



Avifaunal Diversity of Patna Bird Sanctuary under the Taj Trapezium Zone in India

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Abstract

The paper documents the avifaunal diversity of Patna Bird Sanctuary during a continuous survey period from March 2023 to February 2024. This sanctuary is a vital wetland component of the Taj Trapezium Zone (TTZ). A total of 127 bird species, comprising 19 orders and 47 families, were observed using the fixed radius point count method. The study emphasises the importance of continued monitoring to understand seasonal variations, population trends, and the conservation needs of avifauna in this region. These findings provide a valuable baseline for ongoing ecological sustainability and contribute to the quality of life in the wetlands of the Taj Trapezium Zone.

Keywords: Avifauna; Diversity; Ecology; Taj Trapezium Zone; Wetland

Introduction

Wetlands are perennial or seasonal water-saturated bodies that support the diversity of all fauna and offer vital functions such as carbon storage, flood control, and water purification (Mitsch & Gosselink, 1993). The ecological balance of any ecosystem in which invertebrates, aquatic flora, and aquatic fauna exist must include wetlands (Woodward & Wu, 2001). Although wetlands make up 5–10% of the world's land surface, possibly more than 70% have already been destroyed or impaired, leading to high rates of biodiversity loss (Kingsford, Basset & Jackson, 2016). Roughly 4.64% of the total geographical area of India—approximately 15,260,572 hectares—is composed of 757 thousand different kinds of wetlands (Ministry of Environment, Forest and Climate Change, 2025). Due to their extreme sensitivity to environmental changes, birds serve as excellent models for evaluating biodiversity responses to habitat variations (Xu *et al.*, 2018). Birds are sensitive to environmental changes and act as biological indicators of a viable habitat, contributing to pollination, pest control, seed dispersal, and forming a key part of the food chain (Şekercioğlu, 2006). Wetlands are vital to bird ecology, providing essential habitats for feeding, breeding, and migration. They support a diverse range of bird species, including waterfowl, waders, and migratory birds, thereby ensuring ecological balance. The loss of wetlands results in a decline in bird populations and disruption of ecosystem services (Ma *et al.*, 2010). Globally, avifaunal diversity encompasses approximately 11,524 bird species, with significant concentrations in tropical regions. In India, 1,450 avian species are found, accounting for about 12.58% of the world's total avifauna (Praveen & Jaypal, 2024). Uttar Pradesh, one of the largest states in India with an area of 240,928 km², hosts more than 561 species, highlighting its ecological significance and the need for conservation efforts to protect these diverse bird populations (eBirds, 2025). Sites designated as globally significant for bird population protection based on a set of internationally accepted criteria are known as Important Bird and Biodiversity Areas (IBAs) (Donald *et al.*, 2019). The Patna Bird Sanctuary

is one of the important wetlands in the Taj Trapezium Zone, supporting a large population of migratory birds, and has been designated as one of the Important Bird and Biodiversity Areas (IBA) by BirdLife International for the protection of bird populations (Rahmani & Islam, 2004).

