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**COMMUNICATION**

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DIVERSITY AND STATUS OF AVIFAUNA IN MAN-MADE SACRED PONDS OF KURUKSHETRA, INDIA

Parmesh Kumar & Archna Sharma

1,2 Department of Zoology, University College, Kurukshetra University, Thanesar, Kurukshetra, Haryana 136119, India

1 parmeshkuk@rediffmail.com (corresponding author), 2 sharma.archna6@gmail.com

Abstract: Located in the Trans-Gangetic Plains of India, Kurukshetra is dotted with a number of man-made, perennial, sacred ponds of great historical and religious importance. These wetlands also serve as important wintering and stopover sites for birds coming from the Palearctic region. Surveys were conducted from April 2014 to March 2015 to record the diversity and status of avifauna in four sacred ponds of Kurukshetra. Point counts and direct observations were used to record the bird species. A total of 126 bird species of 98 genera belonging to 45 families and 16 orders were identified, of which 41 were winter migrants, six were summer migrants, and 79 were residents. Anatidae (n=15) was the most common family, followed by Ardeidae (n=8), and Motacillidae and Muscicapidae (n=7 each). Based on the guilds, 37 species were carnivorous, 36 omnivorous, 29 insectivorous, six herbivorous, six frugivorous, five granivorous, four insectivorous/nectarivorous, and three piscivorous. Of the species recorded, five species are classified as Near Threatened and one species as Vulnerable in the IUCN Red List of Threatened Species; nine species are listed in Appendix II of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and six species are included in Schedule I of the Indian Wildlife (Protection) Act, 1972. We hope that this study will provide a baseline for future research on monitoring the population and seasonal changes in the bird assemblage of sacred ponds.

Keywords: Avifauna, diversity, India, Kurukshetra, sacred ponds, status.
INTRODUCTION

Wetlands are the most productive biomes in the world (Kumar et al. 2005) and provide the transitional link between aquatic and terrestrial habitats (Torell et al. 2001; Zedler & Kercher 2005). They have specific ecological characteristics, functions, and values, occupying about 6% of the earth’s surface (Maltby & Turner 1983; Green 1996; Getzner 2002) and providing habitat to a wide array of flora and fauna (Buckton 2007). Wetlands are, thus, often considered as treasuries of biodiversity within a region or a landscape (Gopal & Sah 1993; Surana et al. 2007). Birds constitute an important component of the biotic community of wetland ecosystems as they occupy several trophic levels in the food web of wetlands and form the terminal links in many aquatic food chains (Custer & Osborn 1977). Because of their high mobility, birds respond quickly to changes in their habitats (Morrison 1986); they are, thus, valuable indicators of the ecological health, productivity, trophic structure, human disturbance, and contamination of wetland ecosystems (Custer & Osborn 1977; Subramanya 1996).

India, with its varied topography and climatic regimes, supports diverse and unique wetland habitats that occupy an estimated area of 15.26 million hectares (Panigrahy et al. 2012). Apart from natural wetlands, which support 20% of the known biodiversity of India (Kumar et al. 2005), there are a large number of man-made wetlands that also support rich flora and fauna. It is estimated that there are 5,55,557 small-sized wetlands (<2.25 ha) in the form of village tanks/ponds in India (Panigrahy et al. 2012). These wetlands provide suitable habitats and food resources for a wide variety of birds (Stewart 2007; Ali et al. 2013). Of the 1,263 bird species reported from India (Praveen et al. 2016), 310 species are known to be dependent on wetlands (Kumar et al. 2005). Wetlands in India, as elsewhere, however, are under tremendous anthropogenic pressures including encroachment of wetland habitat, unsustainable harvesting of resources, industrial pollution, poisoning, agricultural runoff, eutrophication, siltation, and invasion of alien species (Prasad et al. 2002). These impacts can lead to population declines and changes in community structure of birds (Kler 2002; Verma et al. 2004; Reginald et al. 2007).

Biodiversity inventories or checklists serve as repositories of baseline information on species occurrences, biogeography, and their conservation status (Chandra & Gajbe 2005). They are essential tools for developing our knowledge and understanding of biodiversity, and often the first step to evolve an appropriate long-term conservation strategy for birds and their habitats (Kumar et al. 2005; Badola & Aitken 2010).

Located in the Trans-Gangetic Plains of India, the landscape of Kurukshetra is dotted with a number of perennial, man-made, sacred wetlands of great historical and religious importance. A large number of pilgrims and tourists visit these sacred tanks to take a holy dip and perform religious ceremonies. These wetlands are also potentially important for birds, not only because they provide foraging, roosting, and breeding habitats for resident species, but also for their role as stopover sites or wintering areas for several migrants of the Palearctic region (Kumar et al. 2016). The avifauna of these sacred wetlands, however, remains poorly known. Lack of adequate information on bird species inhabiting wetlands greatly limits the development and establishment of effective conservation strategies. The present study was hence undertaken to make an inventory of bird species that inhabit sacred ponds of Kurukshetra in the Trans-Gangetic Plains of India along with their conservation and residential status.

