

# Identifying avifauna and the presence time of migratory birds at a university campus in the southwest of Iran

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## Abstract

In wildlife management, sufficient information about fauna is vital for conservation of species and their habitats. Furthermore, the number of bird species in a habitat can represent an index of habitat quality. Therefore, this study was carried out to identify bird fauna on a university campus (*i.e.* Agricultural Sciences and Natural Resources University of Khuzestan, abbreviated as ASNRUKH) in the southwest of Iran in order to determine the number of bird species, the day of their arrival, and the presence time of migratory birds on campus. Field survey and identification of birds were carried out in the study area, with an area of 72.9 ha, using binoculars from June 2017 to May 2018 in linear transects spaced 20 meters apart. We identified 62 bird species, including nine raptors, which is equal to 11.25% of bird species in Iran. In total, 19 residents, five summer visitors, 21 winter visitors and 17 passing migratory birds were identified. The lowest co-occurrence number of species (21–25) was observed from middle June to early October and the maximum number of concurrent species (38–41) were recorded from late November to early January. The Western Barn Owl *Tyto alba* was the only resident raptor, which is part of an integrated pest management system throughout the year. ASNRUKH's long-established persistent favorable microclimate supports both resident and migratory birds. In addition, the study area provides food and safety for migratory birds from across the globe as a stopover site.

Received: 5 April 2020

Accepted: 12 May 2020

Published online: 20 May 2020

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**Key words:** ASNRUKH, bird species, day of arrival, raptors, stopover site

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## Introduction

Birds (class Aves) are endothermic vertebrates with feather-covered bodies and toothless beaks, which are distributed all around the world (Kaboli et al., 2016). Barrowclough et al. (2016) estimated the highest number of bird species in the world around 18,000 species. The International Union for Conservation of Nature (IUCN) identified 11,126 bird species in its Red List so far, of which 1,492 (13% of birds) are threatened (224 species are critically endangered [CR], 469 endangered [EN] and 799 vulnerable [VU]) (IUCN, 2019). Birds are classified into 36 orders, with Passeriformes containing the largest number of species (6,648 species) and Opisthocomiformes and Leptosomiformes containing the smallest number of species (one species in each order) (IUCN, 2019).

Iran is a vast country in the Palearctic realm, located on the border of the Oriental and Ethiopian realms, with a variety of topographical and climatic regions because Iran's biodiversity is affected by these three realms (Coad and Vilenkin, 2004). A total of 551 bird species in 26 orders and 80 families have been identified in Iran (Khaleghizadeh et al., 2017; Ashoori, 2018); approximately equal to the total number of bird species in Europe (Kaboli et al., 2016). Furthermore, the country has the highest number of migratory bird species in the Middle East (Kirby et al., 2008; Nourani et al., 2014). In addition, 62 raptors (birds of prey) have been identified from Iran (Khaleghizadeh et al., 2017).

Raptors are members of the orders Accipitriformes, Falconiformes and Strigiformes. Raptors are apex predators and play essential roles in ecosystems (Donazar et al., 2016; Khaleghizadeh and Anuar, 2019). They offer indicators of habitat quality because of their sensitivity to human activities (*e.g.* environmental pollution). Therefore, conservation biologists pay special attention to raptors in their conservation plans (Rodríguez - Estrella et al., 1998). Raptors are also considered as surrogates of biodiversity in the landscape when prioritizing areas for protection (Burgas et al., 2014).

In wildlife management, sufficient information about fauna is necessary for conservation of species and their habitats (Ayodeji and Kilishi, 2019; Vilkov, 2020); basically, the number of bird species in a habitat can be an index of habitat quality. Therefore, this study was aimed at identifying bird fauna on a university campus in the southwest of Iran to detect the number of bird species, including raptors, and the presence time of any migratory birds.

## Material and Methods

### Study area

Agricultural Sciences and Natural Resources University of Khuzestan (hereafter ASNRUKH) (31°35'51.45" N and 48°53'3.84" E, with an area of 72.9 ha) is located in the center of Khuzestan Province, southwestern Iran (Fig. 1). The area experiences high temperatures in summer averaging ~37 °C with a maximum of 50 °C, and mild winters averaging ~17 °C and a minimum of 5 °C (IRIMO, 2017). ASNRUKH is almost six decades old, and the presence of green spaces with large old trees (*e.g.* Lebbek Tree *Albizia lebbek*, Pipal Tree *Ficus religiosa*, Christ's Thorn Jujube *Ziziphus spina-christi* and Eucalyptus *Eucalyptus camaldulensis*) and palm species (*e.g.* Date Palm *Phoenix dactylifera*, Canary Island Date Palm *Phoenix canariensis* and Washington Palm *Washingtonia filifera*) attracts many bird species. The Karun River, the longest river in Iran, is located to the west of ASNRUKH (Fig. 1) and its riparian habitats attract many bird species, especially waders (Behrouzi-Rad et al., 2015). Southern Iran, where Khuzestan Province and the study area are located, is affected by both the Oriental and Ethiopian zoogeographical realms, which has led to its high biodiversity (Coad and Vilenkin, 2004).

