Indian Journal of Ecology (2023) 50(5) (SI): 1801-1805
DOI: https://doi.org/10.55362/IJE/2023/4140

Manuscript Number: 4140
NAAS Rating: 5.79

Impact of Urban Landscape on Relative Abundance of Invasive Bird Species

Navleen Kaur Sahni and Tejdeep Kaur Kler

Department of Zoology, Punjab Agricultural University, Ludhiana-141 004, India
E-mail: navleen.nks@gmail.com

***Abstract*:** Invasive species owing to their habitat flexibility are able to exploit the ample feeding and nesting resources offered by urban landscapes. The current study was conducted in Jalandhar city of northwest India, where all the studied transects reported a relative abundance of more than 75% for invasive bird species. Tree species diversity was the most important habitat feature that positively affected bird species richness, species diversity and species evenness, while also reducing the relative abundance of invasive bird species. Hence a better planning of urban vegetative cover can help us maintain a more diverse urban avifauna.

***Keywords*:** Urban birds, Invasive species, Urban biodiversity, Urban avifauna

Invasive species are becoming a part of ecosystems all over the world and irreversibly changing their biodiversity (Capinha et al 2015, Dawson et al 2017). Several studies have recognized the negative impact of invasive species, causing decline in native species, economic damages, and transmission of diseases in plants, animals, and humans (Crowl et al 2008, Dove at al 2011, Ahmad et al 2012). The Global Invasive Species Database (2015) enlists 16 invasive bird species present in India with four recognized as Alien Invasive and 12 as Native Invasive species. The distribution of invasive species is determined by various factors differing in their importance and the interaction between these factors throughout the process of invasion (Blackburn et al 2011). The dominance of an invasive species in a habitat can be through two pathways: direct competition for resources, or being resistant to environmental stressors that limit other species. The later known as 'passenger model' has more support in recent studies where native species have declined due to environmental pressures forming an empty niche which is exploited by invasive species (Sol et al 2012). Growing urban centres with their constantly changing landscape offer new niches to be exploited by opportunistic species, and invasive species are often the ones to take advantage of these newly available resources (González-Oreja et al 2018). Blackburn et al (2009) stated that most successful invasive birds prefer habitats disturbed by humans which are avoided by indigenous species. Invasive bird species threaten the native bird diversity of a place, so much so that some countries adopt various methods to capture and control their population (Abd Rabou 2022). Urbanization is considered a primary threat to birds all over the world (SoIB 2020). In the past 20 years in India, urban cover in the top 100 cities alone has increased by almost 2.5-fold, by an extent greater than 5000 km^2 area (Nagendra et al 2014). This study aimed to understand the factors affecting the spatial distribution of invasive bird species in urban centres.

MATERIAL AND METHODS

Study area: The study was carried out in Jalandhar city (31.3260° N, 75.5762° E) situated in the northwestern state of Punjab, India. It has a humid subtropical climate with temperature ranging from 5ºC in winters to as high as 45 ºC in summers. Two transects 1 km each were selected from residential (R I and R II), commercial (C I and C II) and industrial areas (In I and In II) of the city to study bird composition.

R I – Unplanned residential area with narrow lanes and double-story houses with old infrastructure. The vegetation included one large *Ficus benghalensis* tree apart from a few short trees and bushes.

R II – Well planned residential area with wider roads and modern houses. In addition to two public parks, the vegetation comprised of several roadside trees, and gardens in homes with short trees, bushes, and seasonal flowering plants.

C I – It was an unplanned commercial area with heavy footfall for most part of the day and almost no vegetation except for one *Ficus religiosa* tree. The marketplace had mostly single or double-story shops with a residence on the upper floor.

C II – A well-planned marketplace with wide roads, a public park, and several shops and shopping complexes. Roads having heavy vehicular traffic in the evening.

In I – This was an industrial area having factories with high metal roofs. Vegetation mostly consisted of short trees along the outer walls of factories, most common being *Saraca asoca* that were regularly pruned and kept short.

In II – This industrial area was on the outskirts of the city having agricultural fields close by. The infrastructure was similar to that of transect In I. The vegetation comprised of several large trees and empty plots with wild grasses and shrubs.

