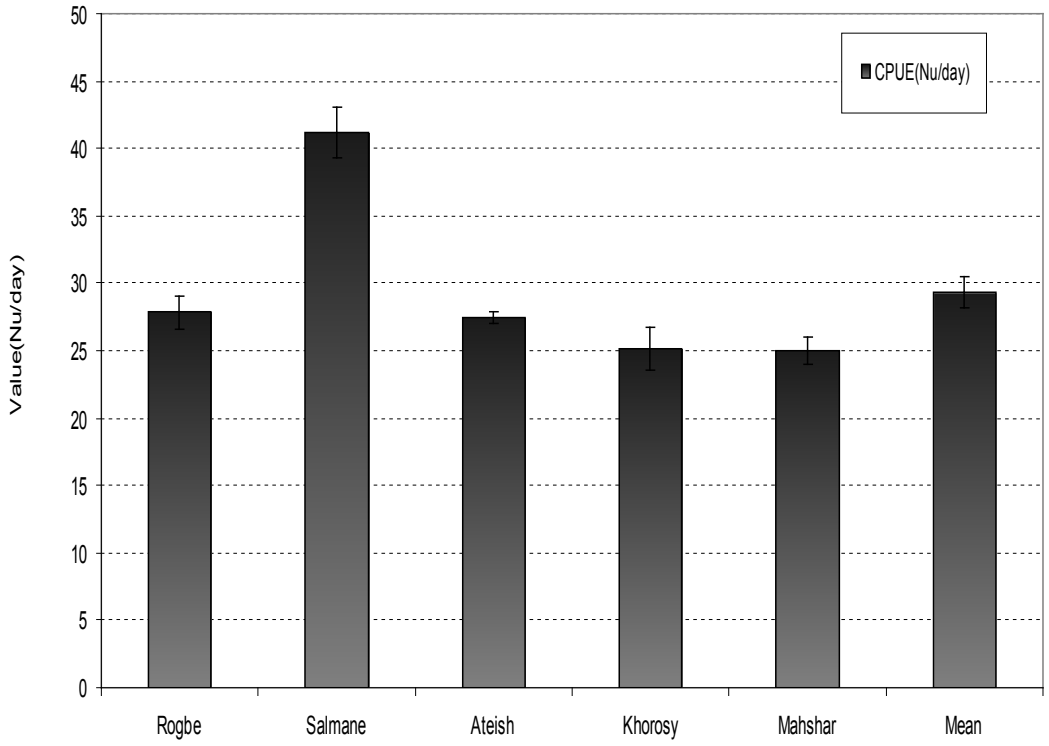

Figure 3: Value CPUE in different station from Shadegan Wetland (2012-13).

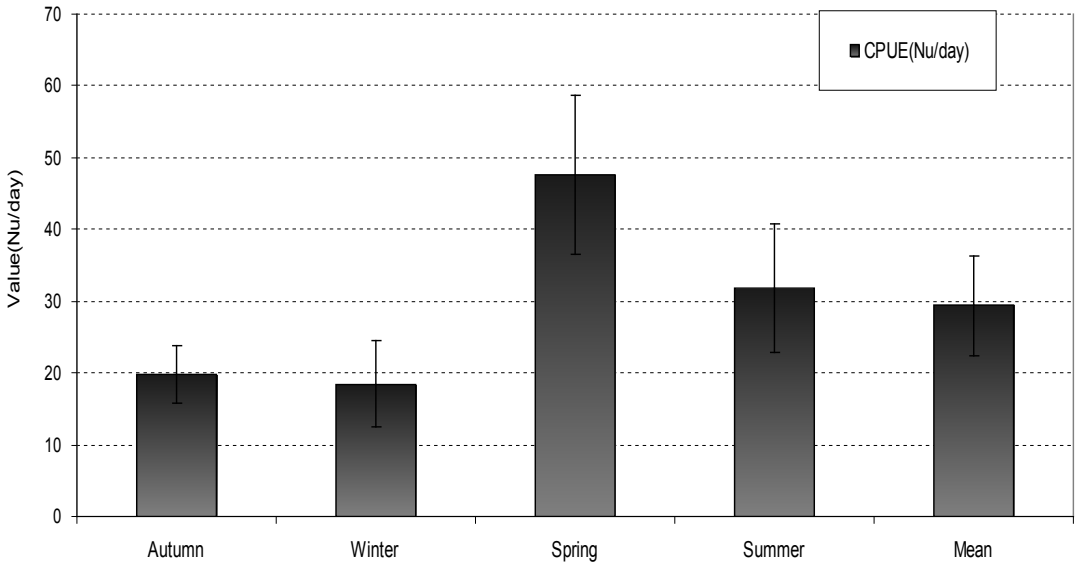

Figure 4: Value CPUE in different season from Shadegan Wetland (2012-13).