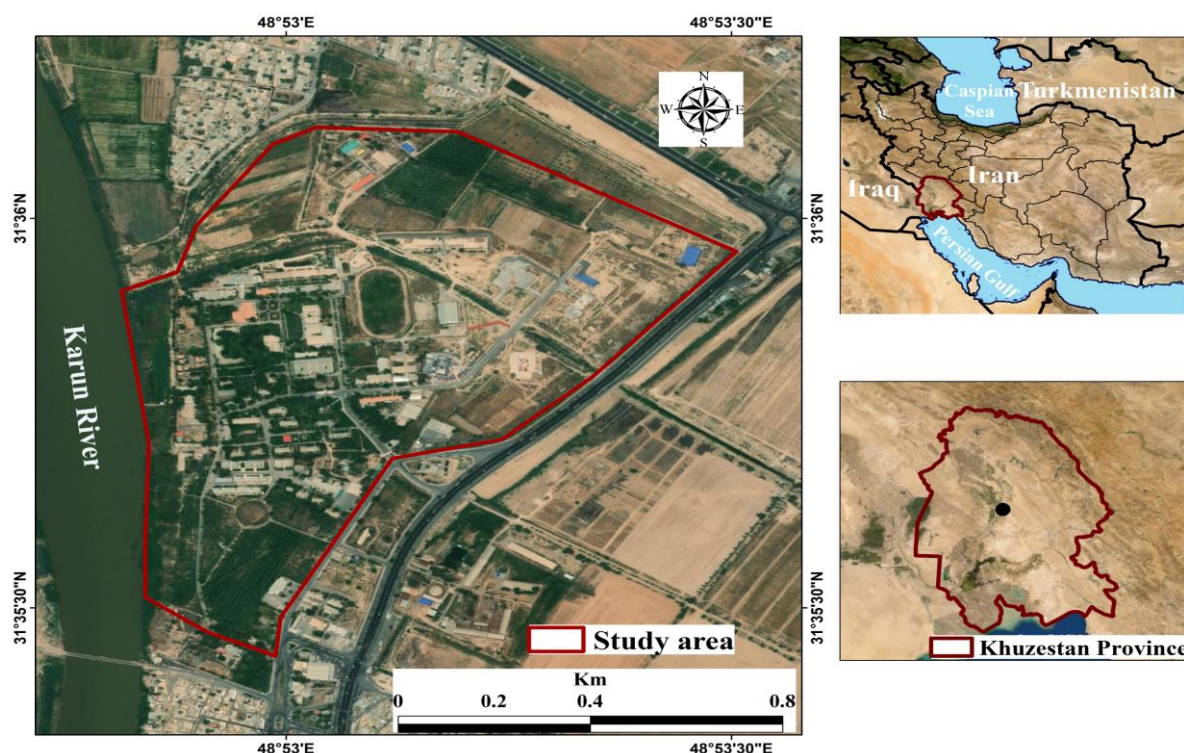
### Data collection and species identification

A field survey was carried out from June 2017 to May 2018, once every two weekends from sunrise for four hours; in addition, several field surveys were carried out randomly for three hours before sundown. As feeding activity in birds generally occurs in early morning and late afternoon, birds are known as species with a bimodal activity pattern (Reyes-Arriagada et al., 2015). Thus, these intervals were selected as the two best times for bird observation (McNamara et al., 1994). Linear transects set 20 meters apart were surveyed at ASNRUKH and bird identification was carried out with direct observation by one person using binoculars (Steiner, model Al-Saghar II 8x30, Germany). In addition, photos of birds were captured with

a digital camera (Canon SX60 with 65x magnification, Japan). Species were identified using - *Birds of the Middle East* (Porter and Aspinall, 2010), *Collins Bird Guide* (Svensson et al., 2010), and *Atlas of Birds of Iran* (Kaboli et al., 2016). To ensure correct identifications, photos of birds were sent to expert ornithologists to check our identifications.

For the taxonomy of species, we used the IOC World Bird List (Gill and Donsker, 2019). We checked the conservation status of each identified species in Iran according to the report by Iran's Department of Environment (DOE) (DOE, 2019) and the global status according to the IUCN Red List of threatened species (IUCN, 2019). We looked for migratory birds every two weeks and their day of arrival and presence time were recorded. As the authors were residents at ASNRUKH, the day of arrival was also recorded on dates other than the biweekly observation. We also relied on bird calls for detecting their arrival. For each species, we determined whether the species was a resident, summer visitor, winter visitor, or passing migrant.

Finally, we overlaid the number of days when species inhabited the study area to determine the interval when the highest number of bird species were present. We also performed the above-mentioned analysis for raptor species and protected species separately to compare them with other species in the study area. The presence time of bird species in the study area was illustrated using Excel software (version 2013).



**Figure 1:** Location of the study area in Khuzestan Province and Iran. Map created in ArcGIS (version 10.3) with Imagery Basemap.

## Results

We recorded 62 bird species belonging to 32 families and 12 orders in the study area, which is equal to 11.25% of bird species in Iran (Table 1). In total, 19 residents, 5 summer visitors, 21 winter visitors and 17 passing migratory birds were identified in the study area (Table 1). The largest number of species in the study area belonged to the order Passeriformes (32 species) and family Accipitridae (7 species) (Table 1).