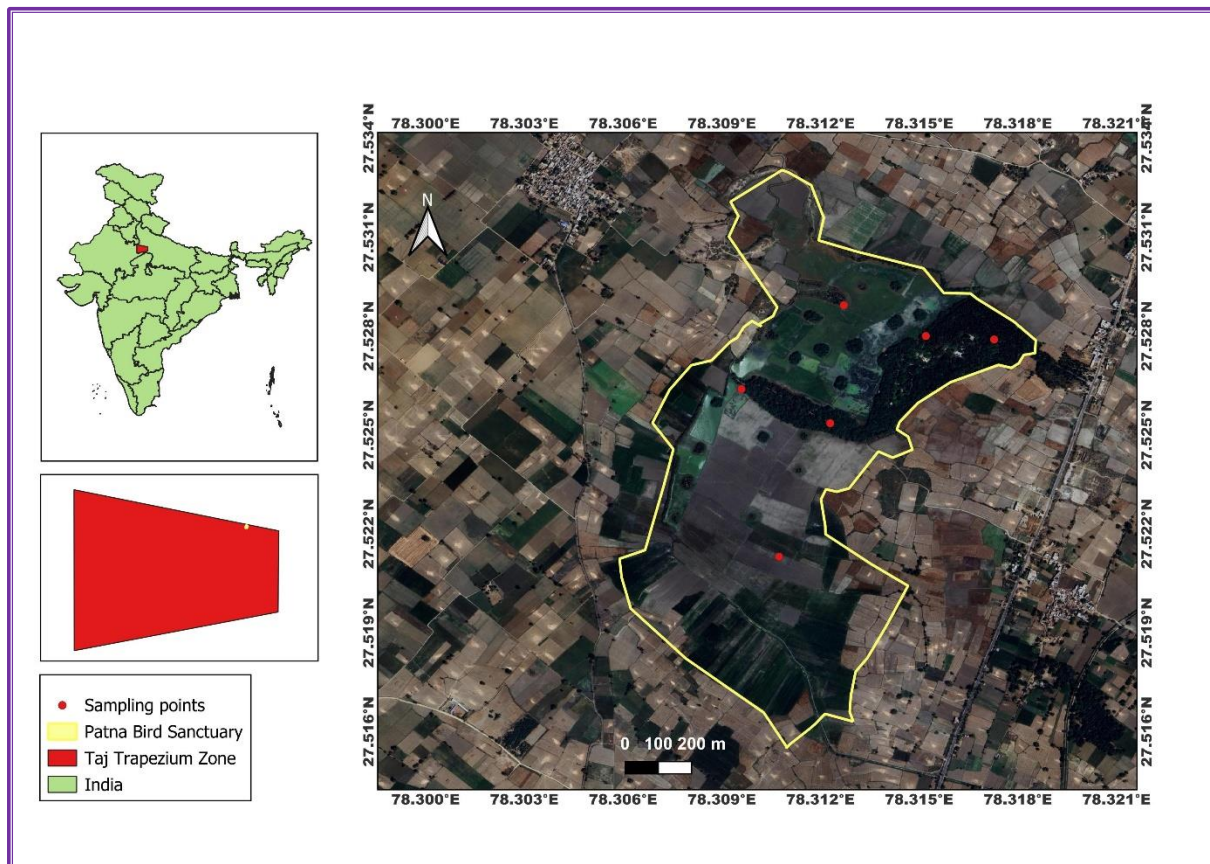


Figure 1: Study Area Map of Patna Bird Sanctuary prepared using Google Earth Pro and QGIS

The Taj Trapezium Zone covers an area of 10,400 km² and surrounds all the heritage monuments, including the Taj Mahal. It was designated for regulating environmental pollution and conserving habitats (Fig. 1) (Yadav & Prakash, 2021). The present study is part of an ongoing survey of the flora and fauna of the TTZ, including the wetlands and protected areas, aimed at documenting the status of natural wealth. The Patna Bird Sanctuary lies within its boundaries and is lesser known than the Ghana Bird Sanctuary of Bharatpur and the Soor Sarovar Bird Sanctuary of Agra. This study presents the status of the Patna Bird Sanctuary, which also reflects the ecological health of the Taj Trapezium Zone and its associated heritage monuments.

Material and Methods

Data Collection

The field surveys were conducted in the morning hours (from 6:00 AM to 10:00 AM) from March 2023 to February 2024 and the same process was followed in the evening (from 15:00 PM to 18:00 PM). Bird surveys were carried out on foot using fixed radius count (Bibby *et al.*, 2000). Birds were observed by positioning on a fixed point at six different sampling points for 20 minutes and 360 degrees scoring. Field identification of birds was done based on (Grimmett *et al.* 2011) and (Birdlife International 2024) and the categorisation based on their threatened category was done following the (IUCN Red List 2024) (Table 1). The feeding habits of recorded avifauna were assigned according to field observation (Ali, Ripley & Dick, 1987) (Table 1).

Data Analysis

Diversity indices are essential tools for assessing the complexity and variability of avifaunal communities, providing species richness and evenness. The Shannon-Wiener Index, which considers the number of bird species and individual distribution within those species into account, is commonly used to measure diversity. It addresses the species relative abundance as well as their richness, giving a comprehensive view of community structure (Shannon & Weaver 1963). Shannon-Weiner Index,

$$H' = -\sum p_i \ln(p_i)$$

Conversely, Simpson's Diversity Index emphasizes dominance and equality within the group by calculating the likelihood that two randomly chosen individuals are members of different species (Simpson 1949). Simpson's Diversity Index,

$$D = 1 - \sum [n_i(n_i - 1)] / N(N-1)$$

The value of Simpson's Diversity Index falls between 0 (highest dominance) and 1 (highest evenness).

