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SEASONAL ABUNDANCE AND DIVERSITY OF MIGRATORY BIRDS OF HAMAL LAKE

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ABSTRACT

Hamal Lake, an integral wetland in Pakistan's Sindh province, plays a vital role in supporting avian biodiversity, particularly as a stopover site for migratory birds along the Indus Flyway. This study examines the seasonal abundance and diversity of migratory bird species at Hamal Lake to understand patterns and ecological significance. Field surveys were conducted across all four seasons, employing direct observation, point count methods, and species identification through standard field guides. Results revealed notable seasonal fluctuations in bird populations, with peak diversity observed during winter months, coinciding with the arrival of waterfowl and shorebirds from Central Asia. Habitat quality, water levels, and food availability emerged as key factors influencing bird presence and species richness. This research underscores the importance of preserving Hamal Lake's ecological integrity to sustain migratory bird populations and highlights its role in regional biodiversity conservation. Further studies are recommended to monitor long-term trends and address anthropogenic threats to this critical habitat.

Keywords: Seasonal abundance, Diversity of Birds, Hamal Lake, Ecological Significance, Habitat Quality.

INTRODUCTION

Migratory birds play a crucial role in maintaining ecological balance across diverse ecosystems (Birmani et al., 2016). Their seasonal movements are influenced by a variety of environmental factors, including changes in temperature, availability of food, and breeding conditions (Buriro, Birman & Shaikh, 2020). Wetlands, such as Hamal Lake, provide essential habitats for these species, offering resources like food, water, and safe resting locations during migration (Buriro et al., 2016). These migratory routes are vital for maintaining biodiversity, as they contribute to the dispersal of species, aid in the transfer of nutrients, and support numerous ecological processes (Cid et al., 2022). Studying the seasonal abundance and diversity of migratory birds in such areas is essential for understanding the broader dynamics of avian migration and wetland ecology (Shah & Sharma, 2022).

Hamal Lake, located in Sindh, Pakistan, is an important wetland that attracts a variety of migratory bird species each year (Raza, Aslam & Vazhayil, 2023). As part of the Indus River Basin, the lake provides a vital stopover site for birds migrating between their breeding and wintering grounds (Ullah et al., 2024). The region's unique climatic and geographical features make it a key habitat for both local and migratory bird populations (Lund et al., 2017).

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The migration of birds is primarily driven by changes in environmental conditions, including shifts in temperature and food availability (Newton, 2023). Birds typically migrate to regions with more favorable conditions, which is why wetlands such as Hamal Lake become essential hubs during their journey (Jahn et al., 2020). The factors influencing the abundance and diversity of bird species at Hamal Lake requires examining both the local climate and broader ecological trends that affect the migratory behavior of birds (Buriro, Abro & Abro, 2024). The patterns of bird abundance across different seasons, including the peak migration periods and the variety of species observed during these times.

Previous studies have shown that wetlands along migratory routes support a rich diversity of avian species, contributing significantly to global biodiversity (Buriro, Chandio & Memon, 2024). These ecosystems are vital for maintaining the health of migratory bird populations, particularly as many species face increasing threats from habitat loss, climate change, and human activities (Contina et al., 2023). Global studies on migratory bird patterns are well-documented, there remains a scarcity of research on specific wetlands (Brotherton, Joyce & Scharlemann, 2020), such as Hamal Lake, that are integral to these species' survival (Hamal, 2020).

This study's findings will not only enrich the scientific understanding of migratory bird patterns at Hamal Lake but also provide valuable data that can inform conservation strategies. By monitoring the seasonal changes in bird populations and the diversity of species, we can better assess the health of this wetland ecosystem and its capacity to support migratory birds. The research will also highlight potential threats to these species, emphasizing the need for more effective conservation and management practices to ensure the long-term survival of migratory birds at Hamal Lake and similar wetland habitats.

