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Status and Impact of Wooded Patches in Semi-Urban Landscape on Avian Community Structure in Aligarh, Uttar Pradesh, India

Aditya Rana and Jamal Ahmad Khan

Department of Wildlife Sciences, Aligarh Muslim University, Aligarh-202 002, India
E-mail: ranaaditya1751@gmail.com

Abstract: This short-term study is an effort to estimate density and diversity of birds in wooded patches present at the outskirts of Aligarh city. Point count method was used to determine the diversity and abundance of birds. The total of 40 points were laid through systematic random sampling and monitored in the morning hours. In total, 140 species were recorded, with Passeriformes as the most dominating order. Seven near threatened and three threatened species were recorded. Bird density was 60 birds/ha and large grey babbler had the highest density (18.72 birds/ha). Density was significantly positively correlated with the shrub height. In addition to with resident species, many winter/summer migrants and passage migrant birds were found during the study period. These small and scattered patches are important for wildlife coping with urbanization; therefore better management of these wooded patches is required for effective conservation.

Keywords: Point count, Distance, Urbanization, Wooded patches, Density

Birds provide various ecosystem services and play important roles in our agroecosystems (Mariyappan et al . 2023). The flourishing bird population is essential for any stable ecosystem and their status indicates how well the ecosystems are functioning (Mariyappan et al 2023). Rapid urbanization is an emerging threat and it is having adverse effects on the diversity and abundance of birds and in turn, negatively affects ecosystem functioning. Urbanization has led to the conversion of natural habitats and farmlands into a series of different architectures which are heavily fragmented and have a high edge effect (Shochat et al 2006, Moller 2009). In this process, some wildlife species benefit and some are negatively affected (Devictor et al 2007, Akram et al 2015, Sahni & Kler 2023).

Urban green spaces such as parks and lawns etc. are vital for birds in urban areas but still, birds flourish in islets of natural habitats located in the vicinity of urban areas (Felappi et al 2020, Machar et al 2022). Most of the studies conducted in urban areas are usually focused on urban green spaces (Shochat et al 2006, Moller 2009, Prakash and Baldodia 2013, Rajashekara and Venkatesha 2015, Mukhopadhyay and Mazumdar 2019). These spaces only harbour those species that benefit from the urban environment and are better adapted to the changing environmental conditions (Moller 2009, Verma and Murmu 2015, Singh et al 2018).

The natural habitats located on the outskirts of cities provide more opportunities for those species that are not able to adapt to the urban environments and are more elusive, as these areas are comparatively less disturbed and less prone to the frequent changes that the city experiences (Rajashekara and Venkatesha 2015, Mukhopadhyay and Mazumdar 2019). These areas are important stopover points for locally migrating birds and provide shelter as well as variable food resources (Siddiqui et al 2019, Mazumdar and Khan 2020, Yashmita-Ulman 2022). Therefore, scientific information on the diversity and abundance of birds in these natural habitats located on the outskirts of cities is essential for the effective management of these areas.

Most of the natural vegetation of the Aligarh district is lost due to the conversion of natural areas into agricultural fields and human settlements. But few small isolated wooded patches of natural vegetation and plantations still existed in the district supporting various species of wildlife. Avian diversity of Aligarh is rich and varied and more than 150 species are reported from the district (Akram et al 2015, Siddiqui et al 2019, Mazumdar and Khan 2020). Each year many migratory birds visit the area as their wintering grounds and represent the ecological significance of the Aligarh region (Mazumder and Khan 2020). Therefore, this study is an attempt to find out avian density and diversity of these isolated wooded patches and to determine the vegetation parameters affecting density and diversity of birds.

MATERIAL AND METHODS

Site location: Aligarh district is located in the western part of Uttar Pradesh state of India and spread over an area of 3650 sq. km., from 27.5714° – 28.1798°N to 77.4756° – 78.6077° E (Fig. 1). A major part of the district is primarily under

agriculture (Ali 2013). There are sparsely distributed wooded patches in the district having variable sizes from 6 ha to > 200 ha surrounded by agricultural lands. Major tree species found in these patches are *Vachellia nilotica*, *Prosopis cineraria, Azadirachta indica*, along with various alien invasive species such as *Prosopis juliflora*, *Lantana camara* etc. The study was carried out from February to May 2021. Identification of probable wooded patches was conducted with the help of Google Earth Pro. A total of 14 patches were identified but after a quick reconnaissance survey and ground truthing, nine sites were selected for further study. The area of these patches varies from 19.5 ha to 256 ha (Table 1). The criteria for the selection of patches were that patches must have intact and continuous vegetation in a minimum of ~20 ha, not be owned by a private person and must not be under any agricultural practices (Fig. 1).