MATERIALS AND METHODS

Study area

The present study was carried out in four religious ponds: namely, Brahma Sarovar, Jyoti Sarovar, Baan Ganga, and Sannihit Sarovar located in and around Kurukshetra (29.866–30.200° N & 76.416–77.066° E), Haryana, in the Trans-Gangetic Plains of India (Fig. 1, Table 1). These ponds are surrounded by human habitations and agricultural fields. The surrounding agriculture fields, with wheat and paddy as main crops, provide extra foraging space and food for certain wetland bird species. The study area, experiencing sub-tropical climate, has three seasons: rainy (July–September), cool-and-dry (October–February), and the hot-and-dry (March–June); temperature ranges from 3–45 °C and annual rainfall averages to 582mm. The wetlands support many types of macrophytes that may be grouped into marginal, submerged, floating, and emergent categories, of which *Eichhornia crassipes* (a deadly invasive) is the dominant free-floating, *Hydrilla verticillata* the dominant submerged, and *Cynodon dactylon* the dominant marginal species in the wetlands. Various tree species like Jamun *Syzygium cumini*, Mango *Mangifera indica*, Alstonia sp., Acacia *Acacia nilotica* & *Acacia arabica*, Neem *Azadirachta indica*, Jujube *Mangifera indica*, Neem *Azadirachta indica*, Jujube
Zizyphus jujube, Wild Senna Cassia tora, Banyan Tree Ficus benghalensis, Bodhi Tree or Peepal Ficus religiosa, and the Indian Rosewood Dalbergia sissoo at the banks or in the surroundings of the ponds provide suitable roosting and nesting sites for various bird species. The ponds are also surrounded by Mesquite Prosopis juliflora, a deadly invasive shrub, and the non-native Eucalyptus sp.
Data collection

Bird surveys were conducted at two-week intervals in all the ponds from April 2014 to March 2015, following the point count method (Bibby et al. 2000). Six to 10 vantage points, at least 250m apart, were selected at the perimeter of each pond, and each point location was surveyed 24 times during the entire study period. The observer waited for a few minutes after arrival at each station before beginning to count. This allowed the birds to settle down following the observer’s arrival and 10–20 minutes were spent at each point surveying the birds. Birds were counted directly, aided by 7x35 Nikon binoculars, during hours of peak activity 0600–1000 hr and 1600–1800 hr. In addition to these regular surveys, opportunistic records were also collected during other time periods of the day by walking at a slow pace along the bank of selected ponds and recording the species observed. Field guides (Grimmett et al. 1999; Kazmierczak & Perlo 2000) were used for field identification. Taxonomy and nomenclature follow Praveen et al. (2016). For residential status, birds were categorised as resident, winter visitor, and summer visitor on the basis of their presence in the study area (Ali & Ripley 1987). Feeding guilds were classified on the basis of direct observations and available literature (Ali & Ripley 1987; Grimmett et al. 1999). For national and global conservation status of recorded avifauna, we followed IWPA (1972), CITES (2012), and IUCN (2017). The relative abundance (RA) of families was calculated using the following formula as per Torre-Cuadros et al. (2007):

\[
RA = \frac{\text{Number of species in a family}}{\text{Total number of species}} \times 100
\]

RESULTS AND DISCUSSION

A total of 126 species of birds belonging to 98 genera, distributed among 45 families and 16 orders were recorded from four sacred ponds of Kurukshetra during the study period (Table 2, Images 1–102). Of these, 62 species were wetland-associated and the rest were terrestrial. Of all species recorded, 31 (24.60%) were observed from all the four sacred wetlands, and 95 (75.39%) were recorded from some specific wetlands alone (Table 2). Passeriformes had the highest diversity with 46 species and 17 families (Fig. 2). The proportion of species richness of birds by family varied from 0.79–11.90%. Anatidae, the richest family represented by 15 species, accounted for 11.90% of the total bird species in the study area (Table 3). Apodidae, Burhinidae, Rostratulidae, Strigidae, Bucerotidae, Upupidae, Picidae, Meropidae, Coraciidae, Campephagidae, Dicruridae, Nectariniidae, Ploceidae, Passeridae, Pycnonotidae, etc.
Zosteropidae, and Timaliidae were poorly represented families with a single species in each. Similarly, Gupta & Kumar (2009) recorded 110 bird species belonging to 41 families and 14 orders from different habitats of Kurukshetra. For comparison, Alfred et al. (2001) reported 216 wetland bird species from various wetland habitats in the much more expansive Sub-Himalayan Terai and Indo-Gangetic Plains of northern India. Ducks and geese (Anatidae) are the most copious and remarkable winter migrants to the Indian-subcontinent, and constitute about 85% of the migrant bird populations (Alfred et al. 2001). These results are in confirmation with findings of earlier workers who have reported Anatidae to be the most dominant family among bird communities in different wetland habitats of Haryana in northern India (Kumar & Gupta 2009, 2013; Tak et al. 2010; Kumar et al. 2016).

Of the 126 species identified, 41 were winter migrants, six were summer migrants, and 79 were residents. The occurrence of a considerable number of winter migratory species can be attributed partly to the study area being on the Central Asian Flyway and serving as a wintering and stopover site for migratory birds that breed in the Palearctic region (Kumar et al. 2016). These migratory birds form a major component of the aquatic bird populations in various wetland habitats of northern India (Alfred et al. 2001; Manral et al. 2013; Kumar et al. 2016). We observed that the majority of the winter migrants stayed in the sacred wetlands from November to February. The summer visitors, including Cotton Teal *Nettapus coromandelianus*, Lesser Whistling Duck *Dendrocygna javanica*, Comb Duck *Sarkidiornis melanotus*, Pied Cuckoo *Clamator jacobinus*, Pheasant-tailed Jacana *Hydrophasianus chirurgus*, and Greater Painted-snipe *Rostratula benghalensis* were spotted during summer season (April–August) in the study area. Little Cormorant *Microcarbo niger* and Black-winged Stilt *Himantopus himantopus*, being common resident species, were recorded in and around the wetlands throughout the year, but their populations augmented due to the influx of migrant birds during the winter season.

