



Proposing Zarivar Wildlife Refuge (Western Iran) as a Ramsar Site Based on Avian Diversity and Conservation Criteria

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Abstract

This study aimed to document avifaunal diversity of the Zarivar Wildlife Refuge (ZWR), western Iran, to evaluate its potentiality to propose as a Ramsar site. Bird surveys were carried out during 2015–2016. In total, 222 species belonging to 50 families and 16 orders were identified, of which 95 species were new records for this habitat. Based on preferred habitat, 131 species were terrestrial birds (59%) and 91 species waterbirds (41%). Of 222 species, seven species are endangered and 30 species are protected species in Iran's Department of the Environment. Twenty-one species are listed in the Appendix I and II of the Convention on International Trade in Endangered Species (CITES), and 11 species are in the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. Our results showed that the ZWR meets five criteria (A1, B2, B3, B4, and B6) of the Ramsar Convention on Wetlands. Accordingly, it is proposed that the ZWR be designated in list of wetlands of international importance under the Ramsar Convention on Wetlands.

1. Introduction

Iran is a wonderful country for ornithologists and bird-watchers because of its special zoogeographic position (Roselaar & Aliabadian 2007; Scott 1989), total area of protected areas as Wildlife Refuges (Bureau of Protected Areas and Wildlife Refuges 2017), possessing eight habitat types (Scott 1989), 250 wetlands (Behrouzi-Rad 2006) and 105 Important Bird Areas (IBAs) (Evans 1994). Therefore alone contains approximately 60% of total number of birds species recorded throughout the Middle East. Many international and Iranian ornithologists have investigated the avifauna of Iran during the past two centuries (Khaleghizadeh 2007; Roselaar & Aliabadian

2007). As a result, a total of 551 bird species from 26 orders and 84 families have been recorded from Iran until February 2017 (Khaleghizadeh *et al.* 2017). However, while the avifauna of the south Caspian region, northwest, northeast and south of Iran has been well-covered in these studies, some provinces in western Iran are hardly covered, or not at all (Roselaar & Aliabadian 2007, Khaleghizadeh *et al.* 2011).

Kordestan Province, with the area of 28,203 km², is located in the west of Iran. Much of its area is covered with mountainous habitats, prevailing with oak forests and meadows with cold Mediterranean climate (Rastegar-Pouyani *et al.* 2009). It possesses a rich flora consisted of 2,110 species from 113 families and 629 genera, which is equivalent to about 25% of

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plant species recorded throughout the country (Maroufi 2012). While the herpetofauna (Rastegar-Pouyani *et al.* 2009; Rastegar-Pouyani 2011; Bahmani *et al.* 2012; Bahmani *et al.* 2014) and ichthyofauna (Esmaeili *et al.* 2010; Esmaeili *et al.* 2011) of this province has been well-studied, no comprehensive ornithological study has been published yet. Habitat diversity of this region highlights the need of avifaunal studies. The most important gathering places of birds in this province are Zarivar Wildlife Refuge (ZWR), Shahid Kazemi dam, Gheshlagh dam, Golbolagh dam, Chardoli seasonal wetland and a vast network of rivers including Sirwan and Ghezel Ozan. Situated in the far west of Iran, Zarivar Wildlife Refuge supports a significant number of bird species, especially some globally threatened species. This paper summarizes avifaunal information gathered during 21 months of field surveys in the ZWR, to evaluate its potentiality as a Ramsar site.

2. Material and Methods

2.1. Study Area

Marivan Plain which surrounds the city of Marivan consists of three parts. The eastern plain with east-west orientation, the western plain with north-south orientation and Ghezelche-su plain in the north (Zarei *et al.* in press). The Zarivar Lake (46°12 E, 35°54 N, 830 hectares, 1,285 m a.s.l., 2 km northwest to the city of Marivan), also called Zarivar Wetland, is located inside the western plain (Fig. 1). The depth of the lake varies between 1.3 and 5.9 m; and its main water sources are precipitation (snow and rain), springs on the lake floor and a seasonal canal diverted from Ghezelche-su River in the north. In 2009, it was officially declared as Zarivar Wildlife Refuge (hereafter ZWR) by the Iran's Department of the Environment (DOE) (see Fig. 1). ZWR with an area of 3,291 ha (Bureau of Protected Areas and Wildlife Refuges 2017) is an Important Bird Area (Evans 1994) and a wetland with international importance in the Middle East (Scott 1995).

2.2. Fauna and flora of the ZWR

Ichthyofauna of the ZWR consist of 6 native and 15 exotic species from six families, namely Cyprinidae, Mastacembelidae, Poeciliidae, Serrasalimidae, Lepisosteidae and Gobiidae

(Esmaeili *et al.* 2011; Imanpour-Namin *et al.* 2015; Zarei & Rajabi-Maham 2017; Esmaeili *et al.* 2017a,b; Sadeghi *et al.* in press). Three amphibian species, namely *Rana ridibunda* Pallas, 1771, *Bufo viridis* Laurenti, 1768 and *Hyla savignyi* (Audouin, 1827) live in this ecosystem (Rastegar-Pouyani 2011; Bahmani *et al.* 2014). Meanwhile, there is no reliable information on the mammalian fauna of this area, a formal report listed 12 species for this province (Barati & Attaie 2007). However, reptiles have received more attention than any other taxa. Fourteen lizard species and subspecies of families Agamidae, Gekkonidae, Lacetidae and Scincidae exist in this province with probably nine in the ZWR (Rastegar-Pouyani *et al.* 2009; Bahmani *et al.* 2012). Two turtle species, *Mauremys caspica* (Gmelin, 1774) and *Testudo graeca* Linnaeus, 1758; seven snake species, namely *Natrix tessellata* (Laurenti, 1768), *Platyceps najadum* (Eichwald, 1831), *P. rhodorachis* (Jan, 1865), *Hemorrhoids ravergeri* (Ménétries, 1832), *Eirenis punctato lineatus* (Boettger, 1892), *Telescopus tessellatus* (Wall, 1908), *Macrovipera lebetina obtuse* (Dwigubsky, 1832) and *Typhlops vermicularis* (Merrem, 1820), and two skink species, namely *Ablepharus bivittatus* (Menetries, 1832) and *Trachylepis aurata transcaucasica* Chernov, 1926 were also recorded in the region (Rastegar-Pouyani *et al.* 2009). The ZWR flora consists of 257 species belonging to 183 genera and 53 families, of which, the dominant families are Asteraceae, Gramineae, Papilionaceae and Cyperaceae (Khorasani *et al.* 2014).

2.3. Methods

Bird surveys were carried out from March 2015 to December 2016 in various parts of the ZWR. Birds were identified immediately in the field based on morphological characteristics using various field guides (Porter *et al.* 2004; Svensson *et al.* 2009; Mansoori 2013). They were observed through a Swarovski ATX/STX spotting scope and a Beileshi 10 × 50 396FT/1000YDS Sports Military Optics Binoculars. To support the accuracy of our results, we took photographs using a Canon EOS 70D camera equipped with Canon 100–400mm f/4.5–5.6L IS lens. This also helped us to confirm the identification of those species with some doubt on their identification in the

field. Mid-winter waterbirds census data (MWWC Data) base on counts in the ZWR from 2008 to 2015 were also used. Furthermore, Shannon-Wiener (H'), Simpson's ($1-D$), Simpson's Dominance (D) and Hill's Evenness (N) indices were calculated using PAST software version 3.14 (Hammer *et al.* 2001) to determine the diversity and richness of bird species in the ZWR.

