ABSTRACT

This study was carried out in the wetlands across Ayodhya District, Uttar Pradesh using fixed radius point counts, to understand the diversity and distribution of birds in these ecosystems. A total of 102 bird species belonging to 35 families and 12 orders were recorded from the study area. Amongst the order, Passeriformes (24 and 12) had the maximum number of species and families. The highest number of species recorded were Carnivores (44 species, 43%). A total of 61 bird species (60%) were resident, 41 bird species (40%) were winter visitors and ten species were in the threatened category of IUCN Red List (2021) which highlights the conservation value of wetland ecosystems in Ayodhya District, Uttar Pradesh.

Keywords: Avifauna; migratory; threatened; conservation; foraging guild; feeding guild.

1. INTRODUCTION

The transitional zones between terrestrial and aquatic ecosystems are known as wetlands [1], providing habitat for birds, fish, amphibians, reptiles, mammals and plants. Birds form an important constituent of a wetland ecosystem. They help in breaking seed dormancy, flower pollination, nutrient cycling, form an important part of food chain, act as biological control agents, etc [2]. The wetland ecosystem provides the birds both seasonal as well as resident with...
feeding, breeding and nesting habitats [3]. The wetlands in Uttar Pradesh are used as stop over sites by the migrating birds as this state forms a part of the Central Asian Flyway. This State also hosts eight wetlands designated as protected under Ramsar Convention. In addition to this, the state has many other wetlands either protected or unprotected.

Out of 1263 bird species found in India [4], 25% species are wetland dependent [5]. However, wetlands are exposed to tremendous anthropogenic pressures [6] and nearly 50% of wetlands have been lost all over the world [7]. The area under wetland is being constantly reduced due to spreading villages, expansion of agricultural fields, dumping of solid waste and discharging of domestic sewage. Other problems faced by wetlands are extraction of plants (water chestnut) and animals (fish), diversion of water flow, overgrazing, excessive use of pesticides by nearby agricultural fields leading to eutrophication, hunting of waterbirds [8] and fast spread of water hyacinths over water surface. Loss in wetland area leads to birds gathering in dense concentrations at available wetlands thus, increasing competition among species for survival. All this influences the structure of bird community. Moreover, water birds being at the top of food chains, get easily affected by habitat disturbances. They therefore act as indicators of wetland quality and restoration success [9]. So, an assessment of waterbirds in wetlands can help in better understanding the health of ecosystem and thereby the well-being of humans dependent on it.

In Uttar Pradesh, there have been some studies conducted on bird diversity in wetlands such as Samaspur Bird Sanctuary, Rae Bareli [10], Sandi Bird Sanctuary, Hardoi [11], Nawabganj Bird Sanctuary, Unnao [12] and in wetlands of Lucknow [13]. The district of Ayodhya in Uttar Pradesh has 1.86% of land under wetlands [14] but none of it is under protected category. There is also no documentation done on the wetland bird diversity of this district. Keeping this in mind, the present study was carried out to prepare a checklist of birds distributed in the wetland ecosystems of Ayodhya District. This information can be used to implement better methods of management and conservation for the wetland ecosystems of this district.

2. MATERIALS AND METHODS

2.1 Study Area

This study was conducted in the Ayodhya District of Uttar Pradesh which consists of five tehsils (Fig. 1). This district lies between 26.7730°N and 82.1458°E. This district is situated 93 m above MSL (Mean Sea Level) [15]. The climate of the district is tropical monsoon. The average temperature varies from 32 °C in summers to 16 °C in winters [15]. There are three distinct seasons – summer (March to June), rainy (July to October) and winter (November to February). The study area includes reserve forests, remnant vegetation patches, rivers, temple ponds, wetlands, gardens, paddy fields and human habitations.