Bird and vegetation surveys: Line transects method was followed for conducting bird surveys in the selected transects (Verner 1985). Surveys were conducted weekly, for a period of one year from July 2018 to June 2019. Birds were identified based on The Book of Indian Birds (Ali 2002) and Birds of the Indian Subcontinent (Grimmett et al 2016). The common and scientific names of birds were given according to Praveen et al (Praveen et al 2016). Information on the enlisted invasive bird species was taken from the Global Invasive Species Database (GISD 2015).

Tree species were recorded and identified based on trees of Delhi. A field guide (Krishen 2006) and The Book of Indian Trees (Sahni 1998). Land cover data including built cover, road cover and green cover was obtained from Punjab Remote Sensing Centre, Ludhiana (Punjab).

Data analysis: Habitat features including percentage road cover, percentage green cover, tree species richness and tree count were the independent variables for regression analysis. Four ecological indexes were taken as dependent variables: Bird species richness, species diversity, species evenness and bird count per observation. Regression analysis was carried out using SPSS Version 23, to analyse the association between habitat features and ecological indices.

RESULTS AND DISCUSSION

During the present study, a total of 50 bird species belonging to 29 families and 13 orders were recorded (SS 1). Bird species richness varied from 15 in transect C I to 34 in transect In II. Among the bird species recorded, seven species fall under the category of invasive species, namely Rock Pigeon (*Columba livia*), Common Myna (*Acridotheres tristis*), Eurasian Collared-Dove (*Streptopelia decaocto*), House Crow (*Corvus splendens*), House Sparrow (*Passer domesticus*), Red-vented Bulbul (*Pycnonotus cafer*) and Rose-ringed Parakeet (*Psittacula krameri*). All transects had six to seven invasive species while the native species richness varied from 9 to 28. Transect R I and C I had the lowest native species richness while In II had the maximum number of native bird species (Table 2). The total percent abundance of invasive bird species was highest in transect C I (98.33%), followed by R I, R II, and C II. The abundance of invasive species was comparatively lower in transects In I (77.72%) and In II (75.71%) than other transects (Table 3).

Road cover significantly decreased bird species richness, species diversity and species evenness by 0.46 (β = -0.64), 0.09 (β = -0.91) and 0.03 (β = -0.88) respectively (Table 4).

Table 1. Habitat features of six selected transects

Transect components	R I	R II	C I	C II	In I	In II
Built cover (%)	89.66	69.57	92.4	66.08	88.12	80.27
Road cover (%)	7.79	18.47	6.47	2.24	1.72	1.99
Green cover (%)	2.54	11.95	1.13	31.69	10.17	17.73
Public parks	-	2	-	1	-	1
Average road width	3 m	4 m	2.5 m	8 m	5 m	4.5 m
Tree species richness	13	42	1	20	24	22
Tree count	25	361	1	92	301	143

- Absent

Table 2. Species richness and relative abundance of birds from different nativity status in the selected transects

Transects	Total species richness	Native species		Invasive species	
		Richness	Abundance	Richness	Abundance
R I	17	10	0.15	7	0.85
R II	30	23	0.15	7	0.85
C I	15	9	0.02	6	0.99
C II	24	18	0.16	6	0.84
In I	30	23	0.22	7	0.78
In II	34	28	0.24	6	0.76

Green cover significantly increased the bird count per observation by 3.30 (β = 1.55) while it decreased the bird diversity by 0.02 (β = -0.39) and evenness by 0.01 (β = -0.44). Tree species richness significantly increased the bird species richness, species diversity and species evenness by 0.39 (β = 1.15), 0.11 (β = 2.33) and 0.04 (β =2.52) respectively. Tree count significantly increased the bird count per observation by 0.25 (β = 1.56) but was related to decreased bird species diversity and evenness. The tree species richness increased bird species richness, species diversity as well as evenness while tree count increased the bird count per observation. The tree species richness is more important than green cover and tree number for the sustenance of a diverse urban avifauna. Road cover decreased bird species richness, species diversity and species evenness but bird count per observation. Since road cover is an indicator of urbanization, it may be derived that although urban habitats may show larger bird count, the species richness, diversity and evenness is low. This is an indication for species homogeneity recorded in various studies based in urban habitats. Road cover and green cover significantly increased the abundance of invasive species by 1.77 (β = 1.20) and 0.51 (β = 0.60), respectively (Table 4). Tree species richness significantly decreases the abundance of invasive species by 1.47 (β = -2.09). Tree count on the other hand increased the invasive species abundance by 0.06 (β = 0.86).