Diversity and density: To determine the diversity and density of birds, point count method was used. Systematic random sampling was used to lay the points in the study area. The first point in the patch had been chosen randomly and then successive points were laid at every 300 m in a fixed direction. A total of 40 points were laid for monitoring of birds.

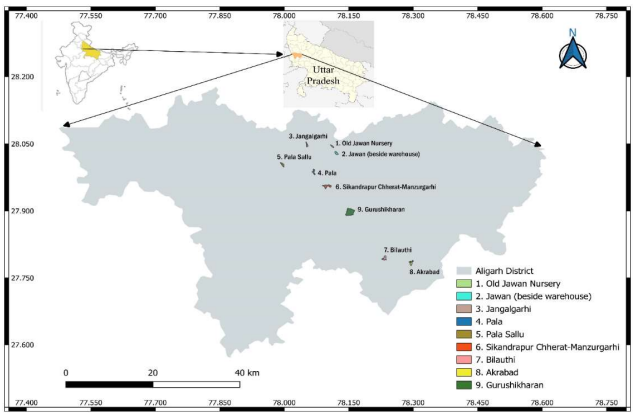

Fig. 1. Site location

The number of points in a particular patch was laid in proportion to its area. Each point was monitored four times for 15 minutes, making a total effort of 160 points. As birds are most active in the morning hours, all the monitoring was conducted in the early mornings. Variable radius point count monitoring protocol was used following Verner (1985) and Javed and Kaul (2002). No flying bird had been considered for an observation. Birds sighted outside the point count stations were recorded on a separate sheet for preparation of the checklist.

To quantify the vegetation on the point, number of trees was counted in a 20-meter circular plot. Plants having >30 cm GBH were considered as trees. An ocular estimation of canopy cover was also taken at each point. Visual obstruction technique via Robel Pole was used to measure shrub layer height. A pole with black and white 10 cm bands is used. The pole was placed at a fixed distance from a point, and then the last visible band number was recorded to estimate relative heights of shrub layer in all the patches.

Statistical analysis: PAST (paleontological statistics) statistical software was used to compute diversity indices for each point and then further for each patch after the data had been pooled. The density of birds was calculated in DISTANCE software (v_7.5). Multiple Covariate Distance Sampling (MCDS) was used using MCDS engine in Distance to estimate density after incorporating covariables such as tree density, canopy cover, shrub height, etc in the original dataset. Density estimation through MCDS engine gives more accurate results and better density figures (Marques et al 2007). Spearman's rank correlation was computed in PAST software to determine the correlation between bird density and various vegetation parameters.

RESULTS AND DISCUSSION

Species occurrence: Out of 140 bird species recorded during the study period, 71 species were recorded at point

Table 1. Wooded patches selected for the study

Patch No.	Patch name	Area (ha)	Major tree species
1	Old Jawan Nursery	19.5	*Cassia fistula, Holoptelea integrifolia, Magnifera indica* & *Vachellia nilotica*
2	Jawan Patch (beside Hitachi Warehouse)	34	*Prosopis juliflora*
3	Jangalgarhi	23.2	*Prosopis juliflora*
4	Pala	41.8	*Prosopis juliflora*
5	Pala Sallu Blackbuck Community Reserve	33.9	*Vachellia nilotica* & *Prosopis juliflora*
6	Sikandrapur Chherat–- Manzurgarhi	75.56	*Vachellia nilotica* & *Prosopis juliflora*
7	Bilauthi	54.7	*Prosopis juliflora*
8	Akrabad	43	*Vachellia nilotica* & *Prosopis juliflora*
9	Gurushikharan	256.26	*Vachellia nilotica* & *Prosopis juliflora*

stations and a total of 1785 individuals were observed belonging to 18 orders and 56 families. Passeriformes with 68 species was the most dominating order (48.6%) in the study area, while only two species each from three orders (1.43%) have been recorded (Table 2). Birds are usually better adapted to urban establishments than any other faunal group (Luniak 2004). Wooded patches situated outside the city environments are being used more extensively by the negatively affected species as a result these species are seldomly seen in the cities (Siddiqui et al 2019). These patches provide refuge to these species as they are being driven away from the city due to various developmental processes.

The number of bird species (140 species) recorded is close to the species recorded by Mazumdar and Khan (2020) (146 species) and higher than the other studies Akram et al (2015) (92 species); Siddiqui et al (2019) (63). Birds are an indicator of the health of any ecosystem (Wade et al 2014). The rich diversity of birds in the study area highlights how important these wooded patches are for the sustainance of birds and in turn overall health of various ecosystems (Wade et al 2014, Mariyappan et al 2023).