![Location map of study area](image-url)
2.2 Methods

The study was carried out from March 2020 to April 2021 with an aim to prepare a checklist of birds present in wetlands of Ayodhya District, Uttar Pradesh. Fixed radius, point counts [16] were placed at fixed sites distributed across the wetlands throughout the district. Surveys were conducted during summers (06:00 am to 09:00 am) and winters (after disappearance of fog). Bird species were recorded for 10 minutes at every point count using a pair of field binoculars (Nikon 7x35). The opportunistic sightings of birds during other time of day were also included. Grimmett [17] was referred for bird identification. For every species observed, the details such as the date, time, GPS location (Garmin GPS), species name, number of individuals, feeding habit and habitat were noted. Every species recorded was assigned the taxonomic position, common and scientific names following Praveen [18]. The IUCN Red List [19] was referred for assigning the threat status to each bird species recorded.

3. RESULTS AND DISCUSSION

A total of 102 bird species belonging to 35 families and 12 orders were recorded from the study area (Table 1). Bird diversity studies in wetlands of Lucknow and Samaspur Bird Sanctuary, Rae Bareli, Uttar Pradesh have revealed 71 species [13] and 78 species [10] respectively. Amongst the order, Passeriformes (24 and 12) had the maximum number of species and family, followed by Charadriiformes (22 and 8) (Fig. 2). The order of Columbiformes and Falconiformes (1 each) had the lowest number of species (Fig. 2). Similar results were reported in other studies [20]. The family Anatidae (15) had the highest number of species, followed by Accipitridae (9) (Fig. 3). Similar results were found in other studies [3, 21]. Waterbirds are highly habitat specific. It was observed that most of the birds belonging to the Anatidae family, preferred open deep-water habitat in the study area. The Porphyrio porphyrio preferred ponds with Water hyacinth (Eichhornia crassipes), whereas the Hydrophasianus chirurgus preferred ponds with Lotus (Nelumbo nucifera). The wetland birds depend on variety of habitats and microhabitats for their survival. The wetlands surrounded by paddy fields, trees and scattered vegetation might have offered diverse options for roosting and foraging of waterbirds. The birds like cormorants, egrets, herons were seen roosting and nesting on the trees at the banks of wetlands.

![Fig. 2. Order wise bird community composition in wetlands of study area](image-url)
Table 1. Checklist of birds recorded in wetlands of study area