Wetland characteristics like size, water depth, quality of water, trophic structure, and presence of suitable roosting and nursery sites influence the abundance and diversity of birds (Wiens 1989; Mukherjee et al. 2002; Ma et al. 2010). During the study period, species richness was recorded to be the highest at Jyoti Sarovar (n=107), followed by Brahma Sarovar (n=88), Baan Ganga (n=53), and Sannihit Sarovar (n=34). Generally, habitats with a complex architecture generate greater resources for birds, allowing the persistence of a greater number of species and guilds than in less complex habitats (MacArthur & MacArthur 1961; Tews et al. 2004; Codesido et al. 2013). In the present study, Jyoti Sarovar wetland, along with the adjacent rural pond, marshy area, and irrigated crop fields, provided a mosaic of habitats leading to multiple and variety of alternative food sources for the birds, and thus registered highest species richness (Aynalem & Bekele 2008). Brahma Sarovar and Sannihit Sarovar, being located in urban areas of the Kurukshetra City, are more exposed to local people and tourists. As a result, bird activities like feeding, nesting, hiding, and breeding are affected at these sites.

The quality and quantity of food available is the major factor that determines the spatio-temporal distribution and relative abundance of birds in a given habitat (Wiens 1989; Ma et al. 2010; Jha 2013). The different species of birds occupying a particular feeding guild and space have evolved specialized foraging strategies to explore and obtain food resources efficiently and thereby to reduce competition (Nudds & Bowly 1984). As far as foraging habits of the bird community in the study area are concerned, eight major feeding guilds were identified (Fig. 3). This representation of major trophic guilds in the area indicated that the area holds a wide spectrum of food resources for birds. The carnivore guild was the most abundant one with 37 species followed by omnivore (36), insectivore (29), herbivore (six), frugivore (six), granivore (five), insectivore/nectarivore (four), and piscivore (three). Due to their specialized diet and low availability of preferable food resources, the nectarivores and piscivores are generally less represented (Wiens 1989). The diversity of avifauna in the study area may be due to the presence of a wide spectrum of food niches, which reduced food competition among different species (Jose & Zacharias 2003). About half of the recorded bird...
species were those associated with wetland habitats, such as ducks, herons, egrets, cormorants, jacanas, grebes, kingfishers, and storks, which were observed to feed on aquatic organisms (worms, insects, snails, fish, and amphibians) at various water depths available in the wetlands and adjoining paddy fields and marshy area.

Bronze-winged Jacana *Metopidius indicus* and Pheasant-tailed Jacana *Hydrophasianus chirurgus* were spotted at Jyoti Sarovar alone, the only pond with lotuses. The vegetation cover of lotuses provides suitable feeding, nesting, and breeding habitat for herons, moorhens, and jacanas. Purple Swamphen *Porphyrio porphyrio*, a common resident species, was observed only in weedy marsh areas flanking the sacred pond of Jyoti Sarovar, where there were frequent human activities; this bird species may be a bio-indicator of enhanced weed infestation and increased vegetation cover in the wetlands of Haryana (Kumar et al. 2016). Waders, shorebirds, Purple Moorhen, and wagtails were also observed foraging in the irrigated wheat and paddy fields flanking the sacred ponds in rural habitats (Jyoti Sarovar and Baan Ganga). This observation is consistent with earlier reports, where foraging by aquatic birds outside the wetlands in surrounding agriculture fields has been recorded (Lane & Fujioka 1998; Mukherjee et al. 2002; Urfi 2003; Jha 2013; Kumar et al. 2016).

Among the recorded avifauna, five species, namely, Painted Stork *Mycteria leucocephala*, Black-necked Stork *Ephippiorhynchus asiaticus*, Black-headed Ibis *Threskiornis melanocephalus*, River Tern *Sterna aurantia*, and Alexandrine Parakeet *Psittacula eupatria* are listed as Near Threatened, and one species, Common Pochard *Aythya ferina*, as Vulnerable in the IUCN Red List (IUCN 2017). All the remaining species (n=120) are placed in the Least Concern category in the Red List of IUCN (2017). Additionally, nine species are included in Appendix-II of CITES (2012). Six species, including five species of Accipitridae and one of Phasianidae, are considered nationally threatened as these are listed under Schedule-I of the Indian Wildlife (Protection) Act, 1972.

**Significant records**

**Painted Stork - Near Threatened:** A winter migrant in the study area was recorded in a small flock (4–8 individuals) only at Jyoti Sarovar during winter months (December–January). The birds were often recorded roosting on large trees at the bank of the wetland.

**Black-necked Stork - Near Threatened:** A lone male individual was recorded foraging in the mud-flat adjacent to Jyoti Sarovar on 25 January 2015. This species is very widely but thinly distributed in India, with the northern and northwestern regions forming its main strongholds (Rahmani 1989).

**Black-headed Ibis - Near Threatened:** A resident wader species (Kumar et al. 2016) was recorded in small loose groups (1–4 individuals) only at Jyoti Sarovar throughout the study period. It was often observed foraging with other waders at the margins of the pond, and mudflats and paddy fields adjoining the sacred wetland.

**River Tern - Near Threatened:** A common resident species in the study area (Kumar et al. 2016) was recorded as 1–7 scattered individuals at all the four sacred ponds throughout the study period.

