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# Diversity of waterbird species and threats to them at Siliserh Lake in Alwar, Rajasthan, India

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**Abstract**
Siliserh lake is one of the most significant and productive environments for birds, as it provides various requirements for their survival is, located in the Aravalli hills in the district of Alwar, Rajasthan. The study conducted from January 2021 to February 2023. During the post-monsoon season, 60 species from 15 families were recorded, while the pre-monsoon season observed 37 species from 14 families. The study area supports a diverse range of waterbird species, including resident, local migratory, and winter visitors with 48.33%, 16.67%, and 35%, respectively. The aquatic avian species in this lake face threats due to various anthropogenic activities, including encroachment for agriculture and urban construction, waste dumping, catchment degradation, drainage for agriculture, and recreational activities at the wetland site. These activities pose significant challenges to the conservation of the lake's avian biodiversity. Worldwide, 12% of all avian species are threatened with global extinction. Wetlands are very important for the conservation of waterbirds, as 20% of the population of threatened bird species from Asia inhabits wetlands.

**Keywords:** Biodiversity, Ecosystem, Encroachment, Migratory birds, Wastewater, Wetland, Winter visitors, Threats to wetland

## Introduction:

Biotic community structures play crucial role functioning of ecosystem. In the context of wetland ecosystem, birds serve as bioindicators and monitoring their species density is essential for assessing ecosystem health and effective management. Avian species play a crucial role in monitoring the health of natural ecosystems, such as wetlands (Koskimies 1989). They serve as highly mobile and easily observed indicators of environmental changes (Morrison 1986). There are approximately 10,000 avian species reported globally, and the Indian subcontinent contributes about 13% of the world's avian

species (Grimmett et al. 2011). As of 2022, India is home to a total of 1348 bird species, with 310 species identified as wetland birds (Kumar et al. 2005; Praveen et al. 2022). Every year, a significant number of waterbirds from their nesting areas in the northern hemisphere—particularly Siberia—migrate into India (Verma 2008). Birds that are known to live in Keoladeo National Park have relocated to the wetlands that are nearby, like Siliserh lake and Bandh Baretha (Bhadouria et al. 2012).

Wetlands are important areas for birds, supporting their species diversity and playing a regulatory role in the ecological web (Mitsch & Gosselink 1986; Guadagnin et al. 2005). Many waterfowl species, occupying the upper tiers of the food chain, demonstrate sensitivity to the condition of both freshwater and marine ecosystems (Bashir 2020). The movement and aggregations of waterbirds in wetlands inherently impact nutrient flows (Green & Elmberg 2013). Given the significant role of water birds as bio-indicators of changing environments, understanding the ecology of the major species that utilize wetlands becomes essential (Sivaperuman 2004). With their extensive range of services, urban wetlands are one of the most significant green-blue infrastructure elements supporting waterfowl biodiversity. (Alikhani et al. 2021). Aquatic birds also contribute to regulating services, such as seed dispersal and pollination, which are considered essential ecosystem services (Michel et al. 2020).

Wetlands play a vital role in recharging groundwater, facilitating recreational activities, retaining and controlling pollutants, and providing a habitat for numerous aquatic flora and faunal species which is crucial for their sustenance (Chapman et al. 2001). However, wetlands rank among the most threatened habitats in the world, as they suffered due to extensive drainage and fragmentation (Dudgeon et al. 2006). Consequently, there is a decline in wetland biodiversity, causing habitat loss, especially for aquatic birds (Kačergytė 2021). Approximately 1,186 bird species (12% of all avian species) worldwide are threatened with global extinction, with 182 of those species classified as critically endangered, meaning they have a very high chance of going extinct in the near future (Arya et al. 2019). Therefore, it is crucial to understand the root cause of the population drop in biodiversity at wetlands and to control these trends to prevent a decline in vital components of wetland habitat biodiversity (Datta 2011).

Some studies have focused on waterbirds as an indicator to assess the health of urban ecosystems (Colwell 2010; Datta 2011; Sinha et al. 2011; Rajashekara & Venkatesha 2017), using richness and diversity as tools, where diversity tends to decrease with increased urbanization, encroachment for agriculture, and other infrastructure development. Waterbird communities are primarily influenced by the resources available at the wetland site and the birds' ability to exploit them. The arrangement and communal behaviors among waterbird guilds can serve as crucial ecological indicators of the quality and diversity of habitats (Chatterjee et al.2020). After fish, waterbirds are probably the most significant category of wildlife that draws people towards the wetlands (Verma 2008).