3. Results

Our results showed that the ZWR is shelter for a significant number of bird species (Table 1) despite its relatively small area. During the fieldworks, a total of 222 species belonging to 50 families and 16 orders were recorded (131 species of terrestrial birds (59%) and 91 species of waterbirds (41%).

The conservation status of birds shows that 37 species have conservation priority at national level (as designated in the DOE laws, 7 species as endangered and 30 species as protected (Supreme Council on Environment 2017). Appendix I of the Convention on International

Trade in Endangered Species (CITES; www.cites.org) applies to two species, while its Appendix II applies to 19 species. The 2015 International Union for Conservation of Nature Red List of Threatened Species (IUCN; www.iucn.org) considered 3 species as Vulnerable (VU) and 8 other species as Near Threatened (NT) (see Table 1).

Table 2 shows the MWWC Data on waterbirds in the ZWR from 2008 to 2015, while Table 3 shows species diversity indices of bird species during the period. The Pearson Correlation Coefficient (r) value indicated no significant correlation between the species diversity values and the January mean temperatures and precipitations. However, there is more correlation between the species diversity values and the January mean temperatures ($r_{1-D,T}= 0.47, P>0.05$; $r_{H,T}= 0.47, P>0.05$; $r_{N,T}= 0.44, P>0.05$) than between the species diversity values and the January precipitations ($r_{1-D,P}= -0.47, P>0.05$; $r_{H,P}= -0.52, P>0.05$; $r_{N,P}= -0.22, P>0.05$).

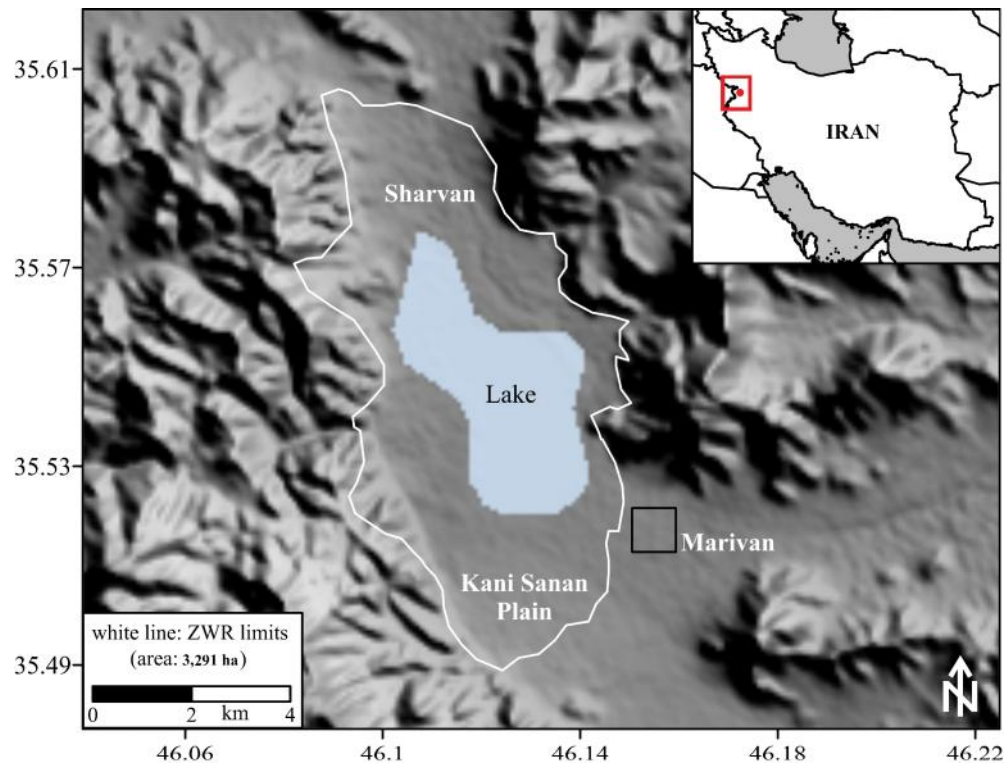


Fig. 1. Location and area of the ZWR in Western Iran.

Table 1. List of bird species recorded in the ZWR from March 2015 to December 2016, with regional and conservation status and literature review on each species. Key to symbols and status of each species for Iran follows Scott & Adhami (2006). Key to symbols: R= common resident (present year round); r= scarce resident; S= common summer visitor; s= scarce summer visitor; W= common winter visitor; w= scarce winter visitor; P= common passage migrant (in spring and/or autumn); p= scarce passage migrant; V= vagrant (fewer than five records) and (b), may breed; EN= Endangered; VU= Vulnerable; NT= Near Threatened; Prot= protected; 1= Evans (1994); 2= Scott (1995); 3= Barati & Attaie (2007); 4= Shabaniyan & Barati (2009); 5= Barati *et al.*(2011); 6= Shil-Amaysh (2011); 7= Ahsani *et al.* (2015); 8= MWWC Data.