Varible	Value	Kanal	Atish	Rogbe	Mahshar	Khorosy	P-values
Do	Max	7.5	8	6	8	10.5	>0.05
	Min	4.5	4.5	2	2	3	
	Mean	6.38 ± 1.31	6.88 ± 1.68	3.25 ± 1.85	5.13 ± 3.23	6.95 ± 3.35	
BOD	Max	3.5	4.5	2.5	3	6.5	>0.05
	Min	2.5	2.5	1	2	4	
	Mean	2.88 ± 0.48	3.63 ± 0.85	1.75 ± 0.65	2.38 ± 0.47	4.74 ± 0.95	
PH	Max	8.2	8.3	8.3	7.5	8.7	>0.05
	Min	7.5	8	8	7.2	7.2	
	Mean	8.03 ± 0.03	8.13 ± 0.13	8.10 ± 0.10	7.28 ± 0.12	7.98 ± 0.61	
Tem.	Max	22	22	25	24	21	>0.05
	Min	10	8	10	9	15	
	Mean	16.50 ± 5.20	16 ± 6.20	17.50 ± 6.24	16.75 ± 6.34	18.20 ± 2.64	
Sal.	Max	40	6	17	50	8	< 0.05
	Min	6	5	6	10	2	
	Mean	23 ± 14	5.25 ± 0.5	10.5 ± 4.8	18.75 ± 10.24	3.68 ± 2.97	
No3	Max	4.5	8.5	5	5.5	8	>0.05
	Min	3	4	4.5	4	4.5	
	Mean	4 ± 0.71	5.75 ± 1.43	4.63 ± 0.48	4.88 ± 1.15	6.79 ± 1.32	
Po4	Max	0.7	0.6	0.6	0.8	1.2	>0.05
	Min	0.2	0.3	0.1	0.2	0.2	
	Mean	0.5 ± 0.22	0.45 ± 0.13	0.5 ± 0.39	0.58 ± 0.26	0.65 ± 0.24	
Deep	Max	2.2	2.8	2.4	2.4	2	>0.05
	Min	2	2.1	1.4	1.4	1.4	
	Mean	2.08 ± 0.1	2.45 ± 0.29	1.9 ± 0.44	1.93 ± 0.5	1.73 ± 0.32	

Table 2: Physic-chemical parameters in different station from Shadegan Wetland (2012-13).

(autumn), respectively. A comparison of value Shannon-Weinner, Margalef's, Evenness and Simpson's didn't differ significantly between different season (ANOVA, P>0.05). The correlation analysis showed that mean water temperature value was related significantly to deep water parameters used in this study; it related strongly and negatively (r^2= -0.89, P<0.05).

WFI and CCA

The WFI calculated for the entire wetland using total abundance was 2.99. These values fell between a possible range of 1-5, where 1 is most degraded and 5 is least degraded. An ordination of the 26 fish species with eight environmental variables produced significant correlations between species and variables associated with environmental degradation for AB data (Table 1). The position of a species on the CCA biplot is a reflection of the environmental conditions where it was found. The first axis of the CCA was strongly correlated with environmental conditions, where the positive end of CCA axis 1 was associated with species normally found in degraded conditions (e.g.,

Variable	Kanal	Atish	Rogbe	Mahshar	Khorosy	*P-values*
Margalef's	2.03	2.71	2.31	2.63	2	>0.05
Shannon-Weinner	1.7	2.04	1.61	2.39	1.95	< 0.05
Evenness	0.82	0.93	0.85	0.93	0.94	>0.05
Simpson's	0.25	0.15	0.16	0.1	0.4	>0.05

Table 3: Diversity of fish species in different station from Shadegan Wetland.

Variable	Spring	Summer	Autumn	Winter	*P-values*
Margalef's	2.62	2.09	2.11	2.39	>0.05
Shannon-Weinner	2.21	2.06	2	2.02	>0.05
Evenness	0.86	0.94	0.96	0.97	>0.05
Simpson's	0.14	0.15	0.14	0.13	>0.05

Table 4: Diversity of fish species in different season from Shadegan Wetland.