| S/N | Order/Family/Common name | Scientific name | Residential status | Feeding guild | IUCN status |
|-----|--------------------------|-----------------|--------------------|---------------|-------------|
| 1   | Black Kite               | Milvus migrans  (Boddaert, 1783) | R                  | C             | LC          |
| 2   | Black-winged Kite        | Elanus caeruleus (Desfontaines, 1789) | R                  | C             | LC          |
| 3   | Indian Spotted Eagle     | Clanga hastata  (Lesson, 1831)     | R                  | C             | LC          |
| 4   | Long-legged Buzzard      | Buteo rufinus   (Cretzschmar, 1829) | WV                 | C             | LC          |
| 5   | Oriental Honey Buzzard    | Pernis pilorhynchus (Temminck, 1821) | R                  | C             | LC          |
| 6   | Shikra                   | Accipiter badius (Gmelin, 1788)     | R                  | C             | LC          |
| 7   | Tawny Eagle              | Aquila rapax    (Temminck, 1828)    | R                  | C             | VU          |
| 8   | Western Marsh Harrier     | Circus aeruginosus (Linnaeus, 1758) | WV                 | C             | LC          |
| 9   | White-eyed Buzzard       | Butastur teesa  (Franklin, 1831)    | R                  | C             | LC          |
|     | Pandionidae (1)          |                 |                    |               |             |
| 10  | Osprey                   | Pandion haliaetus (Linnaeus, 1758)  | WV                 | C             | LC          |
|     | Anseriformes Anatidae (15)|                 |                    |               |             |
| 11  | Bar-headed Goose         | Anser indicus   (Latham, 1790)       | WV                 | O             | LC          |
| 12  | Common Pochard           | Aythya ferina   (Linnaeus, 1758)    | WV                 | O             | VU          |
| 13  | Common Teal              | Anas crecca     (Linnaeus, 1758)     | WV                 | O             | LC          |
| 14  | Cotton Pygmy-goose       | Nettapus coromandelianus (Gmelin, 1789) | R                  | O             | LC          |
| 15  | Gadwall                  | Mareca strepera (Linnaeus, 1758)    | WV                 | O             | LC          |
| 16  | Garganey                 | Spatula querquedula (Linnaeus, 1758) | WV                 | O             | LC          |
| 17  | Graylag Goose            | Anser anser     (Linnaeus, 1758)     | WV                 | O             | LC          |
| 18  | Indian Spot-billed Duck  | Anas poecilorhyncha (Forster, 1781)  | R                  | O             | LC          |
| 19  | Knob-billed Duck         | Sarkidiornis melanotos (Pennant, 1769) | R                  | O             | LC          |
| 20  | Lesser Whistling Duck    | Dendrocynya javanica (Horsfield, 1821) | R                  | O             | LC          |
| 21  | Mallard                  | Anas platyrhynchos (Linnaeus, 1758)  | WV                 | O             | LC          |
| 22  | Northern Pintail         | Anas acuta      (Linnaeus, 1758)     | WV                 | O             | LC          |
| 23  | Northern Shoveler        | Spatula clypeata (Linnaeus, 1758)    | WV                 | O             | LC          |
| 24  | Ruddy Shelduck           | Tadorna ferruginea (Pallas, 1764)    | WV                 | O             | LC          |
| 25  | Tufted Duck              | Aythya fuligula (Linnaeus, 1758)     | WV                 | O             | LC          |
|     | Charadriiformes Burhinidae (2) |                 |                    |               |             |
| 26  | Eurasian Thick-knee      | Burhinus ioedicnemus (Linnaeus, 1758) | R                  | O             | LC          |