Species	Spring	Summer	Autumn	Winter	Status (Iran)	IUCN	CITES	DOE	Literature review
Greylag Goose <i>Anser anser</i>		*	*	*	s, W				2; 4; 6; 8
Greater White-fronted Goose <i>Anser albifrons</i>			*		W			Prot	2
Lesser White-fronted Goose <i>Anser erythropus</i>			*		w	VU			
Mute Swan <i>Cygnus olor</i>	*		*	*	W			Prot	4
Whooper Swan <i>Cygnus cygnus</i>			*	*	W				8
Common Shelduck <i>Tadorna tadorna</i>		*	*	*	R, W				4; 6; 8
Ruddy Shelduck <i>Tadorna ferruginea</i>	*		*	*	R, W				6
Gadwall <i>Anas strepera</i>		*	*	*	W				2; 6; 7-8
Eurasian Wigeon <i>Anas penelope</i>	*		*	*	W				6; 8
Mallard <i>Anas platyrhynchos</i>	*	*	*	*	r, W		I		2; 4; 6-8
Northern Shoveler <i>Anas clypeata</i>	*	*	*	*	W, P				4; 6
Northern Pintail <i>Anas acuta</i>	*		*	*	W, P				4; 8
Garganey <i>Anas querquedula</i>	*	*	*	*	s, P				4; 6-7
Eurasian Teal <i>Anas crecca</i>	*	*	*	*	(b), W, P				2; 4; 6-8
Red-crested Pochard <i>Netta rufina</i>	*		*	*	(b), W			Prot	2
Common Pochard <i>Aythya ferina</i>	*		*	*	r, W, P	VU			2; 4; 6; 8
Ferruginous Duck <i>Aythya nyroca</i>	*	*	*	*	s, w, p	NT		EN	1-4; 6-8
Smew <i>Mergellus albellus</i>				*	W			Prot	2; 6
Common Quail <i>Coturnix coturnix</i>	*	*			S, w, P				6
Little Grebe <i>Tachybaptus ruficollis</i>	*	*	*	*	R, W				1-2; 4-8
Great Crested Grebe <i>Podiceps cristatus</i>	*	*	*	*	R, W				1-2; 4-8
Black-necked Grebe <i>Podiceps nigricollis</i>	*	*		*	r, W, P				4; 6-7
Greater Flamingo <i>Phoenicopterus roseus</i>	*			*	R, W		II	Prot	2; 4; 6-8
White Stork <i>Ciconia ciconia</i>		*	*	*	S, W			Prot	1; 2; 4; 6-8
Glossy Ibis <i>Plegadis falcinellus</i>	*	*	*		S, w, P				2; 4; 6-7
Eurasian Bittern <i>Botaurus stellaris</i>	*	*	*	*	r, W				8
Little Bittern <i>Ixobrychus minutus</i>	*	*			S, P			Prot	2; 4; 6-8
Black-crowned Night Heron <i>Nycticorax nycticorax</i>	*	*	*	*	S, w, P			Prot	4; 7-8
Squacco Heron <i>Ardeola ralloides</i>	*	*	*		S, w, P			Prot	4; 6-7
Western Cattle Egret <i>Bubulcus ibis</i>	*	*	*		s, w, P				4; 6-8
Grey Heron <i>Ardea cinerea</i>	*	*	*	*	r, W, P			Prot	4; 6-8
Purple Heron <i>Ardea purpurea</i>	*	*			S, w, P			Prot	2; 4; 6; 8
Great Egret <i>Ardea alba</i>	*		*	*	R, W, P				4; 7-8
Little Egret <i>Egretta garzetta</i>	*	*	*	*	S, w, P				4; 6-8
Great White Pelican <i>Pelecanus onocrotalus</i>			*	*	S, W, P			Prot	6
Dalmatian Pelican <i>Pelecanus crispus</i>			*	*	r, W	VU	I	EN	
Pygmy Cormorant <i>Microcarbo pygmeus</i>			*	*	r, W			EN	4; 7-8
Great Cormorant <i>Phalacrocorax carbo</i>	*		*	*	r, W, P			Prot	4; 6; 8
Short-toed Snake Eagle <i>Circaetus gallicus</i>	*	*	*		S		II	Prot	
Levant Sparrowhawk <i>Accipiter brevipes</i>		*			s, p		II	Prot	
Eurasian Sparrowhawk <i>Accipiter nisus</i>			*	*	r, W		II	Prot	6; 8
Western Marsh Harrier <i>Circus aeruginosus</i>	*	*	*	*	R, W, P		II	Prot	1; 2; 4; 6-8
Northern Harrier <i>Circus cyaneus</i>			*	*	W		II	Prot	8
Pallid Harrier <i>Circus macrourus</i>			*	*	(b), W, P	NT	II	Prot	
Montagu's Harrier <i>Circus pygargus</i>	*				s, p		II	Prot	7
Long-legged Buzzard <i>Buteo rufinus</i>	*	*	*	*	R		II	Prot	
Common Buzzard <i>Buteo buteo</i>	*	*	*	*	R, P		II	Prot	6
Water Rail <i>Rallus aquaticus</i>	*	*	*	*	R, W				2; 4-7
Corn Crane <i>Crex crex</i>	*	*			(b), P			Prot	
Little Crane <i>Porzana parva</i>	*	*			p				
Spotted Crane <i>Porzana porzana</i>		*			s, P				
Grey-headed Swamphen <i>Porphyrio poliocephalus</i>				*	R				

Species	Spring	Summer	Autumn	Winter	Status (Iran)	IUCN	CITES	DOE	Literature review
Common Moorhen <i>Gallinula chloropus</i>	*	*	*	*	R, W				4-8
Eurasian Coot <i>Fulica atra</i>	*	*	*	*	R, W				2; 4-8
Common Crane <i>Grus grus</i>			*	*	W		II	Prot	
Eurasian Stone-curlew <i>Burhinus oedicephalus</i>	*	*	*	*	S, P				6
Black-winged Stilt <i>Himantopus himantopus</i>	*	*	*	*	RS, W, P				4; 6-7
Pied Avocet <i>Recurvirostra avosetta</i>	*	*	*	*	S, P				4; 6
Northern Lapwing <i>Vanellus vanellus</i>	*	*	*	*	S, W	NT			2; 4; 6-8
Spur-winged Lapwing <i>Vanellus spinosus</i>			*	*	V, w				
White-tailed Lapwing <i>Vanellus leucurus</i>	*	*			R, s, W, P				
Common Ringed Plover <i>Charadrius hiaticula</i>	*	*			W, P				4; 6
Little Ringed Plover <i>Charadrius dubius</i>	*	*			S, P				6-7
Kentish Plover <i>Charadrius alexandrinus</i>	*	*	*	*	RS, W, P				4
Greater Sand Plover <i>Charadrius leschenaultii</i>			*	*	s, W, P				
Eurasian Woodcock <i>Scolopax rusticola</i>			*	*	W				8
Great Snipe <i>Gallinago media</i>				*	p	NT			
Common Snipe <i>Gallinago gallinago</i>	*	*	*	*	W, P				2; 4; 6; 8
Black-tailed Godwit <i>Limosa limosa</i>	*		*	*	W, P	NT			8
Bar-tailed Godwit <i>Limosa lapponica</i>			*	*	W, P	NT			
Spotted Redshank <i>Tringa erythropus</i>	*		*	*	w, P				
Common Redshank <i>Tringa totanus</i>	*	*	*	*	RS, W, P				4; 6-8
Marsh Sandpiper <i>Tringa stagnatilis</i>	*	*			w, P				6-7
Common Greenshank <i>Tringa nebularia</i>	*		*		W, P				4; 6
Green Sandpiper <i>Tringa ochropus</i>	*		*	*	W, P				
Wood Sandpiper <i>Tringa glareola</i>	*		*	*	w, P				2; 6
Terek Sandpiper <i>Xenus cinereus</i>				*	W, P				
Common Sandpiper <i>Actitis hypoleucos</i>	*	*	*	*	s, w, P				7-8
Sanderling <i>Calidris alba</i>				*	W, P				
Little Stint <i>Calidris minuta</i>			*	*	W, P				4
Temminck's Stint <i>Calidris temminckii</i>			*	*	W, P				
Curlew Sandpiper <i>Calidris ferruginea</i>	*			*	w, P	NT			
Dunlin <i>Calidris alpina</i>	*		*	*	W, P				4
Broad-billed Sandpiper <i>Limicola falcinellus</i>			*	*	W, P				
Ruff <i>Philomachus pugnax</i>			*	*	w, P				
Red-necked Phalarope <i>Phalaropus lobatus</i>			*		P				4
Red Phalarope <i>Phalaropus fulicarius</i>	*				V, p				
Collared Pratincole <i>Glareola pratincola</i>	*	*	*	*	S, P				7
Slender-billed Gull <i>Chroicocephalus genei</i>	*		*	*	RS, W, P				4; 6
Black-headed Gull <i>Chroicocephalus ridibundus</i>	*		*	*	s, W, P				4; 6-8
Little Gull <i>Hydrocoloeus minutus</i>			*	*	W				
Pallas's Gull <i>Ichthyaeetus ichthyaeetus</i>	*		*	*	W, P				4; 6; 8
Caspian Gull <i>Larus cachinnans</i>	*		*	*	W, P				6
Armenian Gull <i>Larus armenicus</i>			*	*	S, w	NT			4; 6; 8
Lesser Black-backed Gull <i>Larus fuscus</i>	*		*		w, p				
Gull-billed Tern <i>Gelochelidon nilotica</i>			*	*	RS, W, P				
Caspian Tern <i>Hydroprogne caspia</i>			*	*	r, s, w, p				4
Common Tern <i>Sterna hirundo</i>	*	*	*	*	S, P				4; 6; 8
Whiskered Tern <i>Chlidonias hybrida</i>	*	*	*	*	S, w, P				4-5; 7
White-winged Tern <i>Chlidonias leucopterus</i>		*	*		P				4; 7
Black Tern <i>Chlidonias niger</i>		*	*		p				
Rock Dove <i>Columba livia</i>	*	*	*	*	R				6
Stock Dove <i>Columba oenas</i>	*	*	*		R, W				7
Common Wood Pigeon <i>Columba palumbus</i>	*	*	*	*	R, W				6-7
Eurasian Collared Dove <i>Streptopelia decaocto</i>	*	*	*	*	R				
Laughing Dove <i>Spilopelia senegalensis</i>	*	*	*	*	R				
Common Cuckoo <i>Cuculus canorus</i>	*	*	*	*	S, P				
Eurasian Scops Owl <i>Otus scops</i>	*	*	*	*	S, P	II	Prot		6-7
Little Owl <i>Athene noctua</i>	*	*	*		R	II	Prot		6-7
Long-eared Owl <i>Asio otus</i>	*				(b), W	II	Prot		7
Short-eared Owl <i>Asio flammeus</i>			*	*	W	II	Prot		
Alpine Swift <i>Tachymarptis melba</i>	*	*	*		S				