**Table 1:** Characteristics of identified bird species in the study area in Khuzestan Province, Iran.

Number	English name	Scientific name	Family	Order	The day of arrival	Status in the study area	Conservation status	
							IUCN	DOE
1	Shikra	<i>Accipiter badius</i> (Gmelin, 1788)	Accipitridae	Accipitriformes	19 October	WV	LC	P
2	Eurasian Sparrowhawk	<i>Accipiter nisus</i> (Linnaeus, 1758)	Accipitridae	Accipitriformes	17 November	WV	LC	P
3	Western Marsh Harrier	<i>Circus aeruginosus</i> (Linnaeus, 1758)	Accipitridae	Accipitriformes	5 October	WV	LC	P
4	Pallid Harrier	<i>Circus macrourus</i> (Gmelin, 1770)	Accipitridae	Accipitriformes	29 December	PM	NT	P
5	Long-legged Buzzard	<i>Buteo rufinus</i> (Cretzschmar, 1829)	Accipitridae	Accipitriformes	15 November	WV	LC	P
6	European Honey Buzzard	<i>Pernis apivorus</i> (Linnaeus, 1758)	Accipitridae	Accipitriformes	19 October	PM	LC	P
7	Black-winged Kite	<i>Elanus caeruleus</i> (Desfontaines, 1789)	Accipitridae	Accipitriformes	17 December	WV	LC	P
8	Common Kestrel	<i>Falco tinnunculus</i> (Linnaeus, 1758)	Falconidae	Falconiformes	6 October	WV	LC	P
9	Western Barn Owl	<i>Tyto alba</i> (Scopoli, 1769)	Tytonidae	Strigiformes	-	R	LC	P
10	Great Cormorant	<i>Phalacrocorax carbo</i> (Linnaeus, 1758)	Phalacrocoracidae	Suliformes	12 December	WV	LC	NP
11	Little Egret	<i>Egretta garzetta</i> (Linnaeus, 1766)	Ardeidae	Pelecaniformes	23 November	WV	LC	NP
12	Western Cattle Egret	<i>Bubulcus ibis</i> (Linnaeus, 1758)	Ardeidae	Pelecaniformes	19 September	WV	LC	NP
13	Common Moorhen	<i>Gallinula chloropus</i> (Linnaeus, 1758)	Rallidae	Gruiformes	-	R	LC	NP
14	Red-wattled Lapwing	<i>Vanellus indicus</i> (Boddaert, 1783)	Charadriidae	Charadriiformes	-	R	LC	NP
15	Collared Pratincole	<i>Glareola pratincola</i> (Linnaeus, 1766)	Glareolidae	Charadriiformes	24 April	PM	LC	NP

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Table 1: (Continued)

Number	English name	Scientific name	Family	Order	The day of arrival	study area	Conservation status	
							IUCN	DOE
16	Black-headed Gull	<i>Chroicocephalus ridibundus</i> (Linnaeus, 1766)	Laridae	Charadriiformes	1-Nov	WV	LC	NP
17	Pied Kingfisher	<i>Ceryle rudis</i> (Linnaeus, 1758)	Alcedinidae	Coraciiformes	-	R	LC*	NP
18	White-throated Kingfisher	<i>Halcyon smyrnensis</i> (Linnaeus, 1758)	Alcedinidae	Coraciiformes	-	R	LC+	NP
19	Common Kingfisher	<i>Alcedo atthis</i> (Linnaeus, 1758)	Alcedinidae	Coraciiformes	3-Nov	PM	LC+	NP
20	Indian Roller	<i>Coracias benghalensis</i> (Linnaeus, 1758)	Coraciidae	Coraciiformes	-	R	LC	NP
21	Blue-cheeked Bee-eater	<i>Merops persicus</i> (Pallas, 1773)	Meropidae	Coraciiformes	14-Apr	SV	LC	NP
22	Green Bee-eater	<i>Merops orientalis</i> (Latham, 1801)	Meropidae	Coraciiformes	-	R	LC	NP
23	European Bee-eater	<i>Merops apiaster</i> (Linnaeus, 1758)	Meropidae	Coraciiformes	12-Apr	PM	LC	NP
24	Eurasian Hoopoe	<i>Upupa epops</i> (Linnaeus, 1758)	Upupidae	Bucerotiformes	13-Sep	WV	LC	NP
25	Eurasian Wryneck	<i>Jynx torquilla</i> (Linnaeus, 1758)	Picidae	Piciformes	19-Oct	PM	LC	NP
26	Black Francolin	<i>Francolinus francolinus</i> (Linnaeus, 1766)	Phasianidae	Galliformes	-	R	LC	P
27	Rock Dove	<i>Columba livia</i> (Gmelin, 1789)	Columbidae	Columbiformes	-	R	LC	NP
28	Eurasian Collared Dove	<i>Columba palumbus</i> (Linnaeus, 1758)	Columbidae	Columbiformes	-	R	LC	NP
29	Laughing Dove	<i>Spilopelia senegalensis</i> (Linnaeus, 1766)	Columbidae	Columbiformes	-	R	LC	NP
30	Common Wood Pigeon	<i>Streptopelia decaocto</i> (Frisvaldszky, 1838)	Columbidae	Columbiformes	-	R	LC	NP

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Table 1: (Continued)

Number	English name	Scientific name	Family	Order	The day of arrival	Status in the study area	Conservation status	
							IUCN	DOE
31	Barn Swallow	<i>Hirundo rustica</i> (Linnaeus, 1758)	Hirundinidae	Passeriformes	7 March	SV	LC	P
32	Grey Hypocolius	<i>Hypocolius ampelinus</i> (Bonaparte, 1850)	Hypocoliidae	Passeriformes	25 March	SV	LC	NP
33	Isabelline Shrike	<i>Lanius isabellinus</i> (Hemprich and Ehrenberg, 1833)	Laniidae	Passeriformes	5 October	WV	LC	NP
34	Afghan Babbler	<i>Argya huttoni</i> (Blyth, 1847)	Leiотrichidae	Passeriformes	-	R	LC	NP
35	Purple Sunbird	<i>Cinnyris asiaticus</i> (Latham, 1790)	Nectariniidae	Passeriformes	-	R	LC	NP
36	Eurasian Golden Oriole	<i>Oriolus oriolus</i> (Linnaeus, 1758)	Oriolidae	Passeriformes	14 April	PM	LC	NP
37	White-eared Bulbul	<i>Pycnonotus leucotis</i> (Gould, 1836)	Pycnonotidae	Passeriformes	-	R	LC	P
38	Water Pipit	<i>Anthus spinoletta</i> (Linnaeus, 1758)	Motacillidae	Passeriformes	23 November	WV	LC	NP
39	White Wagtail	<i>Motacilla alba</i> (Linnaeus, 1758)	Motacillidae	Passeriformes	12 October	WV	LC	NP
40	Western Yellow Wagtail	<i>Motacilla flava</i> (Linnaeus, 1758)	Motacillidae	Passeriformes	21 September	PM	LC	NP
41	Rufous-tailed Scrub Robin	<i>Cercotrichas galactotes</i> (Temminck, 1820)	Muscicapidae	Passeriformes	25 May	SV	LC	NP
42	Common Nighthale	<i>Luscinia megarhynchos</i> (Brehm, 1831)	Muscicapidae	Passeriformes	13 April	PM	LC	P
43	Bluethroat	<i>Luscinia svecica</i> (Linnaeus, 1758)	Muscicapidae	Passeriformes	23 November	WV	LC	NP
44	Pied Wheatear	<i>Oenanthe pleschanka</i> (Lepechin, 1770)	Muscicapidae	Passeriformes	12 April	PM	LC	NP
45	European Stonechat	<i>Saxicola rubicola</i> (Linnaeus, 1766)	Muscicapidae	Passeriformes	23 November	WV	LC	NP
46	Spotted Flycatcher	<i>Muscicapa striata</i> (Pallas, 1764)	Muscicapidae	Passeriformes	21 September	PM	LC	NP