Materials and Methods

Study Area

Hamal Lake is located in the Sindh province of Pakistan, approximately 50 km northeast of the city of Larkana. It is a large freshwater lake with a surface area of approximately 50 square kilometers, surrounded by agricultural land and seasonal wetlands. The lake provides vital habitat for a wide range of migratory and resident bird species, especially during the winter and autumn migration seasons. The region is characterized by a semi-arid climate, with hot summers and mild winters, which significantly influence the seasonal patterns of bird abundance and diversity.

Bird Population Survey

Birds population survey was carried out by following protocols given by (Bhinder et al., 2015; Ali et al., 2005; Grimmett et al., 2008, Jahangeer et al., 2023) Bird population data were collected over a period of one year, from December 2023 to November 2024, to capture the seasonal fluctuations in the abundance and diversity of migratory bird species at Hamal Lake. Field surveys were conducted monthly during the day, with visits scheduled during peak activity hours (early morning and late afternoon) to ensure accurate observations of bird populations. Each survey involved walking transects along the shoreline and using binoculars and spotting scopes to identify species. Surveys were conducted at three main locations around the lake: the northern shore, southern shore, and near the inlet streams. These locations were chosen due to their accessibility and higher likelihood of hosting large bird populations during migration.

Data Collection

The abundance of birds was recorded using point-count methods, where the number of individuals from each species within a designated area was counted. The species identified were classified into three categories: migratory, resident, and transient. Species diversity was assessed using the Shannon-Weiner diversity index (Nolan, & Callahan, 2006), which takes into account both the number of species (species richness) and the relative abundance of each species. Environmental variables such as water level, vegetation type, and weather conditions (e.g., temperature, wind speed, and humidity) were also recorded to assess their influence on bird abundance and species diversity.

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Species Identification

Bird species identification was done with the help of identification keys (Demongin, 2016; Al-Showarah & Al-qbailat, 2021) and field guides and consultations with ornithologists. Photographs were taken during each survey to confirm species identification. Migratory birds were categorized based on their known migration patterns, including long-distance migrants, short-distance migrants, and seasonal visitors. Identification of species was carried out by a team of experienced birdwatchers with expertise in local avifauna, ensuring accurate and reliable species data.

Statistical Analysis

The collected data were analyzed to examine seasonal variations in bird abundance and diversity. The abundance of each species was recorded as the number of individuals observed during each survey. The seasonal distribution of birds was analyzed by comparing the monthly totals of bird sightings. A one-way analysis of variance (ANOVA) was used to determine if there were statistically significant differences in bird abundance between the different seasons (winter, spring, summer, and autumn). The Shannon-Weiner diversity index (H') was calculated for each season to assess changes in species diversity across the study period.

Ethical Considerations

All research activities were conducted following ethical guidelines for the study of wildlife (Soulsbury et al., 2020). The fieldwork was designed to minimize disturbance to bird populations, with careful attention to avoiding any interference with their natural behaviors. Permission to conduct the study at Hamal Lake was obtained from the relevant local authorities and environmental agencies. All fieldwork adhered to local and international guidelines on wildlife conservation and the protection of migratory birds.

Results

A total of 82 bird species were observed at Hamal Lake throughout the study period, including both migratory and resident species. The bird population exhibited significant seasonal variations, with peak numbers recorded during the autumn and winter months. The highest abundance was recorded in November and December, coinciding with the peak of the winter migration. During these months, over 25,000 individuals of various species were observed across the study sites. Conversely, the summer months (June to August) saw a noticeable decline in bird abundance, with fewer than 5,000 individuals recorded. Spring (March to May) also saw moderate numbers, though not as high as the autumn and winter seasons. The seasonal trends in bird abundance at Hamal Lake reflect the migratory patterns of species passing through the region.