Advancement in agricultural practices (Alavaisha 2019), encroachment of wetlands for settlement (Gideon 2018), illegal dumping of waste in water bodies (Nabulo et al. 2008), and restriction of water flow in the catchment area led to damage to the wetland ecosystem, with detrimental consequences for bird biodiversity (Kuchara 2023). A study was conducted to document the avifaunal diversity of Siliserh lake. Additional objectives included assessing the threats posed to the wetlands and suggesting remedial measures for conservation of the wetlands.

## Material and methods:

**Study area:** Siliserh lake is located 13 km away from the Alwar city (Fig.1), and serves as a prominent tourist attraction. Known for its diverse bird species, including migratory ones that visit during the winter season, Siliserh lake is a popular destination for birdwatchers. Situated at coordinates 24.596140°N, 72.703066°E, the lake covers an area of about 7- 10 sq. km. Bordered by dense

woodlands and cenotaphs along its embankment (Vashistha, 2016), Siliserh lake is surrounded by the Aravalli hills. These hills not only contribute to water runoff to keep the lake filled but also enhance the beauty of the Alwar district with diverse vegetation (Sharad 2022). Alwar receives an average precipitation of 595 mm, whereas some parts of the dry region get as little as 100 mm of precipitation annually (Chitrakshi & Haritash 2022). The average maximum and minimum ambient temperatures around the lake are 38 $^{o}$C and 28 $^{o}$C, respectively, making the climate near the lake semi-arid to desert. The lake also supports fauna like fish, turtles, birds and wild crocodiles, and the fish population in the lake includes carp, catfish, and tilapia (Chitrakshi & Haritash 2022). The vegetation in the surrounding areas is arid or semi-arid, but during the wet seasons, a remarkable diversity of vegetation emerges, representing a complex taxonomic entity in this lush region (Agrawal 2017). The region around the Siliserh lake has been reported to host a total of 110 plant species, representing 88 genera and 43 families (Dular 2015). A number of compositions of vegetation have been reported, such as herbs (*Achyranthes aspera*, *Acalypha paniculata*, *Verbascum* spp., etc.), shrubs (*Zizypus jujube*, *Abutilon indicum*, *Justicia adhotod*, etc.), and trees (*Acacia arabica*, *Acacia catechu*, *Ricinus communis*, etc.) (Agarwal 2017).

Each year, Siliserh lake attracts numerous migratory birds due to their abundant food sources, suitable environment, and shelter for egg-laying.

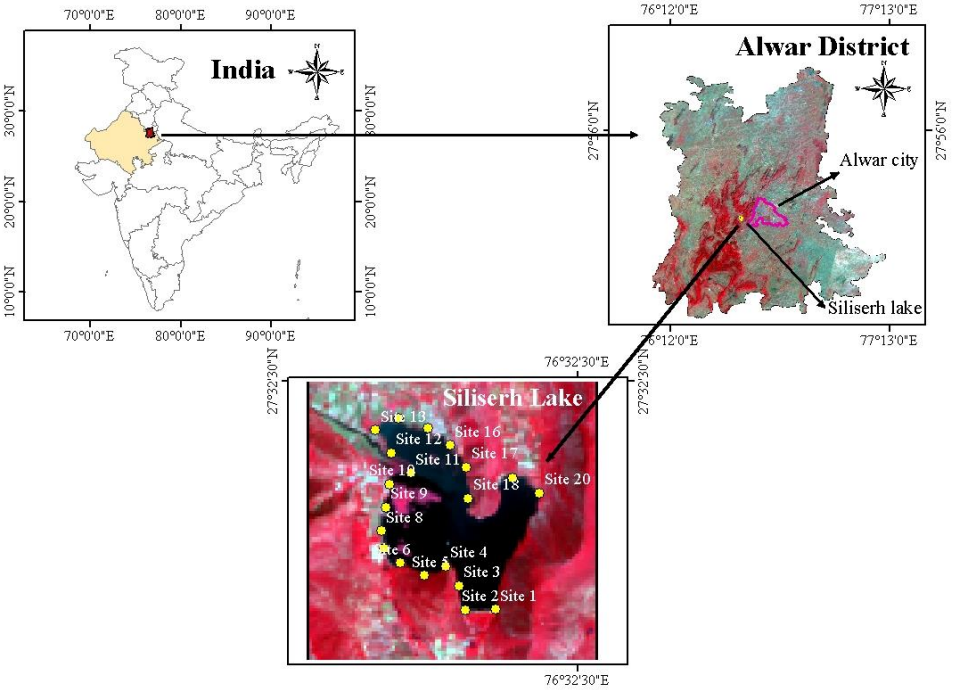


**Figure.1.** Siliserh lake as Study area in Alwar district, Rajasthan

## Methodology:

The avian survey on resident and water migratory birds was conducted from January, 2021 to February, 2023, dividing the year into pre-monsoon (February-May), and post-monsoon (October-January). The early morning (0600 to 1000) and evening hours (1600 to 1800) were preferred for the sighting of birds, as birds were more active during these hours (Tsigereda 2011). A team of five people carried out the aquatic bird data collection, and the equipment used by them was binoculars, a digital camera, a compass, a watch, measuring tape, plastic rope, data forms, and a pencil. Twenty systematic sampling points were strategically selected throughout the entire length (perimeter) of the wetland, ensuring coverage of all regions and maintaining the consistent sampling size for the comparison of various

