Pakistan J. Zool., pp 1-8, 2024. **DOI**: https://dx.doi.org/10.17582/journal.pjz/20240203193416

Extent of Occurrence of Migratory and Resident Avifauna at Spin Karez Lake, Quetta, Pakistan

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ABSTRACT

Avian migration is a remarkable and widespread phenomenon, with birds covering extensive distances across diverse landscapes to locate suitable environments and habitats for sustainable breeding and rearing offspring. In adverse conditions, such as low temperatures at breeding sites, these agile creatures migrate to more favorable locations. This study aimed to compile a comprehensive list of visiting/migratory and native avian fauna at the local water reservoir, Spin Karez Lake, located in Quetta, Pakistan (30°13'20" N, 67°9'4" E, approximately 1994 meters above sea level). Documenting the avifauna of this reservoir represents a pioneering effort in regional studies. Field visits were conducted bi-weekly during late fall, winter, and early spring, capturing photographic evidence for each species, and noting the total number of individuals. Six avian species were identified as common visitors, with two classified as migratory and four as resident. The Eurasian coot emerged as the most common and abundant species, followed by the white wagtail. Species richness was observed during the 2nd (October 2019), 5th (December 2019), and 12th visit (March 2020). All species were classified as least concerned (LC) according to the IUCN Red List of threatened Species of Fauna and Flora. These are ecological dynamics contribute to the rich avian diversity observed at Spin Karez Lake. Further studies are recommended to document the migratory routes of birds in conjunction with other water reservoirs in Pakistan.

Article Information
Received 03 February 2024
Revised 10 April 2024
Accepted 28 April 2024
Available online
(early access)
Published

Authors' Contribution
SM: Methodology, data collection and analysis, and wrote the original draft. NR: Review and editing. SN: Conceptualization, methodology, and project supervision. NT: Writing and shaping of the final draft.

Key words
Avifauna, Extent of occurrence, Migratory birds, Native, Reservoir, Spin Karez Lake

INTRODUCTION

The captivating history of migratory avifauna has garnered global attention and contemplation. Birds engage in migration for various reasons, primarily driven by the necessity to access abundant food resources in specific areas. Migration, a regular and seasonal movement, is a common phenomenon among diverse bird species (Newton, 2008). Notably, a comprehensive assessment reveals that 1855 migratory bird species, with 352 extant ones, adhere to recurrent patterns. These movements occur at precise intervals during their wintering and breeding seasons (Somveille *et al*., 2013). Bird migration unfolds on a vast spatial scale, with some species traversing continents while others cover only a few degrees of latitude to find suitable non-breeding habitats (Newton, 2008). Within the African migration system, long-distance migrants winter in tropical Africa, necessitating twice-yearly crossings of the Sahara Desert. This expansive desert has been identified as a significant factor contributing to the mortality of migratory birds (Klaassen *et al*., 2014; Strandberg *et al*., 2010). Recent advancements in tracking technology enable researchers to depict the continental-scale migration routess, wintering areas, and stopover sites of birds (Bairlein, 2003). A crucial aspect of migration is the energetically costly nature of migratory flight (Gill *et al*., 2008; Klaassen *et al*., 2014). However, for most species, flight energy accumulates over several days at stopover sites (Schwilch *et al*., 2002). The duration of a bird's stay at a stopover site is influenced by internal factors such as stopover duration, physical condition, fuel load at departure, age, experience, and dominance status (Arizaga *et al*., 2011; Cohen *et al*., 2014; Fusani *et al*., 2009). External factors, including food availability, competition, perceived predation risk, vigilance, and local weather conditions, can directly or indirectly affect fuel deposition rates and departure decisions (Andueza *et al*., 2013; Barriocanal *et al*., 2002; Buler *et al*., 2007; Hope *et al*., 2011). In terms of fuel deposition rates, optimal migration models suggest birds adjust their fuel stores

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0030-9923/2024/0001-0001 $ 9.00/0

and site use based on these external factors to maximize survival and reproductive success (Weber *et al*., 1998). The organization of stopovers significantly influences overall migration speed, surpassing the impact of alterations in flight speed (Alerstam *et al*., 2003; Nilsson *et al*., 2013). Therefore, understanding stopover behavior and bird responses to local environmental factors is vital for comprehending the strategies adopted during migration.

Recent climate change has led to shifts in abiotic factors, influencing geographical dispersion, species abundance, and variability over time (IPCC, 2007). Failure of species to adapt to changing conditions may result in declines or extinctions (Parmesan, 2006). Bird migration has historically evolved as a response to natural conditions' regularities (Newton, 2008), with breeding in birds being a well-documented response to climate change (Rubolini *et al*., 2007).