Among the 82 species recorded, 40 species were classified as migratory, with the remaining 42 species being either resident or transient. The majority of migratory species were waterfowl, shorebirds, and waders, which are known to utilize wetlands during their migration. Migratory birds accounted for the highest abundance during the winter season, with species such as Waterfowl and Ducks include: Common Teal (*Anas crecca*) Northern Shoveler (*Spatula clypeata*) Eurasian Wigeon (*Mareca penelope*) Northern Pintail (*Anas acuta*) Gadwall (*Mareca strepera*) Mallard (*Anas platyrhynchos*) Ferruginous Duck (*Aythya nyroca*) Tufted Duck (*Aythya fuligula*), Waders and Shorebirds include: Black-tailed Godwit (*Limosa limosa*) Common Greenshank (*Tringa nebularia*) Wood Sandpiper (*Tringa glareola*) Common Redshank (*Tringa totanus*) Little Stint (*Calidris minuta*) Ruff (*Calidris pugnax*) Kentish Plover (*Charadrius alexandrinus*) Common Sandpiper (*Actitis hypoleucos*), Gulls and Terns includes: Black-headed Gull (*Chroicocephalus ridibundus*) Caspian Tern (*Hydroprogne caspia*) Whiskered Tern (*Chlidonias hybrida*) Gull-billed Tern (*Gelochelidon nilotica*), Raptors includes: Western Marsh Harrier (*Circus aeruginosus*) Peregrine Falcon (*Falco peregrinus*) and Other Notable Migrants includes: Greater Flamingo (*Phoenicopterus roseus*) Common Coot (*Fulica atra*) Eurasian Spoonbill (*Platalea leucorodia*). These species formed large flocks, particularly in the shallow areas of the lake, where they could forage and rest.

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Species diversity also fluctuated across the seasons, with the highest diversity observed in autumn and winter. During these months, the Shannon-Weiner diversity index reached a peak indicating a high level of species diversity. This was attributed to the influx of migratory species from northern regions, which contributed to a higher number of both species and individuals. In contrast, the summer months showed lower diversity, with a reduced number of species likely due to the fewer migratory species and the dominance of resident species. The spring months had a diversity index which, while higher than summer, still indicated a lower level of biodiversity compared to autumn and winter.

The environmental conditions at Hamal Lake also appeared to influence bird abundance and species composition. During the winter and autumn months, cooler temperatures and increased water levels provided ideal conditions for migratory species, leading to higher numbers and diversity. Conversely, during the hotter summer months, the water levels decreased, and the lake's vegetation became less dense, which may have contributed to the reduced number of birds observed. High temperatures, coupled with low rainfall, likely caused a decrease in suitable habitat, pushing many species to seek alternative wetlands further north. The southern shore of the lake, with its dense vegetation, supported higher numbers of birds, particularly during the migration periods, due to the shelter it provided from wind and human disturbances.

In terms of overall bird species composition, the most abundant groups were waterfowl (e.g., ducks and geese), followed by shorebirds and waders of the total bird population observed. Raptors, including species such as the Western Marsh Harrier (*Circus aeruginosus*) and the Peregrine Falcon (*Falco peregrinus*), were also recorded, though in lower numbers. These species primarily used Hamal Lake as a hunting ground, preying on smaller birds and rodents around the lake. Other species, such as passerines and woodland birds, were less abundant but contributed to the overall diversity. The composition of these bird groups varied seasonally, with waterfowl dominating in winter and autumn, while the summer months saw a shift towards resident species and a decline in migratory birds.