ecological data among wetlands (Fig. 1). The point count method was employed to monitor bird diversity, as it is widely used to track fluctuations in bird populations and assess overall bird diversity (Hostetler & Martin 2000).

**Table 1.** Twenty systematic points showing location, time, and habitat are laid along Siliserh lake for the aquatic bird data collection.

| Points | Location | Timing of data collection | Habitat |
|---|---|---|---|
| 1 | 27°31'04" N 76° 32'09" E | 0715 | Siliserh lake garden |
| 2 | 27°31'04" N 76°31'40" E | 0830 | Siliserh lake garden |
| 3 | 27°31'13" N 76° 31' 55" E | 0915 | Road towards the Siliserh lake Palace |
| 4 | 27°31'20" N 76° 31' 51" E | 1005 | Settlement area Siliserh lake Palace |
| 5 | 27°31'16" N 76° 31' 45" E | 1635 | Bush |
| 6 | 27°31'18" N 76° 31' 31" E | 1750 | Bush |
| 7 | 27°31'25" N 76° 31' 26" E | 0652 | Open area |
| 8 | 27°31'43" N 76° 31' 28" E | 0745 | Open area |
| 9 | 27°31'57" N 76° 31' 25" E | 0837 | Ditch |
| 10 | 27°31'57" N 76° 31' 12" E | 0934 | Ditch |
| 11 | 27°32'18" N 76° 31' 07" E | 1600 | Road side |
| 12 | 27°32'20" N 76° 31' 18" E | 1710 | Road side |
| 13 | 27°32'19" N 76° 31' 33" E | 1815 | Agricultural land |
| 14 | 27°32'11" N 76° 31' 33" E | 0730 | Agricultural land |
| 15 | 27°32'02" N 76° 31' 58" E | 0835 | Agricultural land |
| 16 | 27°31'55" N 76° 31' 59" E | 0940 | Settlement |
| 17 | 27°31'45" N 76° 32' 00" E | 1630 | Agricultural land |
| 18 | 27°31'47" N 76° 32' 10" E | 1745 | Bush |
| 19 | 27°31'59" N 76° 32' 10" E | 0800 | Agricultural land |
| 20 | 27°31'49" N 76° 32' 26" E | 0910 | Agricultural land |

For each sampling point, an observer collected three types of data within a designated timeframe: (1) recording the count of individuals per species observed within a 25 -meter radius from the observer; (2) identifying whether individuals of each species were present—whether singular or in multiples—beyond the 25-meter radius but still within the habitat of interest; and (3) documenting the identity of individuals observed while the observer moved between counting points (Hutto et al.1986). Aquatic bird species were identified visually and acoustically within a 25-m radius with the help of binoculars (8 × 30 and 8 × 40) and/or human vision during each 10-min sampling interval (Sutherland 2000). To prevent the edge effect, each point was placed 100~m from the roadside, and a minimum distance of 200 to 300m was maintained using the GPS system in order to avoid counting the same particular species of birds again (Sutherland 1996). The number of aquatic birds and different species were noted at each point during a 15-minute observation period, either heard or seen (Bibby et al. 1999). At each site along the wetland, bird diversity, abundance, and habitat were noted. Photographs were taken for the identification of birds to species level using the field guide (Grimmett et al. 2011). The recorded data were examined on the basis of frequency of observation to get the abundance status, showing that common (C) was observed between seven and nine times, uncommon (UC) was sighted between three and six times, and rare (Ra) was seen one or two times (Sahoo 2020). The scientific name, common name, IUCN status on the Red List, and migration status are followed using Praveen & Jayapal 2022. Species accumulation curves were generated using software Estimates 9.0 after 999 randomizations (Colwell 2010). Chao 1 provides an estimate of the total

number of species in an assemblage based on the number of rare species in a sample. It is also recommended for evaluation inventory completeness values as a ratio of observed and estimated richness (Sørensen et al. 2002; Scharff et al. 2003). Jacknife 2 is known for species richness with greater precision and less bias, and is also less dependent on the sample size (Chiarucci et al. 2003; Petersen et al. 2003).

