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Research Article

Seasonal comparison of catch composition, biodiversity and length-weight relationships of fish fauna in Doroudzan Dam, Fars Province, Iran

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Abstract

This investigation was conducted in Doroudzan Dam located in Fars province from winter 2017 to summer 2018. The fish specimens were caught using monofilament gillnet with 20, 70, 100 and 120 mm mesh sizes. Overall, 283 fish specimens belong to the Cyprinidae (seven species) and Mugilidae families (a single species) were caught which were included: *Cyprinus carpio*, *Carassius gibelio*, *Hypophthalmichthys molitrix*, *H. nobilis*, *Alburnus mossulensis*, *Capoeta damascina*, *Carasobarbus luteus* and *Planiliza abu. C. carpio* and *P. abu* were dominant species during sampling seasons. The highest range of total length and weight belonged to *H. nobilis* (Length range: 52.8-102.6 cm; Weight range: 2811.5-20628.9 g) and the lowest ranges belonged to *A. mossulensis* (Length range: 8.6-15.1 cm; Weight range: 5.05-29.4 g) and *P. abu* (Length range: 8.3-19.6 cm; Weight range: 4.52-59.48 g). The highest amounts of the Shannon-Wiener and Simpson indices were observed in spring (2.413) and winter (0.795), respectively. PCA result showed that *C. carpio* and *P. abu* were the most effective species that caused the changes in the seasonal fish abundance and diversity. Also, the most amounts of seasonal similarity were between summer and spring (J= 0.625; S= 0.729) and the lowest amounts were between summer and winter (J= 0.375; S= 0.545).

Keywords: Biodiversity, Doroudzan Dam, Fars Province, fish fauna.

Introduction

Dam reservoirs are artificial lakes that simultaneously have different animal and plant assemblages (Abbasi and Sarpanah 2001). These reservoirs have different usages such as urban water supply, irrigation, fish farming, power generation, and ecotourism (Goodarzi *et al.* 2012). The lakes are also important in terms of income generation and job creation. The habitation of human communities near the water resources and extensive associated activities will cause varied effects on the residents of the water resources (especially on biological communities) and the biodiversity of these areas (Carden and Armitage 2013). The dams also have importance for fisheries management. They are one of the main sources of protein production and can play an important role in aquatic production (Abbasi *et al.* 2017).

Doroudzan dam is one of the main sources of drinking water in Shiraz city. This reservoir is also a place for fish rearing (Goodarzi *et al.* 2012). Fisheries management annually releases a high number of carps in the dam lake and several fishing cooperatives are engaged in the harvesting of these fish. In addition to the released carps, there are several endemic carp species (Zamanpoor and Yaripour 2017). The important features of various ecosystems are

dependent on the different environmental conditions and availability of resources (Levin 1992). The study on catch composition and their potential can have an imperative effect on their production, quality, and marketability. Numerous studies about fish fauna diversity, fisheries activities, and management have been done on the artificial lakes in Iran (Qani Nezhad and Pour Gholam Moghadam 1995, Abdolmaleki 2004, Aghili *et al.* 2008, Mirzajani 2008, Mirzajani 2009, Salavatian *et al*. 2014, Mohammadi *et al.* 2016, Zamanpoor and Yaripour 2017, Abbasi*et al.* 2017, Yousefi Siahkalroodi *et al.* 2018).

The release of fish larvae into the dams is one of the key principles in fisheries planning and management in many countries. Therefore, ichthyological studies such as species composition, abundance, growth, and stock assessments are very beneficial for dam production management. Due to the hypothesis of season effect on fish fauna in this dam, the main objectives of this research were the evaluation of catch composition, biodiversity and length-weight relationships of fish fauna in the reservoir of Doroudzan Dam during three seasons (winter, spring, and summer) in Fars province.

Materials and Methods

This research was conducted in Doroudzan Dam located in Fars province (latitude 30° 12′ to 30° 13′ N; longitude 52° 19′ to 52° 24′ E) from winter 2017 to summer 2018 (Fig. 1). The fish specimens were collected using monofilament gillnet with 20, 70, 100 and 120 mm mesh sizes. The total length (TL) was measured with a digital caliper to the nearest 0.1 cm, and body weight was measured on a digital scale to the nearest 0.1 g. Sampling information such as fishing operation, species, length, and weight were recorded. All caught fish were identified according to the standard identification keys (Coad 2016, Nelson *et al.* 2016).