Seven recorded species are near threatened, two are vulnerable (Indian Spotted Eagle *Clanga hastata* & Sarus Crane *Grus antigone*) and one (Egyptian Vulture *Neophron percnopterus*) is endangered. Eurasian Collared Dove had the highest relative frequency (8.77%) while 16 species had only 0.13% as the lowest relative frequency (Table 3).The seven near-threatened and three threatened species recorded in the study area need immediate conservation focus (IUCN 2023). Regular assessment focused on these species will provide insights for their better management and survival. Egyptian vulture, in particular, is an endangered species (IUCN 2023), but their frequent recordings from the study area, either in the form of a single individual or in large flocks (recorded 23 individuals in a single flock), may indicate yet another success story for the revival of an endangered species in the study area (Singh and Gibson 2011, Kierulff et al 2012). Grimmett et al (2011) observed that many bird species recorded in the study are winter and summer migrants. Furthermore, some species are passage migrants and utilise these patches as their stopover points. All of these species utilise these patches for varying duration in different seasons of the year; indicating the importance of these small and scattered wooded patches for them.

Density and diversity of birds: Based on minimum AIC value, the Hazard Rate- Simple Polynomial model was selected to calculate the density of birds. After considering all the covariables, terrestrial birds' density was 60.63 birds/ha (Table 4). Highest density was recorded in Old Jawan Nursery patch with 235.21 birds/ha whereas lowest density in Jawan Patch (beside Hitachi warehouse) with 52.097 birds/ha. Bird density was is higher than Siddique et al (2019) with 36.82 birds/ha and Akram et al (2015) with 54.45 birds/ha but these studies have more focus on birds in urban areas of Aligarh district.

Further, the diversity of birds is more or less similar to the many studies conducted in nearby areas (Gupta et al 2009, Chopra et al 2012, Prakash and Baldodia 2013, Singh et al 2021). This indicates that the Aligarh region still holds importance for various species inhabiting these wooded patches and to the various migratory species that happen to visit this region annually. Density of birds and Shannon diversity index e of Old Jawan Nursery was highest in all the individual patches. This is because it holds the highest tree density and relatively high shrub height; these factors help in creating more available niches and hence greater density and diversity (Pigot et al 2016, Kaur and Kler 2019). Keeping this patch as a model, we can further enhance the carrying capacity of other patches, leading to greater avian density and diversity and also giving ideas for better management of such patches.

Large grey babbler have the highest density with 18.72 birds/ha, followed by Green Bee-eater (11.68 birds/ha) (Table 5) which was due to agroecosystems surrounding the

Table 2. Number and percentage of species in their respective orders

Order	No. of families	Percentage of species
Accipitriformes	1	7.14
Anseriformes	1	2.14
Bucerotiformes	2	1.43
Caprimulgiformes	2	1.43
Charadriiformes	5	5.71
Ciconiiformes	1	2.14
Columbiformes	1	5.00
Coraciiformes	3	2.86
Cuculiformes	1	2.86
Galliformes	1	1.43
Gruiformes	2	2.86
Passeriformes	26	48.57
Pelecaniformes	2	6.43
Piciformes	2	2.14
Podicipediformes	1	0.71
Psittaciformes	1	2.14
Strigiformes	2	2.86
Suliformes	2	2.14

Table 3. Bird species listed on points with their frequency of occurrence and relative frequency