| 27  | Great Thick-knee         | Esacus recurvirostris (Cuvier, 1829) | R                  | C             | NT          |
|     | Charadriidae (6)         |                 |                    |               |             |
| 28  | Grey-headed Lapwing      | Vanellus cinereus (Blyth, 1842)     | WV                 | C             | LC          |
| 29  | Kentish Plover           | Charadrius alexandrinus (Linnaeus, 1758) | WV                 | C             | LC          |
| S/N | Order/Family/Common name | Scientific name | Residential status | Feeding guild | IUCN status |
|-----|--------------------------|-----------------|--------------------|---------------|-------------|
| 30  | Little Ringed Plover     | *Charadrius dubius* (Scopoli, 1786) | R | O | LC |
| 31  | Red-wattled Lapwing      | *Vanellus indicus* (Boddart, 1783) | R | O | LC |
| 32  | River Lapwing            | *Vanellus duvauceli* (Lesson, 1826) | R | C | NT |
| 33  | Yellow-wattled Lapwing   | *Vanellus malabaricus* (Boddart, 1783) | R | C | LC |
|     | **Glareolidae (1)**     |                 |                    |               |             |
| 34  | Small Pratincole         | *Glareola lactea* (Temminck, 1820) | R | I | LC |
| 35  | Bronze-winged Jacana     | *Metopidius indicus* (Latham, 1790) | R | O | LC |
| 36  | Pheasant-tailed Jacana   | *Hydrophasianus chirurgus* (Scopoli, 1786) | R | O | LC |
|     | **Jacanidae (2)**       |                 |                    |               |             |
| 37  | River Tern              | *Sternula aurantia* (Gray, 1831) | R | C | VU |
|     | **Recurvirostridae (1)**|                 |                    |               |             |
| 38  | Black-winged Stilt       | *Himantopus himantopus* (Linnaeus, 1758) | WV | C | LC |
|     | **Rostratulidae (1)**   |                 |                    |               |             |
| 39  | Greater Painted-snip     | *Rostratula benghalensis* (Linnaeus, 1758) | R | O | LC |
|     | **Scolopacidae (8)**    |                 |                    |               |             |
| 40  | Common Greenshank       | *Tringa nebularia* (Gunnerus, 1767) | WV | C | LC |
| 41  | Common Redshank         | *Tringa totanus* (Linnaeus, 1758) | WV | C | LC |
| 42  | Common Sandpiper         | *Actitis hypoleucus* (Linnaeus, 1758) | WV | C | LC |
| 43  | Common Snipe            | *Gallinago gallinago* (Linnaeus, 1758) | WV | O | LC |
| 44  | Green Sandpiper          | *Tringa ochropus* (Linnaeus, 1758) | WV | O | LC |
| 45  | Little Stint            | *Calidris minuta* (Leisler, 1812) | WV | O | LC |
| 46  | Temminck's Stint        | *Calidris temminckii* (Leisler, 1812) | WV | O | LC |
| 47  | Wood Sandpiper           | *Tringa glareola* (Linnaeus, 1758) | WV | O | LC |
|     | **Pelecaniformes Ciconiidae (3)** | | | | |
| 48  | Asian Openbill          | *Anastomus oscitans* (Boddaert, 1783) | R | C | LC |
| 49  | Painted Stork           | *Mycteria leucocephala* (Pennant, 1769) | WV | C | NT |
| 50  | Woolly-necked Stork     | *Ciconia episcopus* (Boddaert, 1783) | R | C | NT |
|     | **Columbiformes Columbidae (1)** | | | | |
| 51  | Yellow-footed Green-pigeon | *Treron phoenicopterus* (Latham, 1790) | R | F | LC |
|     | **Coraciiformes Alcedinidae (4)** | | | | |
| 52  | Common Kingfisher       | *Alcedo atthis* (Linnaeus, 1758) | R | C | LC |
| 53  | Pied Kingfisher         | *Ceryle rudis* (Linnaeus, 1758) | R | C | LC |
| 54  | Stork-billed Kingfisher | *Pelargopsis capensis* (Linnaeus, 1766) | R | C | LC |
| 55  | White-throated Kingfisher| *Halcyon smyrnensis* (Linnaeus, 1758) | R | C | LC |
|     | **Falconiformes Falconidae (1)** | | | | |