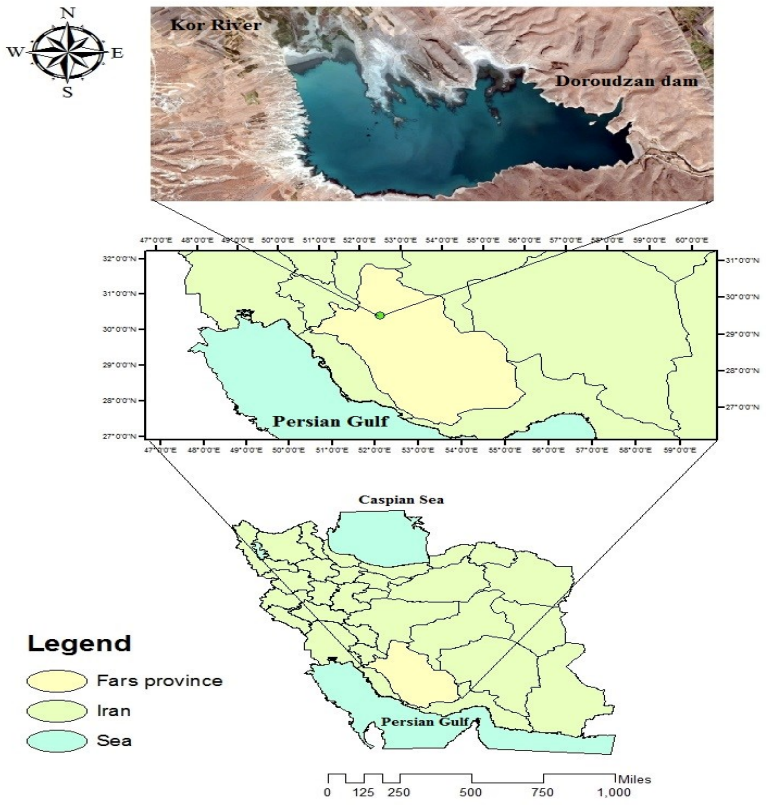

Figure 1. The geographical location of Doroudzan dam, Fars Province, Iran

Length-weight relationships (LWRs) were estimated by linear equation (Froese *et al.* 2011):

$\log(W) = \log(a) + b \log(L)$

Where W is the whole body weight (g); and L is the total length (cm).

Shannon-Wiener (H') and Simpson indices (D) were used for the calculation of seasonal diversity as follow (Washington 1984):

$$H' = \sum_{i=1}^{s} Pi \, ln \, Pi$$

$$D = \sum_{i=1}^{s} Pi^2$$

Where Pi is the relative abundance of the i^{th} taxon, S is the total number of taxa

Jaccard (S_J) and Sørensen indices (S_S) were used for calculation of seasonal similarity as follow (Washington 1984):

$$Sj = \frac{a}{(a + b + c)}$$

Where S_J is Jaccard similarity coefficient; a is the number of species common to (shared by) quadrats; b is number of species unique to the first quadrat, and; c is number of species unique to the second quadrat

$$Ss = \frac{2a}{(2a + b + c)}$$

Where S_s is Sorensen similarity coefficient, a isthe number of species common to both quadrats, b is the number of species unique to the first quadrat, and c is the number of species unique to the second quadrat.

Data analysis

Data are presented as means ± standard error of means. Data analysis was performed using SPSS software (Version 21) and figures were depicted in Excel software (Version 2013). Diversity and similarity indices were calculated using Ecological Methodology software. Cluster PCA (Principle Component Analysis) analyses were done using PRIMER software (Version 5).