Margalef's Richness Index evaluates species richness relative to the overall number of individuals, providing insight into how species diversity changes with community size (Margalef 1958). Margalef's richness index,

$$d = (S-1) / \ln N$$

where 'S' is the total number of species and 'N' is the total number of individuals in the sample. Pielou's evenness index (Pielou 1966),

$$J' = H' / \ln(S)$$

where H' is the Shannon Weiner Index of diversity and S is the total number of species. This index ranges from 0 (no evenness) to 1 (complete evenness).

Calculation of Relative diversity (RDi) of bird families was done using following the formula of (La Torre-Cuadros, Herrando-Pérez & Young, 2007),

$$RDi = \text{No. of Species in } i\text{th Family} / \text{Total No. of Species} \times 100$$

Collected data were analysed seasonally: Summer (from March to June), Monsoon (from July to October), and Winter (from November to February) (Table 3).

Photo Documentation

Binoculars or the unaided eye were used to observe birds, and for additional identification and documentation, images were taken with a Canon M50 mirrorless camera that was equipped with an 18-400 Tamaron lens.

Result

A comprehensive summary of the overall assessment of bird species across all categorised groups reflects a total of 127 identified bird species belonging to 19 orders and 47 families (Table 1). Across the recording months, January recorded the highest number with 109 species inhabiting the Patna Bird Sanctuary. The number reduced to half in May as the temperature increased, resulting in a decline in evenness (Figure 2, Table 3).

Further analysis revealed that the order *Passeriformes* comprised the largest number of families, including 20 families, followed by the order *Charadriiformes* with 4 families (Figure 3). *Anatidae* was the most diverse family (14 species, RDi = 11.02), followed by *Ardeidae* (8 species, RDi = 6.30). In contrast, 21 families—namely, *Passeridae*, *Nectariniidae*, *Dicruridae*, *Zosteropidae*, *Hirundinidae*, *Recurvirostridae*, *Alcedinidae*, *Coraciidae*, *Meropidae*, *Upupidae*, *Bucerotidae*, *Anhingidae*, *Podicipedidae*, *Apodidae*, *Psittacidae*, *Oriolidae*, *Laniidae*, *Alaudidae*, *Strigidae*, *Gruidae*, and *Falconidae*—were least represented (1 species each, RDi = 0.79) (Table 2).

The Egyptian Vulture was the only species recorded that belongs to the Endangered category of the IUCN (Table 1, Figure 4).

Of the 127 reported avian species, 32 were migratory and 95 were resident (Figure 5). Omnivores (49 species) and carnivores (39 species) were the most represented guilds in the hierarchy based on feeding patterns, while nectivores (1 species) were the least represented (Figure 6). A comparative account of the IUCN global status of the surveyed birds is illustrated in Figure 7 as per their current trend: Stable (48) < Decreasing (37) < Increasing (25) < Unknown (17).

Table 1: Avifauna status and bird checklist of Patna Bird Sanctuary in Etah, Uttar Pradesh, India