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Table 1: (Continued)

Number	English name	Scientific name	Family	Order	The day of arrival	Status in the study area	Conservation status	
							IUCN	DOE
47	Song Thrush	<i>Turdus philomelos</i> (Brehm, 1831)	Turdidae	Passeriformes	1 December	WV	LC	NP
48	Common Blackbird	<i>Turdus merula</i> (Linnaeus, 1758)	Turdidae	Passeriformes	-	R	LC	NP
49	European Robin	<i>Erithacus rubecula</i> (Linnaeus, 1758)	Turdidae	Passeriformes	24 October	WV	LC	NP
50	Black Redstart	<i>Phoenicurus ochruros</i> (Gmelin, 1774)	Turdidae	Passeriformes	1 November	WV	LC	NP
51	Common Redstart	<i>Phoenicurus phoenicurus</i> (Linnaeus, 1758)	Turdidae	Passeriformes	29 December	PM	LC	NP
52	Garden Warbler	<i>Sylvia borin</i> (Boddaert, 1783)	Sylviidae	Passeriformes	10 May	PM	LC	NP
53	Eurasian Blackcap	<i>Sylvia atricapilla</i> (Linnaeus, 1758)	Sylviidae	Passeriformes	24 April	PM	LC	NP
54	Common Whitethroat	<i>Sylvia communis</i> (Latham, 1787)	Sylviidae	Passeriformes	10 May	PM	LC	NP
55	Desert Whitethroat	<i>Sylvia minula</i> (Hume, 1873)	Sylviidae	Passeriformes	10 May	PM	LC	NP
56	Common Chiffchaff	<i>Phylloscopus collybita</i> (Vieillot, 1817)	Phylloscopidae	Passeriformes	4 October	WV	LC	NP
57	Graceful Prinia	<i>Prinia gracilis</i> (Lichtenstein, MHK, 1823)	Cisticolidae	Passeriformes	-	R	LC	NP
58	Eastern Olivaceous Warbler	<i>Iduna pallida</i> (Hemprich and Ehrenberg, 1833)	Acrocephalidae	Passeriformes	14 April	PM	LC	NP
59	Crested Lark	<i>Galerida cristata</i> (Linnaeus, 1758)	Alaudidae	Passeriformes	-	R	LC	NP
60	Yellow-throated Sparrow	<i>Gymnoris xanthocolis</i> (Burton, 1838)	Passeridae	Passeriformes	15 April	SV	LC	NP
61	Spanish Sparrow	<i>Passer hispaniolensis</i> (Temminck, 1820)	Passeridae	Passeriformes		WV	LC	NP
62	House Sparrow	<i>Passer domesticus</i> (Linnaeus, 1758)	Passeridae	Passeriformes	-	R	LC	NP

Status in the study area: WV (winter visitor), SV (summer visitor), PM (passage migrant) and R (resident).

DOE: P (protected), NP (not protected)

\* Endangered in Europe

+ Vulnerable in Europe

We took photos of all observed species except the Black Francolin *Francolinus francolinus* (Linnaeus), which was observed but not photographed (Appendix 1). Two dead birds were found in the study area (the Common Moorhen *Gallinula chloropus* (Linnaeus) and Eurasian Blackcap *Sylvia atricapilla* (Linnaeus)). In addition, five species, namely the Pallid Harrier *Circus macrourus* (Gmelin), Common Kingfisher *Alcedo atthis* (Linnaeus), Pied Wheatear *Oenanthe pleschanka* (Lepechin), Common Whitethroat *Sylvia communis* (Latham) and Desert Whitethroat *Sylvia minula* (Hume) were observed only once (December 29<sup>th</sup>, November 3<sup>rd</sup>, April 12<sup>th</sup>, May 10<sup>th</sup> and May 10<sup>th</sup>, respectively). Therefore, the single instance when the species (alive or dead) was observed is recorded as its time of presence in the study area (except *G. chloropus*, which is resident in the study area).

According to the IUCN Red List, all identified species are currently categorized as least concern (LC) (three species are threatened only in Europe), except for *C. macrourus*, which is near threatened (NT). On the other hand, 13 species, including nine raptors, are categorized as nationally protected species according to the DOE criteria. The raptors belong to three orders (seven species from Accipitriformes, one species from Falconiformes and one species from Strigiformes) (Table 1). Six raptors were winter visitors and two raptors were passing migrants. The Western Barn Owl *Tyto alba* (Scopoli) was the only resident raptor in the study area (Table 1; Fig. 2).

