

# Natural remnants are refuges for rare birds in an urban area: a study from Pune city, India

Kiran CHOUDAJ<sup>1,2\*</sup> & Chaitali SHAHA<sup>1,3</sup>



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**Abstract** The green spaces in many urban areas are under severe threats; the area under green cover is declining, habitat quality is deteriorating due to fast urbanisation and the booming real estate market. Therefore, we investigated the avian richness of a natural remnant area and compared it with species richness data previously published in the literature about gardens, urban parks, and academic campuses in Pune, India. In two years of our survey, we recorded 65 species at the natural remnant site, 15 of which are rare considered in urban areas. Among recorded species, 17 are habitat specialists and 14 have declining population. Natural remnant patches are generally inaccessible to the general public; they have undergrowth of vegetation and aerial leaf litter, which may be the reason for the higher species richness and the occurrence of rare species. Our findings indicate that the natural remnant site in Pune has a unique and relatively rich assemblage of bird species, thus provide further support for the notion that natural remnant sites are valuable for urban biodiversity conservation. Therefore, we suggest that small, isolated patches of natural vegetation should receive more attention in conservation planning.

Keywords: avifauna, ecological value, native vegetation, unique biodiversity, urban ecology and sustainability

**Összefoglalás** A zöldfelületek sok városi területen komoly veszélynek vannak kitéve; a területük csökken, az élőhelyek minősége romlik a gyors urbanizáció és a fellendülő ingatlanpiac miatt. Jelen vizsgálatban összehasonlítottuk a megmaradt természetes területek fajgazdagságát a korábban Pune-i kertekből, városi parkokból és egyetemi kampuszokból megjelent szakirodalmi adatokkal. Felmérésünk két éve alatt 65 fajt rögzítettünk ezeken a maradványterületeken, amelyek közül 15 ritka a városi környezetben. A nyilvántartott fajok közül 17 élőhelyspecialista, 14 csökkenő állományú. A természetes visszamaradt foltok a nagyközönség számára hozzáférhetetlenek; aljnövényzetük dús, és jelentős a lombzatban rekedt lehulló falevelek aránya is. Ez lehet az oka a magasabb fajgazdagságnak és a ritka fajok előfordulásának. Eredményeink azt mutatják, hogy a természetes élőhelymaradványok egyedülálló madárfaj-társulásokkal rendelkeznek; ezek a maradványok értékesek a városi biodiverzitás megőrzése szempontjából. A természetvédelmi tervezés során előnyben kell részesíteni a kis, elszigetelt, természetes növényzetfoltokat.

Kulcsszavak: madárvilág, ökológiai érték, őshonos növényzet, egyedülálló biodiverzitás, városökológia és fenntarthatóság

<sup>1</sup> Department of Zoology, Savitribai Phule Pune University, Ganeshkhind, Pune, India 411007

<sup>2</sup> Department of Biodiversity, Abasaheb Garware College, Karve Road, Pune, India 411004

<sup>3</sup> Department of Zoology, Modern College of Arts, Commerce and Science, Ganeshkhind, Pune, India, 411007

\* corresponding author; e-mail: kiranchoudaj@gmail.com

## Introduction

Cities are expanding rapidly around the world in both size and density, significantly impacting urban ecosystems. More than half of the world's population lives in urban areas, and it is expected to reach six billion by 2041 (United Nations 2018). Urban growth leads to deforestation, which diminishes ecosystem services that are beneficial to people

and biodiversity. Urbanisation affects various spheres of society, the environment, and biodiversity (Parris 2016). Urbanisation generally decreases the variety of plant species, homogenises the habitat, encourages invasive non-native species, modifies phenological occurrences, and due to pollution, may hinder plant development (Raus *et al.* 2022). Urban green spaces are one of the most important elements of any urban ecosystem because of their dynamism and their essential contribution to the well-being of mankind. In urban habitats, at first, the original vegetation is cleared due to the need for land for buildings, and later, artificial landscapes are created in the newly developed areas. The composition and structure of artificial landscapes are also changing in urban habitats; gardens that used to have local plants are replaced by turf grass and exotic plants in landscape design (Nagendra & Gopal 2010, Nagendra 2016). These artificial landscapes are created mainly for recreational activities, and less attention is paid to their ecological role. The turf grass and exotic ornamental plants that dominate urban green spaces make it difficult for native plants to grow and offer little habitat for wildlife (Choudaj & Wankhade 2022).