**Alexandrine Parakeet - Near Threatened:** A resident species in the study area was recorded in small groups of 5–10 individuals. The birds were frequently observed roosting on trees at banks of all the ponds.

**Common Pochard - Vulnerable:** This is a common winter visitor in India (Grimmett et al. 1999). The species was recorded in flocks of 6–50 individuals during winter months (November–March) in Brahma Sarovar only.

**Comb Duck - Appendix II of CITES:** A resident species in the Indian subcontinent with local movements (Grimmett et al. 1999) was recorded only at Jyoti Sarovar in a pair during summer (May 2014).

In addition to the cultural and religious legacy of the region, the presence of significant numbers of migratory species as well as those with conservation priorities underlines the importance of these sacred wetlands as important bird habitats in Haryana. It is evident from the present study that if some attention is provided to these sacred wetlands, these could be developed as a good site for harbouring avifauna and as a haven for bird-watchers. Our efforts contributed towards filling biological information gaps in the region; continuing studies will allow monitoring of the population and seasonal changes in the bird assemblage.

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Table 2. Checklist and status of avifauna recorded in sacred ponds of Kurukshetra in the Trans-Gangetic Plains, India

| Order/family/common name | Scientific name | Residential status | Feeding guild | Conservation status | Sacred pond | Image |
|--------------------------|-----------------|---------------------|--------------|---------------------|-------------|-------|
|                          |                 | IUCN (2017)         |              | CITES (2012)        | IWPA (1972) | BS | JS | BG | SS |
| ANSERIFORMES             | Anatidae (15)   |                     |              |                     |             |     |    |    |    |
| 1 Lesser Whistling Duck  | Dendrocygna javanica (Horsfield, 1821) | SM | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 1 |
| 2 Common Shelduck        | Tadorna tadorna (Linnaeus, 1758) | WM | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ |   |
| 3 Ruddy Shelduck         | Tadorna ferruginea (Pallas, 1764) | WM | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 2 |
| 4 Red Crested Pochard    | Netta rufina (Pallas, 1773) | WM | H | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 3 |
| 5 Common Pochard         | Aythya ferina (Linnaeus, 1758) | WM | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 4 |
| 6 Tufted Duck            | Aythya fuligula (Linnaeus, 1758) | WM | H | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 5 |
| 7 Northern Shoveler      | Spatula clypeata (Linnaeus, 1758) | WM | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 6 |
| 8 Gadwall                | Mareca strepera (Linnaeus, 1758) | WM | H | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 7 |
| 9 Eurasian Wigeon        | Mareca penelope (Linnaeus, 1758) | WM | H | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 8 |
| 10 Indian Spot-billed Duck | Anas poecilorhyncha Forster, 1781 | WM | H | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 9 |
| 11 Mallard               | Anas platyrrhynchos Linnaeus, 1758 | WM | H | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 10 |
| 12 Northern Pintail      | Anas acuta Linnaeus, 1758 | WM | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 11 |
| 13 Common Teal           | Anas crecca Linnaeus, 1758 | WM | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 12 |
| 14 Comb Duck             | Sarcidornis melamotos (Pennant, 1769) | SM | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 13 |
| 15 Cotton Teal           | Nettapus coromandelianus (Gmelin, 1789) | SM | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 14 |
| GALLIFORMES              | Phasinidae (2)   |                     |              |                     |             |     |    |    |    |
| 16 Indian Peafowl        | Pavo cristatus Linnaeus, 1758 | R | O | LC | - | I | ✓ | ✓ | ✓ | ✓ | 15 |
| 17 Grey Francolin        | Francolinus pondicerianus (Gmelin, 1789) | R | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 16 |
| PHOENICOPTERIFORMES      | Podicipedidae (2) |                     |              |                     |             |     |    |    |    |
| 18 Little Grebe          | Tachybaptus ruficollis (Pallas, 1764) | R | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 17 |
| 19 Great Crested Grebe   | Podiceps cristatus (Linnaeus, 1764) | WM | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 18 |
| COLUMBIFORMES            | Columbidae (5)   |                     |              |                     |             |     |    |    |    |
| 20 Rock Pigeon           | Columba livia Gmelin, 1789 | R | G | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 19 |
| 21 Spotted Dove          | Spilopelia chinensis (Scopoli, 1786) | R | G | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 20 |
| 22 Eurasian Collared Dove | Streptopelia decaocto (Frivaldsky, 1838) | R | G | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 21 |
| 23 Laughing Dove         | Spilopelia serenogensis (Linnaeus, 1766) | R | G | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 22 |
| 24 Yellow-legged Green Pigeon | Treron phoenicopterus (Latham, 1790) | R | F | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 23 |
| CAPRIMULGIFORMES         | Apodidae (1)     |                     |              |                     |             |     |    |    |    |
| 25 Indian House Swift    | Apus affinis (Gray, 1830) | R | In | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 24 |
| CUCULIFORMES             | Cuculidae (3)    |                     |              |                     |             |     |    |    |    |
| 26 Pied Cuckoo           | Clamator jacobinus (Boddart, 1783) | SM | In | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 25 |
| 27 Asian Koel            | Eudynamys scolopaceus (Linnaeus, 1758) | R | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 26 |
| Order/family/common name | Scientific name | Residential status | Feeding guild | Conservation status | Sacred pond | Image |
|--------------------------|-----------------|-------------------|---------------|---------------------|-------------|-------|
|                         |                 |                   |               | IUCN (2017) CITES (2012) IWPA (1972) | BS | JS | BG | SS |
| Greater Coucal | Centropus sinensis (Stephens, 1815) | R | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 23 |
| Rallidae (4) | | | | | | | |
| White-breasted Waterhen | Amauraia phoenicurus (Pennant, 1769) | R | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 24 |
| Purple Swamphen | Porphyrio porphyrio (Linnaeus, 1758) | R | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 25 |
| Common Moorhen | Gallinula chloropus (Linnaeus, 1758) | WM | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 26 |
| Common Coot | Fulica atra (Linnaeus, 1758) | WM | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 27 |