Road cover had the most positive effect on the abundance of invasive species. Of all the studied independent variables, only tree species diversity had a significant negative impact on the abundance of invasive species. Over the years several studies have shown the negative impact of urbanization on local biodiversity, both floral and faunal (Evans et al 2009). The success of invasive bird species has been attributed to their ability to exploit ecological opportunities that most native bird species are not able to (Sol et al 2012 and González-Oreja at al 2018). Several studies have shown an increase in taxonomic homogenization in urban centres (Crooks et al 2004 and Menon and Mohanraj 2016). Similar results were observed in

Table 3. Relative abundance of Invasive bird species at selected transects (%)

Invasive bird species	R I	R II	C I	C II	In I	In II	Overall
Rock pigeon	50.71	23.88	87.25	29.35	42.04	24.99	43.04
Common Myna	8.65	8.75	3.35	16.81	6.09	17.52	10.2
Eurasian collared-dove	9.83	8.86	3.12	5.36	9.25	13.65	8.34
House crow	5.34	16.05	2.91	21.78	6.71	7.5	10.05
House sparrow	6.07	16.69	-	-	0.37	-	3.85
Red-vented bulbul	4.5	8.14	1.01	3.99	11.2	6.1	5.82
Rose-ringed parakeet	0.31	2.6	0.69	6.56	2.06	5.95	3.03
Total abundance	85.41	84.97	98.33	83.85	77.72	75.71	84.33

- Absent

Table 4. Effect of habitat features on bird species richness, species diversity, species evenness, bird count per observation and abundance of invasive species

Parameter	Species richness		Species diversity		Species evenness		Bird count per observation		Invasive species abundance	
	B (SE)	Beta	B (SE)	Beta	B (SE)	Beta	B (SE)	Beta	B (SE)	Beta
Constant	9.17 (0.71)		1.09 (0.03)		0.47 (0.01)		39.83 (2.56)		87.84 (1.30)	
Road cover (%)	-0.46 (0.10)	-0.64*	-0.09 (0.00)	-0.91*	-0.03 (0.00)	-0.88*	3.80 (0.37)	1.02*	1.77 (0.19)	1.20*
Green cover (%)	-0.06 (0.06)	-0.14	-0.02 (0.00)	-0.39*	-0.01 (0.00)	-0.44*	3.30 (0.21)	1.55*	0.51 (0.11)	0.60*
Tree species diversity	0.39 (0.11)	1.15*	0.11 (0.01)	2.33*	0.04 (0.00)	2.52*	-3.88 (0.38)	-2.19*	-1.47 (0.19)	-2.09*
Tree count	0.00 (0.01)	-0.15	0.00 (0.00)	-1.03*	0.00 (0.00)	-1.25*	0.25 (0.03)	1.56*	0.06 (0.01)	0.86*
R^2		0.60		0.95		0.92		0.82		0.70
Adjusted R^2		0.58		0.95		0.92		0.81		0.68

*p < 0.001

the present study with few invasive bird species forming more than 75% of species abundance in all transects. Previous studies have also recorded the spatial association between alien bird species and high human density (Hugo and Rensburg 2009). McLean et al (2017) cautioned that urban centres may become launching sites for invasive species into peri-urban and natural habitats making it all the more important to study the habitat factors that affect the success of invasive species in the cities. The most densely urbanized and unplanned transects, R I and C I showed the lowest bird species richness, which may be attributed to their lower tree species richness compared to planned residential areas, and industrial areas on the outskirts of city. Sub-urban areas can have a higher bird species richness due to villages and village ponds attracting a variety of bird species (Sekhon et al 2023). Trees species richness was observed to have a strong positive effect on the bird species richness, species diversity as well as evenness. The negative impact of road cover on bird species richness, species diversity and evenness also explain the lower bird diversity observed in densely urbanized regions. Kaushik et al (2020) also observed that the size of urban green patches and tree richness were important factors affecting bird species richness and density.