The urban habitat is primarily composed of housing developments and retains very low species diversity (Sewell & Catterall 1998). Urbanisation has an impact on bird populations, and species richness typically diminishes in urban settings, leading to assemblages of generalist and urban-adapted species (Chace & Walsh 2006). Remnant natural vegetation is vital for the sustainability of urban wildlife since it provides resources such as food and shelter for many species; bird diversity is positively associated with retaining native vegetation within the urban matrix (Evans *et al.* 2009). It was reported that green areas with native vegetation have a greater richness of bird species than recently developed artificial landscapes with exotic vegetation (Sewell & Catterall 1998, Chace & Walsh 2006).

Currently, urbanisation is rapid in India, which will have the world's largest urban population by 2050 (United Nations 2019). Despite the importance of natural vegetation, human settlements have encroached on additional land that is needed to keep up with the unsustainable growth of the human population. Pune is one of the fastest-growing metropolitan areas in Asia, and Pune Municipal Corporation has become the largest in the Maharashtra state of India. The influx of people to the Pune urban area has created a huge demand for land for infrastructure and housing projects that are transforming native vegetation and agricultural land into built-up areas (Butsch *et al.* 2017). The use of exotic plants for urban beautification is increased in Pune; exotic plantations over hills are present in the city (Punalekar *et al.* 2010); a higher percentage of exotic plants is common in newly created gardens and parks (Choudaj & Wankhade 2022).

Urban sprawl intruded on all natural habitats in the Pune urban area, and as a result, bird diversity has decreased across all the habitats (Ingalhalikar *et al.* 2001). Nerlekar *et al.* (2016) and Choudaj and Wankhade (2021a) studied the avifauna of premier academic institutions in Pune city, noted decline in richness of birds due to loss of suitable habitat. Exotic plantations over the native savannas of Pune city affected grassland birds (Choudaj & Wankhade 2021b). Small green spaces with native plants support more birds, but increasing percentage of exotic plants negatively affect them, especially the specialist ones (Choudaj & Wankhade 2022). All the habitats in the Pune urban area have been surveyed for birds except the natural remnant vegetation. Most of the studies investigating the importance of

natural vegetation in urban biodiversity conservation have been carried out in the western part of the world (Pautasso *et al.* 2011, Aronson *et al.* 2014), and even though there are numerous studies in south Asian developing countries (Bhagwat & Rutte 2006, Devkota 2013, Mohammad *et al.* 2013, Gopal *et al.* 2018, Sarkar & Mujumdar 2022), these studies are generally lacking from India. Thus, our goal was to explore the bird diversity of natural remnant vegetation in the Pune urban area.

## Material and Methods

### Study area

Pune city is located on the eastern edge of the Western Ghats; some hill ranges pass through it in a north-south direction. The current study was conducted at a natural remnant vegetation patch (9.71 ha) at Pashan Lake (*Figure 1*). This remnant patch contains both native and exotic plant species (*Figure 2*). Native tree species recorded are *Acacia nilotica*, *Acacia polyacantha*, *Pongamia pinnata*, *Phoenix sylvestris*, *Dalbergia sissoo*, *Dalbergia lanceolaria*, *Bombax ceiba*, *Ficus religiosa*, *Ficus benghalensis*, *Cordia obliqua*, *Broussonetia papyrifera*, *Senna siamea*, *Morinda pubescens*, *Azadirachta indica*, *Ziziphus mauritiana*, *Syzygium cumini*, *Albizia procera*, *Trema orientalis*. Exotic tree species recorded