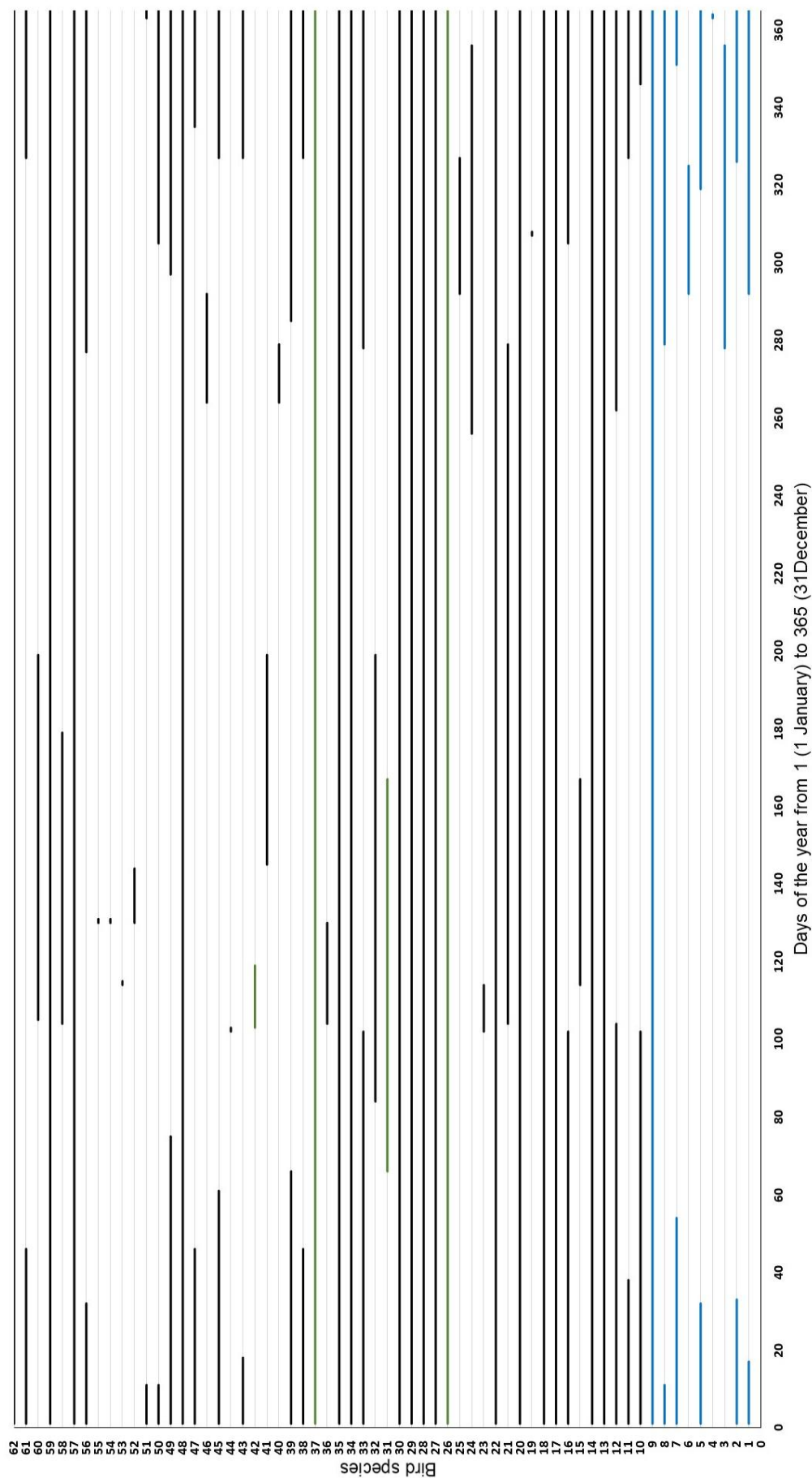
The day of arrival (Table 1) and the time of presence (Fig. 2) for each bird species was recorded. The minimum concurrent presence of 21–25 species was recorded from middle June to early October and the maximum concurrent presence of 38–41 species was detected from late November to early January (Fig. 2). Overall, the number of bird species in the study area reached a peak in November and December, and then a downward trend began, finally reaching its minimum in July and September. A maximum of 6–7 raptor species was observed from middle November to early January at ASNRUKH. This number fell to one species (*T. alba*) from late February to early October. Regarding protected species, the presence of a maximum of 8–9 species was detected at ASNRUKH from middle November to early January. The minimum number of protected species (three species) was recorded from middle June to early October (for the exact time of co-occurrence, refer to Table 1 and Fig. 2).

## Discussion

The avifauna of the study area supported different birds with varying global distributions; from cosmopolitan species (e.g. the Barn Swallow *Hirundo rustica* (Linnaeus) and House Sparrow *Passer domesticus* (Linnaeus)), Palearctic species (e.g. the European Stonechat *Saxicola rubicola* (Linnaeus) and European Robin *Erithacus rubecula* (Linnaeus)), Oriental species (e.g. the Red-wattled Lapwing *Vanellus indicus* (Boddaert), White-throated Kingfisher *Halcyon smyrnensis* (Linnaeus), Green Bee-eater *Merops orientalis* (Latham) and Afghan Babbler *Argya huttoni* (Blyth)), Palearctic-African species (e.g. the European Honey Buzzard *Pernis apivorus* (Linnaeus) and Collared Pratincole *Glareola pratincola* (Linnaeus)), to Oriental-Ethiopian species (e.g. the Shikra *Accipiter badius* (Gmelin), Black-winged Kite *Elanus caeruleus* (Desfontaines) and Pied Kingfisher *Ceryle rudis* (Linnaeus) (Khaleghizadeh et al., 2017; IUCN, 2019). Therefore, despite its small size, the study area is able to support avifauna from different parts of the world.