	Family	Common Name	Scientific Name	Conservati on Statu s	Resid ent Statu s	Feed ing Statu s	IUC N Tren d
Order 1. Accipitriformes							
1	Accipitridae	Black Kite	<i>Milvus migrans</i>	LC	R	CV	↑
2		Eurasian Marsh-Harrier	<i>Circus aeruginosus</i>	LC	WV	CV	→
3		Egyptian vulture	<i>Neophron percnopterus</i>	EN	R	CV	↓
4		Shikra	<i>Accipiter badius</i>	LC	R	CV	→
5		Black-winged Kite	<i>Elanus caeruleus</i>	LC	R	CV	→
6		Oriental Honey-buzzard	<i>Pernis ptilorhynchus</i>	LC	R	CV	↓
Order 2. Anseriformes							
7	Anatidae	Knob-billed Duck	<i>Sarkidiornis melanotos</i>	LC	R	OV	↓
8		Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	LC	R	OV	↓
9		Northern Pintail	<i>Anas acuta</i>	LC	WV	OV	↓
10		Garganey	<i>Spatula querquedula</i>	LC	WV	OV	↓
11		Common pochard	<i>Aythya ferina</i>	VU	WV	OV	↓
12		Green-winged Teal	<i>Anas crecca</i>	LC	WV	OV	↑
13		Gadwall	<i>Mareca strepera</i>	LC	WV	OV	↑
14		Eurasian wigeon	<i>Mareca Penelope</i>	LC	WV	OV	↓
15		Northern Shoveler	<i>Spatula clypeata</i>	LC	WV	OV	↓
16		Cotton pygmy goose	<i>Nettapus coromandelianus</i>	LC	R	OV	→
17		Graylag Goose	<i>Anser anser</i>	LC	WV	HV	↑
18		Bar-headed Goose	<i>Anser indicus</i>	LC	WV	HV	↓
19		Lesser Whistling-Duck	<i>Dendrocygna javanica</i>	LC	R	OV	↓
20		Ferruginous duck	<i>Aythya nyroca</i>	NT	WV	OV	↓
Order 3. Passeriformes							
21	Motacillidae	Western Yellow Wagtail	<i>Motacilla flava</i>	LC	WV	IV	↓
22		White-browed Wagtail	<i>Motacilla maderaspatensis</i>	LC	R	IV	→
23		Gray Wagtail	<i>Motacilla cinerea</i>	LC	WV	IV	→
24		Citrine Wagtail	<i>Motacilla citreola</i>	LC	WV	IV	↑
25		Tree Pipit	<i>Anthus trivialis</i>	LC	WV	IV	↓
26		White Wagtail	<i>Motacilla alba</i>	LC	WV	IV	→
27		Paddyfield Pipit	<i>Anthus rufulus</i>	LC	R	IV	→
28	Cisticolidae	Rufous-fronted Prinia	<i>Prinia buchanani</i>	LC	R	IV	→
29		Ashy Prinia	<i>Prinia socilis</i>	LC	R	IV	→
30		Plain Prinia	<i>Prinia inornata</i>	LC	R	IV	→
31	Sylviidae	Common Tailorbird	<i>Orthotomus sutorius</i>	LC	R	OV	→
32		Lesser Whitethroat	<i>Sylvia curruca</i>	LC	R	OV	→
33	Muscicapidae	Black Redstart	<i>Phoenicurus ochruros</i>	LC	WV	IV	↑
34		Pied Bushchat	<i>Saxicola caprata</i>	LC	R	IV	→
35		Brown Rock Chat	<i>Oenanthe fusca</i>	LC	R	IV	→
36		Oriental Magpie-Robin	<i>Copsychus saularis</i>	LC	R	IV	→
37		Indian Robin	<i>Copsychus fulicatus</i>	LC	R	IV	→

