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Preliminary study on birds of Rajgir Wildlife Sanctuary, Nalanda, Bihar, India

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Abstract
India's diverse physiography and climatic gradients support exceptional biological richness, particularly of birds, which serve as sensitive indicators of habitat condition and environmental change. Despite this, systematic avifaunal assessments in Bihar's forested protected areas remain sparse. Rajgir Wildlife Sanctuary (WLS), located at the interface of the Chotanagpur Plateau and the Gangetic plains, encompasses a heterogeneous landscape of Sal-dominated forests, bamboo patches, scrublands, and rocky hill systems, creating a range of ecological niches for avian communities. The present study provides a preliminary assessment of bird diversity in Rajgir WLS with the aim of establishing baseline information for conservation planning and long-term monitoring. Birds were surveyed from March to October 2022, employing transect count methods across key habitats. A total of 77 bird species belonging to 60 genera, 41 families, and 12 orders were recorded. The assemblage was dominated by Passerines, with insectivorous and omnivorous guilds most prevalent. Community structure was characterised by a few abundant resident species and a large proportion of low-abundance taxa, while migratory species were represented sparsely. Although temporally limited, the study underscores the ecological significance of Rajgir WLS and provides a foundational reference for future avifaunal research and management interventions.

Keywords: Baseline survey, bird inventory, nalanda, species richness, rajgir wildlife sanctuary, relative abundance

Introduction
India supports a remarkable diversity of bird species due to its varied climate, physiography, and vegetation types (Grimmett *et al.,* 2011 [8]; Praveen, Jayapal & Pittie (2016) [13]. Birds play vital ecological roles as pollinators, seed dispersers, predators, and scavengers, and are widely recognised as effective indicators of habitat condition and environmental change (Gregory *et al.,* 2003; Sutherland, 2006) [7, 16]. Consequently, assessments of avian diversity form an essential component of biodiversity documentation and provide critical baseline information for conservation planning, particularly in protected areas experiencing rapid land-use and management changes (Bibby *et al.,* 2000; Khan & Pant, 2017) [2, 9].

In eastern India, especially in Bihar, avifaunal studies remain spatially limited despite the presence of diverse forest, wetland, and agro-ecological landscapes (Khan & Pant, 2017) [9]. Existing ornithological research in the region has largely focused on riverine systems and wetlands of the Gangetic plains, while forested protected areas have received comparatively less systematic attention (Debnath *et al.,* 2018; Singh, 2022) [5, 15]. As a result, baseline data on species composition, habitat associations, and seasonal occurrence remain inadequate for several wildlife sanctuaries, limiting effective conservation prioritisation and long-term monitoring efforts (Panda, 2021) [12].

Rajgir Wildlife Sanctuary (WLS), located in Nalanda district of Bihar, occupies a biogeographically important transitional zone between the Chotanagpur Plateau and the middle Gangetic plains. The sanctuary encompasses a heterogeneous mosaic of Sal-dominated forests, mixed deciduous forests, bamboo patches, scrub–grasslands, rocky hill slopes, seasonal streams, and plantation areas, which collectively support diverse avian guilds (Champion & Seth, 1968; Khan & Pant, 2017) [4, 9]. Habitat heterogeneity of this nature is known to promote higher bird species richness and functional diversity (MacArthur & MacArthur, 1961; Panda, 2021) [12].

In recent years, Rajgir has experienced increasing tourism-related development, including expansion of road networks, ropeway facilities, and nature-based recreational activities. While tourism contributes to local livelihoods, it also introduces anthropogenic pressures such as habitat modification, noise, and increased human disturbance, to which birds are particularly sensitive (Gregory *et al.,* 2003; Sutherland, 2006) [7, 16]. Establishing baseline avifaunal information is therefore crucial for detecting ecological change and guiding future management interventions.

Material and Methods
Study Area
Rajgir WLS is situated in the Nalanda district of Bihar, India, and occupies an area of approximately 35.84 km² (Figure 1). The sanctuary lies between 24°55′–25°05′ N latitude and 85°06′–85°30′ E longitude (Rodgers & Panwar, 1988) [14]. It forms part of the Rajgir sub-division and is influenced by two important river systems, the Phalgu and the Mohane, which together sustain the local hydrological regime and support diverse ecological processes in and around the sanctuary (Ghosh & Kanjilal, 2001) [6].