Results

The catch composition of caught carp fish in the Doroudzan dam is presented in Table 1. Totally, 283 fish specimens belong to the Cyprinidae family (seven species) and Mugilidae family (one species) were caught that *Cyprinus carpio* and *Planiliza abu* were observed during all sampling seasons. *C. carpio* and *P. abu* with 99 (34%) and 67 (23.67%) specimens had the most abundance and *Hypophthalmichthys molitrix* and *Carassius gibelio* both with 16 (5.65%) specimens had the lowest abundance**.** The highest weight amounts of caught fish belonged to *H. nobilis* and *C. carpio* with 172025.14 (41.03%) and 128232.96 g (30.59%) and the lowest weight amounts belonged to *A. mossulensis* with 320.37 g (0.058%) (Fig. 2, 3).

Table 1. Catch composition according to the Presence (+) and absence (-) of caught fish during sampling seasons in Doroudzan Dam, Fars Province, Iran

Family	Species	Winter	Spring	Summer	Origin
Cyprinidae	*Cyprinus carpio (*Linnaeus, 1758)	+	+	+	Exotic
	Carassius gibelio (Bloch, 1782)	+	-	+	Exotic
	Hypophthalmichthys molitrix (Valenciennes, 1844)	-	+	+	Exotic
	Hypophthalmichthys nobilis (Richardson, 1845)	+	+	-	Exotic
	Alburnus mossulensis (Heckel, 1843)	-	+	+	Endemic
	Capoeta damascina (Valenciennes, 1842)	-	+	+	Endemic
	Carasobarbus luteus (Heckel, 1843)	+	+	-	Endemic
Mugilidae	*Planiliza abu (*Heckel, 1843*)*	+	+	+	Exotic

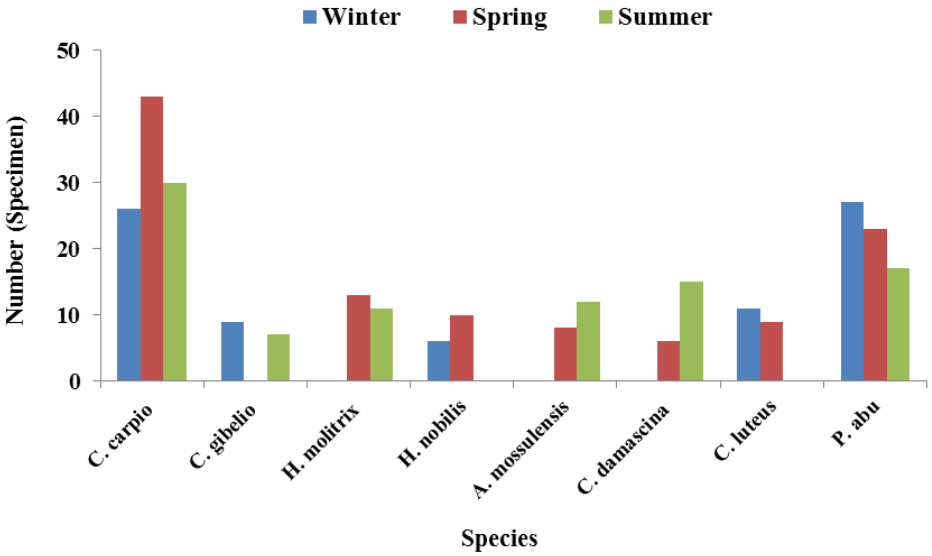

Figure 2. The number of caught fish specimens during sampling seasons in Doroudzan Dam, Fars Province, Iran