Species	Spring	Summer	Autumn	Winter	Status (Iran)	IUCN	CITES	DOE	Literature review
Common Swift <i>Apus apus</i>	*	*	*	*	S, P			Prot	6
Common Kingfisher <i>Alcedo atthis</i>	*	*	*	*	R				4; 6-8
Pied Kingfisher <i>Ceryle rudis</i>	*	*	*	*	S				4; 7
Persian (Blue-cheeked) Bee-eater <i>Merops persicus</i>	*	*	*	*	S, P				
European Bee-eater <i>Merops apiaster</i>	*	*	*	*	S, P				6
Eurasian Hoopoe <i>Upupa epops</i>	*	*	*	*	S, w, P				6-7
Middle Spotted Woodpecker <i>Dendrocopos medius</i>	*	*	*	*	R				1; 6
Syrian Woodpecker <i>Dendrocopos syriacus</i>	*	*	*	*	R				6-7
Lesser Kestrel <i>Falco naumanni</i>	*	*	*	*	S, P		II	EN	6; 8
Common Kestrel <i>Falco tinnunculus</i>	*	*	*	*	R, W		II	EN	6-8
Merlin <i>Falco columbarius</i>			*	*	W		II	EN	
Eurasian Hobby <i>Falco subbuteo</i>		*	*	*	S, P		II	EN	
Red-backed Shrike <i>Lanius collurio</i>	*	*	*	*	S, P				6-7
Red-tailed Shrike <i>Lanius phoenicuroides</i>	*	*	*	*	S, W, P				7
Lesser Grey Shrike <i>Lanius minor</i>	*	*	*	*	S, P				
Southern Grey Shrike <i>Lanius meridionalis</i>		*	*	*	R, W				
Woodchat Shrike <i>Lanius senator</i>	*	*	*	*	S, w, P				6
Masked Shrike <i>Lanius nubicus</i>	*	*	*	*	S, p				1
Eurasian Jay <i>Garrulus glandarius</i>	*	*	*	*	R				6
Eurasian Magpie <i>Pica pica</i>	*	*	*	*	R				6-8
Rook <i>Corvus frugilegus</i>	*	*	*	*	R, W			Pest	
Hooded Crow <i>Corvus cornix</i>	*	*	*	*	R, w			Pest	
Sombre Tit <i>Poecile lugubris</i>		*	*	*	R				1
Great Tit <i>Parus major</i>	*	*	*	*	R				6-7
Eurasian Blue Tit <i>Cyanistes caeruleus</i>	*	*	*	*	R				7
Eurasian Penduline Tit <i>Remiz pendulinus</i>	*	*	*	*	RS, W				1; 2; 7
Bearded Reedling <i>Panurus biarmicus</i>			*	*	V, w				
Woodlark <i>Lullula arborea</i>	*		*	*	R, W				
Eurasian Skylark <i>Alauda arvensis</i>	*	*	*	*	R, W				
Crested Lark <i>Galerida cristata</i>	*	*	*	*	R				6-7
Horned Lark <i>Eremophila alpestris</i>	*	*	*	*	RS, W				
Greater Short-toed Lark <i>Calandrella brachydactyla</i>	*	*	*	*	S, P				
Bimaculated Lark <i>Melanocorypha bimaculata</i>	*	*	*	*	R, W				
Calandra Lark <i>Melanocorypha calandra</i>	*	*	*	*	R, W				
Lesser Short-toed Lark <i>Alaudala rufescens</i>	*	*	*	*	R, W				6
Sand Martin <i>Riparia riparia</i>	*	*	*	*	S, P				6
Barn Swallow <i>Hirundo rustica</i>	*	*	*	*	S, w, P				4; 6
Cetti's Warbler <i>Cettia cetti</i>	*	*	*	*	RS, W				
Long-tailed Tit <i>Aegithalos caudatus</i>	*	*	*	*	R				
Willow Warbler <i>Phylloscopus trochilus</i>	*	*	*	*	P				
Common Chiffchaff <i>Phylloscopus collybita</i>	*	*	*	*	S, W, P				6
Plain Leaf Warbler <i>Phylloscopus neglectus</i>	*	*	*	*	S, W				
Great Reed Warbler <i>Acrocephalus arundinaceus</i>	*	*	*	*	S, P				2; 4; 7
Clamorous Reed Warbler <i>Acrocephalus stentoreus</i>	*	*	*	*	S, w				6
Moustached Warbler <i>Acrocephalus melanopogon</i>	*	*	*	*	RS, W				2; 6-7
Sedge Warbler <i>Acrocephalus schoenobaenus</i>		*	*	*	s, P				6
Paddyfield Warbler <i>Acrocephalus agricola</i>		*	*	*	s, p				
Eurasian Reed Warbler <i>Acrocephalus scirpaceus</i>	*	*	*	*	S, P				6
Eastern Olivaceous Warbler <i>Iduna pallida</i>	*	*	*	*	S, P				6
Upcher's Warbler <i>Hippolais languida</i>	*	*	*	*	S				1
Common Grasshopper Warbler <i>Locustella naevia</i>				*	s, P				
Eurasian Blackcap <i>Sylvia atricapilla</i>		*	*	*	S, w, P				
Garden Warbler <i>Sylvia borin</i>		*	*	*	P				
Barred Warbler <i>Sylvia nisoria</i>		*	*	*	s, P				
Asian Desert Warbler <i>Sylvia nana</i>	*	*	*	*	W, P				
Eastern Orphean Warbler <i>Sylvia crassirostris</i>		*	*	*	S, w, P				
Common Whitethroat <i>Sylvia communis</i>		*	*	*	S, P				
Menetries's Warbler <i>Sylvia mystacea</i>		*	*	*	S, w				
Goldcrest <i>Regulus regulus</i>			*	*	w				
Eurasian Wren <i>Troglodytes troglodytes</i>	*	*	*	*	R, W				