Ecologically, Rajgir WLS is embedded within the Rajgir Hills, which are a component of the ancient Munger–Rajgir metasedimentary belt (Bose *et al.,* 1989) [3]. These hill ranges are composed mainly of Precambrian rocks that have undergone repeated metamorphic and tectonic events, producing a rugged, uneven terrain. Such geological history has given rise to a variety of slope conditions, soil types, and micro-topographic features, which in turn govern vegetation structure and faunal assemblages across the landscape.

The sanctuary lies at a biogeographically important position where the boundaries of Nalanda, Gaya, and Nawada

districts meet. Owing to this location, Rajgir WLS functions as a transitional zone linking forest and grassland systems of southern Bihar. Within this zone occur multiple habitat types, including dry deciduous forests, scrub patches, and regenerating secondary woodlands, each supporting distinct species assemblages. This fine-scale habitat mosaic plays a critical role in promoting species movement, ecological connectivity, and gene flow among populations across the broader region (Bhera *et al.,* 2012).

Topographically, Rajgir WLS is encircled by five major hills Vipulgiri, Ratnagiri, Udaigiri, Sonagiri, and Baibhavgiri which collectively form a natural amphitheatre-like setting. This ring of hills acts as a physical buffer, reducing the immediate impact of expanding urban settlements and agricultural fields surrounding the sanctuary. Ratnagiri is the highest among these hills, rising to nearly 305 m above mean sea level, and supports specific microclimatic conditions that favour altitude-responsive and habitat-specialist species (Champion & Seth, 1968; Mehrotra *et al.,* 2002) [4, 11].

Administratively, the sanctuary is included within the Nalanda Forest Division and is managed by the Bihar Forest Department. The surrounding hill slopes and forested tracts create a clear natural boundary between protected habitats and adjacent human-dominated landscapes. This configuration helps in partially limiting habitat fragmentation and moderating anthropogenic pressures such as grazing, fuelwood collection, and encroachment. The interplay of altitudinal gradients, narrow valleys, and patchy habitat units makes Rajgir an important site for investigating ecological patterns, species interactions, and conservation concerns in a tropical landscape affected by human activities.

Vegetation in and around Rajgir WLS comprises several forest types as recognized in the classification of Champion and Seth (1968) [4], including:

- Dry Peninsular Sal Forest (dominated by *Shorea robusta*)
- Dry Deciduous Scrub Forests
- Boswellia Forest
- Northern Dry Mixed Deciduous Forests
- Cane brakes and plantation tracts

These forest categories represent gradients in moisture availability, soil conditions, disturbance intensity, and management history. The coexistence of relatively natural stands with plantation areas adds to the structural heterogeneity of the habitat. This heterogeneity, in turn, has important implications for the distribution, abundance, and diversity of birds, butterflies communities and other faunal groups in the region.

Birds Sampling and Identification

Birds were sampled during March 2022 to October 2022 using transect count methods (Bibby *et al.,* 2000) [2]. A total 25 transects of 1000m each were laid at different locations across 2 major habitat type (*viz.,* Sal mixed forest, Bamboo mixed forest) (Figure 1). Thus, a total of 25 transects were surveyed. Birds were sampled during 0600 – 0900 hrs with more than 70% cloud cover.

Bird species were identified using Grimmett *et al.* (2011 [8]; 2016) and Bhardwaj *et al.* (2022). Photographic documentation was carried out using a Nikon Coolpix P900 digital camera, and geographic coordinates were recorded with a Garmin eTrex® 10 GPS device. Spatial mapping was performed using QGIS 3.32.1-Lima, a free and open-source Geographic Information System software.