| PELECANIFORMES | | | | | | | |
| GRUIFORMES | | | | | | | |
| Ardeidae (8) | | | | | | | |
| Black-crowned Night-Heron | Nycticorax nycticorax (Linnaeus, 1758) | R | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 30 |
| Indian Pond Heron | Ardea grayii (Sykes, 1832) | R | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 31 |
| Cattle Egret | Bubulcus ibis (Linnaeus, 1758) | R | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 32 |
| Grey Heron | Ardea cinerea Linnaeus, 1758 | R | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 33 |
| Purple heron | Ardea purpurea Linnaeus, 1766 | R | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 34 |
| Great Egret | Ardea alba Linnaeus, 1758 | WM | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 35 |
| Intermediate Egret | Ardea intermedia Wagler, 1829 | WM | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 36 |
| Little Egret | Egretta garzetta (Linnaeus, 1766) | R | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 37 |
| Threskiornithidae (3) | | | | | | | |
| Black-headed Ibis | Threskiornis melanocephalus (Linnaeus, 1758) | R | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 38 |
| Indian Black Ibis | Plegadis falcinellus (Linnaeus, 1758) | R | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 39 |
| Glossy Ibis | Plegadis falcinellus (Linnaeus, 1766) | R | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 40 |
| Phalacrocoracidae (3) | | | | | | | |
| Little Cormorant | Microcarbo niger (Vielliot, 1817) | R | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 41 |
| Great Cormorant | Phalacrocorax carbo (Linnaeus, 1758) | WM | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 42 |
| Indian Cormorant | Phalacrocorax fuscocephalus Stephens, 1826 | WM | P | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 43 |
| CHARADRIIFORMES | | | | | | | |
| Burhinidae (1) | | | | | | | |
| Eurasian Thick-knee | Burhinus oedicnemus (Linnaeus, 1758) | R | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 44 |
| Recurvirostridae (2) | | | | | | | |
| Pied Avocet | Recurvirostra avosetta Linnaeus, 1758 | WM | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 45 |
| Black-winged stilt | Himantopus himantopus (Linnaeus, 1758) | R | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 46 |
| Charadriidae (2) | | | | | | | |
| Red-wattled Lapwing | Vanellus indicus (Roddert, 1783) | R | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 47 |
| Order/family/common name | Scientific name | Residential status | Feeding guild | Conservation status | Sacred pond | Image |
|--------------------------|-----------------|--------------------|---------------|---------------------|-------------|-------|
|                          | WM C LC - IV    |                    |               |                     | BS JS BG SS |       |
| 54 White-tailed Lapwing  | Vanellus leucurus (Lichtenstein, 1823) | WM C LC - IV |                    |                     | BS JS BG SS |       |
| Rostratulidae (1)        | SM O LC - IV |                    |               |                     | BS JS BG SS |       |
| 55 Greater Painted-Snipe  | Rostratula benghalensis (Linnaeus, 1758) | WM C LC - IV |                    |                     | BS JS BG SS |       |
| Jacanidae (2)            | SM O LC - IV |                    |               |                     | BS JS BG SS |       |
| 56 Pheasant-tailed Jacana | Hydrophasianus chirurgus (Scopoli, 1786) | WM C LC - IV |                    |                     | BS JS BG SS |       |
| 57 Bronze-winged Jacana  | Metopidius indicus (Latham, 1790) | WM C LC - IV |                    |                     | BS JS BG SS |       |
| Scolopacidae (3)         | WM C LC - IV |                    |               |                     | BS JS BG SS |       |
| 58 Common Sandpiper      | Actitis hypoleucos Linnaeus, 1758 | WM C LC - IV |                    |                     | BS JS BG SS |       |
| 59 Common Greenshank    | Tringa nebularia (Gunnerus, 1767) | WM C LC - IV |                    |                     | BS JS BG SS |       |
| 60 Common Redshank       | Tringa totanus (Linnaeus, 1758) | WM C LC - IV |                    |                     | BS JS BG SS |       |
| Laridae (2)              | WM C LC - IV |                    |               |                     | BS JS BG SS |       |
| 61 Pall's Gull           | Larus ichthyaetus Pallas, 1773 | WM C LC - IV |                    |                     | BS JS BG SS |       |
| 62 River Tern            | Sterna aurantia Gray, 1831 | WM C LC - IV |                    |                     | BS JS BG SS |       |
| ACCIPITRIFORMES          | WM C LC - IV |                    |               |                     | BS JS BG SS |       |
| 63 Black-winged Buzzard  | Elanus caeruleus (Desfontaines, 1789) | WM C LC - IV |                    |                     | BS JS BG SS |       |
| 64 Oriental Honey Buzzard| Pernis ptilorhynchus (Temminck, 1821) | WM C LC - IV |                    |                     | BS JS BG SS |       |
| 65 Shikra                | Accipiter badius (Gmelin, 1788) | WM C LC - IV |                    |                     | BS JS BG SS |       |
| 66 Brahminy Kite         | Haliastur indus (Boddaert, 1783) | WM C LC - IV |                    |                     | BS JS BG SS |       |
| 67 Black Kite            | Milvus migrans (Boddaert, 1783) | WM C LC - IV |                    |                     | BS JS BG SS |       |
| STRIGIFORMES             | WM C LC - IV |                    |               |                     | BS JS BG SS |       |
| 68 Spotted Ovlet         | Athene brama (Temminck, 1821) | WM C LC - IV |                    |                     | BS JS BG SS |       |
| BUCEROTIFORMES           | WM C LC - IV |                    |               |                     | BS JS BG SS |       |
| 69 Indian Grey Hornbill  | Oxyerus bicornis (Scopoli, 1786) | WM C LC - IV |                    |                     | BS JS BG SS |       |
| Upupidae (1)             | WM C LC - IV |                    |               |                     | BS JS BG SS |       |
| 70 Common Hoopoe         | Upupa epops Linnaeus, 1758 | WM C LC - IV |                    |                     | BS JS BG SS |       |
| PICIFORMES               | WM C LC - IV |                    |               |                     | BS JS BG SS |       |
| 71 Lesser Golden-backed Woodpecker | Dinoipus benghalensis (Linnaeus, 1758) | WM C LC - IV |                    |                     | BS JS BG SS |       |
| Ramphastidae (2)         | WM C LC - IV |                    |               |                     | BS JS BG SS |       |
| 72 Brown-headed Barbet   | Psilopogon zeylanicus (Gmelin, 1788) | WM C LC - IV |                    |                     | BS JS BG SS |       |
| 73 Coppersmith Barbet    | Psilopogon haemacephalus (Muller, 1776) | WM C LC - IV |                    |                     | BS JS BG SS |       |
| CORACIIFORMES            | WM C LC - IV |                    |               |                     | BS JS BG SS |       |
| 74 Green Bee-eater       | Merops orientalis Latham, 1802 | WM C LC - IV |                    |                     | BS JS BG SS |       |