Regarding the limitations of this research, we tried to monitor all parts of the study area in a year, however, it is possible that some birds, especially passing migratory birds, might not have been detected. In a few cases, we observed a species only once (alive or dead), which forced us to report the day of observation as its time of presence. All such species were passing migratory birds with limited presence at ASNRUKH.





**Figure 2:** The presence time of bird species in the study area (ASNRUKH), in Khuzestan Province, Iran. Blue lines: protected raptors, green lines: other protected species (relevant species for numbers of Y-axis are available in the Table 1).

We tried to determine the day of arrival and time of presence for the migratory bird species, however, presence time might not be precise for some species in the study area. Furthermore, longer-term monitoring is suggested to determine the arrival time of migratory species and the duration of their presence in the study area. We will try to expand our research in future years in order to detect the changes in date of arrival for migratory birds due to the possible impact of climate change (Wilson, 2013; Kullberg et al., 2015). In the Palearctic region, including the study area, many migratory bird species will likely advance their arrival to the breeding region because of climate change and global warming (Newton, 2010).

The study area reported nine raptors, including *T. alba*. This raptor has an extensive global distribution and is a well-known predator of rodents, providing an economic service to farmers by controlling the rodent population in farmlands (Marti et al., 2005; Kan et al., 2013; Kross et al., 2016). *Tyto alba* is nocturnal (Taylor, 1994; Abramsky et al., 1996) and can hunt nocturnal rodents in the farmlands within the study area. In addition, it is a resident species and can be a part of integrated pest management throughout the year in the farmlands of the study area.

Recently, populations of migratory species have declined globally (Wilcove and Wikelski, 2008). This phenomenon is partly caused by the declining number of stopover sites (Vickery et al., 2014; Howard et al., 2018). Long flights during migration exhaust a considerable portion of a birds' energy reserves (Hutto, 1998); therefore, stopover sites such as ASNRUKH provide food and safety for the passing migratory birds (e.g. *P. apivorus*) whose core habitats in the Middle East have declined or are threatened (Evans, 1994; Khaleghizadeh et al., 2017). In addition, ASNRUKH was a suitable and safe habitat for resident birds, like *F. francolinus* (a protected species and the only species from Galliformes in the study area). *Francolinus francolinus* is experiencing similar degrading conditions as *P. apivorus* in the Middle East (Evans, 1994; Khaleghizadeh et al., 2017).

Given the local mild winters, the study area can attract many winter visiting birds; consequently, the number of bird species in the study area reaches the maximum in the colder months. The same is true for raptors and other protected species. Nevertheless, because of its very hot summers, few summer visiting birds choose the study area. ASNRUKH's long-established persistent microclimate, riparian habitats and availability of different foods in all seasons supports resident and migratory birds, including raptors from around the world.

## Acknowledgments

We thank Mohammad Safrang and other Iranian ornithologists for helping us to identify birds. We are also grateful to Dr. Kazem Negaresh for identifying plant species on the university campus. We appreciate the anonymous reviewers for their careful reading of our manuscript and their valuable comments and suggestions, and Hadi Amini for donating the Black Francolin photo. This work was supported by the Research and Technology of Agricultural Sciences and Natural Resources University of Khuzestan [Project number 961/17].

## References

- Abramsky, Z., Strauss, E., Subach, A., Kotler, B. P. and Riechman, A. (1996). The effect of barn owls (*Tyto alba*) on the activity and microhabitat selection of *Gerbillus allenbyi* and *G. pyramidum*. *Oecologia*, 105 (3): 313–319. <https://doi.org/10.1007/BF00328733>
- Ashoori, A. (2018). The birds of Bujagh national park, Iran, 2004–2016. *Sandgrouse*, 40: 144–156.