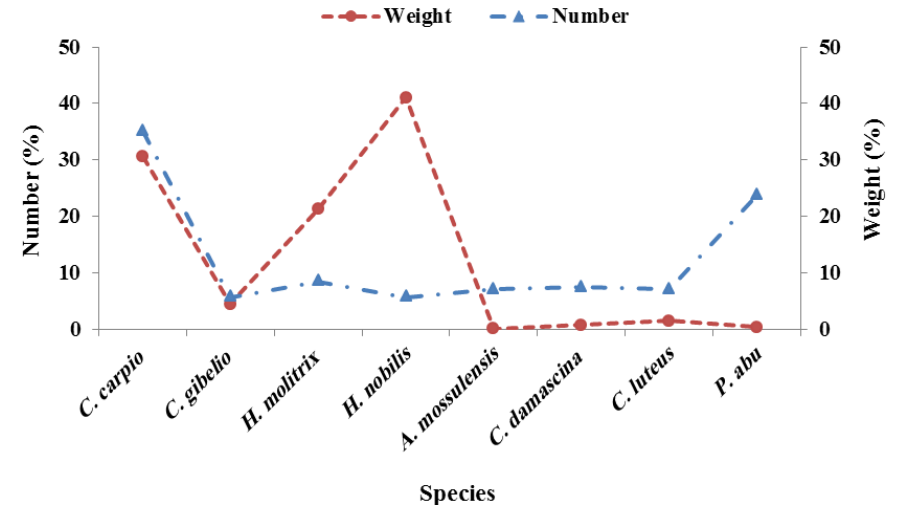

Figure 3. The number and weight Percentage (%) of caught fish during sampling seasons in Doroudzan Dam, Fars Province, Iran

Table 2. Length-weight relationship parameters of 8 fish species in Doroudzan Dam (Fars Province) during autumn 2017 to spring 2018

Species	Number	Total length (cm)	Total weight (g)	Length-weight relationship		
				a	b	R^2
C. carpio	99	21.2-66.1	183.2-4899.3	0.0269	2.89	0.938
H. molitrix	24	38.3-86.3	925-11293.2	0.0123	3.08	0.944
H. nobilis	16	52.8-102.6	2811.5-20628.9	0.0191	3.02	0.976
A. mossulensis	20	8.6-15.1	5.05-29.4	0.006	3.13	0.982
C. damascina	21	18.4-31.6	74.5-361.4	0.0151	2.92	0.977
C. luteus	20	18.5-32.6	104.7-609.9	0.0117	3.12	0.973
P. abu	67	8.3-19.6	4.52-59.48	0.0079	2.99	0.962
C. gibelio	16	21.6-51.2	200.7-2888.16	0.0151	3.09	0.946

Table 3. Comparison of average length and weight (Mean±SE) of caught fish during sampling seasons in Doroudzan dam, Fars Province, Iran

Species	Winter		Spring		Summer	
	Length (cm)	Weight (g)	Length (cm)	Weight (g)	Length (cm)	Weight (g)
C. carpio	35.9±2.1	1052.8±177.6	43.9±2.1	1883 ±215.5	32.8±1.7	788.5±88.9
C. gibelio	41.1±2.3	1597.5±263.9	-	-	29.2±3	621.9±194.9
H. molitrix	-	-	63.7±3.7	5007±859.5	49.4±2.4	2179.2±338.7
H. nobilis	93.1±4.1	15840±4646.2	71.2±4.5	7698.5±1631.7	-	-
A. mossulensis	-	-	12.1±0.8	16.1±3.2	12.1±0.6	15.9±2.2
C. damascina	-	-	24.3±1.9	182.1±42.6	23.5±1.1	161.3±20.9
C. luteus	24.9±1.3	276.4±48.9	26.7±1.3	347.9±49.7	-	-
P. abu	14.1±0.6	25.6±2.9	13.9±0.5	23.1±2.5	14.6±0.8	28±3.92

LWRs characteristics of the caught species are presented in Table 2. Based on the results, the highest range of total length belonged to *H. nobilis* (52.8-102.6 cm) and the lowest ranges belonged to *A. mossulensis* (8.6-15.1 cm) and *P. abu* (8.3-19.6 cm). Also, the highest range of total weight belonged to *H. nobilis* (2811.5-20628.9 g) and the lowest ranges belonged to *A. mossulensis* (5.05-29.4 g) and *P. abu* (4.52-59.48 g). According to the seasonal comparison of caught fish, the highest average length and weight ranges belonged to *H. nobilis* with 93.1±4.1 cm and 15840±4646.2 g in winter and the lowest ranges belonged to *A. mossulensis* with 12.1±0.6 cm and 15.9±2.2 g in summer.

The seasonal comparison of diversity indices is shown in Figure 4. The highest and lowest amounts of the Shannon-Wiener index were observed in spring (2.413) and summer (2.045), respectively. Furthermore, the highest and lowest amounts of Simpson index were observed in winter (0.795) and summer (0.734), respectively.