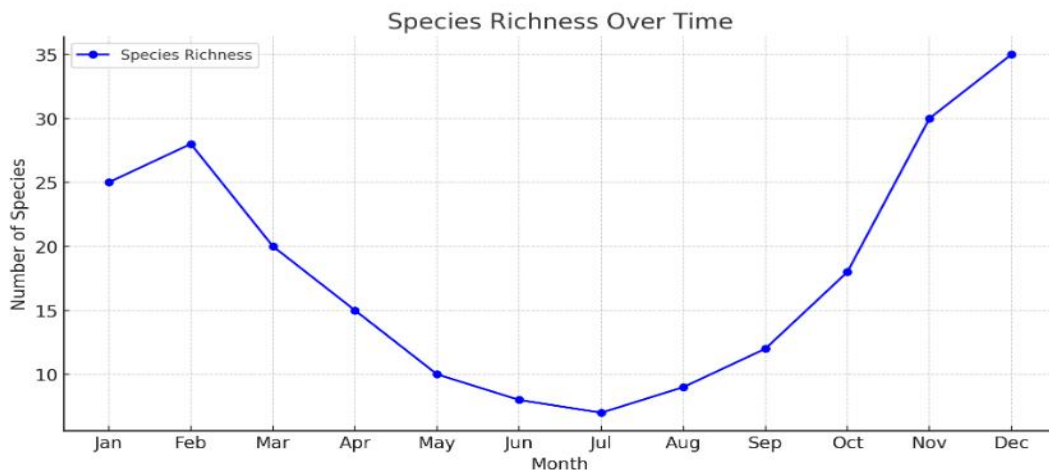


Fig.1. showing species Richness over time

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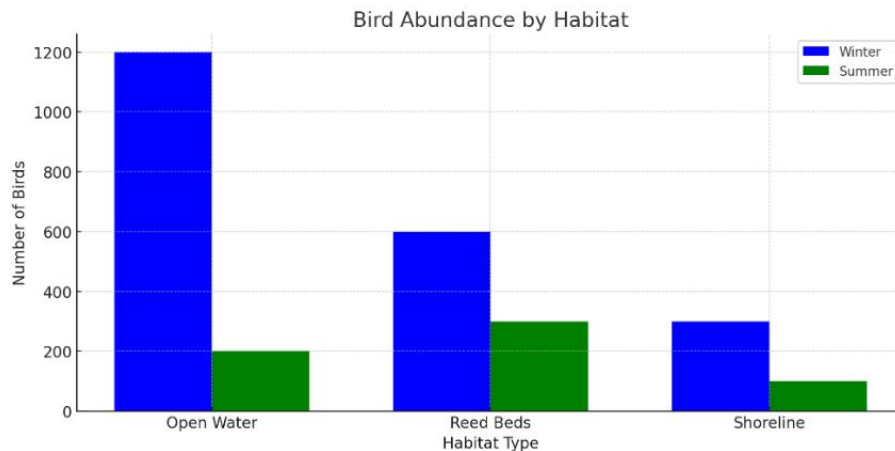


Fig 2. Showing Bird abundance & Percentage

Category	Number of Species	Percentage
Waterfowl and Ducks	12	40%
Waders and Shorebirds	8	27%
Gulls and Terns	4	13%
Raptors	2	7%
Other Notable Migrants	3	13%
Total	29	100%

Discussion

The results of this study highlight the crucial role of Hamal Lake as a key stopover site for migratory birds, especially during the autumn and winter seasons. The observed seasonal variations in bird abundance and diversity are consistent with the migratory patterns of many avian species, which are influenced by environmental factors such as temperature, food availability, and water levels. The peak abundance of migratory birds during the winter months is in line with previous studies on wetland habitats, where migratory birds, particularly waterfowl and shorebirds, converge in large numbers during migration periods (Piersma, 2007). The substantial influx of migratory species during this period underscores the importance of Hamal Lake in supporting these populations as they travel along their migratory routes.

The dominance of waterfowl species, such as the Northern Pintail and Eurasian Wigeon, during the winter migration is consistent with the known migratory patterns of these species, which are typically found in large numbers in wetlands and lakes during winter (Zhang et al., 2023). The abundance of these species during the colder months is likely due to the availability of open water for feeding and the relatively mild climate at Hamal Lake compared to northern breeding grounds. Additionally, the shallower areas of the lake provide ideal foraging sites for ducks and geese enhancing the lake's attractiveness as a stopover site. The presence of other species, such as shorebirds and waders, also highlights the diversity of habitats available at the lake, which cater to different ecological needs during migration.

Species diversity, as indicated by the Shannon-Weiner diversity index, was highest during the autumn and winter months, which is typical of wetlands that host large numbers of migratory species. The influx of migratory birds from northern regions brings a wider range of species, thus increasing overall biodiversity. The peak diversity observed during these months at Hamal Lake may also reflect the seasonal availability of resources, such as food and shelter, which are abundant in the cooler months. These resources are critical for migratory birds, as they rely on wetland ecosystems for resting, feeding, and replenishing energy reserves during long migratory journeys (Sharma & Naik, 2024). The high species diversity observed at Hamal Lake is a strong indicator of the lake's ecological significance as a critical stopover point.

