

Park, later to be known as Safari Zoo Lahore extending its area to 96.4 ha. Safari Zoo Lahore is a composite of terrestrial ecosystem. Out of 96.4 ha area, 12 ha area is occupied by the tiger and lion safari each, 4 ha area by two moated ungulate enclosures, one ha area by bird aviary; the safari park lake is spread over two ha. Remaining area is occupied by trees, shrubs planted in the form of wood-lots or groves within or around the grassy lawns and animal enclosures, residential colony and cafeteria.

Study area was divided into three main categories *viz.*, the lake area, woodlots, tree groves around and within the animal enclosures and trees/shrubs planted around the grassy lawns and residential colony (Fig. 1) to observe, identify and estimate the number of birds.

Surveys were conducted on fortnightly basis (26 days in a year) at dawn (6:00 to 9:00 hours) and at dusk (16:30 to 19:00 hours) in summer and in winter from (6:30 to 9:00 hours) at dawn and (15:00 to 17:30 hours) at dusk. Five observers observed birds. Binoculars (10×50mm) were used to identify the bird species.

For direct species identification during field surveys Roberts (1991), (1992), Grimmett *et al.* (1998), (2008) and Mirza and Wasiq (2007) were consulted.

Number of individuals of a species indicates the local occurrence status including its frequency and comparative abundance (Bull, 1974). The bird species having daily occurrence of individuals at the study area were categorized as very abundant (more than 1000), abundant (200 to 1000), very common (51 to 200), common (21 to

50), fairly common (7 to 20), and uncommon (one to six). One to six individuals of a species recorded in a season (summer or winter) were considered as rare, infrequent or vagrants.

RESULTS

The island within the lake area is richly populated with a variety of trees, shrubs and herbs that provide shelter and food for the avifauna. Woodlots and tree groves exist within and around the animal enclosures including the tiger safari, lion safari, ungulate moated enclosures and antelope safari. Around the residential area, trees and shrubs have been planted that provide natural habitat to birds.

The average temperature typically varied from 6°C to 40°C and only occasionally below 2°C or above 44°C. Relative humidity on an average ranged from 20 to 25% during summer, rising to 40 to 65% during July and August (rainy season) and during winter.

The important flora of Safari Zoo Lahore includes mulberry *Morus alba*, safaida *Eucalyptus camaldulensis*, keekar *Acacia nilotica*, date palm *Phoenix dactylifera* and sukhn chain *Pongamia monosperma*. Important grasses are: Kana *Saccharum bengalensis* and Cat tail *Typha australis*. Herbs and grasses include *Cynodon dactylon*, *Dichanthium annulatum*, *Panicum antidotale*, *Poa annua*, *Parthenium hysterophorus*, *Imperata sp.* along with *Qxalis sp.*; *Calotropis procera* is the dominant shrub.



Fig. 1. Study area guide map. P1, lake area; P2, forest cover; P3, residential colony.

A total of 5456 birds belonging to 71 species, 40 families and 12 orders were recorded during the survey (Supplementary Table I). Fifty (70.4%) bird species observed were resident, 12 (16.9%) winter migrant, and eight (8) (11.3%) summer breeders. Only Eurasian Golden Oriole *Oriolus oriolus* (0.014%) was the passage migrant (Fig. 2).

The highest number of birds were recorded of order Passeriformes (n=4608) (84.46%). The least number of birds were recorded of Galliformes (n=16) (0.29%), Anseriformes (n=10) (0.18%) and Strigiformes (n=7) (0.13%), respectively were represented by only one species (Fig. 3). Most dominant birds were house crow, *Corvus splendens* (n=2518), house sparrow, *Passer domesticus* (n=772), common myna, *Acridotheres tristis* (n=327), black-crowned night heron, *Nycticorax nycticorax* (n=190) and jungle babbler, *Turdoides striatus* (n=186), and the least dominant pied kingfisher *Ceryle rudis* (one); their relative abundance is represented in Table I.

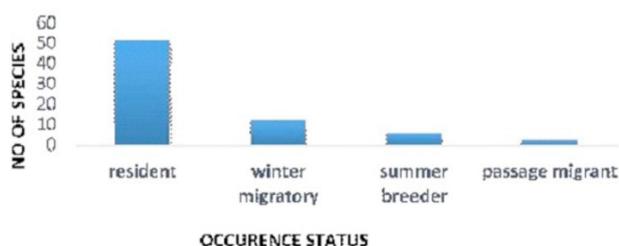


Fig. 2. Distribution of avian fauna showing the occurrence status of resident, winter migratory and summer breeders.