Pakistan, boasting approximately 729 bird species distributed across three zoo-geographic regions (Oriental, Ethiopian, and Palearctic), holds a unique position globally. The presence of these regions is exceptional due to their provision as wintering grounds for migratory birds (Grimmett *et al*., 2011). Annually, a substantial number of migratory birds from Asia, Europe, and India visit Pakistan, spreading across diverse habitats from mud flats in the Indus Delta and the high Himalayas to coastal mangroves (Shirazi, 2006). Pakistan plays a crucial role in preserving wetlands through Ramsar and Bonn conventions, providing vital wintering grounds for many migratory birds. Covering approximately 2800 miles (4500 km) from the northern mountains to the southern coast, wetland areas attract a variety of species, including houbara bustard (*Chlamydotis undulata*), northern pintail (*Anas acuta*), cranes, mallard (*Anas platyrhynchos*), Eurasian teal (*Anas crecca*), pelicans (*Pelecanus species*), Eurasian spoonbill (*Platalea leucorodia*), waders, and geese migrating from Siberia to Pakistan. However, recent years have witnessed a concerning decline in the number of bird species making stopovers at water reservoirs in Pakistan (The Express Tribune, 2016).

Karez, a local irrigation system serving as a water source or reservoir, is a notable feature in the eastern part of Quetta. The term Spin, derived from Pashto, means white, and Spin Karez, located in (eastern) Quetta, offers a spectacular view of the mountains reflecting in its waters. The focus of this research was exploring the diversity and population of migratory birds, as well as coexisting species that are regular visitors to this reservoir selected for study from October 2019 to March 2020, at Spin Karez. The study also intended to assess the protection status and estimate the extent of occurrence for these birds in the specified and nearby regions. This documentation represents the first comprehensive survey of the migratory and native avifauna of Spin Karez, Balochistan, Pakistan.

MATERIALS AND METHODS

The research project focused on Spin Karez Lake, situated 6-8 miles (10-13 km) from Quetta city, with precise GPS coordinates at 30°13'20" N and 67°9'4" E; approximately 1994 meters above sea level. This small lake, surrounded by mountains, provides an aesthetically appealing and ecologically suitable habitat for various water-dwelling bird species (Fig. 1). The study period spanned from October 2019 to March 2020, during which bi-weekly visits to the study site were conducted and observations recorded between 10:00 and 18:00 h, bihourly. Observations of diverse bird species were meticulously recorded by utilizing a DSLR camera (Nikon D5300) with a lens specification ranging from 18 mm to 55 mm (zoom). Individual observations were documented through photographs, with each observation replicated three times, followed by the calculation of an average. Evaluation of the recorded birds included species identification, diversity indices, and subsequent calculation of each species spatial range (Extent of Occurrence, EOO).

Fig. 1. A wide range view of Spin Karez Lake, Quetta, Balochistan, Pakistan.

Identification of bird species was conducted with reference to the literature available (Mirza, 2012). We calculated species diversity indices examined through the Shannon-Weiner diversity index (Shan Wein DI) and Simpson's evenness. We assessed the total number of individuals observed for each bird species during the study period and provided a simple count of the population for each species. The evaluation of species diversity indices and abundance was carried out using Diva-GIS software (version 7.5) (Hijmans *et al*., 2001).

The spatial distribution of identified bird species at Spin Karez Lake was assessed using the extent of occurrence. Information about the identified visitor birds was gathered

Table I. The common habitat and EOO of identified birds as well as their spatial range, were calculated through a minimum convex polygon using presence-based data.