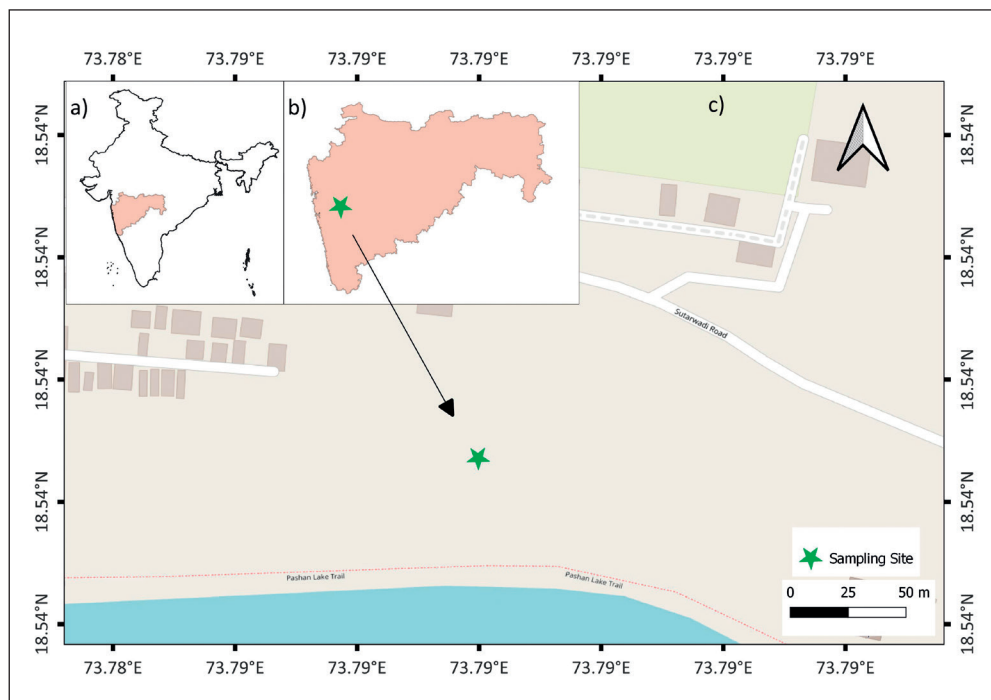


Figure 1. Map of the study area

1. ábra A vizsgált terület térképe



Figure 2. Photograph of natural remnant patch  
2. ábra Fénykép a természetes maradvány területről

are *Gliricidia sepium*, *Samanea saman*, *Tamarindus indica*, *Eucalyptus globules*, *Delonix regia*, and *Spathodea campanulata*. Invasion of exotic plant species, *Lantana camara* and *Leucaena leucocephala*, is also seen in the remnant patch. The average rainfall is 763 mm; the mean annual temp is 24.3 °C.

### Bird survey

The bird survey was conducted between October 2020 and December 2022. The remnant vegetation patch was visited at least once per month. The birds were counted from 7 a.m. to 11 a.m. and from 4 p.m. to 6 p.m. The remnant patch was visited for at least an hour. The entire patch of the natural remnant (9.71ha) was surveyed at each visit by walking through the site and along the edges. Birds were photographed with a Nikon Coolpix B600 and observed with Olympus 10–50 DPS I binoculars. For the identification of birds, we used the field guides of Ali (2002) and Grimmett *et al.* (2011). For nomenclature, we followed Praveen *et al.* (2016), and the food preference of birds was extracted from Ali (2002). All the birds recorded were categorised into four foraging guilds: insectivores, predators, herbivores, and omnivores. Bird information about habitat specialisation, current population trends, and migratory status was taken from the report “State of India’s Birds” (SoIB 2020).