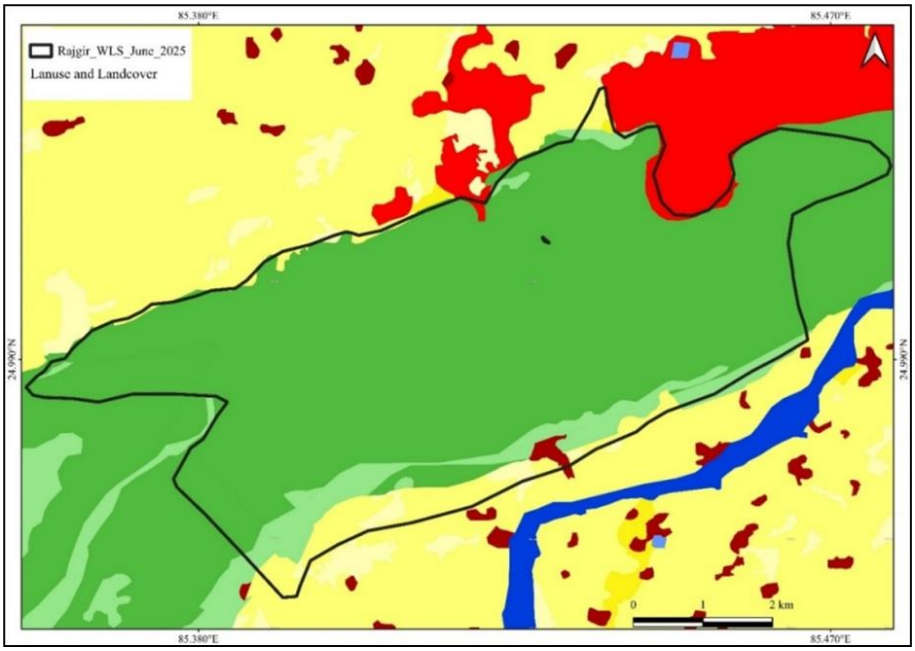

Fig 1: Map of the sampling area showing transect locations in Rajgir WLS.

Results and Discussion

Species richness and composition: The avifaunal survey conducted in Rajgir WLS documented a total of 77 bird species, distributed across multiple 60 genera, 41 families, and 12 orders (Table 1). The recorded species represent a wide range of ecological groups occupying forested areas, scrublands, rocky habitats, wetlands, and human-modified landscapes within the sanctuary. Even within this limited species pool, the assemblage reflects considerable ecological and functional diversity.

Table 1: List of 77 bird species from 60 genera, 41 families and 12 bird orders recorded from Rajgir WLS during preliminary survey