S. No.	Scientific name	Common name	Habitat	EOO (km²)	IUCN Status	No. of ind. observed
1.	*Fulica atra*	Eurasian coot	It is common in freshwater lakes and ponds and breeds in most of the Old World, including Europe, Asia, Australia, and Africa.	37.19 million (km²) (Fig. 2A)	LC	200
2.	*Motacilla alba*	White wagtail	It is commonly found near human habitation and water and breeds in Europe, the Asian Palearctic, and parts of North Africa.	34.51 million (km²) (Fig. 2B)	LC	18
3.	*Spilopelia senegalensis*	Laughing dove	It inhabits clear, dry farmland and coexists closely with human boroughs. It is across a wide range of Africa, Iran, Afghanistan, Pakistan, and India.	12.48 million (km²) (Fig. 2C)	LC	2
4.	*Acridotheres tristis*	Common myna	Native to central and southern Asia, it is widely spread across India, Afghanistan, Turkey, Bangladesh, Sri Lanka, parts of southern China, and Indonesia.	21. 02 million (km²) (Fig. 2D)	LC	2
5.	*Pycnonotus cafer*	Red-vented bulbul	It is commonly found in dry brush, open forest, fields, and cultivated lands, and it is widespread in Asia.	7.32 million (km²) (Fig. 2E)	LC	3
6.	*Pycnonotus leucotis*	White-eared bulbul	It is observed in herds, nesting inside mangroves, open forests, and plant growths while consuming Meswak bush fruit. Widely distributed across Kuwait, Bahrain, southern and central Iraq, southern Iran, Afghanistan, Pakistan, north-western India, parts of Madhya Pradesh, and the Middle East.	3.57 million (km²) (Fig. 2F)	LC	2

LC, least concern (referenced to IUCN red list).

from literature, and documentation reports available on the internet, and species conservation status was specifically sourced from IUCN (2021). The EOO for each bird species was determined by constructing a 112 minimum convex polygon, and maps were generated covering the Asian continent and/or nearby regions. GEOCAT (GeoCAT, n.d.) was employed to calculate the EOO for individual species, and maps for each bird were created using DIVA-GIS.

RESULTS

The objective of the present study was to identify avian migratory visitors at Spin Karez Lake, Quetta (Fig. 2). The observations and data collected indicated the presence of two migratory and four indigenous bird species at the lake, which were further classified into five families and six genera belonging to three orders. Data of all the identified birds, with their common names and habitat distribution, are summarized in Table I.

Spatial distribution

The spatial distribution of encountered species at Spin Karez Lake was examined using presence-based data, and a minimum convex polygon was delineated for each bird species individually. The results of the extent ofoccurrence indicated (Fig. 3) the most common and widely distributed bird species across the Asian continent and nearby regions (Table I).

Fig. 2. Birds visiting Spin Karez Lake, (a) *Fulica atra* (Eurasian coot), (b) *Motacilla alba* (white wagtail), (c) *Spilopelia senegalensis* (laughing dove), (d) *Acridotheres tristis* (common myna), (e) *Pycnonotus cafer* (red-vented bulbul), and (f) *Pycnonotus leucotis* (white-eared bulbul).