| Coraciidae (1)           | WM C LC - IV |                    |               |                     | BS JS BG SS |       |
| 75 Indian Roller         | Coracius benghalensis (Linnaeus, 1758) | WM C LC - IV |                    |                     | BS JS BG SS |       |
| Alcedinidae (2)          | WM C LC - IV |                    |               |                     | BS JS BG SS |       |
| Order/family/common name | Scientific name | Residential status | Feeding guild | Conservation status | Sacred pond | Image |
|--------------------------|-----------------|--------------------|---------------|---------------------|-------------|-------|
|                          |                 |                    |               | IUCN (2017) | CITES (2012) | IWPA (1972) | BS | JS | BG | SS |
| Pied Kingfisher          | Ceryle rudis (Linnaeus, 1758) | R | P | LC | - | IV | ✓ | x | x | x |
| White-throated Kingfisher | Halcyon smyrnensis (Linnaeus, 1758) | R | C | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 67 |
| Slaty-headed Parakeet    | Psittacula himalayana (Lesson, 1832) | WM | F | LC | II | IV | ✓ | x | x | x |
| Alexandrine Parakeet     | Psittacula eupatria (Linnaeus, 1766) | R | F | NT | II | IV | ✓ | ✓ | ✓ | ✓ | 68 |
| Rose-ringed Parakeet     | Psittacula krameri (Scopoli, 1769) | R | F | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 69 |
| Order/family/common name | Scientific name | Residential status | Feeding guild | Conservation status | Sacred pond | Image |
|                          |                 |                    |               | IUCN (2017) | CITES (2012) | IWPA (1972) | BS | JS | BG | SS |
| Scarlet Minivet          | Pericrocotus flammeus (Forster, 1781) | WM | In | LC | - | IV | ✓ | x | x | x |
| Black Drongo             | Dicrurus macrocercus Vieillot, 1817 | R | In | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 70 |
| Bay-backed Shrike        | Laniasittatus Valenciennes, 1826 | R | C | LC | - | IV | ✓ | ✓ | x | x |
| Long-tailed Shrike       | Laniaschach Linnaeus, 1758 | R | C | LC | - | IV | ✓ | ✓ | x | x | 71 |
| Rufous Treepie           | Dendroicctavagabunda(Latham, 1790) | R | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 72 |
| House Crow               | Corvus splendens Vieillot, 1817 | R | O | LC | - | V | ✓ | ✓ | ✓ | ✓ | 73 |
| Large-billed Crow        | Corvus macrorhynchos Wagler, 1827 | WM | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 74 |
| Indian Silverbill        | Euodice malabarica (Linnaeus, 1758) | R | G | LC | III | IV | ✓ | ✓ | x | x | 77 |
| Scaly-breasted Munia     | Lonchurapunctulata (Linnaeus, 1758) | R | O | LC | - | IV | ✓ | ✓ | x | x | 78 |
| House Sparrow            | Passer domesticus (Linnaeus, 1758) | R | O | LC | - | IV | ✓ | ✓ | ✓ | x | 79 |
| Tree Pipit               | Anthus trivialis (Linnaeus, 1758) | WM | In | LC | - | IV | ✓ | ✓ | x | x | 80 |
| Western Yellow Wagtail   | Motacilla flava Linnaeus, 1758 | WM | In | LC | - | IV | ✓ | ✓ | x | x | 81 |
| Grey Wagtail             | Motacilla cinerea Tunstall, 1771 | WM | In | LC | - | IV | ✓ | ✓ | x | x | 82 |
| Citrine Wagtail          | Motacilla citreola Pallas, 1776 | WM | In | LC | - | IV | ✓ | ✓ | x | x | 83 |
| White Wagtail            | Motacilla alba Linnaeus, 1758 | WM | In | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 84 |
| Zitting Cisticola        | Cisticola juncidis (Rafinesque, 1810) | R | In | LC | - | IV | ✓ | ✓ | ✓ | x |
| Order/family/common name | Scientific name | Residential status | Feeding guild | Conservation status | Sacred pond | Image |
|--------------------------|-----------------|--------------------|---------------|--------------------|-------------|-------|
|                          | Ashy Prinia     | Prinia socialis Sykes, 1832 | R | In/N | LC | - | IV | ✓ | ✓ | ✓ | x | 85 |
|                          | Plain Prinia    | Prinia inornata Sykes, 1832 | R | In | LC | - | IV | ✓ | ✓ | x | x | 86 |
|                          | Common Tailorbird | Orthotomus sutorius (Pennant, 1769) | R | In/N | LC | - | IV | ✓ | ✓ | ✓ | x | 87 |
| Hirundinidae (6)         | Northern House Martin | Delichon urbicum (Linnaeus, 1758) | R | In | LC | - | IV | ✓ | ✓ | x | x | 88 |
|                          | Wire-tailed Swallow | Hirundo smithi Leach, 1818 | R | In | LC | - | IV | ✓ | ✓ | x | x | 89 |
|                          | Barn Swallow    | Hirundo rustica Linnaeus, 1758 | R | In | LC | - | IV | ✓ | ✓ | x | x | 90 |
|                          | EURASIAN Crag-Martin | Pseudontoprogne rupestris (Scopoli, 1769) | R | In | LC | - | IV | ✓ | ✓ | x | x | 91 |
|                          | Plain Martin    | Riparia paludicola (Vieillot, 1817) | R | In | LC | - | IV | ✓ | x | x | x | 92 |
|                          | Sand Martin     | Riparia riparia (Linnaeus, 1758) | R | In | LC | - | IV | ✓ | x | x | x | 93 |
| Pycnonotidae (1)         | Red vented Bulbul | Pycnonotus cafer (Linnaeus, 1766) | R | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 94 |
| Zosteropidae (1)         | Oriental White-eye | Zosterops palpebrosus (Temminck, 1824) | R | In/N | LC | - | IV | ✓ | ✓ | x | x | 95 |
| Timaliidae (1)           | White-browed Scimitar Babbler | Pomatorhinus schisticeps Hodgson, 1836 | WM | O | LC | - | IV | ✓ | ✓ | x | x | 96 |
| Leiothrichidae (3)       | Large Grey Babbler | Argya malcolmi (Sykes, 1832) | R | O | LC | - | IV | ✓ | ✓ | x | x | 97 |
|                          | Common Babbler  | Argya caudata (Dumont, 1823) | R | O | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 98 |
|                          | Jungle Babbler  | Turdoides striata (Dumont, 1823) | R | O | LC | - | IV | ✓ | ✓ | x | x | 99 |
| Sturnidae (4)            | Asian Pied Starling | Gracupica contra (Linnaeus, 1758) | R | O | LC | - | IV | ✓ | ✓ | x | x | 100 |
|                          | Brahminy Starling | Sturnia papagona (Gmelin, 1788) | R | O | LC | - | IV | ✓ | ✓ | ✓ | x | 101 |
|                          | Common Myna     | Acridotheres tristis (Linnaeus, 1766) | R | O | LC | - | IV | ✓ | ✓ | ✓ | x | 102 |
|                          | Bank Myna       | Acridotheres ginnianus (Latham, 1790) | R | O | LC | - | IV | ✓ | ✓ | ✓ | x | 103 |
| Muscicapidae (7)         | Indian Robin    | Saxicoloides fulicatus (Linnaeus, 1766) | R | In | LC | - | IV | ✓ | ✓ | ✓ | x | 104 |
|                          | Oriental Magpie Robin | Copyschus saularis (Linnaeus, 1758) | R | In | LC | - | IV | ✓ | ✓ | ✓ | ✓ | 105 |
|                          | Verditer Flycatcher | Eumyias thalassinus Swainson, 1838 | WM | In | LC | - | IV | ✓ | ✓ | x | x | 106 |
|                          | Bluethroat      | Cyanecula svecica (Linnaeus, 1758) | WM | In | LC | - | IV | ✓ | ✓ | x | x | 107 |
|                          | Red-breasted Flycatcher | Ficedula parva (Bechstein, 1792) | WM | In | LC | - | IV | ✓ | ✓ | x | x | 108 |
|                          | Common Stonechat | Saxicola torquatus (Linnaeus, 1766) | WM | In | LC | - | IV | ✓ | ✓ | x | x | 109 |
|                          | Brown Rock Chat | Oenanthe fusca (Blyth, 1851) | R | In | LC | - | IV | ✓ | ✓ | x | x | 110 |