## Results

We recorded 65 species of birds during the study (*Table 1*). Omnivores were dominant (32 species), followed by insectivores (12 species), predators (11 species), and herbivores (8 species) (*Table 1*). Most of the species recorded during the study were residents (58 species), and 7 species were migrants (local migrant: – 4, long-distance migrant: 3). Out of the 65 species recorded at the study site, 17 species were habitat specialists, of which 16 were woodland dwellers (SoIB 2020) (*Table 1*). Current population trend analysis of recorded species shows that, out of 65 species, the population of 14 species is declining (SoIB 2020). Spotted Dove *Spilopelia chinensis*, Yellow-legged Green Pigeon *Treron phoenicopterus*, Grey-bellied Cuckoo *Cacomantis passerines*, Common Hawk Cuckoo *Hierococcyx varius*, Black-winged Kite *Elanus caeruleus*, Oriental Honey Buzzard *Pernis ptilorhynchus*, White-cheeked Barbet *Psilopogon viridis*, Ashy Drongo *Dicrurus leucophaeus*, Thick-billed Flowerpecker *Dicaeum agile*, Forest Wagtail *Dendronanthus indicus*, Puff-throated Babbler *Pellorneum ruficeps*, Chestnut-tailed Starling *Sturnia malabarica*, Malabar Whistling Thrush *Myophonus horsfieldii*, Orange-headed Thrush *Geokichla citrina*, Indian Blackbird *Turdus simillimus* were some of the bird species recorded in the natural remnant site.

## Discussion

Birds use land cover characteristics as important cues when choosing their habitat (Cody 1981). Habitat preference of birds is influenced by the density and diversity of plant species, the number and percentage of native flora and the amount of anthropogenic disturbance (Mills *et al.* 1989, Chamberlain *et al.* 2007). Previous studies have shown that cemeteries (Čanádý & Mošanský 2017, Löki *et al.* 2019) and sacred sites (Devkota 2013, Gopal *et al.* 2018, Sarkar & Mujumdar 2022) are crucial habitats for sensitive and threatened species as well as significant areas for biodiversity conservation in the urban environment. Areas such as natural remnants, cemeteries and sacred sites act as habitat islands for many rare and native species in urban areas (Bhagwat & Rutte 2006). Birds can be seen in all the microhabitats in urban landscapes, often abundant in areas with suitable survival conditions (Cody 1981, Veech *et al.* 2010).

In this study, we recorded 65 bird species in a single natural vegetation patch that hosts higher richness than 20 smaller green spaces (artificial gardens and parks) in the same city (Choudaj & Wankhade 2022). The rare bird species recorded at the natural remnant site were absent from survey conducted in gardens and parks. Vegetation is the primary factor in habitat selection of birds in the urban environment; birds benefit from the diversity of native plants, which may explain the higher species richness in our study (Chace & Walsh 2006, Choudaj & Wankhade 2022).

According to the “State of India’s Birds report”, hundreds of bird species in India are in decline. Raptors, migratory seabirds and habitat specialists have been the most affected birds in the past decades due to habitat destruction, hunting and pet trade. Current annual trends were estimated for 146 bird species, of which 80% are declining, with almost 50% declining strongly (SoIB 2020). In Pune, due to urbanisation, the richness of rare and habitat-specific

**Table 1.** The bird species recorded in the natural remnant at Pashan lake with their common and scientific name, feeding guild (O – omnivore, I – insectivore, H – herbivore, P – predator), habitat specialisation (G – generalist, S – specialist) and global population trend (↓ – declining, ↑ – increasing, → – stable, ? – uncertain), migratory status (R – resident, LM – local migrant, LD – long distance migrant)

**1. táblázat** A Pashán-tónál található természetes maradványban feljegyzett madárfajok angol és tudományos nevükkel, táplálkozási guilddel (O – mindenevő, I – rovarevő, H – növényevő, P – ragadozó), élőhely specializációval (G – generalista, S – specialista) ill. globális populációs trend (↓ – csökkenő, ↑ – növekvő, → – stabil, ? – bizonytalan), vonulási típus (R – állandó, LM – rövidtávú vonuló, LD – hosszútávú vonuló)