- Ayodeji, A. O. and Kilishi, H. S. (2019). Avifauna species diversity and abundance in Kainji Lake National Park, Niger State, Nigeria. *Journal of Wildlife and Biodiversity*, 3 (4): 16–26. <https://doi.org/10.22120/jwb.2019.104859.1058>
- Barrowclough, G. F., Cracraft, J., Klicka, J. and Zink, R. M. (2016). How many kinds of birds are there and why does it matter? *PLoS ONE*, 11 (11): e0166307. <https://doi.org/10.1371/journal.pone.0166307>
- Behrouzi-Rad, B., Maktabi, P. and Jafarnejad, A. (2015). Density and diversity of water birds and terrestrial birds at islands in Karoon River in Ahvaz City. *Coastal and Marine Research*, 3 (1): 1–9. <https://doi.org/10.12966/cmr.01.01.2015>
- Burgas, D., Byholm, P. and Parkkima, T. (2014). Raptors as surrogates of biodiversity along a landscape gradient. *Journal of Applied Ecology*, 51 (3): 786–794. <https://doi.org/10.1111/1365-2664.12229>
- Coad, B. W. and Vilenkin, B. Y. (2004). Co-occurrence and zoogeography of the freshwater fishes of Iran. *Zoology in the Middle East*, 31 (1): 53–62. <https://doi.org/10.1080/09397140.2004.10638022>
- DOE (Department of the Environment of Iran) (2019). Department of the Environment of Iran. [www.doe.ir](http://www.doe.ir) (Accessed 1 October 2019).
- Donazar, J. A., Cortes-Avizanda, A., Fargallo, J. A., Margalida, A., Moleon, M., Morales-Reyes, Z., Moreno-Opo, R., Perez-Garcia, J. M., Sanchez-Zapata, J. A., Zuberogitia, I. and Serrano, D. (2016). Roles of raptors in a changing world: from flagships to providers of key ecosystem services. *Ardeola*, 63 (1): 181–234. <https://doi.org/10.13157/arla.63.1.2016.rp8>
- Evans, M. I. (1994). *Important bird areas in the Middle East. Birdlife Conservation Series, No. 2*. Birdlife International, Cambridge, UK. 410 pp.
- Gill, F. and Donsker, D. (Eds). (2019). IOC World Bird List (v9.2). <https://doi.org/10.14344/IOC.ML.9.2>
- Howard, C., Stephens, P. A., Tobias, J. A., Sheard, C., Butchart, S. H. M. and Willis, S. G. (2018). Flight range, fuel load and the impact of climate change on the journeys of migrant birds. *Proceedings of the Royal Society B: Biological Sciences*, 285 (1873): <https://doi.org/10.1098/rspb.2017.2329>
- Hutto, R. L. (1998). On the importance of stopover sites to migrating birds. *The Auk*, 115 (4): 823–825. <https://doi.org/10.2307/4089500>
- IRIMO (Islamic Republic of Iran Meteorological Organization) (2017). Climate data-base, Iranian cities, from 1993 to 2017. <https://www.irimo.ir> (Accessed 1 October 2018).
- IUCN (International Union for Conservation of Nature) (2019). IUCN Red List of Threatened Species (IUCN, Gland, Switzerland). [www.iucnredlist.org](http://www.iucnredlist.org) (Downloaded on 8 April 2019).
- Kaboli, M., Aliabadian, M., Tohidifar, M., Hashemi, A., Musavi, S. B. and Roselaar, C. C. (2016). *Atlas of birds of Iran*. Iran Department of the Environment, Tehran, Iran. 617 pp.
- Kan, I., Motro, Y., Horvitz, N., Kimhi, A., Leshem, Y., Yom-Tov, Y. and Nathan, R. (2013). Agricultural rodent control using barn owls: is it profitable? *American Journal of Agricultural Economics*, 96 (3): 733–752. <https://doi.org/10.1093/ajae/aat097>
- Khaleghizadeh, A., Roselaar, K., Scott, D. A., Tohidifar, M., Mlíkovský, J., Blair, M. and Kvartalnov, P. (2017). *Birds of Iran: Annotated checklist of the species and subspecies*. Iranshenasi Publishing, Tehran, Iran. 500 pp.

- Khaleghizadeh, A. and Anuar, S. (2019). Comparative behavioral ecology of the White-Bellied Sea Eagle and Brahminy Kite (Aves: Accipitriformes) in Northwestern Malaysia. *Journal of Animal Diversity*, 1 (1): 41–55. <https://doi.org/10.29252/JAD.2019.1.1.6>
- Kirby, J. S., Stattersfield, A. J., Butchart, S. H. M., Evans, M. I., Grimmett, R. F. A., Jones, V. R., O'Sullivan, J., Tucker, G. M. and Newton, I. (2008). Key conservation issues for migratory land- and waterbird species on the world's major flyways. *Bird Conservation International*, 18: S49–S73. <https://doi.org/10.1017/S0959270908000439>
- Kross, S. M., Bourbour, R. P. and Martinico, B. L. (2016). Agricultural land use, barn owl diet, and vertebrate pest control implications. *Agriculture, Ecosystems and Environment*, 223: 167–174. <https://doi.org/10.1016/j.agee.2016.03.002>
- Kullberg, C., Fransson, T., Hedlund, J., Jonzen, N., Langvall, O., Nilsson, J. and Bolmgren, K. (2015). Change in spring arrival of migratory birds under an era of climate change, Swedish data from the last 140 years. *AMBIO*, 44: 69–77. <https://doi.org/10.1007/s13280-014-0600-1>
- Marti, C. D., Alan, F. P. and Bevier, L. R. (2005). Barn owl (*Tyto alba*). Cornell Lab of Ornithology, Ithaca. <http://bna.birds.cornell.edu/bna/species/001>
- McNamara, J. M., Houston, A. I. and Lima, S. L. (1994). Foraging routines of small birds in winter: a theoretical investigation. *Journal of Avian Biology*, 25 (4): 287–302. <https://doi.org/10.2307/3677276>
- Newton, I. (2010). *The migration ecology of birds*. First Edition. Elsevier. 984 pp.
- Nourani, E., Kaboli, M. and Collen, B. (2014). An assessment of threats to Anatidae in Iran. *Bird Conservation International*, 25 (2): 242–257. <https://doi.org/10.1017/S0959270914000264>
- Porter, R. and Aspinall, S. (2010). *Birds of the Middle East*. Second Edition. Princeton University Press, USA. 384 pp.
- Reyes-Arriagada, R., Jiménez, J. E. and Rozzi, R. (2015). Daily patterns of activity of passerine birds in a Magellanic sub-Antarctic forest at Omora Park (55°S), Cape Horn Biosphere Reserve, Chile. *Polar Biology*, 38: 401–411. <https://doi.org/10.1007/s00300-014-1596-5>
- Rodríguez - Estrella, R., Donázar, J. A. and Hiraldo, F. (1998). Raptors as indicators of environmental change in the scrub habitat of Baja California Sur, Mexico. *Conservation Biology*, 12 (4): 921–925. <https://doi.org/10.1111/j.1523-1739.1998.97044.x>
- Svensson, L., Mullarney, K., Zetterström, D. And Grant, P. J. (2010). *Collins bird guide*. Second Edition. Harper Collins Publisher, London. 445 pp.
- Taylor, I. (1994). *Barn Owls: Predator-prey relationships and conservation*. Cambridge University Press, UK. 324 pp.
- Vickery, J. A., Ewing, S. R., Smith, K. W., Pain, D. J., Bairlein, F., Skorpilova, J. and Gregory, R. D. (2014). The decline of Afro-Palaearctic migrants and an assessment of potential causes. *Ibis*, 156 (1): 1–22. <https://doi.org/10.1111/ibi.12118>
- Vilkov, E. (2020). The structure, territorial relationships and ecology of birds in high-mountain Daghestan. *Journal of Wildlife and Biodiversity*, 4 (1): 8–17. <http://dx.doi.org/10.22120/jwb.2019.113176.1097>
- Wilcove, D. S. and Wikelski, M. (2008). Going, going, gone: is animal migration disappearing? *PLoS Biology*, 6 (7): e188. <https://doi.org/10.1371/journal.pbio.0060188>
- Wilson, W. H. (2013). A deeper statistical examination of arrival dates of migratory breeding birds in relation to global climate change. *Biology*, 2 (2): 742–754. <https://doi.org/10.3390/biology2020742>