Tree species diversity had a significantly positive impact on urban bird diversity and also related to low abundance of invasive bird species. In a similar study, bird species diversity was positively related to shrub species richness where birds preferred gardens with high tree and shrub species richness (Parker et al 2014). In the same study it was observed that native bird species preferred native tree species for feeding while alien bird species preferred alien tree species. Other studies have reported an increase in bird species richness with increase in size of urban green spaces and presence of native forests (Carbó-Ramírez and Zuria 2011 and Dale 2018). Retaining established native trees has also been reported to be effective in maintaining higher bird diversity in new urban centres (Barth et al 2015). Karjee et al (2022) conducted a study in a peri-urban area of east India and found that agricultural fields and degraded croplands helped maintain bird diversity. Increase in road cover, green cover and tree count had a positive impact on invasive species while tree species richness decreased the abundance of invasive bird species. Similar results were obtained by Tu et al (2020) where building area had a positive impact on number of birds. Studies report higher bird counts in cities where a few species dominate the urban landscape with high numbers (Ortega-Álvarez and MacGregor-Fors 2009 and Yuan and Lu 2016). Often similar to the present study these species are invasive bird species which exploit the various feeding and nesting opportunities provided by the cities.

CONCLUSION

The current urban landscape provides an unequal advantage to the invasive species and simply increasing urban green cover is not sufficient. There is a need for planned urban greening with the focus on increasing the vegetative diversity of the cities to maintain a diverse urban avifauna.

REFERENCES

Abd Rabou AFN 2022. On the occurrence, trapping and potential risks of the invasive Indian Myna (*Acridotheres tristis* Linnaeus, 1766) in the Gaza Strip: Palestine. *International Journal of Fauna and Biological Studies* **9**(5):45-55.

Ahmad S, Khan HA and Javed M 2012. An Estimation of Rose-Ringed Parakeet (*Psittacula krameri*) Depredations on Citrus, Guava and Mango in Orchard Fruit Farm. *International Journal of Agricultural Biology* **14**(1): 149-152.

Ali S 2002. *The Book of Indian Birds*. Oxford University Press, New Delhi.

Barth BJ, FitzGibbon SI and Wilson RS 2015. New urban developments that retain more remnant trees have greater bird diversity. *Landscape and Urban Planning* **136**: 122-129.

Blackburn TM, Lockwood JL and Cassey P 2009. Avian invasions: the ecology and evolution of exotic birds (Vol. 1). Oxford University Press, USA.

Blackburn TM, Pyšek P, Bacher S, Carlton JT, Duncan RP, Jarošík V, Wilson JR and Richardson DM 2011. A proposed unified framework for biological invasions. *Trends in Ecology & Evolution* **26**(7): 333-339.

Capinha C, Essl F, Seebens H, Moser D and Pereira HM 2015. The dispersal of alien species redefines biogeography in the Anthropocene. *Science* **348**: 1248-1251.

Carbó-Ramírez P and Zuria I 2011. The value of small urban greenspaces for birds in a Mexican city. *Landscape and Urban Planning* **100**(3): 213-222.

Crooks KR, Suarez AV and Bolger DT 2004. Avian assemblages along a gradient of urbanization in a highly fragmented landscape. *Biological Conservation* **115**(3): 451-462.

Crowl TA, Crist TO, Parmenter R, Belovsky G and Lugo AE 2008. The spread of invasive species and infectious disease as drivers of ecosystem change. *Frontiers of Ecology and Environment* **6**(5): 238-246.

Dale S 2018. Urban bird community composition influenced by size of urban green spaces, presence of native forest, and urbanization. *Urban Ecosystems* **21**(1): 1-14.

Dawson W, Moser D, Kleunen MV, Kreft H, Pergl J, Pyšek P, Weigelt P, Winter M, Lenzner B, Blackburn TM and Dyer E 2017. Global hotspots and correlates of alien species richness across taxonomic groups. *Nature Ecology and Evolution* **1**(7): 186.