	Common Name	Scientific Name	Food Habit	Habitat specialization	Current population trend	Migratory Status
1	Rock Pigeon	<i>Columba livia</i>	H	G	↑	R
2	Spotted Dove	<i>Spilopelia chinensis</i>	H	G	→	R
3	Laughing Dove	<i>Spilopelia senegalensis</i>	H	G	?	R
4	Yellow-legged Green Pigeon	<i>Treron phoenicopterus</i>	H	G	↑	R
5	Greater Coucal	<i>Centropus sinensis</i>	P	G	↑	R
6	Asian Koel	<i>Eudynamys scolopaceus</i>	O	G	↑	R
7	Grey-bellied Cuckoo	<i>Cacomantis passerinus</i>	I	G	?	R
8	Common Hawk Cuckoo	<i>Hierococcyx varius</i>	I	S	↓	R
9	Red-wattled Lapwing	<i>Vanellus indicus</i>	P	G	↓	R
10	Black-winged Kite	<i>Elanus caeruleus</i>	P	S	↓	R
11	Oriental Honey-buzzard	<i>Pernis ptilorhynchus</i>	O	S	↓	R
12	Shikra	<i>Accipiter badius</i>	P	G	→	R
13	Black Kite	<i>Milvus migrans</i>	P	G	?	R
14	Spotted Owlet	<i>Athene brama</i>	P	G	?	R
15	Indian Grey Hornbill	<i>Ocyrceros birostris</i>	O	G	?	R
16	Coppersmith Barbet	<i>Psilopogon haemacephalus</i>	H	S	?	R
17	White-cheeked Barbet	<i>Psilopogon viridis</i>	H	G	?	R
18	Green Bee-eater	<i>Merops orientalis</i>	I	G	↓	R
19	White-throated Kingfisher	<i>Halcyon smyrnensis</i>	P	G	↓	R
20	Alexandrine Parakeet	<i>Psittacula eupatria</i>	H	S	↑	R
21	Rose-ringed Parakeet	<i>Psittacula krameri</i>	H	G	→	R
22	Small Minivet	<i>Pericrocotus cinnamomeus</i>	I	S	↓	R
23	Eurasian Golden Oriole	<i>Oriolus oriolus</i>	O	G	?	LM
24	Common Iora	<i>Aegithina tiphia</i>	O	S	↓	R
25	Black Drongo	<i>Dicrurus macrocercus</i>	O	G	↓	R
26	Ashy Drongo	<i>Dicrurus leucophaeus</i>	O	S	?	LM
27	White-browed Fantail	<i>Rhipidura aureola</i>	I	S	?	R
28	Long-tailed Shrike	<i>Lanius schach</i>	P	G	↓	R

	Common Name	Scientific Name	Food Habit	Habitat specialization	Current population trend	Migratory Status
29	Rufous Treepie	<i>Dendrocitta vagabunda</i>	O	G	?	R
30	House Crow	<i>Corvus splendens</i>	O	G	→	R
31	Jungle Crow	<i>Corvus macrorhynchos</i>	O	G	→	R
32	Indian Paradise-flycatcher	<i>Terpsiphone paradise</i>	I	S	?	LM
33	Thick-billed Flowerpecker	<i>Dicaeum agile</i>	O	G	?	R
34	Pale-billed Flowerpecker	<i>Dicaeum erythrorhynchos</i>	O	G	↑	R
35	Purple-rumped Sunbird	<i>Leptocoma zeylonica</i>	O	G	?	R
36	Purple Sunbird	<i>Cinnyris asiaticus</i>	O	G	→	R
37	Baya Weaver	<i>Ploceus philippinus</i>	O	G	↓	R
38	Scaly-breasted Munia	<i>Lonchura punctulata</i>	H	G	?	R
39	House Sparrow	<i>Passer domesticus</i>	O	G	→	R
40	Forest Wagtail	<i>Dendronanthus indicus</i>	P	S	↓	LD
41	Cinereous Tit	<i>Parus cinereus</i>	I	G	?	R
42	Ashy Prinia	<i>Prinia socialis</i>	I	G	?	R
43	Plain Prinia	<i>Prinia inornata</i>	O	G	?	R
44	Grey breasted Prinia	<i>Prinia hodgsonii</i>	O	G	?	R
45	Common Tailorbird	<i>Orthotomus sutorius</i>	O	G	↑	R
46	Blyth's Reed Warbler	<i>Acrocephalus dumetorum</i>	I	G	?	LD
47	Red-whiskered Bulbul	<i>Pycnonotus jacosus</i>	O	G	?	R
48	Red-vented Bulbul	<i>Pycnonotus cafer</i>	O	G	→	R
49	Greenish Warbler	<i>Phylloscopus trochiloides</i>	P	S	?	LM
50	Yellow-eyed Babbler	<i>Chrysomma sinense</i>	O	G	↓	R
51	Oriental White-eye	<i>Zosterops palpebrosus</i>	O	G	?	R
52	Puff-throated Babbler	<i>Pellorneum ruficeps</i>	P	S	?	R
53	Large Grey Babbler	<i>Argya malcolmi</i>	O	G	?	R
54	Brahminy Starling	<i>Sturnia pagodarum</i>	O	G	?	R
55	Chestnut-tailed Starling	<i>Sturnia malabarica</i>	O	S	?	R
56	Common Myna	<i>Acridotheres tristis</i>	O	G	→	R
57	Jungle Myna	<i>Acridotheres fuscus</i>	O	G	↓	R
58	Indian Robin	<i>Saxicoloides fulicatus</i>	P	G	?	R
59	Oriental Magpie Robin	<i>Copsychus saularis</i>	O	G	→	R
60	Tickell's Blue Flycatcher	<i>Cyornis tickelliae</i>	I	S	?	R
61	Red-breasted Flycatcher	<i>Ficedula parva</i>	I	S	?	LD
62	Pied Bushchat	<i>Saxicola caprata</i>	I	G	?	R
63	Malabar Whistling Thrush	<i>Myophonus horsfieldii</i>	O	G	?	R
64	Orange-headed Thrush	<i>Geokichla citrina</i>	O	S	?	R
65	Indian Blackbird	<i>Turdus simillimus</i>	O	G	?	R