S.No.	Order	Family	Species	Common name	Relative abundance (%)
1	Galliformes	Phasianidae	*Galloperdix lunulata*	Painted Spurfowl	1.7
2	Galliformes	Phasianidae	*Ortygornis pondicerianus*	Grey Francolin	1.0
3	Columbiformes	Columbidae	*Streptopelia decaocto*	Eurasian Collared Dove	4.3
4	Columbiformes	Columbidae	*Streptopelia tranquebarica*	Red Collared Dove	0.2
5	Columbiformes	Columbidae	*Streptopelia chinensis*	Spotted Dove	4.9
6	Columbiformes	Columbidae	*Streptopelia senegalensis*	Laughing Dove	1.6
7	Caprimulgiformes	Apodidae	*Apus affinis*	Little Swift	3.2
8	Cuculiformes	Cuculidae	*Centropus sinensis*	Greater Coucal	0.4
9	Cuculiformes	Cuculidae	*Eudynamys scolopaceus*	Western Koel	0.5
10	Pelecaniformes	Ardeidae	*Egretta garzetta*	Little Egret	0.5
11	Charadriiformes	Burhinidae	*Burhinus indicus*	Indian Thick Knee	0.1
12	Charadriiformes	Charadriidae	*Vanellus indicus*	Red Wattled Lapwing	0.6
13	Charadriiformes	Turnicidae	*Turnix sylvaticus*	Common Buttonquail	0.1
14	Accipitriformes	Elanidae	*Elanus axillaris*	Black Shouldered Kite	0.1
15	Accipitriformes	Accipitridae	*Circaetus gallicus*	Short Toed Snake Eagle	0.1
16	Accipitriformes	Accipitridae	*Milvus migrans*	Black Kite	0.6
17	Accipitriformes	Accipitridae	*Accipiter badius*	Shikra	0.1
18	Bucerotiformes	Upupidae	*Upupa epops*	Common Hoopoe	0.8
19	Coraciiformes	Meropidae	*Merops orientalis*	Asian Green Bee Eater	2.6
20	Coraciiformes	Meropidae	*Merops philippinus*	Blue Tailed Bee Eater	0.1
21	Coraciiformes	Coraciidae	*Coracias benghalensis*	Indian Roller	1.8
22	Coraciiformes	Alcedinidae	*Ceryle rudis*	Pied Kingfisher	0.2
23	Coraciiformes	Alcedinidae	*Halcyon smyrnensis*	White Throated Kingfisher	0.8
24	Piciformes	Megalaimidae	*Psilopogon haemacephalus*	Coppersmith Barbet	0.9
25	Piciformes	Picidae	*Dinopium benghalense*	Black-Rumped Flameback	0.6
26	Psittaciformes	Psittacidae	*Himalayapistta cyanocephala*	Plum-headed Parakeet	0.1
27	Psittaciformes	Psittacidae	*Alexandrinus krameri*	Rose Ringed Parakeet	1.1
28	Psittaciformes	Psittacidae	*Palaeornis eupatria*	Alexandrin Parakeet	1.7
29	Passeriformes	Pittidae	*Pitta brachyura*	Indian Pitta	0.1
30	Passeriformes	Oriolidae	*Oriolus xanthornus*	Black Hooded Oriole	0.2
31	Passeriformes	Oriolidae	*Oriolus kundoo*	Indian Golden Oriole	0.4
32	Passeriformes	Oriolidae	*Oriolus chinensis*	Black Naped Oriole	0.1
33	Passeriformes	Campephagidae	*Pericrocotus flammeus*	Scarlet Minivet	0.1
34	Passeriformes	Campephagidae	*Coracina macei*	Indian Cuckooshrike	0.1
35	Passeriformes	Aegithinidae	*Aegithina tiphia*	Common Iora	0.5
36	Passeriformes	Rhipiduridae	*Rhipidura albicollis*	White Throated Fantail	0.1
37	Passeriformes	Dicruridae	*Dicrurus macrocercus*	Black Drongo	2.4
38	Passeriformes	Dicruridae	*Dicrurus leucophaeus*	Ashy Drongo	0.2
39	Passeriformes	Monarchidae	*Hypothymis azurea*	Black Naped Monarch	0.2
40	Passeriformes	Monarchidae	*Terpsiphone paradisi*	Indian Paradise Flycatcher	0.3
41	Passeriformes	Laniidae	*Lanius tephronotus*	Grey Backed Shrike	0.1
42	Passeriformes	Corvidae	*Dendrocitta vagabunda*	Rufous Treepie	1.6
43	Passeriformes	Corvidae	*Corvus splendens*	House Crow	5.3
44	Passeriformes	Corvidae	*Corvus macrorhynchos*	Large Billed Crow	0.1
45	Passeriformes	Cisticolidae	*Prinia hodgsonii*	Grey Breasted Prinia	0.8
46	Passeriformes	Cisticolidae	*Prinia sylvatica*	Jungle Prinia	0.3
47	Passeriformes	Cisticolidae	*Prinia socialis*	Ashy Prinia	0.2
48	Passeriformes	Cisticolidae	*Prinia inornata*	Plain Prinia	4.5
49	Passeriformes	Cisticolidae	*Orthotomus sutorius*	Common Tailorbird	0.8
50	Passeriformes	Hirundinidae	*Hirundo rustica*	Barn Swallow	0.6
51	Passeriformes	Pycnonotidae	*Pycnonotus cafer*	Red Vented Bulbul	8.7
52	Passeriformes	Phylloscopidae	*Phylloscopus collybita*	Common Chiffchaff	0.6
53	Passeriformes	Phylloscopidae	*Phylloscopus occipitalis*	Western Crowned Leaf Warbler	0.1
54	Passeriformes	Zosteropidae	*Zosterops palpebrosus*	Indian White Eye	1.5
55	Passeriformes	Timaliidae	*Dumetia hyperythra*	Tawny Bellied Babbler	0.6
56	Passeriformes	Leiothrichidae	*Argya striata*	Jungle Babbler	14.7
57	Passeriformes	Sturnidae	*Gracupica contra*	Indian Pied Myna	1.6
58	Passeriformes	Sturnidae	*Acridotheres tristis*	Common Myna	2.8
59	Psittaciformes	Sturnidae	*Acridotheres ginginianus*	Bank Myna	0.8
60	Passeriformes	Turdidae	*Geokichla citrina*	Orange Headed Thrush	0.1
61	Passeriformes	Muscicapidae	*Copsychus saularis*	Oriental Magpie Robin	2.6
62	Passeriformes	Muscicapidae	*Copsychus fulicatus*	Indian Robin	4.7
63	Passeriformes	Muscicapidae	*Eumyias thalassinus*	Verditer Flycatcher	0.1
64	Passeriformes	Muscicapidae	*Cyornis tickelliae*	Tickell's Blue Flycatcher	0.4
65	Passeriformes	Muscicapidae	*Ficedula parva*	Red Breasted Flycatcher	0.1