IUCN: International Union for Conservation of Nature and Natural Resources; CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora; IPWA: Indian Wildlife Protection Act; R: Resident; SM: Summer migrant; WM: Winter migrant; LC: Least concern species; NT: Near threatened species; VU: Vulnerable species; I: Schedule- I species of IWPA (high priority species); IV: Schedule - IV species of IWPA (relatively low priority species); BS - Brahma Sarovar; JS - Jyoti Sarovar; BG - Baan Ganga, Dayalpur; SS - Sannihit Sarovar; C-Carnivore; H-Herbivore; In - Insectivore; O - Omnivore; N - Nectarivore; F - Fruigivore; G - Grainivore; P - Piscivore; ✓ - Species recorded in the habitat; x - Species not recorded in the habitat.
Table 3. Relative diversity of various avian families in sacred ponds of Kurukshetra, India

| Order               | Family                  | No. of species recorded | Relative abundance (%) |
|---------------------|-------------------------|-------------------------|------------------------|
| Anseriformes        | Anatidae                | 15                      | 11.90                  |
| Galliformes         | Phasianidae             | 2                       | 1.59                   |
| Phoenicopteriformes | Podicipedidae           | 2                       | 1.8                    |
| Columbiformes       | Columbidae              | 5                       | 3.96                   |
| Caprimulgiformes    | Apodidae                | 1                       | 0.79                   |
| Cuculiformes        | Cuculidae               | 3                       | 2.38                   |
| Gruiformes          | Rallidae                | 4                       | 3.17                   |
| Pelecaniformes      | Ciconiidae              | 3                       | 2.38                   |
| Charadriiformes     | Burhinidae              | 1                       | 0.79                   |
|                    | Recurvirostrida         | 2                       | 1.59                   |
|                    | Charadriidae            | 2                       | 1.59                   |
|                    | Rostratulidae           | 1                       | 0.79                   |
|                    | Jacanidae               | 2                       | 1.59                   |
|                    | Scolopacidae            | 3                       | 2.38                   |
|                    | Laridae                 | 2                       | 1.59                   |
| Accipitriformes     | Accipitridae            | 5                       | 3.96                   |
| Strigiformes        | Strigidae               | 1                       | 0.79                   |
| Bucerotiformes      | Bucerotidae             | 1                       | 0.79                   |
|                    | Upupidae                | 1                       | 0.79                   |
| Piciformes          | Picidae                 | 1                       | 0.79                   |
|                    | Ramphastidae            | 2                       | 1.59                   |
| Coraciiformes       | Meropidae               | 1                       | 0.79                   |
|                    | Coraciidae              | 1                       | 0.79                   |
|                    | Alcedinidae             | 2                       | 1.59                   |
| Piscivornes         | Piscividae              | 3                       | 2.38                   |
| Passeriformes       | Passeridae              | 1                       | 0.79                   |
|                    | Motacillidae            | 7                       | 5.55                   |
|                    | Cisticolidae            | 4                       | 3.17                   |
|                    | Hirundinidae            | 6                       | 4.76                   |
|                    | Pycnonotidae            | 1                       | 0.79                   |
|                    | Zosteropidae            | 1                       | 0.79                   |
|                    | Timalidae               | 1                       | 0.79                   |
|                    | Leiothrichidae          | 3                       | 2.38                   |
|                    | Sturnidae               | 4                       | 3.17                   |
|                    | Muscicapidae            | 7                       | 5.55                   |