Species	Scientific name	Frequency of occurrence	Relative frequency %
Indian Peafowl	*Pavo cristatus*	19	2.38
Grey Francolin	*Francolinus pondicerianus*	28	3.51
Rock Pigeon	*Columbia livia*	2	0.25
Oriental Turtle Dove	*Streptopelia orientalis*	12	1.50
Eurasian Collar Dove	*S. decaocto*	70	8.77
Red Collar Dove	*S. tranquebarica*	4	0.50
Spotted Dove	*Spilopelia suratensis*	3	0.38
Laughing Dove	*S. senegalensis*	61	7.64
Yellow-footed Green Pigeon	*Treron phoenicopterus*	21	2.63
Greator Coucal	*Centropus sinensis*	8	1.00
Asian Koel	*Eudynamys scolopaceus*	13	1.63
Common Hawk Cuckoo	*Hierococcyx varius*	5	0.63
Indian Cuckoo	*Cuculus micropterus*	1	0.13
Indian Thick-knee	*Burhinus indicus*	10	1.25
Red Wattled Lapwing	*Vanellus indicus*	9	1.13
Indian Pond Heron	*Ardeola grayii*	3	0.38
Red Naped Ibis	*Pseudibis papillosa*	1	0.13
Egyptian Vulture	*Neophron percnopterus*	2	0.25
Oriental Honey Buzzard	*Pernis ptilorhynchus*	1	0.13
Crested Serpent Eagle	*Spilornis cheela*	3	0.38
Black Kite	*Milvus migrans*	10	1.25
Spotted Owlet	*Athene brama*	9	1.13
Grey Hornbill	*Ocyceros birostris*	7	0.88
White Throated Kingfisher	*Halcyon smyrnensis*	4	0.50
Asian Green Bee-eater	*Merops orientalis*	67	8.40
Brown Headed Barbet	*Psilopogon zeylanicus*	1	0.13
Lesser Goldenback Woodpecker	*Dinopium benghalense*	4	0.50
Alexandrine Parakeet	*Psittacula eupatria*	2	0.25
Rose Ringed Parakeet	*P. krameri*	22	2.76
Plum Headed Parakeet	*P. cyanocephala*	1	0.13
Black Drongo	*Dicrurus macrocercus*	20	2.51
Ashy Drongo	*D. leucophaeus*	1	0.13
Isabelline Shrike	*Lanius isabellinus*	1	0.13
Bay Back Shrike	*L. vittatus*	1	0.13
Rufous Treepie	*Dendrocitta vagabunda*	37	4.64
House Crow	*Corvus splendens*	1	0.13
Large Billed Crow	*C. macrorhynchos*	11	1.38
Ashy Crowned Sparrow Lark	*Eremopterix griseus*	1	0.13
Crested Lark	*Galerida cristata*	2	0.25
Common Tailorbird	*Orthotomus sutorius*	8	1.00
Jungle Prinia	*Prinia sylvatica*	7	0.88
Ashy Prinia	*P. socialis*	23	2.88
Plain Prinia	*P. inornata*	1	0.13

Cont...

Table 3. Bird species listed on points with their frequency of occurrence and relative frequency

Species	Scientific name	Frequency of occurrence	Relative frequency %
Zitting Cisticola	*Cisticola juncidis*	1	0.13
Blyth's Reed Warbler	*Acrocephalus dumetorum*	17	2.13
Barn Swallow	*Hirundo rustica*	2	0.25
Red Vented Bulbul	*Pycnonotus cafer*	22	2.76
Red Whiskered Bulbul	*P. jocosus*	2	0.25
Hume's Leaf Warbler	*Phylloscopus humei*	1	0.13
Sulphur Bellied Warbler	*P. griseolus*	5	0.63
Common Chiffchaff	*P. collybita*	3	0.38
Greenish Warbler	*P. trochiloides*	1	0.13
Lesser White Throat	*Sylvia curruca*	30	3.76
Yellow Eyed Babbler	*Chrysomma sinense*	1	0.13
Indian White Eye	*Zosterops palpebrosus*	3	0.38
Jungle Babbler	*Argya striata*	24	3.01
Large Grey Babbler	*A. malcolmi*	45	5.64
Asian Pied Starling	*Gracupica contra*	13	1.63
Common Myna	*Acridotheres tristis*	12	1.50
Indian Robin	*Saxicoloides fulicatus*	11	1.38
Oriental Magpie Robin	*Copsychus saularis*	16	2.01
Red Breasted Flycatcher	*Ficedula parva*	7	0.88
Black Redstart	*Phoenicurus ochruros*	7	0.88
Pied Bushchat	*Saxicola caprata*	11	1.38
Purple Sunbird	*Cinnyris asiaticus*	21	2.63
Indian Silverbill	*Euodice malabarica*	5	0.63
Scaly Breasted Munia	*Lonchura punctulata*	1	0.13
Yellow Throated Sparrow	*Gymnoris xanthocollis*	7	0.88
Paddyfield Pipit	*Anthus rufulus*	4	0.50
Long Billed Pipit	*A. similis*	6	0.75
Tawny Pipit	*A. campestris*	3	0.38

Table 4. Bird density, diversity indices and number of species in different wooded patches of Aligarh district