birds is declining in all the habitats (Ingalhalikar *et al.* 2001), including the academic campus (Nerlekar *et al.* 2016, Choudaj & Wankhade 2021a) and hills (Choudaj & Wankhade 2021b). The presence of rare habitat specialists and threatened species in natural remnants highlights the importance of this habitat type in the sustainability of urban biodiversity.

Though we observed the invasion of exotic plant species, *Leucaena leucocephala* and *Lantana camara* in the natural remnant site, it still retains higher avian richness than gardens and parks. The following reasons could contribute to this: this site is inaccessible to the public and it has significant amount of undergrowth of vegetation and aerial leaf litter. Many arthropod species flourish in aerial leaf litter, which serves as an important foraging resource for many insectivorous bird species (Mansor *et al.* 2019). In this study, we observed insectivorous species such as Forest Wagtail *Dendronanthus indicus*, Puff-throated Babbler *Pellorneum ruficeps*, Malabar Whistling Thrush *Myophonus horsfieldii*, Orange-headed Thrush *Geokichla citrina* exploiting leaf litter. The absence of these species in gardens and urban parks may be due to the regular cleaning of leaf litter and the presence of artificial grass, which is a potential threat to ground-feeding birds (Sánchez-Sotomayor *et al.* 2022).

Birds are vulnerable to urbanisation and species richness typically drops in urban centres, leading to generalist and urban-adapted species assemblages (Lim & Sodhi 2004, Chace & Walsh 2006, Devictor *et al.* 2007, van Heezik *et al.* 2008). Many species rely on isolated, remnant natural vegetation for food and shelter, and the presence of this habitat type has been linked to increased bird diversity (Sewell & Catterall 1998, Chace & Walsh 2006, Evans *et al.* 2009).

Most of the cities are established in areas of rich biodiversity. Natural vegetation became fragmented due to extensive development for urbanisation and scattered in small patches. Small, isolated patches are given lower priority in conservation planning because of a belief that they have limited ecological significance (Tulloch *et al.* 2016). The global analysis demonstrates that biodiversity declines when small, isolated patches are ignored, along with numerous species that are unique to particular environments (Wintle *et al.* 2019). Therefore, we advocate prioritising the preservation of natural remnants in urban environments, which will benefit not only birds but also other species that use this type of habitat. The role of natural vegetation in biodiversity has been well studied and understood in developed countries (Western Europe and the United States of America) (Pautasso *et al.* 2011, Aronson *et al.* 2014), more studies are needed in other parts of the world, especially in developing countries. Managers and wildlife planners need to understand the significance of such habitats from the perspective of biodiversity protection.

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