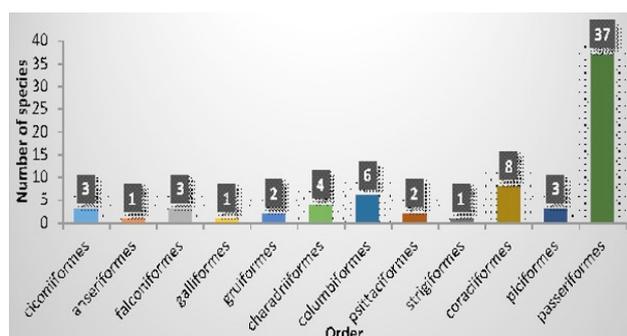


Fig. 3. Diversity among different orders showing the maximum number of bird's species of each respective order.

DISCUSSION

Study area is a composite of terrestrial ecosystem, as a whole it provides favourable shelter to diverse avian fauna regarding their natural habitat, food availability

as well as suitable climatic conditions favouring diverse populations of birds. Raza *et al.* (2015) recorded 52 bird species belonging to 30 families and 12 orders during winter from October to December 2014. In the present study 71 bird species belonging to 40 families and 12 orders were recorded that shows high profile of seasonal avian diversity. In Raza *et al.* (2015) study, among 52 bird species, 37 (71.1%) were resident, eleven (21.1%) winter migrants and four (7.6%) were summer breeders while in the present study, 50 (70.4%) were resident, twelve (16.9%) winter migrants, and eight (11.3%) were summer breeders. Only Eurasian Golden Oriole *Oriolus oriolus* (0.014%) was recorded as the passage migrant.

Table I.- Relative abundance as well as percentage abundance of five most dominant bird species.

Scientific name	Common name	Number of individuals	Relative abundance	Percentage abundance
<i>Corvus splendens</i>	House crow	2518	0.5419	46
<i>Passer domesticus</i>	House sparrow	772	0.104	14
<i>Acridotheres tristis</i>	Common myna	327	0.0791	0.06
<i>Turdoides striatus</i>	Jungle babbler	190	0.0527	0.03
<i>Nycticorax nycticorax</i>	Night heron	186	0.0359	0.03

In the present study out of 12 orders, maximum number of bird species (37; 52%) belonging to 21 families were of Passeriformes followed by eight (11.27%) species of Coraciiformes and six (8.45%) species of Columbiformes. Raza *et al.* (2015) recorded 12 orders, maximum number of bird species (29; 55.7%) belonging to 17 families were of Order Passeriformes followed by three (5.7%) species of Charadriiformes and two (3.84%) species of Coraciiformes. Both studies indicated that Passeriformes was the most prevalent order of the recreational park. Zareen *et al.* (2016) recorded 65 bird species representing 44 genera and 33 families at Jallo Wildlife Park, Lahore from January to August 2015. Qazi and Hadi (2016) conducted a study at Safari park, Karachi during the period from April to December 2015 and recorded 36,179 birds belonging to 22 species and 15 families. Safari Park, Karachi shows low profile of avian diversity that may be due to inadequate food availability, scarcity of shelter and climatic conditions that are not very conducive to vegetation growth. The Safari Zoo Lahore in comparison to Jallo Wildlife Park, Lahore and Safari Park, Karachi supports more diverse avian fauna i.e.,

more number of bird species, that might be due to diverse habitats and variety of food enrichment that support more diverse avifauna.

Study area carries plenty of food resources specifically including insects, small invertebrates, crustaceans, grains, arachnids, seeds, fruits to some extent and food remains from the safari visitors, directly or indirectly favouring the avian fauna, particularly to order Passeriformes like barn swallow, common myna and house sparrow (Tanveer *et al.*, 2002). For instance common myna which feeds particularly on the ground in grass for insects, especially on grasshoppers that's why it has attained its generic name *Acridotheres*, "grasshopper hunter" (Ali *et al.*, 2001). Variety of herbs and grasses provide many insects, molluscs and vegetable matter that comprise the diet of many bird species including red vented bulbul *Pycnonotus cafer*, blue-throat *Luscinia svecica*, Indian blue robin *Saxicoloides fulicata* etc. (Roberts, 1992). *Poa annua* provides best habitat for chats *Saxicola torquata*, *Cercomela fusca*, *Saxicola caprata* and for shrikes *Lanius isabellinus* and *Tephrodornis pondicerianus* (Tanveer *et al.*, 2002).

Breeding season, habitat conditions and food enrichment might have close relationship with birds' relative abundance (Bibi and Ali, 2013). Thirty seven species of 21 families belonged to order Passeriformes mainly due to the most suitable habitat conditions (Khan and Ali, 2015); and particular food presence such as insects, crustaceans, small invertebrates, arachnids and food remains from the safari visitors; plays significant role in the diversity and abundance of various bird orders such as Passeriformes, Coraciiformes and Columbiformes. Various bird species show different scales of preference and attraction towards the availability of particular kind of food (Khan and Ali, 2015).