Patch name	Density (Birds/ha)	% coef. of variation	No. of species	Evenness	Shannon (H) diversity	Simpson diversity	Margalef richness
Old Jawan Nursery	235.21	24.14	34	0.757	2.843	0.925	2.834
Jawan Patch (beside Hitachi Warehouse)	48.55	31.07	8	0.696	1.147	0.596	1.147
Jangalgarhi	58.47	34.31	15	0.699	1.726	0.751	1.726
Pala	52.47	24.38	21	0.698	1.904	0.792	1.904
Pala Sallu Blackbuck Community Reserve	99.74	26.05	15	0.755	2.018	0.831	2.018
Sikandrapur Chherat-Manzurgarhi	92.36	11.24	39	0.694	2.545	0.888	2.545
Bilauthi	54.52	19.47	29	0.664	2.093	0.826	2.093
Akrabad	60.56	29.90	13	0.762	1.557	0.734	1.557
Gurushikharan	53.60	18.10	38	0.731	2.120	0.830	2.120
Overall	60.63	9.19	71	0.715	2.028	0.806	2.028

wooded patches and adding to the fact that they remain in flocks that can go >20 in number (Brraich et al 2023). Crop fields are abundant in food resources for most of the year and LGB being an omnivorous species gains advantage of its diet variability (Puckett et al 2009). LGB flocks can have up to 40 individuals at one time, giving them an advantage over their potential predators as they lookout for each other with greater strength in numbers (Brraich et al 2023). With better utilization of available resources, their populations flourish and hence they are found with the highest density in the study area.

Correlation with vegetation parameters: Highest tree density was recorded in Old Jawan Nursery patch (131.3 trees/ha) while lowest was in Bilauthi patch (3.18 trees/ha). Similarly, highest canopy cover was in Jangalgarhi patch and lowest in Bilauthi. Shrub height in Sikandrapur Chherat-Manzurgarhi patch was highest while in Jawan patch (beside Hitachi Warehouse) recorded lowest shrub height (Table 6). Shrub height was significantly positively correlated with bird density. Although a positive correlation was recorded in bird density with tree density and canopy cover but differences were non-significant.

These wooded patches are important for the sustenance and survival of various species that are negatively affected by urbanization. These patches should be given more concern on how to conserve them and should be viewed more than just as an infertile land. Thriving species like LGB, Green Bee-eater, and Eurasian Collared Dove as well as near threatened and threatened species residing here show the vitality of these patches. For shy migratory birds, these patches are an abode and without these patches, their migration will be affected. The size of these patches also matters and no further encroachment should be allowed over them. These patches need to remain intact without any further fragmentation. In addition to birds, these patches also have a rich diversity of mammalian species and 11 species of mammals (Blackbuck *Antilope cervicapra*, Nilgai *Boselaphus tragocamelus*, Wild Pig *Sus scrofa*, Golden Jackal *Canis aureus*, Rhesus Macaque *Macaca mulatta*, Indian Hare *Lepus nigricollis*, Jungle Cat *Felis chaus*, Small Indian Mongoose *Herpestes auropunctatus*, Grey Mongoose *Herpestes edwardsii*, Five Striped Palm Squirrel *Funambulus pennantii* and Indian Flying Fox *Pteropus giganteus*) were recorded during the study. It also indicates the importance of these wooded patches as they also utilise these wooded patches in toto. More emphasis should be given on how to connect nearby patches so that there will be fewer road kills of wildlife present in the area. Studies conducted over mammalian communities will enhance the knowledge of their association with avian communities in the study area (Cook et al 2020). Few studies have been done in the district on mammals but their association and effect on avian communities is yet to be explored (Khan and Khan 2016, Ahamad et al 2021tc.). These broad studies will further

Table 5. Density of bird species having statistically significant observations individually

Species	Density (Birds/ha)	Per cent coef. of variation	95% confidence interval
Large Grey Babbler	18.72	23.47	11.82 – 29.64
Green Bee-eater	11.68	21.68	7.62 – 17.90
Lesser White Throat	9.03	21.41	5.92 – 13.77
Rufous Tree Pie	7.02	28.39	4.03 – 12.23
Laughing Dove	4.27	23.4	2.70 – 6.74
Eurasian Collared Dove	3.89	19.21	2.67 – 5.67

Table 6. Patch-wise vegetation parameters and other co-variables

Patch name	Tree density (per ha)	Canopy cover (%)	Shrub height (m)
Jawan (Old Nursery)	131.3	45	3.7
Jawan Patch (beside Hitachi Warehouse)	34.48	18.33	0.33
Jangalgarhi	106.1	68.33	0.47
Pala	77.59	48.75	0.65
Pala Sallu Blackbuck Community Reserve	39.79	31.67	1.8
Sikandrapur Chherat-Manzurgarhi	35.81	22.5	4.5
Bilauthi	3.18	1	2.6
Akrabad	35.81	27.5	1.45
Gurushikharan	85.15	49.5	2.56

help in the effective management and conservation of avian populations in the district.

CONCLUSION

Wooded patches situated at the outskirts of urban establishments provide refuge to the faunal species coping with the speed of urbanisation. Conservation and management of these patches may prove critical in ensuring the long-term conservation of biodiversity and maintaining healthy urban ecosystems.

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