Dove CJ, Snow RW, Rochford MR and Mazzotti FJ 2011. Birds consumed by the invasive Burmese python (*Python molurus bivittatus*) in Everglades National Park, Florida, USA. *Wilson Journal of Ornithology* **123**(1): 126-131.

Evans KL, Gaston KJ, Sharp SP, McGowan A and Hatchwell BJ 2009. The effect of urbanisation on avian morphology and latitudinal gradients in body size. *Oikos* **118**(2): 251-259.

Global Invasive Species Database GISD 2015 Available from: http://www.iucngisd.org/gisd/

González-Oreja JA, Zuria I, Carbó-Ramírez P and Charre GM 2018. Using variation partitioning techniques to quantify the effects of invasive alien species on native urban bird assemblages. *Biological Invasions* **20**(10): 2861-2874.

Grimmett R, Inskipp C and Inskipp T 2016. Birds of the Indian Subcontinent: India, Pakistan, Sri Lanka, Nepal, Bhutan, Bangladesh and the Maldives. Bloomsbury Publishing, India.

Hugo S and Van Rensburg BJ 2009. Alien and native birds in South Africa: Patterns, processes and conservation. *Biological Invasions* **11**(10): 2291-2302.

Karjee R, Palei HS, Konwar A, Gogoi A and Mishra RK 2022. Bird Assemblages in a Peri-Urban Landscape in Eastern India. *Birds* **3**: 383-401.

Krishen P 2006. *Trees of Delhi: A field guide*. Penguin Books, India.

Mahey K and Tripathi S 2016. Urbanization and Economic Growth in Punjab (India): An Empirical Analysis. *Urban Research & Practice* **10**(4): 379-402.

McLean P, Gallien L, Wilson JR, Gaertner M and Richardson DM 2017. Small urban centres as launching sites for plant invasions in natural areas: insights from South Africa. *Biological Invasions* **19**(12): 3541-3555.

Menon M and Mohanraj R 2016. Temporal and spatial assemblages of invasive birds occupying the urban landscape and its gradient in a southern city of India. *Journal of Asia- Pacific Biodiversity* **9**(1): 74-84.

Kaushik M, Tiwari S and Manisha K 2020. Habitat patch size and tree species richness shape the bird community in urban green spaces of rapidly urbanizing region of India. *BioRxiv* 2020-10.

Nagendra H, Sudhira HS, Katti M, Tengo M and Schewenius M 2014. Urbanization and its impacts on land use, biodiversity and ecosystems in India. *Interdisciplina* **2**: 305-313.

Ortega-Álvarez R and MacGregor-Fors I 2009. Living in the big city: Effects of urban land-use on bird community structure, diversity, and composition. *Landscape and Urban Planning* **90**: 189-195.

Paker Y, Yom-Tov Y, Alon-Mozes T and Barnea A 2014. The effect of plant richness and urban garden structure on bird species richness, diversity and community structure. *Landscape and Urban Planning* **122**: 186-195.

Praveen J, Jayapal R and Pittie A 2016. A checklist of the birds of India. *Indian Birds* **11**(5&6): 113-172.

Sahni KC 1998. The Book of Indian Trees. Oxford University Press, India.

Sekhon GS, Aulakh RK and Kler TK 2023. Village Ponds as Unexplored Habitation Sites for Resident Migratory and Migratory Bird Species in Punjab State, India. *Indian Journal of Ecology* **50**(3): 864-869.

SoIB 2020. State of India's Birds, 2020: Range, trends and conservation status. The SoIB Partnership.

Sol D, Bartomeus I and Griffin AS 2012. The paradox of invasion in birds: competitive superiority or ecological opportunism? *Oecologia* **169**(2): 553-564.

Tu HM, Fan MW and Ko JCJ 2020. Different habitat types affect bird richness and evenness. *Scientific Reports* **10**(1): 1-10.

Verner J 1985. Assessment of counting techniques. Current ornithology, Springer, Boston, p 247-302.

Yuan B and Lu C 2016. Effects of urbanization on bird diversity: A case study in Yizhou, Guangxi Province, China. *Asia Life Sciences* **25**(1): 79-96.

Received 02 July, 2023; Accepted 22 October, 2023