The study poses various threats to the wetland area, including hazardous waste dumping, agricultural encroachment, pesticide and fertilizer runoff, poor irrigation practices, catchment degradation, unsustainable tourism, urban development encroachment, local fishing, cattle watering, and human use of the reservoir and catchment for bathing and washing. To reinforce these observations, villager interviews and photographic evidence were conducted and documented. To assess Siliserh lake's water quality, physico-chemical parameters were analyzed in samples collected from various sites following established protocols. The resulting data was then compared to recognized water quality standards for a comprehensive evaluation.

**Results and Discussion:**

A total of 1773 waterbirds were recorded, comprising 60 species of wetland birds during the post-monsoon season at Siliserh lake for the study period. In the pre-monsoon, a total of 810 waterbirds were recorded, representing 45 species. The accumulation curve, pooled for all sampling points, reached an asymptote for both Chao1 and Jacknife2, indicating that sampling was nearly complete.

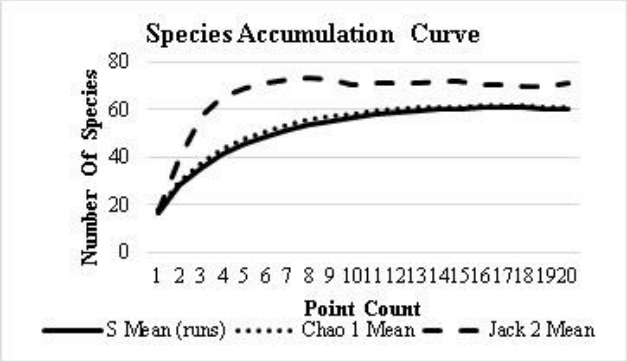


**Figure. 2.:** Species accumulation curve of bird species recorded in Siliserh lake showing the sign of reaching asymptote.