Species	Spring	Summer	Autumn	Winter	Status (Iran)	IUCN	CITES	DOE	Literature review
Eurasian Nuthatch <i>Sitta europaea</i>	*	*	*		R				
Rosy Starling <i>Pastor roseus</i>	*	*	*		s, P			Prot	6
Common Starling <i>Sturnus vulgaris</i>	*	*	*	*	R, W				6-7
Ring Ouzel <i>Turdus torquatus</i>			*		s, W				
Common Blackbird <i>Turdus merula</i>	*	*	*	*	R, W				6
Black-throated Thrush <i>Turdus atrogularis</i>			*	*	W				
Fieldfare <i>Turdus pilaris</i>			*	*	W				
Song Thrush <i>Turdus philomelos</i>			*		r, W				
Mistle Thrush <i>Turdus viscivorus</i>		*	*		r, W				
Bluethroat <i>Luscinia svecica</i>		*	*	*	(b), W, P				
Thrush Nightingale <i>Luscinia luscinia</i>	*	*	*		P				
Common Nightingale <i>Luscinia megarhynchos</i>	*	*	*		S				6
Eversmann's Redstart <i>Phoenicurus erythronotus</i>			*		W				
Black Redstart <i>Phoenicurus ochruros</i>	*	*	*	*	S, W, P				
Common Redstart <i>Phoenicurus phoenicurus</i>	*	*	*		S, P				7
Whinchat <i>Saxicola rubetra</i>	*	*	*		S, P				
European Stonechat <i>Saxicola rubicola</i>			*						
Siberian Stonechat <i>Saxicola maurus</i>		*	*		R, W				7
Isabelline Wheatear <i>Oenanthe isabellina</i>		*	*		S, w, P				
Northern Wheatear <i>Oenanthe oenanthe</i>	*	*	*		S, P				
Kurdish Wheatear <i>Oenanthe xanthopyrma</i>		*	*		S, W				
Black-eared Wheatear <i>Oenanthe hispanica</i>	*	*			S, P				
Finsch's Wheatear <i>Oenanthe finschii</i>	*	*	*		S, W				
House Sparrow <i>Passer domesticus</i>	*	*	*	*	R			Pest	6-7
Spanish Sparrow <i>Passer hispaniolensis</i>	*	*	*	*	R, W			Pest	
Eurasian Tree Sparrow <i>Passer montanus</i>	*	*	*	*	R			Pest	
Yellow-throated Sparrow <i>Gymnoris xanthocollis</i>	*				S			Pest	
Western Yellow Wagtail <i>Motacilla flava</i>	*	*	*		S, P				4; 6
Citrine Wagtail <i>Motacilla citreola</i>	*	*	*		s, W, P				4
Grey Wagtail <i>Motacilla cinerea</i>	*	*	*	*	R, W				4; 6
White Wagtail <i>Motacilla alba</i>	*	*	*	*	R, W, P				4; 6; 8
Tawny Pipit <i>Anthus campestris</i>	*	*			S, w, P				
Meadow Pipit <i>Anthus pratensis</i>	*	*		*	W				
Tree Pipit <i>Anthus trivialis</i>	*	*	*		S, P				
Red-throated Pipit <i>Anthus cervinus</i>			*		w, P				
Water Pipit <i>Anthus spinoletta</i>	*	*	*	*	s, W				6
Common Chaffinch <i>Fringilla coelebs</i>	*	*	*		R, W				6-7
Brambling <i>Fringilla montifringilla</i>				*	W				
European Greenfinch <i>Chloris chloris</i>		*	*		R, W				
Desert Finch <i>Rhodospiza obsoleta</i>	*	*	*	*	R, W				
Common Linnet <i>Linaria cannabina</i>	*	*			R, W				7
European Goldfinch <i>Carduelis carduelis</i>	*	*	*	*	R, W				6-7
Red-fronted Serin <i>Serinus pusillus</i>		*			R, W				
Eurasian Siskin <i>Spinus spinus</i>			*		r, W				
Corn Bunting <i>Emberiza calandra</i>	*	*	*	*	R, W				6-7
Yellowhammer <i>Emberiza citrinella</i>			*		W				
Grey-necked Bunting <i>Emberiza buchanani</i>	*	*	*		S, P				6
Ortolan Bunting <i>Emberiza hortulana</i>	*	*			S, P				
Black-headed Bunting <i>Emberiza melanocephala</i>		*	*		S, P				6-7
Common Reed Bunting <i>Emberiza schoeniclus</i>	*	*	*	*	r, W				4; 6-8

Table 2. Results of mid-winter waterbird censuses in the ZWR from 2008 to 2015 (Kordestan Provincial Office of the DOE, unpublished data).

Species	2008	2009	2010	2011	2012	2013	2014	2015
<i>Anser anser</i>							14	6
<i>Anas strepera</i>	27	6			10			275
<i>Anas crecca</i>	16	72	50	200	267	158	435	350
<i>Anas platyrhynchos</i>	108	420	57	30	379	57	355	265
<i>Anas acuta</i>		2		2				
<i>Anas penelope</i>		4						15
<i>Aythya ferina</i>		8					6	
<i>Aythya nyroca</i>		4		5				12
<i>Marmaronetta angustirostris</i>				3				
<i>Cygnus cygnus</i>				3		3		
Anatinae spp.		350						
<i>Tadorna tadorna</i>		12						
<i>Fulica atra</i>	1,408	2,350	420	4,300	840	4,250	3,803	3,780
<i>Gallinula chloropus</i>		2			2			35
<i>Porzana sp.</i>				8				
<i>Ardea purpurea</i>	9	8						
<i>Nycticorax nycticorax</i>		2						
<i>Ardea cinerea</i>	13	15	8	4	16		16	14
<i>Botaurus stellaris</i>					28			55
<i>Ixobrychus minutus</i>	12		3	3		3	6	25
<i>Egretta garzetta</i>	8	32	23	23	4	23	11	15
<i>Ardea alba</i>			2	2	46		13	10
<i>Bubulcus ibis</i>		3						5
<i>Ciconia ciconia</i>		5			3			
<i>Chroicocephalus ridibundus</i>	21	127	317	250		317	212	175
<i>Larus ichthyaetus</i>					66			0
<i>Larus armenicus</i>					12			79
<i>Larus sp.</i>		70	17	25		17	255	12
<i>Sterna hirundo</i>		25	19	15		11	25	11
<i>Podiceps cristatus</i>		7		10			14	45
<i>Tachybaptus ruficollis</i>	198	21	57	70	26	56	128	135
<i>Phalacrocorax carbo</i>		125		10	50		42	43
<i>Microcarbo pygmeus</i>				5				24
<i>Phoenicopterus roseus</i>					1			
<i>Vanellus vanellus</i>					2			
<i>Limosa limosa</i>					1			
<i>Tringa totanus</i>					3			
<i>Tringa hypoleucos</i>					3			
<i>Scolopax rusticola</i>					5			
<i>Gallinago gallinago</i>					2			
Total count	1,820	3,673	973	4,968	1,766	4,895	5,335	5,386