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Avifauna in man-made sacred ponds of Kurukshetra

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Image 1. Lesser Whistling Duck
Image 2. Ruddy Shelduck
Image 3. Red Crested Pochard

Image 4. Common Pochard
Image 5. Tufted Duck
Image 6. Northern Shoveler

Image 7. Gadwall
Image 8. Indian Spot-billed Duck

Image 9. Mallard
Image 10. Northern Pintail
Image 11. Common Teal

Image 12. Comb Duck
Image 13. Cotton Teal
Image 14. Indian Peafowl
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Image 15. Little Grebe

Image 16. Great Crested Grebe

Image 17. Rock Pigeon

Image 18. Spotted Dove

Image 19. Eurasian Collared Dove

Image 20. Laughing Dove

Image 21. Yellow-legged Green Pigeon

Image 22. Asian Koel

Image 23. Greater Coucal

Image 24. White-breasted Waterhen

Image 25. Purple Swamphen

Image 26. Common Moorhen

Image 27. Common Coot

Image 28. Painted Stork
Avifauna in man-made sacred ponds of Kurukshetra

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Image 29. Asian Openbill
Image 30. Black-crowned Night Heron
Image 31. Indian Pond Heron
Image 32. Cattle Egret
Image 33. Grey Heron
Image 34. Purple heron
Image 35. Great Egret
Image 36. Intermediate Egret
Image 37. Little Egret
Image 38. Black-headed Ibis
Image 39. Indian Black Ibis
Image 40. Glossy Ibis
Avifauna in man-made sacred ponds of Kurukshetra

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Image 41. Little Cormorant

Image 42. Great Cormorant

Image 43. Indian Cormorant

Image 44. Eurasian Thick-knee

Image 45. Pied Avocet

Image 46. Black-winged Stilt

Image 47. Red-wattled Lapwing

Image 48. White-tailed Lapwing

Image 49. Pheasant-tailed Jacana

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Avifauna in man-made sacred ponds of Kurukshetra

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Image 79. House Sparrow

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Image 83. Citrine Wagtail

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Image 85. Ashy Prinia

Image 86. Plain Prinia

Image 87. Common Tailorbird

Image 88. Wire-tailed Swallow

Image 89. Red vented Bulbul

Image 90. Oriental White-eye

Image 91. Large Grey Babbler

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Avifauna in man-made sacred ponds of Kurukshetra

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Image 92. Jungle Babbler

Image 93. Asian Pied Starling

Image 94. Brahminy Starling

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