**Table 2. A checklist of aquatic avian species recorded at Siliserh lake for the year 2021 to 2023.**

| S. No. | Family/Common name | Scientific name | Post Monsoon | Pre-Monsoon | Migratory status | IUCN List status | Abundance stat |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | **u s** |
| | **Alcedinidae** | | | | | | |
| 1 | White-throated Kingfisher | *Halcyon smyrnensis* (Linnaeus, 1758) | Yes | Yes | R | LC | Ra |
| 2 | Common Kingfisher | *Alcedo atthis* (Linnaeus, 1758) | Yes | Yes | R | LC | Ra |
| | **Anatidae** | | | | | | |
| 3 | Indian Spot-billed Duck | *Anas poecilorhyncha* J.R. Forster, 1781 | Yes | ---- | R | LC | C |
| 4 | Greylag Goose | *Anser anser* (Linnaeus, 1758) | Yes | ---- | WV | LC | C |
| 5 | Bar-headed Goose | *Anser indicus* (Latham, 1790) | Yes | ---- | WV | LC | C |
| 6 | Eurasian Wigeon | *Mareca penelope* (Linnaeus, 1758) | Yes | ---- | WV | LC | Ra |
| 7 | Northern Shoveler | *Spatula clypeata* (Linnaeus, 1758) | Yes | ---- | WV | LC | C |
| 8 | Northern Pintail | *Anas acuta* Linnaeus, 1758 | Yes | ---- | WV | LC | C |
| 9 | Garganey | *Spatula querquedula* (Linnaeus, 1758) | Yes | ---- | WV | LC | Ra |
| 10 | Comb Duck | *Sarkidiornis melanotos* (Pennant, 1769) | Yes | ---- | WV | LC | UC |
| 11 | Common Teal | *Anas crecca* Linnaeus, 1758 | Yes | ---- | WV | LC | UC |
| 12 | Ruddy Shelduck | *Tadorna ferruginea* (Pallas, 1764) | Yes | ---- | WV | LC | C |
| 13 | Gadwall | *Mareca strepera* (Linnaeus, 1758) | Yes | ---- | WV | LC | UC |
| 14 | Common Pochard | *Aythya ferina* (Linnaeus, 1758) | Yes | ---- | WV | VU | Ra |
| 15 | Ferruginous Duck | *Aythya nyroca* (Güldenstädt, 1770) | Yes | ---- | WV | NT | Ra |
| 16 | Mallard | *Anas platyrhynchos* Linnaeus, 1758 | Yes | ---- | WV | LC | Ra |
| 17 | Tufted Duck | *Aythya fuligula* (Linnaeus, 1758) | Yes | ---- | WV | LC | Ra |
| | **Anhingidae** | | | | | | |
| 18 | Oriental Darter | *Anhinga melanogaster* Pennant, 1769 | Yes | Yes | LM | LC | Ra |
| | **Ardeidae** | | | | | | |
| 19 | Indian Pond Heron | *Ardeola grayii* (Sykes, 1832) | Yes | Yes | R | LC | UC |
| 20 | Black-crowned Night Heron | *Nycticorax nycticorax* (Linnaeus, 1758) | Yes | Yes | LM | LC | Ra |
| 21 | Little Egret | *Egretta garzetta* (Linnaeus, 1766) | Yes | Yes | R | LC | UC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 22 | Cattle Egret | *Bubulcus ibis* (Linnaeus, 1758) | Yes | Yes | R | LC | UC |
| 23 | Intermediate Egret | *Ardea intermedia* Wagler, 1829 | Yes | Yes | R | LC | Ra |
| 24 | Great Egret | *Ardea albus* Linnaeus, 1758 | ---- | Yes | LM | LC | |
| 25 | Purple Heron | *Ardea purpurea* Linnaeus, 1766 | ---- | Yes | R | LC | UC |
| 26 | Grey Heron | *Ardea cinerea* Linnaeus, 1758 | Yes | Yes | LM | LC | Ra |
| | **Charadriidae** | | | | | | |
| 27 | Red-wattled Lapwing | *Vanellus indicus* (Boddaert, 1783) | Yes | Yes | R | LC | C |
| 28 | White-tailed Lapwing | *Vanellus leucurus* (M.H.C. Lichtenstein, 1823) | Yes | Yes | R | LC | C |
| | **Ciconiidae** | | | | | | |
| 29 | Painted Stork | *Mycteria leucocephala* (Pennant, 1769) | Yes | Yes | R | LC | UC |
| 30 | Asian Openbill | *Anastomus oscitans* (Boddaert, 1783) | Yes | Yes | R | LC | UC |