4. Discussion

Species diversity is the main aspect of biodiversity which is defined as the number of species in a given geographic area. The larger geographic area, the more biological diversity can be expected. However, biological diversity of a given area can be largely affected by the physiography, climatology and other ecological parameters (Rastegar-Pouyani *et al.* 2009). Despite small area size, the remarkable avian diversity of the ZWR probably attributes to its physiographic and climatic complexity which in

turn provides a variety of ecological niches for various avian species. Increasing the drought of the Lake Urmia in the north as an example, it seems that the existence of wetlands and waterbodies located at lower latitudes (including ZWR) has significantly increased their importance for staging and wintering areas of migratory waterbirds in the African-Western Eurasian flyway (Sheykhi Ilanloo *et al.* 2015).

However, according to Table 4, *Streptopelia turtur*, *Coracias garrulus*, *Cercotrichas galactotes*, *Oriolus oriolus* and *Milvus migrans*

were all common birds in ZWR in the 1970s. The fact that none was recorded during the present study is quite remarkable and certainly need further assessment.

4.1. ZWR as a Ramsar Site

The present avifaunal study revealed that the ZWR met the criteria of an Internationally Important Wetland validated by the Ramsar Convention on Wetlands (Secretariat 2010). The most prominent features of the ZWR that make it eligible as a Ramsar site are listed below.

- Zarivar is a relatively deep freshwater lake in the northern Zagros realm and is part of the Iranian-Anatolian biogeographic province, meeting the criteria A1 of the Ramsar Convention on Wetlands. The formation process of the lake is unique and the activity of the bottom springs supplies its water source.
- Many globally VU and NT bird species have been recorded in the ZWR, meeting the criteria B2 of the Ramsar Convention on Wetlands.
- It supports a rich fauna and flora which is important for maintaining the biological and genetic diversity of the Iranian-Anatolian biogeographic province, meeting the criteria B3 of the Ramsar Convention on Wetlands.
- The current study reports 222 bird species belonging to 16 orders and 50 families, of which, 95 were new records for this habitat. Considering 33 species recorded previously by some observers in the ZWR (Table 4), the total number of bird species observed at this wildlife refuge will rise to 255 which is equivalent to about 46.4% of total bird species recorded in Iran. Out of 66 breeding birds in the ZWR (Ahsani *et al.* 2015), at least 34 species (aquatic and semi-aquatic breeding) are ecologically dependent on wetlands during the breeding season, meeting the Criteria B4 of the Ramsar Convention on Wetlands. ZWR harbored two breeding birds, Ferruginous Duck *Aythya nyroca* and Northern Lapwing

Vanellus vanellus, which are currently listed as NT in the 2015 IUCN Red List of Threatened Species.

- During severe winters, while most parts of the lake are frozen, the vegetated margins provide suitable feeding areas and cover for waterbirds. The MWWC Data on the ZWR recorded 1,550 Slender-billed Gull *Chroicocephalus genei* in 1993 and 1,500 Ruddy Shelduck *Tadorna ferruginea* in 1994, the number in each case exceed the minimum 1% of flyway wintering population of these two given species, meeting the criteria B6 of the Ramsar Convention on Wetlands. Also, Scott (1995) had stated that the ZWR “regularly supports over 1% of the regional population of Tufted Duck *Aythya fuligula*”. However, the given species has no longer seen in the ZWR.
- In addition to the problem of population decline in some birds, it should be noted that the true reason may be explored in erratic and superficial mid-winter waterbirds censuses that have been carried out for the last 25 years at the natural and artificial waterbodies of Kordestan Province, as some groups such as gulls, terns, flamingos, egrets, herons, cormorant and grebes have completely been missed from censuses in some years (Tables 2 & 5). According to statistics, in mid-winters of 1994 and 1995, the number of waterbirds counted in the ZWR were 12,401 and 13,500, respectively. However, as observed by the authors as well as experts, in case of strict and regular implementation of mid-winter waterbirds censuses, the B5 criterion of the Ramsar Convention on Wetlands (namely, the presence of at least 20,000 waterbirds) will be realized. In fact, one of the reasons for non-registration of the ZWR in the list of Ramsar sites, have been the lack of adequate and reliable knowledge regarding its avifaunal diversity. Therefore, realization of the B5 criterion of the Ramsar Convention in case of ZWR requires further assessment in future studies.

Table 3. Species diversity indices of birds in the ZWR based on MWWC Data, 2008–2015. *D*, Simpson dominance; *1-D*, Simpson's diversity (1–Dominance); *H'*, Shannon-Wiener diversity; *N*, Hill's evenness index; *P*, precipitation in January; *T*, mean temperature in January. The January precipitation and mean temperature values in January in the ZWR are based on Iran's Meteorological Organization (IRIMO) reports.

Date	Taxa	Individuals	<i>D</i>	<i>1-D</i>	<i>H'</i>	<i>N</i>	<i>P</i> (mm)	<i>T</i> (°C)
2008	10	1,820	0.614	0.386	0.882	0.242	88.90	5.8
2009	24	3,673	0.435	0.565	1.384	0.166	55.40	0.7
2010	11	973	0.303	0.697	1.519	0.415	95.70	4.7
2011	19	4,968	0.754	0.246	0.639	0.101	166.1	1.4
2012	21	1,766	0.299	0.701	1.616	0.241	158.0	0.6
2013	10	4,895	0.759	0.241	0.581	0.179	229.2	0.4
2014	15	5,335	0.524	0.476	1.144	0.209	51.80	2.3
2015	22	5,386	0.504	0.496	1.313	0.169	86.90	1.7

Table 4. List of bird species seen by previous observers in the ZWR, but not recorded during this survey.