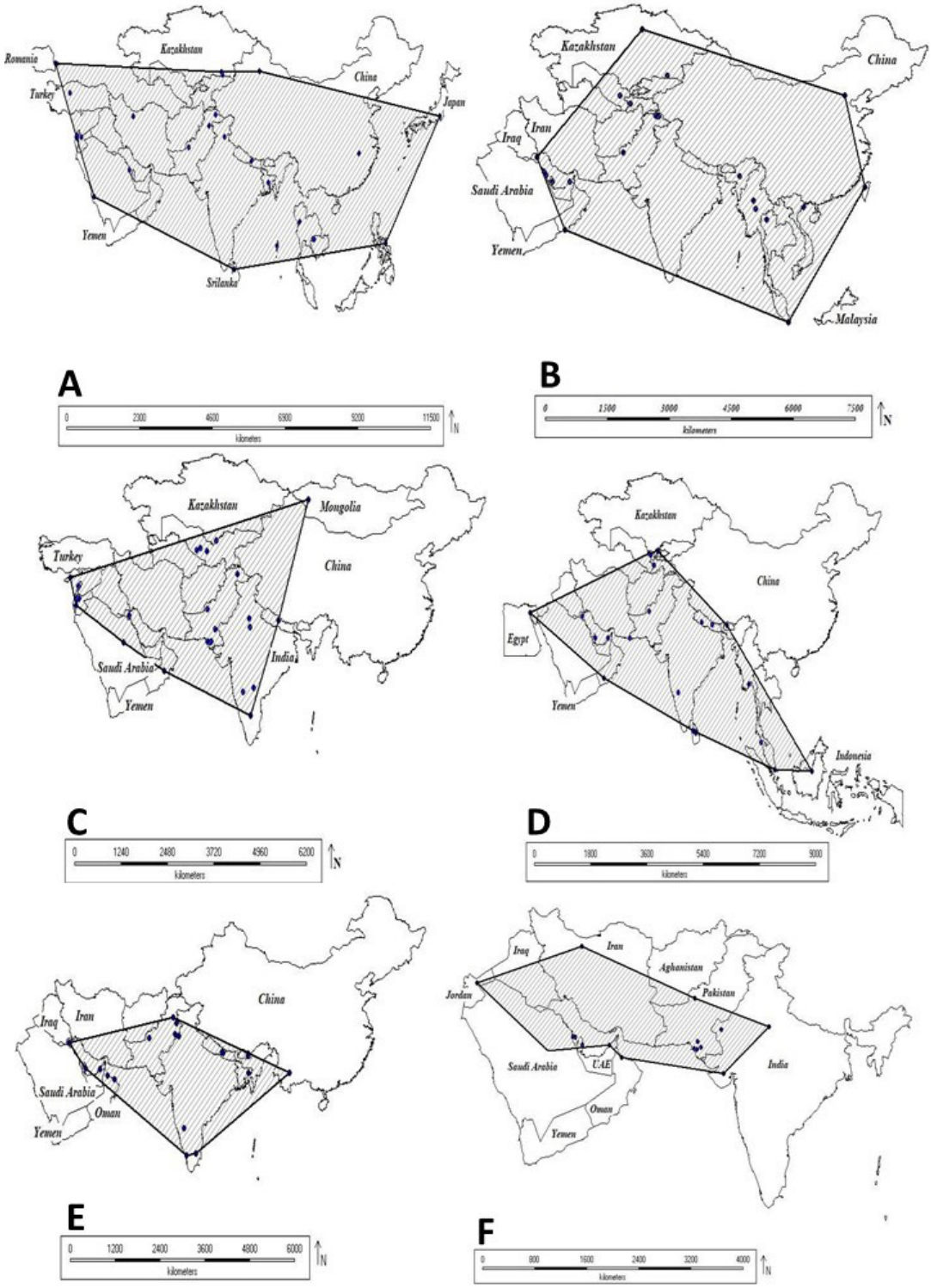

Fig. 3. Spatial maps were generated using Diva-GIS, illustrating the extent of occurrence (EOO), which is represented as polygons with known locations denoted by black circles. The maps depict: (A) *Fulica atra* (Eurasian coot), (B) *Motacilla alba* (white wagtail bird), (C) *Spilopelia senegalensis* (laughing dove), (D) *Acridotheres tristis* (common myna), (E) *Pycnonotus cafer* (red-vented bulbul), and (F) *Pycnonotus leucotis* (white-eared bulbul) (scale range is indicated in each map with north arrow).

Table II. Diversity indices of the avian fauna recorded at Spin Karez Lake, Quetta.

Diversity indices	White wagtail bird	Eurasian coot	Myna	Laughing dove	Red-vented bulbul	White-eared bulbul
Individuals (N)	18	200	2	2	3	2
Shan. Wein DI	1.68	2.43	0	0	0	0
S. Evenness	0.89	0.96	1	1	1	1

Eurasian coot (*Fulica atra*) exhibited an expansive range, extending from the southeastern region to East Asia, with an EOO covering approximately 37,191,293,974 km². Similarly, white wagtail's (*Motacilla alba*) range extended from southwestern Asia to East Asia, covering an area of about 34,515,457,692 km². The laughing dove (*Spilopelia senegalensis*) demonstrated an EOO from Western Asia to South Asia, covering an area of about 12,489,929.488 km². Common myna (*Acridotheres tristis*), a common bird, extends its range from the Northeast region to Southeast Asia, covering an EOO of about 21,019,054.110 km². The red-vented bulbul's (*Pycnonotus cafer*) range extends from western Asia to East Asia, covering an EOO of about 7,325,319.421 km². White-eared bulbul (*Pycnonotus leucotis*) covers a smaller area in our concerned region, extending from Western Asia to South Asia, with an EOO of approximately 3,575,377.671 km². All the birds are designated as the least concerned species according to the IUCN (2021).

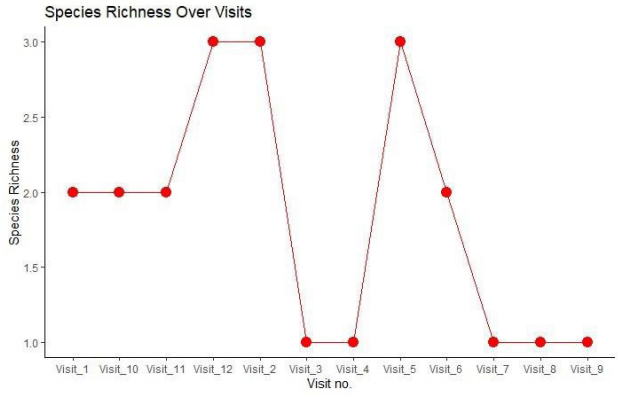

Fig. 4. Species richness plotted against each visit we made to the Karez.