| 31 | Woolly-necked Stork | *Ciconia episcopus* (Boddaert, 1783) | Yes | Yes | LM | NT | Ra |
| 32 | Black-necked Stork | *Ephippiorhynchus asiaticus* (Latham, 1790) | Yes | ---- | WV | NT | Ra |
| | **Gruidae** | | | | | | |
| 33 | Sarus Crane | *Antigone antigone* (Linnaeus, 1758) | Yes | Yes | R | VU | Ra |
| | **Jacanidae** | | | | | | |
| 34 | Bronze-winged Jacana | *Metopidius indicus* (Latham, 1790) | Yes | Yes | R | LC | UC |
| | **Motacillidae** | | | | | | |
| 35 | White Wagtail | *Motacilla alba* Linnaeus, 1758 | Yes | ---- | WV | LC | Ra |
| 36 | White-browed Wagtail | *Motacilla maderaspatensis* J.F. Gmelin, 1789 | Yes | ---- | R | LC | Ra |
| 37 | Citrine Wagtail | *Motacilla citreola* Pallas, 177 | Yes | ---- | WV | LC | Ra |
| 38 | Western Yellow Wagtail | *Motacilla flava* Linnaeus, 1758 | Yes | ---- | WV | LC | Ra |
| | **Phalacrocoracidae** | | | | | | |
| 39 | Great Cormorant | *Phalacrocorax carbo* (Linnaeus, 1758) | Yes | Yes | R | LC | C |
| 40 | Little Cormorant | *Microcarbo niger* (Vieillot, 1817) | Yes | Yes | R | LC | C |
| | **Podicipedidae** | | | | | | |
| 41 | Little Grebe | *Tachybaptus ruficollis* (Pallas, 1764) | Yes | Yes | R | LC | C |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Rallidae** | | | | | | |
| 42 | Common Moorhen | *Gallinula chloropus* (Linnaeus, 1758) | Yes | Yes | WV | LC | UC |
| 43 | White-breasted Waterhen | *Amaurornis phoenicurus* (Pennant, 1769) | Yes | Yes | R | LC | UC |
| 44 | Purple Swamphen | *Porphyrio porphyrio* (Linnaeus, 1758) | Yes | Yes | R | LC | UC |
| 45 | Common Coot | *Fulica atra* Linnaeus, 1758 | Yes | Yes | LM | LC | C |
| 46 | Watercock | *Gallicrex cinerea* (J.F. Gmelin, 1789) | Yes | Yes | R | LC | UC |
| | **Recurvirostridae** | | | | | | |
| 47 | Black-winged Stilt | *Himantopus himantopus* (Linnaeus, 1758) | Yes | Yes | R | LC | C |
| 48 | Pied Avocet | *Recurvirostra avosetta* Linnaeus, 1758 | Yes | Yes | R | LC | UC |
| | **Scolopacidae** | | | | | | |
| 49 | Common Sandpiper | *Actitis hypoleucos* (Linnaeus, 1758) | Yes | Yes | R | LC | C |
| 50 | Black-tailed Godwit | *Limosa limosa* (Linnaeus, 1758) | Yes | ---- | WV | NT | C |
| 51 | Common Redshank | *Tringa totanus* (Linnaeus, 1758) | Yes | Yes | R | LC | C |
| 52 | Common Greenshank | *Tringa nebularia* (Gunnerus, 1767) | Yes | Yes | R | LC | C |
| 53 | Marsh Sandpiper | *Tringa stagnatilis* (Bechstein, 1803) | Yes | Yes | R | LC | UC |
| 54 | Green Sandpiper | *Tringa ochropus* Linnaeus, 1758 | Yes | Yes | R | LC | UC |
| 55 | Temminck's Stint | *Calidris temminckii* (Leisler, 1812) | Yes | ---- | WV | LC | Ra |
| 56 | Bar-tailed Godwit | *Limosa lapponica* (Linnaeus, 1758) | Yes | ---- | LM | NT | Ra |
| 57 | Spotted Redshank | *Tringa erythropus (*Pallas, 1764) | Yes | Yes | R | LC | Ra |
| | **Threskiornithidae** | | | | | | |
| 58 | Indian Black Ibis | *Pseudibis papillosa* (Temminck, 1824) | Yes | Yes | LM | LC | Ra |
| 59 | Black-headed Ibis | *Threskiornis melanocephalus* (Latham, 1790) | Yes | Yes | LM | NT | UC |
| 60 | Eurasian Spoonbill | *Platalea leucorodia* Linnaeus, 1758 | Yes | Yes | LM | LC | UC |