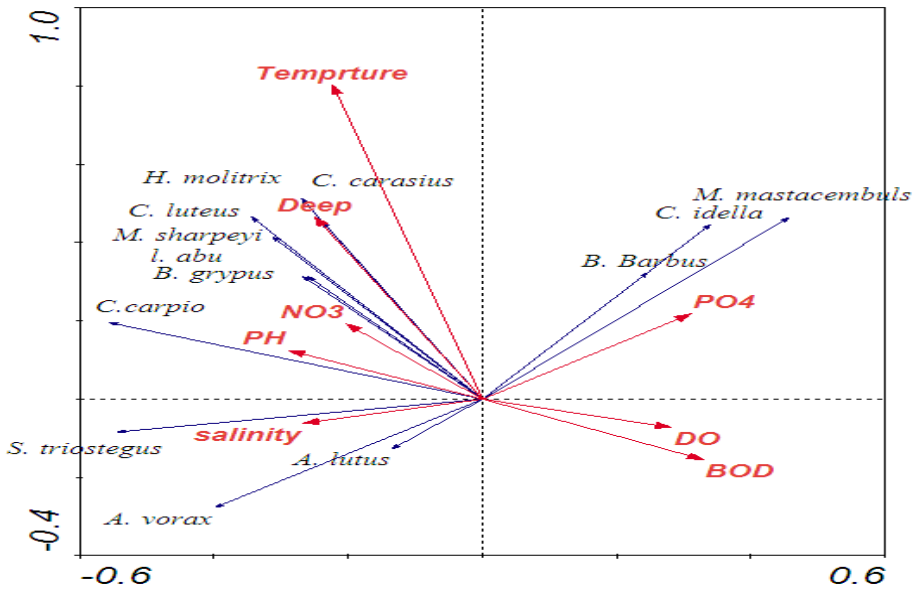

Figure 5: Ordination biplot of 26 fish species (see Table 1 for species numbers) from canonical Correspondence analysis (CCA) with 8 environmental variables in shadegan wetland.

BOD, DO) while the negative end was associated with species that are intolerant of water-quality impairment. The position of a species on the CCA biplot is a reflection of the environmental conditions where it was found. This location can be interpreted as representing the species' affinity for degraded vs. unimpacted habitat. It seems, *distribution of C. carasus*, *L. abu, C. carpio, C. luteus, H. molitrix, M. sharpeyi,* species are associated with temperature, deep, NO_3, PH and also *S. triostegus*, *A. vorax*, *A lutus*; *M. mastacembuls*, C. *idella* species with salinity and PO_4 respectively (Figure 5).

Discussion

The native marshland fish populations were originally dominated by Cyprinid fish of the genus Barbus. Hashemi et al. [21] reported that *C. carpio* was the most abundant species in their study in shadegan wetland. Overall, *B. luteus, M. sharpeyii, C. carpio, C. carasus, A. vorax* and *L. abu* are included over 70% biomass and fish main species of Shadegan wetland species [21]. The dominance of cyprinids in tropical reservoirs has been observed in Sri Lankan reservoirs, where the family formed over 50% of the species present [22]. Abundance of fish populations in river, lake with river source and reservoirs widely changed from year to year and the relative frequency of different species is different in population. This change is affected by rainfall fluctuation and floods. The increasing area and flood flow time is improved spawning, growth and survived rate [23]. Bias associated with fishing gear types can greatly influence comparisons of aquatic habitats, especially when meaningful community information is desired for habitat restoration research [24].

The east stations in different seasons have high amount of Shannon-Weinner. It seems that entering the Jarahi River for east side of the wetland and entering of nutrition element was the reason of phytoplankton increasing and phytobentoz production [25] that caused Shannon-Weinner values increase in these areas. The south station have high amount of Shannon-Weinner that caused entering marine fish species in different seasons to wetland (especial summer and autumn seasons [13]. Six species of Cyprinidae (*C. carpio, H. molitrix, H. nobilis,* C. *idella*, *B, grypus, M. sharpeyii*) were introduced to Shadegan wetland in 2009 to 2012 by the Department of Fisheries Iranian as a potential for fishing in this wetland. This was done under one of the regulation and conservation programs towards maintaining and enhancing the fishery resources in this local. It seems, with induces six species of Cyprinid, abundance fish has increased. This clearly showed that the species diversity indices values using Shannon-

Weaver index in this study is rather higher when compared to the values obtained from past study in this local (H=1.7-2, [26] Zakaria et al. found that species richness, species diversity and species survival in aquatic habitats were affected by several environmental factors, such as the physic- chemistry of the water, topographical, hydrological characteristics and habitat destruction.