Species	IUCN	CITES	Reference / Observer	Date	Count
<i>Oxyura leucocephala</i>	EN	II	Evans (1994)	1974	4
			Scott (1995)	Unknown	–
			Scott (2007)	13 July 1974	13
			Scott (2007)	3 July 1975	3
<i>Aythya fuligula</i>			DA Scott	2 Jan 1972	9
			Scott (2007)	13 July 1974	1
			Shil-Amaysh (2011)	Unknown	–
<i>Marmaronetta angustirostris</i>	VU		Scott (1995)	Jan 1975	3
			DOE MWWC Data	15 Jan 2015	3
			Shil-Amaysh (2011)	Unknown	–
<i>Mergus merganser</i>			H Kowalski	17 Jan 1970	35
			Scott (1995)	2 Jan 1972	31
<i>Platalea leucorodia</i>		II	Shabaniyan & Barat i(2009)	2008	43
			Shil-Amaysh (2011)	Unknown	–
<i>Cygnus columbianus</i>			Shil-Amaysh (2011)	Unknown	–
<i>Aquila chrysaetos</i>		II	Shil-Amaysh (2011)	Unknown	–
			DOE MWWC Data	15 Jan 2014	1
			DOE MWWC Data	3 Jan 2015	4
<i>Haliaeetus albicilla</i>		I	Shil-Amaysh (2011)	Unknown	–
<i>Aquila pomarina</i>		II	Shil-Amaysh (2011)	Unknown	–
<i>Aquila clanga</i>	VU	II	DOE MWWC Data	29 Jan 2009	5
			DOE MWWC Data	15 Jan 2010	7
			DOE MWWC Data	15 Jan 2011	8
			DOE MWWC Data	15 Jan 2013	7
			DOE MWWC Data	3 Jan 2015	7
<i>Milvus migrans</i>		II	DA Scott	1 June 1971	2
			DA Scott	13 July 1974	3
			DA Scott	3 July 1975	1
<i>Falco peregrinus</i>		I	Shil-Amaysh (2011)	Unknown	–
			DOE MWWC Data	15 Jan 2010	2
<i>Falco pelegrinoides</i>		I	Shil-Amaysh (2011)	Unknown	–
			DOE MWWC Data	15 Jan 2013	1
			DOE MWWC Data	3 Jan 2015	3
<i>Alectoris chukar</i>			Shil-Amaysh (2011)	Unknown	–
<i>Pterocles orientalis</i>			Shil-Amaysh (2011)	Unknown	–
<i>Streptopelia turtur</i>	VU		DA Scott	13-14 July 1974	48
			DA Scott	3 July 1975	34
			Shil-Amaysh (2011)	Unknown	–
			Ahsani <i>et al.</i> (2015)	Mar-Sep 2015	50
<i>Strix aluco</i>		II	Shil-Amaysh (2011)	Unknown	–
<i>Coracias garrulus</i>			DA Scott	1 June 1971	–
			DA Scott	13 July 1974	6
			DA Scott	3 July 1975	6
			Shil-Amaysh (2011)	Unknown	–
<i>Erithacus rubecula</i>			Shil-Amaysh (2011)	Unknown	–

Species	IUCN	CITES	Reference / Observer	Date	Count
<i>Sylvia curruca</i>			Shil-Amaysh (2011) DA Scott	Unknown 13 July 1974	– 1
<i>Muscicapa striata</i>			DA Scott Shil-Amaysh (2011)	13 July 1974 Unknown	6 –
<i>Emberiza cineracea</i>	NT		Evans (1994) Scott (2008)	1977 13 July 1974	2 2
<i>Serinus serinus</i>			Scott (2008)	2 Jan 1972	1
<i>Passer moabiticus</i>			Shil-Amaysh (2011)	Unknown	–
<i>Corvus corax</i>			Shil-Amaysh (2011)	Unknown	–
<i>Corvus monedula</i>			DA Scott DA Scott DA Scott Ahsani <i>et al.</i> (2015)	1 June 1971 2 Jan 1972 13 July 1974 Mar-Sep 2015	12 2 45 300
<i>Cercotrichas galactotes</i>			DA Scott DA Scott Ahsani <i>et al.</i> (2015)	13 July 1974 3 July 1975 Mar-Sep 2015	9 3 15
<i>Oriolus oriolus</i>			DA Scott DA Scott Ahsani <i>et al.</i> (2015)	13 July 1974 3 July 1975 Mar-Sep 2015	3 3 20
<i>Larus canus</i>			Shabaniyan & Barati (2009) Shabaniyan & Barati (2009)	Apr 2008 May 2008	6 5
<i>Clamator glandarius</i>			Evans (1994) Scott (2008)	1974 13 July 1974	– 1
<i>Hieraaetus pennatus</i>		II	Evans (1994)	Unknown	–
<i>Ficedula semitorquata</i>			DA Scott DA Scott Evans (1994)	13 July 1974 3 July 1975 Unknown	3 1 –

Table 5. Results of the mid-winter waterbird censuses at natural and artificial waterbodies of Kordestan Province from 1992 to 2007 (Kordestan Provincial Office of the DOE, unpublished data). Dash= not counted or not observed.

Year	Grebes	Cormorants	Hérons & Egrets	Flamingos	Cranes	Storks	Geese, Swans & Ducks	Coots	Gulls & Terns	Total
1992	–	–	52	19	6	–	2,798	1,100	–	3,975
1993	–	–	–	847	85	–	12,828	8,340	–	22,100
1994	236	–	195	–	–	–	16,730	8,500	3,300	28,961
1995	–	–	–	4,620	56	–	31,230	13,000	–	48,906
1996	–	–	–	2,649	23	–	26,349	10,594	–	39,615
1997	–	–	–	1,986	37	–	25,793	11,802	–	39,618
1998	–	–	–	1,626	45	–	7,898	11,526	–	21,095
1999	–	–	–	668	49	–	12,993	7,438	–	21,148
2000	–	–	–	665	51	–	12,814	7,426	–	20,956
2001	–	–	–	66	–	–	936	1,540	–	2,542
2002	1,123	14	24	–	–	1	792	44	67	2,065
2003	106	250	162	–	–	–	14,694	3,900	4,332	23,444
2004	64	121	204	–	–	9	5,447	6,310	517	12,672
2005	436	104	383	–	–	18	3,521	6,353	580	11,395
2006	739	250	576	–	–	–	3,667	7,716	2,252	15,200
2007	49	56	137	–	–	–	4,714	222	2,051	7,229

4.2. Rare birds

Here we present some birds that have already been considered as rare species for Iran by several authors (Scott 2008; Roselaar & Aliabadian 2009; Khaleghizadeh *et al.* 2011). They are listed as follows:



Fig. 2. Spur-winged Lapwing *Vanellus spinosus* at the ZWR, October 2016, © J. Pezeshk.



Fig. 3. A juvenile Long-eared Owl *Asio otus* and a nest belonged to this species at the ZWR, October 2015 and April 2016, respectively, © S. Kanisanani & J. Pezeshk.



Fig. 4. European Stonechat *Saxicola rubicola* at the ZWR, December 2016, © J. Pezeshk.

Red Phalarope *Phalaropus fulicarius*: Three individuals were observed on 1 April 2015 in Shravan, north of the ZWR. This species has a circumpolar breeding range, while its wintering occurs mainly in tropical oceans (Ashoori *et al.* 2007). It is a scarce passage migrant in the south Caspian region and also a passage migrant and winter visitor to the south coast of Iran (Scott 2008; Roselaar & Aliabadian 2009; Khaleghizadeh *et al.* 2011; Mansoori 2013).

Great Snipe *Gallinago media*: One was recorded on 6 February 2016 in Shravan. Great Snipe is considered as NT in the 2015 IUCN Red List of Threatened Species. Its wintering range is located solely in Africa south of the Sahara, but has rarely been observed in grasslands and wetlands along the northern and western parts of Iran (Khaleghizadeh *et al.* 2011; Mansoori 2013).

Spur-winged Lapwing *Vanellus spinosus*: One was photographed on 11 October 2015 in Shravan (Fig. 2). Zarudny (1911) listed this species as a scarce winter visitor to the Khuzestan Plain and the Zagros realm. With the increasing number of records, this species is becoming a scarce bird in Iran.