**IUCN Red list status: LC – Least concern, VU – Vulnerable, NT– Near threatened Migratory status: WV– Winter visitor, R– Resident, LM– Local migrant**

**Abundance status: C–Common, Ra–Rare, UC–Uncommon**

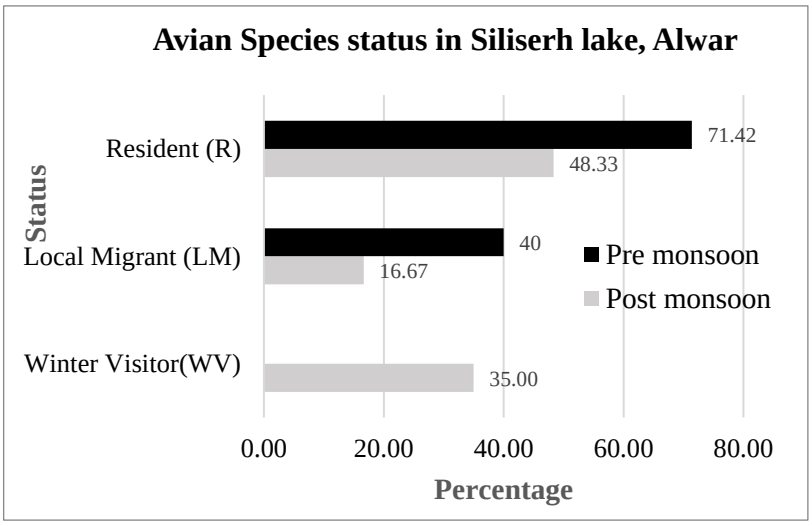


**Figure. 3**: Status of bird species in study area

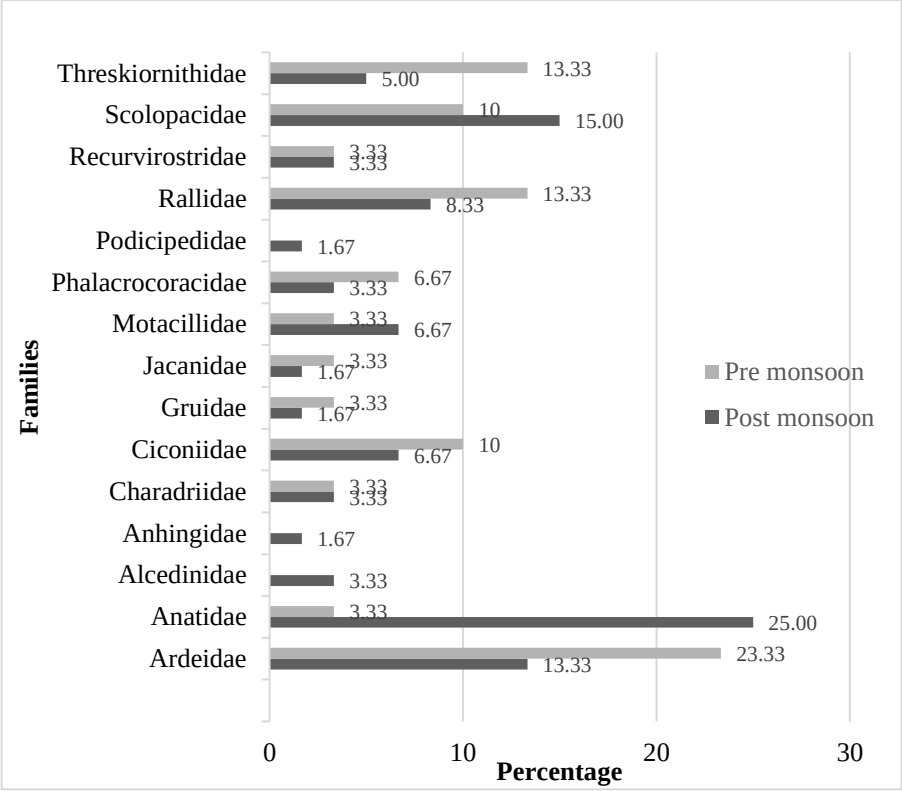


**Figure. 4**: Percentage wise contribution of families of bird species in study area

A total of 60 waterbirds belonging to 15 families were recorded during the post-monsoon season, while 37 waterbirds from 12 families were recorded during the pre-monsoon season (Table 2). The highest number of waterbird species belonged to family Anatidae (15 species), followed by Scolopacidae (9 species), Ardeidae (8 species). The result also indicated that in the study area, resident species constituted 48.33%, winter migratory species contributed to 35%, and local migratory species (birds breeding in one region of the area and moving to another region within the state or country in another season) accounted for 16.67% (Fig. 3). Some of the dominant resident birds are Indian Spot-billed Duck *Anas poecilorhyncha*, Red-wattled Lapwing *Vanellus indicus* , and Great Cormorant *Phalacrocorax carbo*; for local migratory birds, Common Coot *Fulica atra ,* and Great Egret *Ardea albus*;

whereas for winter visitors, dominant species are Northern Shoveler *Spatula clypeata*, Northern Pintail *Anas acuta*, Ruddy Shelduck *Tadorna ferruginea*, and Greylag Goose *Anser anser*.

The Anatidae family dominated the study area with maximum number of species,25%, including species like, Northern Pintail *Anas acuta*, Ruddy Shelduck *Tadorna ferruginea*, Mallard *Anas platyrhynchos*, Greylag Goose *Anser anser*, etc., all of which are winter visitor except for the Indian Spot-billed Duck *Anas poecilorhyncha*, which is resident. The Scolopacidae family shows the presence of 15% of aquatic bird species like Black-tailed Godwit *Limosa limosa*, Common Sandpiper *Actitis hypoleucos*, Common Redshank *Tringa totanus*, Bar-tailed Godwit *Limosa lapponica*, etc., covering all three migratory statuses – resident, local migratory, and winter visitors. The Ardeidae family contributes 13.33% of the aquatic bird diversity, including Indian Pond Heron *Ardeola grayii*, Black-crowned Night Heron *Nycticorax nycticorax*, Grey Heron *Ardea cinerea*, Little Egret *Egretta garzetta*, Cattle Egret *Bubulcus ibis*, etc., with varied migratory statuses, including resident and local migratory. Other significant families of waterbirds present included Rallidae (8.33%), Ciconiidae (6.67%) and Motacillidae (6.67%). This lake provides a rich food resource and adequate breeding grounds for some of the winter visitor (Ruddy Shelduck *Tadorna ferruginea*, Common Teal *Anas crecca* and Bar-headed Goose *Anser indicus*), local migratory (Woolly-necked Stork *Ciconia episcopus,* and Painted Stork *Mycteria leucocephala*), and resident species (Little Cormorant *Microcarbo niger* and Indian Spot-billed Duck *Anas poecilorhyncha*). In India, various types of topography and climatic regimes support wetland habitats (Prasad et al. 2002). However, there is a significant decrease in wetland resources in the country, attributed to the rapid growth of the human population, extensive alterations in land use, widespread agricultural practices, and inappropriate watershed utilization (Meena 2019). The study area has witnessed different threats to the wetland, including the wetland catchment area and the shore being utilized for agriculture.


**Figure.5:** Different threats observed at the wetland site, 1. Dumping of waste, 2. Encroachment for agriculture, 3. Catchment degradation, 4. Recreation at the wetland, 5. Encroachment for urban construction, 6. Drainage for agriculture

**Threats due to the agriculture:** Siliserh Lake, primarily used for irrigation without proper management practices, faces ecological stress due to agricultural encroachment, agricultural runoff, domestic sewage influx, and cattle waste, all of which negatively impact water quality. (Chitrakshi & Haritash 2022). Agricultural runoff laden with chemical fertilizers and untreated wastewater emerges as a significant contributor to wetland pollution (Sagasta 2017). Encroachments for urban construction and agriculture have been noted at the lake's bank, as shown in Fig.5.