The maximum CPUE obtained was in spring (inversely in Autumn season), it seems related to wetland climate status [13] and nutrients entering to river flow may be due to the season and also maximum phytoplankton production, wetland phytobentoz which was showed in spring time [25]. Managers commonly use catch per unit of effort (CPUE) methods for estimating population size and catchability coefficients in fish fisheries, because these parameters are key in the exploitation [27].

WFI scores was reported 2.64 in Shadegan wetland that near our finding (WFI=2.99). Interannual variation in WFI scores was not large and implies that the index will be a powerful tool for monitoring and for comparing scores calculated for wetlands sampled in different years. Fish are a suitable group of organisms for monitoring aquatic condition because they have a documented relationship with environmental perturbations (i.e., increased trophic status and degraded fish community). Variation in environmental condition cause changes in the fish community and those changes can then be extracted into ecological indicators to quantify environmental impacts [19]. For best results, we recommend consistent sampling gear and fishing effort be used when collecting fish data for use with the WFI. When WFI compared with other diversity indices (Shannon–Wiener's H′, Simpson's, evenness, and species richness), only the WFI varied as a linear function of WQI (Water Quality Index), demonstrating that the WFI is more useful than the others as an indicator of anthropogenic impact [20].

In the CCA ordination, axes 1 and 2 together explained a high percentage of variance of the species-environment biplot, with temperature, salinity, NO_3 and PO_4, as the most important variables influencing the variation of fish composition in the Shadegan wetland (Figure 5). It seems in multivariate indices; Do and BOD have low affect associated with species distribution. Thus, the fish assemblage of the freshwater-influenced habitat was characterized by the presence of numerous species that are tolerant to low-salinity conditions, and enter the system mainly for food and protection. The fish assemblage of the marine-influenced habitat was characterized by the presence of occasional and seasonal species. Multimetric indicators are especially vulnerable to bias because many of the metrics use community factors, such as percent of total catch from feeding guilds or percent of total biomass from specific species [28].

Finally, Fish are only one of many bioindicators in use today, but it is only a single tool and should be used in accord with other indices for greatest knowledge of wetland condition. Nevertheless, the Wetland Fish Index should prove to be an effective tool to aid in the management and protection of important fish habitat in Shadegan wetlands. This study provides basic information for fishery biologists in this local [29-35].