Species abundance and diversity

Species diversity indices are summarized in Table II, which exhibits that the white wagtail and Eurasian coot have the highest number of individuals (18 and 200, respectively), indicating their higher abundance. Eurasian Coot has the highest Shannon-Weiner Diversity Index (2.43), indicating high species richness and evenness. The values of Simpson's Evenness for all species are close to 1, suggesting a relatively even distribution of individuals among species. Species diversity is graphically illustrated in Figure 4, where visit number is displayed on the x-axis and species richness on the y-axis. The most diversified visits were 2, 5, and 12, on which three distinct species were observed in Spin Karez Lake. This suggests the most diversified number of birds were present in October and December of 2019 and March of 2020.

DISCUSSION

Human fascination with the enigmatic phenomenon of bird migration, a recurring spectacle each spring and a disappearance act before winter, has endured through the ages. Small, lightweight migratory birds, like matchboxes in flight, are resilient against weather and wind and cover vast distances, crossing oceans and deserts. In intercontinental migration, these birds exploit long summer days abundant with food resources. For many species, especially nocturnal migratory passerines, the precise migratory routes remain shrouded in mystery. Migratory birds have been a subject of extensive study over the years (Somveille *et al*., 2013). Migration, a regular and seasonal phenomenon, is a widespread behavior observed in various bird species. Birds embark on migratory journeys for diverse reasons, predominantly driven by the necessity to relocate to areas with abundant food resources. This study aimed to assess the abundance of migratory birds in Spin Karez Lake. One notable winter visitor observed in significant numbers at Spin Karez Lake is the Eurasian coot. This aligns with the findings of (Hashimoto and Sugawa, 2013), who noted an increase in the wintering population of Eurasian coots in Japan and South Korea, possibly influenced by changes in coot population dynamics or habitat alterations. Interestingly, the observed population of white wagtail, an insectivorous bird commonly found near human habitation, as a winter visitor (18 individuals) is in concordance with (Umar *et al*., 2018) observations in Azad Jammu and Kashmir, Pakistan, where this bird is abundant in both summer and winter.

The laughing dove, a species often found in dry farmlands and human-dominated areas across Sub-Saharan Africa, Iran, Iraq, Afghanistan, and Pakistan,

faces challenges due to hunting and trapping, impacting its population. The common myna, native to central and southern Asia and widespread in India, Afghanistan, Turkestan, Bangladesh, Sri Lanka, China, and Indonesia, exhibited the least number of individuals in our study area. This contrasts with observations in other countries, like Japan, Turkey, Israel, Jordan, Lebanon, and other regions of Pakistan, where it has been quite abundant in distribution and population (Mehmood *et al*., 2018; Rabia *et al*., 2015). The red-vented bulbul commonly distributed throughout Asia, showed a decreased population in our study area, unlike observations in New Caledonia (Thibault *et al*., 2019).

White-eared bulbul is present in scrub forests and garden lands and found in flocks in Kuwait, Bahrain, mid and southern Iraq, southern Iran, Afghanistan, Pakistan, north-western India, parts of Maharashtra, Madhya Pradesh, and the Arabian Peninsula, recorded in least numbers during our survey period at Spin Karez Lake.

CONCLUSION

In our survey, we recorded a total of six species, with two being migratory and four local birds. The migratory patterns observed underscore the fundamental drivers of bird migration seeking areas with abundant resources for nourishment and nesting. This natural phenomenon is critical for survival, particularly during harsh conditions like winter (Piersma and Lindström, 2004). The presence of transient bird species in the surveyed zones indicates that Spin Karez Lake offers a favorable environment for feeding, settling, and breeding. Various studies have shown that bird migration is influenced by factors such as food availability (Scott, 1993), seasonal changes, and the avoidance of predation risks (Shirazi, 1993). These ecological dynamics contribute to the rich avian diversity observed at Spin Karez Lake. More studies should be followed to document the route of migratory birds further along the water reservoirs of Pakistan.

DECLARATIONS

Acknowledgement

Thanks to the authorities of SBK Women's University, for facilitating the conduct of this study.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not for profit sectors.

Ethics approval and consent to participate

This study involving resident and migratory birds does not require ethics approval as it does not involve any birds' capture.

Consent for publication

All authors have given their consent for the publication of this manuscript.

Availability of data and material

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Statement of conflict of interest

The authors have declared no conflict of interest.

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