66	Passeriformes	Muscicapidae	*Phoenicurus ochruros*	Black Red Start	1.5
67	Passeriformes	Muscicapidae	*Oenanthe fusca*	Brown Rock Chat	0.3
68	Passeriformes	Dicaeidae	*Dicaeum agile*	Thick-Billed Flowerpecker	0.6
69	Passeriformes	Nectariniidae	*Cinnyris asiaticus*	Purple Sunbird	4.8
70	Passeriformes	Estrildidae	*Euodice malabarica*	Indian Silverbill	1.5
71	Passeriformes	Estrildidae	*Lonchura punctulata*	Scaly Breasted Munia	0.1
72	Passeriformes	Passeridae	*Gymnoris xanthocollis*	Chestnut Shouldered Bush Sparrow	0.6
73	Passeriformes	Motacillidae	*Anthus trivialis*	Tree Pipit	0.1
74	Passeriformes	Motacillidae	*Anthus hodgsoni*	Olive Backed Pipit	0.7
75	Passeriformes	Motacillidae	*Motacilla cinerea*	Grey Wagtail	0.1
76	Passeriformes	Motacillidae	*Motacilla maderaspatensis*	White Browed Wagtail White-browed Wagtail	0.1
77	Passeriformes	Motacillidae	*Motacilla alba*	White Wagtail	0.4

Taxonomic composition

Passeriformes was the most dominant order, contributing the highest number of species (over 60% of the total assemblage). This order was represented by a wide range of families, including Leiothrichidae, Pycnonotidae, Muscicapidae, Cisticolidae, Dicruridae, Motacillidae, Sturnidae, Nectariniidae, Estrildidae, and Corvidae, indicating the availability of diverse vegetation strata and foraging microhabitats.

Among non-passerine orders, Columbiformes were well represented by four species of doves, followed by Coraciiformes, Accipitriformes, Charadriiformes, Psittaciformes, Piciformes, Cuculiformes, Galliformes, Pelecaniformes, Caprimulgiformes, Bucerotiformes, and Cuculiformes, each contributing fewer species but adding to overall taxonomic breadth.

Relative abundance pattern

Relative abundance analysis revealed a highly uneven distribution, with a few species contributing disproportionately to total observations. Jungle Babbler (*Argya striata*) was the most abundant species (14.7%), followed by Red-vented Bulbul (*Pycnonotus cafer*, 8.7%), House Crow (*Corvus splendens*, 5.3%), Spotted Dove (*Streptopelia chinensis*, 4.9%), Purple Sunbird (*Cinnyris asiaticus*, 4.8%), and Indian Robin (*Copsychus fulicatus*, 4.7%).

Most species occurred at low relative abundance (≤0.5%), including pittas, leaf warblers, flycatchers, thrushes, wagtails, pipits, raptors, and ground-dwelling birds. This pattern indicates dominance by a small number of common resident species alongside a large proportion of rare or infrequently encountered taxa.

Feeding guild structure

The avifaunal community was dominated by insectivorous species, particularly among prinias, flycatchers, warblers, drongos, chats, bee-eaters, and wagtails. Omnivorous species, including babblers, bulbuls, mynas, and crows, showed relatively higher abundance values. Granivorous and frugivorous species, such as doves, munias, parakeets, barbets, and orioles, were consistently recorded, while nectarivorous species, notably sunbirds and flowerpeckers, contributed moderately to the assemblage. Piscivorous birds such as kingfishers and egrets were restricted to aquatic habitats and occurred at low abundance.

Migratory status

The assemblage was dominated by resident species, with a smaller component of winter migrants and partial migrants. Migratory taxa included leaf warblers, flycatchers, pipits, wagtails, shrikes, and cuckoos, most of which showed low relative abundance. Their presence during the survey period highlights seasonal use of Rajgir Wildlife Sanctuary by migratory birds.

Conclusion

In total, 77 bird species were recorded during the survey, with community structure characterized by strong dominance of passerines, uneven relative abundance, and representation of multiple feeding guilds and migratory categories. Although not exhaustive, the dataset provides a reliable baseline for future long-term avifaunal monitoring in Rajgir Wildlife Sanctuary.

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