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References

1. Galactos K, Barriga-Salazar R, Stewart DJ (2004) Seasonal and habitat influences on fish communities within the lower Yasuni River basin of the Ecuadorian Amazon. Environmental Biology of Fishes. 71: 33-51
2. Mace G, Masundire H, Baillie J, Ricketts T, Brooks T (2005) Biodiversity. In: Hassan R, Scholes R, Ash N (eds.), Ecosystems and Human Well- Being: Current State and Trends (Findings of the Condition and Trends Working Group). Island: 77-122.
3. Hamzah N (2007) Assessment on water quality and biodiversity within Sungai Batu Pahat. Master of thesis. Universiti Teknologi Malaysia: 124.
4. Zainudin MRY (2005) Assessment of fish community distribution and composition in the Perak River in order to determine biological indicators for freshwater health. Master of thesis. Universiti Sains Malaysia.
5. Hooper DU, Chapin FS, Ewel JJ, Hector A, Inchausti, P et al., (2005) Effects of biodiversity on ecosystem functioning: a consensus of current knowledge. Ecol. Monogr. 75: 3-36.
6. Diaz S, Fargione J, Chapin III FS, Tilman D (2006) Biodiversity loss threatens human well-being. PLoS Biol 4: 1300-1305.
7. Haruna AB, Abubakar KA, Ladu BMB (2006) An assessment of physico-chemical parameters and productivity status of Lake Geriyo, Yola, Adamawa State, Nigeria. Biological and Environmental Sciences Journal for the Tropics 3: 18 23.
8. Mitsch WJ, JG Gosselink (2000) The value of wetlands: Importance of scale and landscape setting. Ecological Economics 35: 25-35.
9. Lotfi A, Ghafari H, Behrozirad B, A Savari, K Kawosi (2003) Human activity and their affect in shadegan Wetland. ConselorEngining publisher: 382.
10. Ansari H, Hashemi SAR, Eskandari GH (2009) Survey fishing status and Biomass fish in shadegan Wetland. The 1th Scientific Conference of Iranian Wetland, 3-4 March 2009, Ahwaz: 43
11. Maramazi GH (1997) Fish stock assessment in shadegan Wetland, South of Iran aquaculture fishery research center, Ahwaz. Iran: 57
12. Ansari H, Mohammadi GH (2001) Capture fishing status in shadegan Wetland. South of Iran aquaculture fishery research center,Ahwaz. Iran: 60.
13. Hashemi S, Eskandary Gh, Ansary H, Yooneszadeh M (2011)Stock assessment and production of fish species in the Shadegan Wetland, Iran. World Journal of Fish and Marine Sciences 3: 502-508.
14. Nelson JS (2006) Fishes of the World, 4th edition. John Wiley and Sons, Inc. Hoboken, New Jersey 601.
15. Coad BW (2012) The freshwater fishes of Iran. www.Briancoad.com.
16. Clesceri SL, AE Greenberg, RR Trussel (1989) Standard Method for the Examination of Water and Wastewater. 17th, EcIn., APHA Press.
17. Pielou EC (1966) The measurement of diversity in different types of biological collections. J. Theoret. BioI. 13: 131-144.
18. May RM (1993) Patterns of species abundance and diversity. In: Cody JM (ed) Ecology and Evolution of CommunitiesCambridge, Mass.: Harvard University Press. Solow AR.. A simple test for change in community structure. J Journal of Animal Ecol, 62: 191-193.
19. Seilheimer TS, Chow-Fraser P (2006) Development and use of the wetland fish index to assess the quality of coastal wetlands in the Laurentian Great Lakes. Can J Fish Aquat Sci 63: 354-366.
20. Chow-Fraser P, Lougheed VL, Crosbie B, LeThiec V, Simser L (1998) Long-term response of the biotic community to fluctuating water levels and changes in water quality in Cootes Paradise Marsh, a degraded coastal wetland of Lake Ontario. Wetlands Ecol Manag 6: 19-42.
21. Hashemi S, Eskandary Gh, Ansary H (2012) Biomass of Fish Species in the Shadegan Wetland, IRAN. Research Journal of Recent Sciences,1: 66-68.
22. Amarasinghe US (1992) Recent trends in the inland fishery of Sri Lanka. In: Baluyut EA (ed.) Indo-Pacific Fishery Commission, FAO Fishery Report No. 458 Supplement, Rome: 84-105
23. Welcomme R (2001) Inland fisheries ecology and management. Food and Agriculture Organization and Fishing News Books, Blackwell Science Ltd: 345

24. Jackson DA, Harvey HH (1997) Qualitative and quantitative sampling of lake fish communities. Can. J Fish Aquat Sci 54: 2807-2813.

25. Kholfenilsaz M (2009) Survey frequency and diversity planktonic in shadegan Wetland. Scientific Journal of Marine Biology, Islamic Azad university Ahvaz Branch, 1-12

26. Zakaria R, Mansor M, Ali AB (1999) Swamp-riverine tropical fish population: A comparative study of two spatially isolated freshwater ecosystems in Peninsular Malaysia. Wetlands and Ecology Management 6: 261-268.

27. Zhou SH, Dichmont C, Burridge CY, Venables W, et al. (2007) Is catchability density-dependent for schooling prawns?. Fisheries Research: 23-36.

28. Simon TP (1999) Assessing the suitability and biological integrity of water resources using fish communities. Boca Raton, Florida: CRC Press.

29. Horn HS (1966) Measurement of “overlap” in comparative ecological studies. Amer Nat. 100: 419-423.

30. Karr JR (2000) Health, integrity, and biological assessment: The importance of whole things. In: Pimentel D, Westra L, Noss RF (eds.) Ecological integrity: integrating environment, conservation, and health, 209-226.

31. Karr JR, Chu EW (1999) Restoring life in running waters: better biological monitoring. Washington, Dist rict of Columbia: Island Press.

32. Niemi GJ, McDonald ME (2004) Application of ecological indicators. Annu Rev Ecol Evol Syst 35: 89-111.

33. Simon TP (1991) Development of index of biotic integrity expectations for the ecoregions of Indiana. I. Central Corn Belt Plain. Chicago, IL. U.S. Environmental Protection Agency.

34. Ter braak CJF, Smilauer P (1998) CANOCO reference manual and user’s guide to CANOCO for windows: software for canonical community ordination. Version 4. Ithaca, New York: Microcomputer Power.

35. Verdonschot PFM (1995) Canonical correspondence analysis and related multivariate methods in aquatic ecology. Aquat Sci 57: 255-289.

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