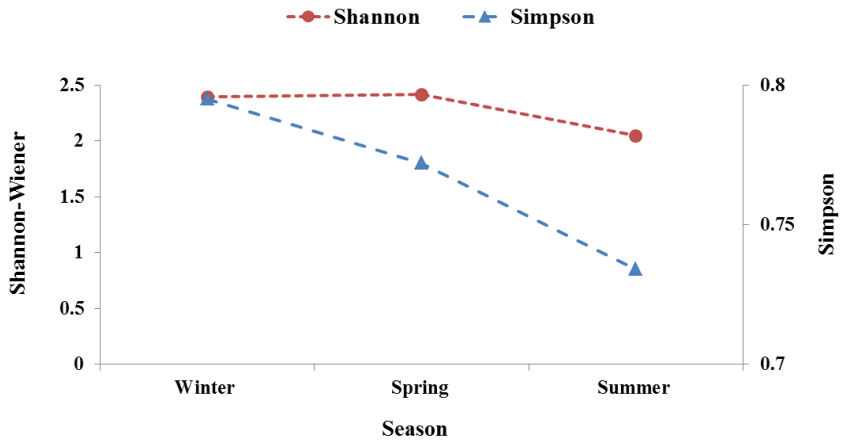

Figure 4. Biodiversity comparison of caught fish during sampling seasons in Doroudzan Dam, Fars Province, Iran

The PCA result of the study is presented in Figure 4. According to the PCA, *C. carpio* and *P. abu* were the most effective species that caused the changes in the seasonal fish

abundance and diversity during the sampling period. Based on the Jaccard and Sørensen similarity indices, the most seasonal similarity amounts were between summer and spring (J= 0.625; S= 0.729) and the lowest amounts were between summer and winter (J= 0.375; S= 0.545) (Table 3). Similarly, cluster analysis showed two categorize that winter was in category A and summer and spring were in category B (Figure 5).

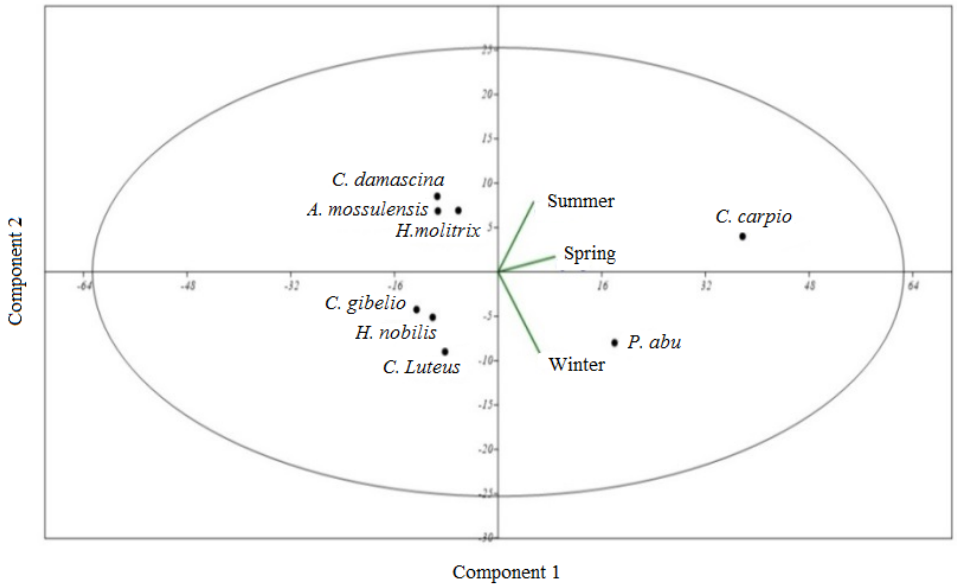

Figure 5. Principle Component Analysis (PCA) of caught fish based on the sampling seasons in Doroudzan Dam, Fars Province, Iran

Table 3. Similarity comparison of caught fish during sampling seasons in Doroudzan Dam, Fars Province, Iran

Season	Similarity Index	Winter	Spring	Summer
Winter	Jaccard	1		
	Sørensen	1		
Spring	Jaccard	0.5	1	
	Sørensen	0.667	1	
Summer	Jaccard	0.375	0.625	1
	Sørensen	0.545	0.769	1