## Appendix

**Appendix 1:** Photos of bird species in the study area (ASNRUKH), (all photos with the exception of photo 26 were taken by the first author).



1. Shikra, *Accipiter badius*



2. Eurasian Sparrowhawk, *Accipiter nisus*



3. Western Marsh Harrier, *Circus aeruginosus*



4. Pallid Harrier, *Circus macrourus*



5. Long-legged Buzzard, *Buteo rufinus*



6. European Honey Buzzard, *Pernis apivorus*



7. Black-winged Kite, *Elanus caeruleus*



8. Common Kestrel, *Falco tinnunculus*



9. Western Barn Owl, *Tyto alba*



10. Great Cormorant, *Phalacrocorax carbo*



11. Little Egret, *Egretta garzetta*



12. Western Cattle Egret, *Bubulcus ibis*



13. Common Moorhen, *Gallinula chloropus*



14. Red-wattled Lapwing, *Vanellus indicus*



15. Collared Pratincole, *Glareola pratincola*



16. Black-headed Gull, *Chroicocephalus ridibundus*



17. Pied Kingfisher, *Ceryle rudis*



18. White-throated Kingfisher, *Halcyon smyrnensis*



19. Common Kingfisher, *Alcedo atthis*



20. Indian Roller, *Coracias benghalensis*



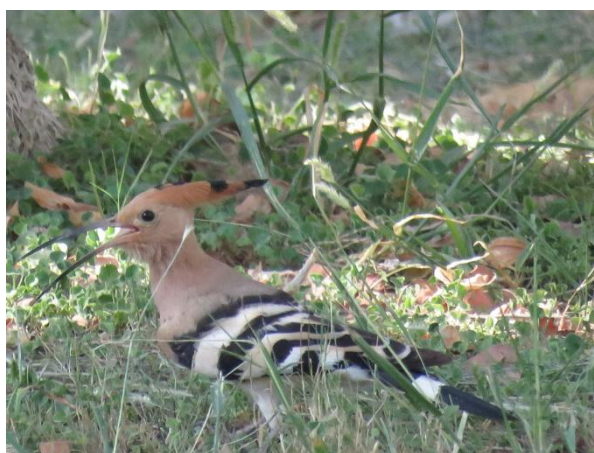
21. Blue-cheeked Bee-eater, *Merops persicus*



22. Green Bee-eater, *Merops orientalis*



23. European Bee-eater, *Merops apiaster*



24. Eurasian Hoopoe, *Upupa epops*





25. Eurasian Wryneck, *Jynx torquilla*



26. Black Francolin, *Francolinus francolinus*



27. Rock Dove, *Columba livia*



28. Eurasian Collared Dove, *Streptopelia decaocto*



29. Laughing Dove, *Spilopelia senegalensis*



30. Common Wood Pigeon, *Columba palumbus*



31. Barn Swallow, *Hirundo rustica*



32. Grey Hypocolius, *Hypocolius ampelinus*



33. Isabelline Shrike, *Lanius isabellinus*



34. Afghan Babbler, *Argya huttoni*



35. Purple Sunbird, *Cinnyris asiaticus*



36. Eurasian Golden Oriole, *Oriolus oriolus*



37. White-eared Bulbul, *Pycnonotus leucotis*



38. Water Pipit, *Anthus spinoletta*



39. White Wagtail, *Motacilla alba*



40. Western Yellow Wagtail, *Motacilla flava*



41. Rufous-tailed Scrub Robin, *Cercotrichas galactotes*



42. Common Nightingale, *Luscinia megarhynchos*



43. Bluethroat, *Luscinia svecica*



44. Pied Wheatear, *Oenanthe pleschanka*



45. European Stonechat, *Saxicola rubicola*



46. Spotted Flycatcher, *Muscicapa striata*



47. Song Thrush, *Turdus philomelos*



48. Common Blackbird, *Turdus merula*



49. European Robin, *Erithacus rubecula*



50. Black Redstart, *Phoenicurus ochruros*



51. Common Redstart, *Phoenicurus phoenicurus*



52. Garden Warbler, *Sylvia borin*



53. Eurasian Blackcap, *Sylvia atricapilla*



54. Common Whitethroat, *Sylvia communis*



55. Desert Whitethroat, *Sylvia minula*



56. Common Chiffchaff, *Phylloscopus collybita*



57. Graceful Prinia, *Prinia gracilis*



58. Eastern Olivaceous Warbler, *Iduna pallida*



59. Crested Lark, *Galerida cristata*



60. Yellow-throated Sparrow, *Gymnoris xanthocollis*



61. Spanish Sparrow, *Passer hispaniolensis*



62. House Sparrow, *Passer domesticus*