**Encroachment of urban development:** Land encroachment along the wetland is observed in peri-lacustrine (around the lake) wetlands, which exemplifies the growing threat of seemingly minor developments like farmhouses, rest houses, shops, and restaurants. While the absence of large-scale urban development might be perceived as positive, such encroachment disrupts the ecological balance of the wetland and consequently degrades the adjacent lake's aquatic environment.

**Discharge of waste:** Siliserh lake serves as a vital freshwater resource and ecological habitat, but it suffers from increasing anthropogenic pollution linked to religious activities.
Waste dumped within the wetland jeopardizes biodiversity, potentially harming fish, avian life, reptiles, mammals, and other aquatic organisms (Sanjoy 2019).

**Ecotourism:** Ecotourism plays a considerable role in the world economy. Nevertheless, it is an intensive human activity that can damage protected areas and disturb the ecological balance of wetlands. Field observations at Siliserh lake documented recreational boating activities coinciding with a lack of aquatic bird presence in those specific areas. Furthermore, visitor behavior resulted in the deposition of plastic water bottles and food packaging, which are major components of wetland litter (Kumbhar & Mhaske 2023). They fragment into microplastics over time, entering the food web and harming wildlife through ingestion and bioaccumulation (Li et al. 2024).

**Water quality:** The water in Siliserh lake has an average pH of 8. 5. This can be attributed to high carbonate dissolution from the soil/rocks and the introduction of domestic wastewater containing carbonate components found in detergents (Chitrakshi & Haritash 2022). The chemical properties of the water at Siliserh lake not only impact the physical properties of the environment but also significantly influence the metabolic functions of organisms, contributing to the gradual alteration of water's chemical composition over time (Khinchi et al. 2015). The threats observed at the lake degrade habitat quality, impact aquatic vegetation and invertebrate communities, disrupt breeding grounds, and migration patterns. The substantial percentage (35.93%) of migratory birds in the study area indicates its potential for attracting bird watchers, ecologist, conservationist, ornithologist and research scholars. This study on bird diversity, can serves as baseline information for understanding the status of birds in Siliserh lake. Given the observed threats in the Sariska forest and surrounding buffer zone, including Siliserh lake (Dular 2013; Kumar & Chauhan 2014), it is crucial for the government and ecologists to take initial steps to address these issues. Creating awareness among local communities is essential, as protecting the lake could make it an excellent site for resident and migratory birds. Accurate delineation and mapping of wetlands using remote sensing and ground surveys are crucial for establishing clear boundaries and enforcing regulations that will be helpful in creating legal frameworks to designate wetlands as protected areas. Wetland conservation prioritizes restoring natural water flow and native vegetation to create healthy ecosystems teeming with prey for waterbirds. Additionally, ongoing monitoring and pollution reduction efforts from agriculture and urban growth ensure the long-term health of these vital habitats. On-site wastewater treatment for

residences and improved waste management (bins and regular collection) are crucial to curb human-caused pollution in wetlands, protecting their ecological health. To ensure the ecological health of Siliserh Lake, visitor education programs promoting responsible waste disposal and implementation of designated waste collection points are crucial in mitigating plastic and food waste pollution.

## Conclusion:

We can conclude from the current study that protecting wetlands is crucial for supporting bird species, as these habitats provide essential breeding grounds, feeding areas, and shelter for many avian species. This study shows that the availability of habitat that meets the set goals in terms of quantity and quality is necessary for the recovery of bird communities. Regular monitoring and research will help to assess the health of wetland ecosystems and the populations of bird species inhabiting them. This information can help identify threats, track changes over time, and inform conservation efforts. The Wildlife Department can provide support and coordination for the work of numerous field-based groups involved in surveys and research on bird migration. Increased involvement and communication between researchers from many disciplines, decision-makers, wetland managers, conservation practitioners, and local and international stakeholders will be necessary for all of these initiatives. Wetlands can be used sustainably through management practices that prioritize the utilization of wetland resources while ensuring their long-term health and ecological integrity.


Figure 6. 1. View of Siliserh lake, 2. Aquatic birds at Siliserh lake, 3. Northern Shoveler *Spatula clypeata,* 4. Grey Heron *Ardea cinerea 5*. Ruddy Shelduck *Tadorna ferruginea* 6. Comb Duck *Sarkidiornis melanotos* 7. Little Cormorant *Microcarbo niger* 8. Greylag Goose *Anser anser* 9. Bar-

headed Goose *Anser indicus* 10. Northern Pintail *Anas acuta* 11. Painted Stork *Mycteria leucocephala*

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