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| S/N | Order/Family/Common name                      | Scientific name                          | Residential status | Feeding guild | IUCN status |
|-----|---------------------------------------------|------------------------------------------|--------------------|--------------|-------------|
| 56  | Common Kestrel                              | *Falco tinnunculus* (Linnaeus, 1758)    | WV                 | C            | LC          |
|     | **Gruiformes Gruidae (1)**                 |                                          |                    |              |             |
| 57  | Sarus Crane                                 | *Antigone antigone* (Linnaeus, 1758)    | R                  | O            | VU          |
|     | **Rallidae (5)**                            |                                          |                    |              |             |
| 58  | Common Coot                                 | *Fulica atra* (Linnaeus, 1758)          | R                  | O            | LC          |
| 59  | Common Moorhen                             | *Gallinula chloropus* (Linnaeus, 1758)  | R                  | O            | LC          |
| 60  | Purple Swamphen                            | *Porphyrio porphyrio* (Linnaeus, 1758)  | R                  | O            | LC          |
| 61  | Watercock                                   | *Gallinex cinerea* (Gmelin, 1789)       | R                  | C            | LC          |
| 62  | White-breasted Waterhen                    | *Amaurornis phoenicurus* (Pennant, 1769) | R                  | O            | LC          |
|     | **Passeriformes Acrocephalidae (1)**        |                                          |                    |              |             |
| 63  | Blyth's Reed Warbler                       | *Acrocephalus dumetorum* (Blyth, 1849)  | WV                 | O            | LC          |
|     | **Alaudidae (1)**                          |                                          |                    |              |             |
| 64  | Sand Lark                                  | *Alauda rayal* (Blyth, 1845)            | R                  | O            | LC          |
|     | **Cisticolidae (2)**                       |                                          |                    |              |             |
| 65  | Ashy Prinia                                | *Prinia socialis* (Sykes, 1832)         | R                  | I            | LC          |
| 66  | Plain Prinia                               | *Prinia inornata* (Sykes, 1832)         | R                  | I            | LC          |
|     | **Dicruridae (1)**                         |                                          |                    |              |             |
| 67  | Black Drongo                               | *Dicrurus macrocercus* (Vieillot, 1817) | R                  | C            | LC          |
|     | **Estrildidae (2)**                        |                                          |                    |              |             |
| 68  | Indian Silverbill                          | *Euodice malabarica* (Linnaeus, 1758)   | R                  | G            | LC          |
| 69  | Scaly-breasted Munia                       | *Lonchura punctulata* (Linnaeus, 1758)  | R                  | O            | LC          |
|     | **Hirundinidae (3)**                       |                                          |                    |              |             |
| 70  | Barn Swallow                               | *Hirundo rustica* (Linnaeus, 1758)      | WV                 | I            | LC          |
| 71  | Streak-throated Swallow                    | *Petrochelidon fluvicola* (Blyth, 1855) | R                  | I            | LC          |
| 72  | Wire-tailed Swallow                        | *Hirundo smithii* (Leach, 1818)         | R                  | I            | LC          |
|     | **Leiothrichidae (1)**                     |                                          |                    |              |             |
| 73  | Common Babbler                             | *Argya caudata* (Dumont, 1823)          | R                  | O            | LC          |
|     | **Motacilidae (5)**                        |                                          |                    |              |             |
| 74  | Citrine Wagtail                            | *Motacilla citreola* (Pallas, 1776)     | WV                 | I            | LC          |
| 75  | Grey Wagtail                               | *Motacilla cinerea* (Tunstall, 1771)    | WV                 | I            | LC          |
| 76  | Western Yellow Wagtail                     | *Motacilla flava* (Linnaeus, 1758)      | WV                 | I            | LC          |
| 77  | White Wagtail                              | *Motacilla alba* (Linnaeus, 1758)       | WV                 | I            | LC          |
| 78  | White-browed Wagtail                       | *Motacilla maderaspatensis* (Gmelin, 1789) | R                  | I            | LC          |
|     | **Muscicapidae (2)**                       |                                          |                    |              |             |
| 79  | Black Redstart                             | *Phoenicurus ochruros* (Gmelin, 1774)   | WV                 | I            | LC          |
| 80  | Bluethroat                                 | *Luscinia svecica* (Linnaeus, 1758)     | WV                 | I            | LC          |
| S/N | Order/Family/Common name | Scientific name | Residential status | Feeding guild | IUCN status |
|-----|--------------------------|-----------------|--------------------|--------------|-------------|
| 81  | House Sparrow            | *Passer domesticus* (Linnaeus, 1758) | R | O | LC |
| 82  | Hume’s Warbler           | *Phylloscopus humei* (Brooks, 1878) | WV | I | LC |
| 83  | Asian Pied Starling      | *Gracupica contra* (Linnaeus, 1758) | R | O | LC |
| 84  | Bank Myna                | *Acridotheres gingenianus* (Latham, 1790) | R | O | LC |
| 85  | Brahminy Starling        | *Sturnia pagodarum* (Gmelin, 1789) | R | O | LC |
| 86  | Common Myna              | *Acridotheres tristis* (Linnaeus, 1766) | R | O | LC |
| 87  | Black-crowned Night Heron| *Nycticorax nycticorax* (Linnaeus, 1758) | R | O | LC |
| 88  | Cattle Egret             | *Bubulcus ibis* (Linnaeus, 1758) | R | C | LC |
| 89  | Great Egret              | *Ardea alba* (Linnaeus, 1758) | R | C | LC |
| 90  | Grey Heron               | *Ardea cinerea* (Linnaeus, 1758) | WV | C | LC |
| 91  | Indian Pond Heron        | *Ardeola grayii* (Sykes, 1832) | R | C | LC |
| 92  | Intermediate Egret       | *Ardea intermedia* ( Wagler, 1829) | R | C | LC |
| 93  | Little Egret             | *Egretta garzetta* (Linnaeus, 1766) | R | C | LC |
| 94  | Purple Heron             | *Ardea purpurea* (Linnaeus, 1766) | R | C | LC |
| 95  | Oriental Darter          | *Anhinga melanogaster* (Pennant, 1769) | WV | O | NT |
| 96  | Indian Cormorant         | *Phalacrocorax fuscicollis* (Stephens, 1826) | WV | C | LC |
| 97  | Little Cormorant         | *Microcarbo niger* (Vielliott, 1817) | R | C | LC |
| 98  | Red-naped Ibis           | *Pseudibis papillosa* (Temminck, 1824) | WV | C | LC |
| 99  | Great Crested Grebe      | *Podiceps cristatus* (Linnaeus, 1758) | WV | C | LC |
| 100 | Little Grebe             | *Tachybaptus ruficollis* (Pallas, 1764) | R | C | LC |
| 101 | Jungle Owlet             | *Glaucidium radiatum* (Tickell, 1833) | R | C | LC |
| 102 | Spotted Owlet            | *Athene brama* (Temminck, 1821) | R | C | LC |