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On the other hand, the lower species diversity observed during the summer months can be attributed to several factors. During this period, the hot temperatures and decreased water levels likely reduce the availability of suitable habitat for migratory birds. Many species tend to leave wetlands when conditions are less favorable, and only resident species or those adapted to the summer conditions remain (Hess et al., 2024). The dominance of resident species during the summer months further suggests that the lake is less critical for migratory birds during this time, and many species may migrate to other, more suitable locations for breeding or feeding. Reduced water availability and vegetation density may have also led to less shelter for birds contributing to the drop in both abundance and diversity (Ramírez et al., 2024).

Environmental conditions, such as water levels and vegetation cover, were found to influence bird abundance and distribution across the lake. Higher water levels and cooler temperatures in the autumn and winter months created favorable conditions for migratory species, providing ample feeding and resting areas (Newton, 2023). This finding aligns with studies showing that water level fluctuations in wetlands can significantly impact the distribution and abundance of bird populations (Zhu, Wang & Guo, 2021)). The southern shore of the lake, with its denser vegetation, provided more shelter and thus supported higher bird populations, especially during migration periods (Zwarts, Bijlsma, & van der , 2023).. This suggests that the heterogeneity of habitats within Hamal Lake is important for supporting a wide variety of species, highlighting the need for habitat conservation and management efforts that take into account the varying needs of different bird species.

The overall composition of bird species at Hamal Lake also indicates the importance of the lake for both migratory and resident species. While waterfowl dominated during the winter months, other species such as raptors and passerines were recorded in smaller numbers, contributing to the lake's biodiversity. Raptors, including species like the Western Marsh Harrier and Peregrine Falcon, rely on the lake's wetlands for hunting, demonstrating the interconnectedness of species in these ecosystems. The presence of these top predators further emphasizes the ecological importance of Hamal Lake as a critical habitat for a range of avian species. As such, the conservation of the lake's diverse habitats is essential to maintaining the integrity of the entire ecosystem and ensuring the continued support for migratory bird populations.

Conclusion

Hamal Lake plays a vital role in supporting the seasonal movements of migratory birds, offering a critical habitat for feeding, resting, and sheltering during migration. The seasonal abundance and diversity of migratory birds at Hamal Lake, highlighting its critical role as a stopover site along migratory routes. The seasonal fluctuations in both the number of birds and species diversity, with peak abundance observed during the autumn and winter months, coinciding with the height of migratory activity. The presence of a wide variety of species, including waterfowl, shorebirds, and raptors, underscores the ecological importance of the lake as a vital habitat for both migratory and resident bird populations. The seasonal variation in species diversity, with the highest levels observed during the cooler months, reflects the dynamic nature of wetland ecosystems and the diverse ecological needs of migratory birds.

The findings also highlight the significant influence of environmental factors such as water levels, vegetation cover, and temperature on the abundance and distribution of bird species at Hamal Lake. Higher water levels and favorable temperatures during the winter months create ideal conditions for migratory species, making the lake an essential refuge for birds traveling long distances. However, during the summer, when water levels decrease and temperatures rise, the lake becomes less suitable for migratory species, resulting in a lower abundance and diversity of birds. These seasonal changes emphasize the need for ongoing monitoring and management to ensure that the lake continues to provide critical resources for migratory birds throughout the year.

The study reinforces the importance of preserving wetland habitats like Hamal Lake, which are increasingly threatened by human activities and climate change. As migratory birds face growing challenges from habitat loss and environmental degradation, the conservation of key stopover sites like Hamal Lake is essential to maintaining biodiversity and supporting the survival of migratory populations combined with conservation

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efforts aimed at protecting its habitats, will be crucial in ensuring that this important wetland continues to support migratory birds for generations to come.

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