Study area is richly populated with diversified plant species which directly or indirectly provide enough food resources and shelter, facilitating nest building for different bird species including common myna, house sparrow, and jungle babbler etc. Climatic conditions are semi-arid with four seasons, all this prominently supports the Passeriformes and winter migrants. Diversified plant species have a direct or indirect relation with the availability of shelter including their nesting space, food and water, perching and roosting facilities (Mahboob *et al.*, 2013).

Bird species (52) recorded during winter season by Raza *et al.* (2015) were remarkably more in number than the species recorded during summer season. This increase in number of species simply illustrates that the increase was due to winter migrants; 12 out of 71 bird species that were not seen during the summer season. Lahore Safari

Zoo indeed is an important wintering place for many migratory birds such as mallard *Anas platyrhynchos*, temminck's stint *Calidris temminckii*, blue-throat *Luscinia svecica* etc. due to suitable better habitat and favourable climatic conditions.

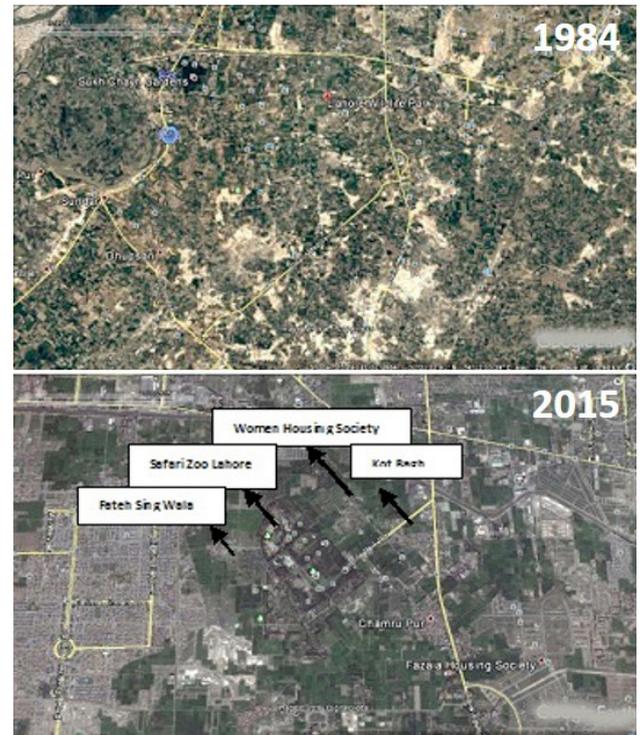


Fig. 4. Map of Safari Zoo Lahore in 1984 and in 2015.

Threats to bird populations

Rapid increase in human population and the development of new housing colonies (LDA etc.) are causing natural habitat degradation which ultimately leads to the decline of diverse avian fauna. Lack of awareness among the people about the importance of wildlife, diversity and conservation due to low literacy rates also has serious negative impact upon the study area *i.e.* interference in their breeding sites, natural habitat or their nesting places. Development projects according to future master plan of the construction of new enclosures for more captive animals will also have some negative impacts reducing the species number around the study area such as in case of Indian roller *Coracias benghalensis* habitat, it was frequently observed near the safari lake but after the construction of ostrich enclosure, it has not been observed probably due to additional disturbance. Figure 4 shows that the area in green colour is under usage in the form of captive enclosure; for lion and tiger safaris at present but the area other than green in colour is the future master plan

and after the completion of master plan project, the present ecosystem favouring the diverse avian fauna would be disturbed that could result in the decline of bird diversity. Better awareness among communities in surrounding areas and improvement in habitat conditions is strongly recommended to support the diverse avian fauna.

CONCLUSION

It is concluded that the Safari Zoo Lahore supports a rich diversity of avian fauna. Rapid increase in urbanization due to development of different housing schemes would increase pollution around the locality that would affect the avian fauna in future because many bird species are sensitive to pollution e.g. house sparrow. Cutting of trees, for the construction of new enclosures that can alter natural habitat or shelter for avifauna, should be properly planned at study site. Recording 71 bird species is an indication of a healthy ecosystem. Any anthropological and natural change could disturb the bird population and harmony of the safari. For protection and propagation of avifauna awareness among visitors and communities around should be promoted through publicity campaigns, leaflets, brochures, boards, media etc. at local level and any disturbance in the habitat by visitors should also be prohibited. Dos and don'ts guides should be advertised in the safari and also widely circulated to conserve the habitat.

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Supplementary material

There is supplementary material associated with this article. Access the material online at: <http://dx.doi.org/10.17582/journal.pjz/2018.50.2.533.538>

Statement of conflict of interest

The authors declare that there is no conflict of interest with this publication.

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