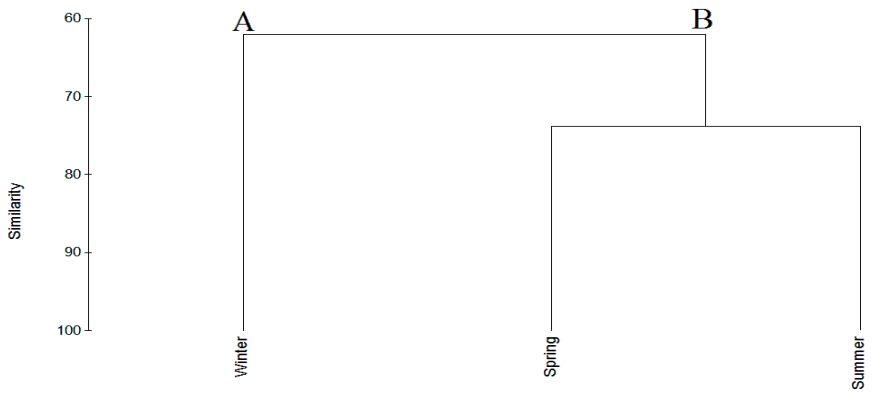

Figure 5. Seasonal similarity comparison of caught fish using cluster analysis during sampling seasons in Doroudzan Dam, Fars Province, Iran

Discussion

The lakes behind the dams (similar to the natural lakes and wetlands) are a good fish habitat for initial breeding, sexual maturation, rearing, and protection against natural predators and floods (Ahmad *et al.* 2011, Faradonbe and Eagdari 2015). Based on the result obtained, 8 fish species were identified that 7 species belonged to the Cyprinidae family. Aghili *et al*. (2008) found 9 freshwater species which were included *Alburnoides bipunctatus*, *Barbus capito*, *B. lacerta*, *B.mursa*, *Capoeta capoeta*, *Leuciscus cephalus*, *Salmo trutta*, *Onchorhynchus mykiss*, and *Nemachilus bergianus* in the Alamut Dam. Zamanpoor and Yaripour (2017) identified seven carp species including *A. mossulensis*, *C. aculeate*, *C. damascina, C. luteus, C. gibelio*, *C. carpio*, *and H. molitrix* in Doroudzan dam. Abbasi *et al*. (2017) reported 5 carp species including *Ctenopharyngodon idella*, *C. damascina, C. gibelio*, *C. carpio*, and *H. molitrix* in Zayandehrud dam**.** Also, Yousefi Siahkalroodi *et al*. (2018) recognized 14 species, belonging to 12 genera and 2 families of bony fishes in the Seymare dam which Cyprinidae family had the highest rate with 97.85% and *Cyprinion macrostomum* and *C. gibelio* had the most abundant. Naik et al (2013) observed 32 species of finfishes belong to 26 genera, 14 families and 6 orders in Mullamari Reservoir which Cypriniformes (17 species), Siluriformes (9 species) and Perciformes (3 species) were dominant species. Jindal et al (2014) reported 28 fish species belonging to 7 families (Cyprinidae, Channidae, Siluridae, Belontidae, Mastacembelidae, and Sisoridae) in Pong dam reservoir that Cyprinidae family with 19 species was dominant species. Attee and Lazem (2016) identified 19 species belong to seven families that *Luciobarbus grypus* (23.6%), *Carassius auratus* (20.07%) and *Cyprinus carpio* (11.39%) were dominant species in Himreen dam Lake. Most freshwater species of Iran belong to the Cyprinidae family (80 species), which are found in the dams, natural waters, wetlands, and rivers (Abdoli 1999, Abbasi and Sarpanah 2001, Abbasi *et al.* 2009). Many researchers believe that fish ability to adapt to different environmental conditions is the main reason for the carp dominance in different freshwater (Yu and Lee 2002). Abundance and distribution of fish species in the aquatic resources depend on the favorable conditions for species, effective habitat factors such as physicochemical factors (bed, water velocity, slope, drainage, pollution, water temperature), biological factors (vegetation, competition, nutrient sources) and the adaptability degree in their environment (Wootten 2012).