Great Spotted Cuckoo *Clamator glandarius*: A juvenile with a family of Eurasian Magpies was observed on 13 July 1974 in eastern part of the ZWR (Scott 2008). In the 1970s, this was the only record of this species in Iran.

Long-eared Owl *Asio otus*: One on 25 May 2015, 4 juveniles on 27 April 2015, as well as one bird along with a nest and three eggs on 16 April 2016 on Kani Sanan Plain, southwest of the ZWR (Fig. 3). It is a breeding bird in the South Caspian region, Khorasan and West Azerbaijan (Scott 2008; Roselaar & Aliabadian 2009; Khaleghizadeh *et al.* 2011; Mansoori 2013). The presence of juveniles and observation of its active nest in the ZWR indicate that its breeding range has expanded toward the south and west of the country. With the increasing number of records, this species is becoming a more common bird in Iran and should be omitted from the list of Iran's rare birds in future assessments (Khaleghizadeh *et al.* 2015).

European Stonechat *Saxicola rubicola*: One was photographed in December 2016 in west of the ZWR (Fig. 4).

Common Grasshopper Warbler *Locustella naevia*: One was observed on 14 May 2016 on

Kani Sanan Plain. It is a passage migrant to the west of Iran and also breeds in the northwest of the country (Mansoori 2013).

Paddyfield Warbler *Acrocephalus agricola*: One was photographed on 31 August 2016 (Fig. 5) and two on 10–22 December 2016 on Kani Sanan Plain. It is a scarce and local summer visitor to the northeast of Iran and the Sistan basin; probably a fairly common passage migrant in the east and southeast. Sometimes listed as a breeding bird in Khorasan and Sistan (Scott 2008; Mansoori 2013).

Bearded Reedling *Panurus biarmicus*: Three individuals were observed on 17 December 2016 in the eastern side of the ZWR (Fig. 6). This species is mainly regarded as a scarce winter visitor to the south of the Caspian Sea (Scott 2008; Khaleghizadeh *et al.* 2011).



Fig. 5. Paddyfield Warbler *Acrocephalus agricola* at the ZWR, August 2016, © J. Pezeshk.



Fig. 6. Bearded Reedling *Panurus biarmicus* at the ZWR, December 2016, © J. Pezeshk.

European Serin *Serinus serinus*: One was observed on 2 January 1972 near the southeast corner of the ZWR following a heavy fall of snow (Scott 2008). It is a vagrant species to the west of the Zagros Mountains.

Cinereous Bunting *Emberiza cineracea*: Two were observed on 13 July 1974 (Scott 2008). This is a scarce summer visitor to the northwest of Iran.

4.3. Threats

Nowadays, three categories of human activities are threatening the ZWR and its avifauna: (1) agricultural and livestock activities, (2) land-use change and habitat destruction, and (3) breaking the environmental laws, lack of public awareness and strict management.

Progressive over-growth of sugar cane fields during the past three decades, leads to intensification of eutrophication phenomenon of Zarivar Lake. Eutrophication itself is a result of the pollution caused by human activities (Ticehurst *et al.* 2007). Studying the destruction dynamics of the ZWR using satellite imagery in a 32-year period (1977–2014) showed a 15% reduction in the area of water body and a 21% increase in the margin area during this period. Furthermore, during the same period, approximately 45% of lush forests around the lake has been disappeared and about 38% and 43% has been added to the areas of sparse forests and agricultural/residential lands, respectively (Solaimanabad *et al.* 2016). These conditions led to increased emission of pollutants into the lake, decrease of water body area, intensification of eutrophication, and therefore, creation of an environmental crisis in the ZWR (Ebrahimi-Mohammadi 2013). According to the researches, some parts of the lake with less than 1 meter deep will be filled up due to the increased sediments during the next 20 years.

The tributaries from the Ghezalche-su River in the north, solely, enter a major part of sediments and sewages into the ZWR. Due to poor sewage system, sanitary sewages of the south-western part of the Marivan city and those of six villages located around the ZWR enter directly into the lake. Therefore, the entrance of c. 300 litres of sewage per second into the lake, and consequently generation of floated biomaterials, up to 3.2 times more in each cubic meter of water, has led to

increasingly growth of sugar cane fields, change in aquatic ecosystem and subsequently mortality of biological species (Ebrahimi-Mohammadi 2013). Furthermore, a dam has been constructed at the south of the lake. As a result, due to the increased water level, bottom springs are not able to discharge their normal water volume. Some other man-made threats to the ZWR and its biodiversity include overgrazing of livestock, construction of a transit road inside the ZWR, motor boat traffic beyond the lake's carrying capacity, deliberate fires in the sugar cane fields and forests around the lake, introduction of exotic fish species into the lake (Esmaili *et al.* 2017a,b; Zarei & Rajabi-Maham 2017; Sadeghi *et al.* in press), and discharge of garbage and construction wastes into the ZWR.

4.4. Conservation

Considering internationally protected bird species, three species in the ZWR are assessed as under severe threat— Dalmatian Pelican *Pelecanus crispus*, Lesser White-fronted Goose *Anser erythropus* and Common Pochard *Aythya ferina* as VU, and eight species are Near Threatened in the 2015 IUCN Red List of Threatened Species, namely Ferruginous Duck *Aythya nyroca*, Pallid Harrier *Circus macrourus*, Black-tailed Godwit *Limosa limosa*, Bar-tailed Godwit *Limosa lapponica*, Great Snipe *Gallinago media*, Curlew Sandpiper *Calidris ferruginea*, Northern Lapwing *Vanellus vanellus* and Armenian Gull *Larus armenicus*. CITES appendixes apply to 21 species of total of 222 bird species, including two in Appendix I and 19 species in Appendix II. Iran's environmental laws designated seven species as endangered, namely Ferruginous Duck *Aythya nyroca*, Pygmy Cormorant *Microcarbo pygmeus*, Dalmatian Pelican *P. crispus*, Lesser Kestrel *Falco naumanni*, Common Kestrel *Falco tinnunculus*, Merlin *Falco columbarius* and Eurasian Hobby *Falco subbuteo* and 30 other species as protected species (Supreme Council on Environment 2017). Considering species reported from the previous studies (Table 4), the number of species with the conservation value in the ZWR would rise to 60, indicating the high conservation value of this habitat.

Ecotourism industry now is one of the main sectors of the world economy. It requires to be

set a number of strict rules and proper infrastructures in order to develop in the right way. In recent years, the rapid growth of birdwatching activity as the main branch of ecotourism, and its high potential to provide financial supports for local communities in order to better preservation of natural resources, has attracted much attentions from the perspective of conservation biology (Sekercioglu 2002). One of the main goals of the Zarivar Bird Records Group at the Chya Green Association, an environmental nonprofit organization, was to create a birdwatching site in the ZWR. Due to high avian diversity, Sharvan area with 70 ha at the north of the ZWR has been proposed as a potential candidate to the DOE of Iran. This will certainly lead to the development of ecotourism in the area and thereby will promote species conservation through local communities.

Overall, our results showed that the ZWR meets five criteria of the Ramsar Convention on wetlands. Accordingly, it is introduced for designation in the list of wetlands of international importance under the Ramsar Convention on Wetlands.

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