IUCN: International Union for Conservation of Nature and Natural Resources; R: Resident; WV: Winter Visitor; C: Carnivorous; O: Omnivorous; I: Insectivorous; F: Frugivorous; G: Granivorous; LC: Least Concern; VU: Vulnerable; NT: Near Threatened.
Out of 102 bird species recorded, 61 bird species (60%) were resident and 41 bird species (40%) were winter visitors (Fig. 4). So, in this study the maximum species recorded were resident (Fig. 4). This result is in agreement with the earlier studies conducted in this regard [3,22]. Occurrence of significant numbers of migratory birds may be due to the fact that the study area is situated in the Central Asian Flyway of migrating birds. This also increases the importance of the wetlands found in this region. According to the feeding guilds, the 102 bird species recorded were classified into five foraging guilds. The maximum number of species recorded were Carnivores (44 species, 43%), followed by Omnivores (42 species, 41%) and the least number of species were frugivores and granivores (1 species each, 1% each) (Fig. 5). This result is similar to the result of Basavarajappa [23]. The presence of significant numbers of carnivores and omnivores suggest the abundance of fish and diverse food availability.

According to the IUCN Red List (2021), out of the 102 bird species recorded, five species each (4.90%) were ‘Vulnerable’ and ‘Near Threatened’ and the rest 92 species (92.20%) were ‘Least Concern’ (Table 1). The presence of globally threatened bird species such as Clanga hastata, Aquila rapax, Aythya farina, Sterna aurantia, Antigone antigone, Esacus recurvirostris, Vanellus duvaucelli, Mycteria leucocephala, Mycteria leucocephala, and Anhinga melanogaster highlights the conservation value of these unprotected wetland ecosystems specially during wintering season in Uttar Pradesh. This also suggests that, all wetlands both large and small are equally important from conservation point of view. This result reveals that humans and bird conservation can go hand-in-hand.

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**Fig. 3.** Family wise bird community composition in wetlands of study area
4. CONCLUSION

It can be concluded that the wetland ecosystems of Ayodhya District support a good number of resident, migratory and threatened species. The ecological importance of any landscape can be assessed on the basis of its bird species richness and composition [24]. This is the preliminary work on documentation of the bird diversity in wetlands of District Ayodhya, Uttar Pradesh. The results of the current study provide a baseline data to carry out further scientific studies. In-depth studies on effects of wetland water quality, depth and anthropogenic activities on birds, bird use of wetlands for breeding and nesting can be planned to understand the interactions between the birds and this valuable but fast depleting ecosystem.

This result will also prove to be useful to the policy makers and foresters to implement proper management plans to improve the condition of this important ecosystem which attracts migratory and threatened bird species. Awareness can be raised among the school students and local people by organising conservation programmes. Checklist, factsheets and pocket guides of bird diversity of these wetlands can be published to aid in awareness. Management interventions such as reducing pollution load and weed infestation, removing plastic and other garbage, minimizing...
anthropogenic activities, maintaining the water level and flow, mechanical harvesting of aquatic macrophytes and raising artificial platforms that will provide nesting and roosting sites for wetland birds must be practised by the government with the help of local NGO’s and community.

ACKNOWLEDGEMENT

The author is thankful to the Dean, College of Horticulture and Forestry, ANDUAT, for permitting to carry out the field research and to the local people of Ayodhya district for their cooperation. This is a self-funded research.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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