Among the collected fish, *C. carpio*, *C. gibelio, H. molitrix, H. nobilis,* and *P. abu* are exotic species that are released in the dam for economic fisheries activities while *A. mossulensis*, *C. damascina,* and *C. luteus* are endemic species in the Kor River which can be observed in Doroudzan Dam. *A. mossulensis* is mostly dispersed in Iran and its adjacent countries. This species is found in the Tigris (Karun and Karkheh river basins), Fars, Bushehr and Hormuz basins in Iran (Nelson *et al.* 2016, Esmaeili *et al.* 2017). This species is found in streams, rivers, lakes, reservoirs, and marshes (Coad 2016). *C. damascina* is a very abundant native cyprinid in Iranian waters. It is also widely distributed in other countries such as Lebanon, Palestine, Syria, Turkey, and Iraq which live in lakes, slow and fast-moving rivers, muddy and clear waters (Asadollah *et al.* 2011, Freyhof 2014). *C. luteus* is commonly distributed in the Tigris River, Kor River, Maharlu Lake, and Hormozgan Basins (Borkenhagen *et al.* 2011, Coad 2011). This fish is found in the lower and middle parts of streams and prefers standing waters adjacent aquatic plants and algae (Coad 2006).

The *b* values measured for 8 caught species were between 2.89 to 3.13, respectively. These values were within the expected range of 2.5–3.5 (Froese 2006). The LWRs are regularly applied by researchers as worthwhile tools in fish biology researches (Ferreira *et al.* 2008, Parsa *et al.* 2017). The LWRs of fish species

are used to estimate biomass from measured lengths, forecast of weight ranges from fish length range and comparison of life cycle features of separated fish populations from various regions (Keivany *et al.* 2016, Saberi *et al.* 2017). The LWRs of fishes are changed by a number of parameters including living environment, season, dwellers, gonad evolution stage, food consumption regime, gender, health situation, stomach contents, fish size, sampling methods, and protection techniques (Esmaeili and Ebrahimi 2006, Esmaeili *et al.* 2014, Faradonbe *et al.* 2014).

The highest amount of fishes was caught in the spring season while the lowest was in the winter season. Aquatic organisms tolerate different types of environmental effects on spatial and temporal scales (Colas *et al.* 2014, Zamani Faradonbe and Eagdari 2015). During the winter season, Due to low-temperature ranges and deactivation of feeding activities, carps live in the winter dormancy period with less mobility in the water body (Estoki 2000, Abdolmaleki 2004, Abbasi *et al.* 2017). Therefore, the catch rate was decreased and the winter population was lower than spring and summer populations.

According to the measured diversity indices, spring and winter seasons had more diversity amounts during the research period. Species biodiversity is the number of varied species that are displayed in a particular community (Tuomisto 2010). Biodiversity is usually a different degree at the species, genetic, and ecosystem level (Luck *et al*. 2003). Environment features, either abiotic or biotic components have been recognized as the main factors in the abundance and distribution of fish communities from former periods (Arunachalam 2000). Fish species are separated according to the accessibility of the several macro and microhabitat traits and abundance of food sources (Ahmad *et al.* 2011, Wootton 2012).

Biological and ecological studies of various fish species in an aquatic ecosystem can be precious to preserve the survival rates of fish stocks (Vossoughi and Mostajeer 2000). Based on the need for ecological management of fish habitat preferences in artificial lakes in Iran, accurate and comprehensive surveys on the selection of suitable fish habitats are required and most exploitation of aquatic resources should be made. Therefore, annual monitoring of fish fauna and ecological conditions is recommended in order to preserve biodiversity and manage aquatic production in dams.

Conclusion

Generally, it is concluded that caught fishes belonged to Cyprinidae and Mugilidae families during the sampling seasons. *C. carpio* and *P. abu* had the most abundance and *H. molitrix* and *C. gibelio* had the lowest abundance**.** The highest and lowest average length and weight ranges belonged to *H. nobilis* and *A. mossulensis*, respectively. The highest and lowest amounts of the Shannon-Wiener index were observed in spring and summer, respectively. Moreover, the highest and lowest amounts of Simpson index were observed in winter and summer, respectively. Based on the Jaccard and Sørensen similarity indices, the most seasonal similarity amounts were between summer and spring and the lowest amounts were between summer and winter.

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