38		Common Stonechat	<i>Saxicola torquatus</i>	LC	WV	IV	→
39		Red-breasted Flycatcher	<i>Ficedula parva</i>	LC	WV	IV	↑
40	Passeridae	House Sparrow	<i>Passer domesticus</i>	LC	R	GV	↓
41	Corvidae	Large-billed Crow	<i>Corvus macrorhynchos</i>	LC	R	OV	→
42		Rufous Treepie	<i>Dendrocitta vagabunda</i>	LC	R	OV	↓
43		House Crow	<i>Corvus splendens</i>	LC	R	OV	→
44	Pycnonotidae	Red-vented Bulbul	<i>Pycnonotus cafer</i>	LC	R	OV	↑
45		Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>	LC	R	OV	↓
46	Estrildidae	Scaly-breasted Munia	<i>Lonchura punctulata</i>	LC	R	OV	→
47		Indian Silverbill	<i>Euodice malabarica</i>	LC	R	OV	→
48		Red Avadavat	<i>Amandava amandava</i>	LC	R	OV	→
49	Ploceidae	Baya weaver	<i>Ploceus philippinnus</i>	LC	R	OV	→
50		Streaked weaver	<i>Ploceus manyar</i>	LC	R	OV	→
51	Leiotrichidae	Large Gray Babbler	<i>Turdoides malcolmi</i>	LC	R	OV	→
52		Jungle Babbler	<i>Turdoides striata</i>	LC	R	OV	→
53		Common Babbler	<i>Turdoides caudata</i>	LC	R	OV	→
54		Striated Babbler	<i>Argya earlei</i>	LC	R	OV	↓
55	Nectariniidae	Purple Sunbird	<i>Cinnyris asiaticus</i>	LC	R	NV	→
56	Sturnidae	Brahminy Starling	<i>Sturnia pagodarum</i>	LC	R	OV	?
57		Asian Pied Starling	<i>Gracupica contra</i>	LC	R	OV	↑
58		Common Myna	<i>Acridotheres tristis</i>	LC	R	OV	↑
59		Bank Myna	<i>Acridotheres ginginianus</i>	LC	R	OV	↑
60	Dicruridae	Black Drongo	<i>Dicrurus macrocercus</i>	LC	R	IV	?
61	Zosteropidae	Indian White-eye	<i>Zosterops palpebrosus</i>	LC	R	IV	↓
62	Phylloscopidae	Hume's leaf-warbler	<i>Phylloscopus humei</i>	LC	WV	IV	→
63		Brooks's Leaf Warbler	<i>Phylloscopus subviridis</i>	LC	WV	IV	→
64	Hirundinidae	Wire-tailed Swallow	<i>Hirundo smithii</i>	LC	R	IV	↑
65	Oriolidae	Indian Golden Oriole	<i>Oriolus kundoo</i>	LC	SV	OV	?
66	Laniidae	Long-tailed Shrike	<i>Lanius schach</i>	LC	R	OV	?
67	Alaudidae	Crested Lark	<i>Galerida cristata</i>	LC	R	OV	↓
68	Stenostiridae	Gray-headed Canary-Flycatcher	<i>Culicicapa ceylonensis</i>	LC	WV	IV	→
Order 4. Charadriiformes							
69	Charadriidae	Red-wattled Lapwing	<i>Vanellus indicus</i>	LC	R	OV	?
70		Yellow-wattled Lapwing	<i>Vanellus malabaricus</i>	LC	R	CV	→
71		Little ringed plover	<i>Charadrius dubius</i>	LC	R	CV	→
72	Scolopacidae	Common Greenshank	<i>Tringa nebularia</i>	LC	WV	CV	→
73		Green Sandpiper	<i>Tringa ochropus</i>	LC	WV	CV	↑
74		Marsh Sandpiper	<i>Tringa stagnatilis</i>	LC	WV	CV	↓
75		Wood Sandpiper	<i>Tringa glareola</i>	LC	WV	OV	→
76		Spotted Redshank	<i>Tringa erythropus</i>	LC	WV	CV	→
77		Common Redshank	<i>Tringa totanus</i>	LC	WV	CV	?
78	Recurvirostridae	Black-winged Stilt	<i>Himantopus himantopus</i>	LC	WV	CV	↑
79	Jacanidae	Bronze-winged Jacana	<i>Metopidius indicus</i>	LC	R	CV	?
80		Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i>	LC	R	CV	↓
Order 5. Coraciiformes							
81	Alcedinidae	White-throated Kingfisher	<i>Halcyon smyrnensis</i>	LC	R	CV	?
82	Coraciidae	Indian Roller	<i>Coracias benghalensis</i>	LC	R	CV	↑
83	Meropidae	Green Bee-eater	<i>Merops orientalis</i>	LC	R	IV	↑
Order 6. Bucerotiformes							
84	Upupidae	Eurasian Hoopoe	<i>Upupa epops</i>	LC	R	OV	↓
85	Bucerotidae	Indian Gray Hornbill	<i>Ocyrceros birostris</i>	LC	R	OV	→
Order 7. Gruiformes							
86	Rallidae	Eurasian Moorhen	<i>Gallinula chloropus</i>	LC	R	OV	→
87		White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	LC	R	OV	?
88		Grey-headed Swamphen	<i>Porphyrio poliocephalus</i>	LC	R	OV	?

89		Eurasian Coot	<i>Fulica atra</i>	LC	R	OV	↑
90	Gruidae	Sarus Crane	<i>Antigone antigone</i>	VU	R	OV	↓
Order 8. Ciconiiformes							
91	Ciconiidae	Asian Openbill	<i>Anastomus oscitans</i>	LC	R	CV	?
92		Painted Stork	<i>Mycteria leucocephala</i>	NT	R	CV	↑
93		Woolly-necked Stork	<i>Ciconia episcopus</i>	VU	R	CV	↓
94		Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	NT	R	CV	↓
Order 9. Suliformes							
95	Phalacrocoraci dae	Great Cormorant	<i>Phalacrocorax carbo</i>	LC	R	CV	↑
96		Little Cormorant	<i>Microcarbo niger</i>	LC	R	CV	?
97		Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	LC	R	CV	?
98	Anhingidae	Oriental Darter	<i>Anhinga melanogaster</i>	NT	R	CV	↓
Order 10. Galliformes							
99	Phasianidae	Gray Francolin	<i>Francolinus pondicerianus</i>	LC	R	OV	→
100		Indian Peafowl	<i>Pavo cristatus</i>	LC	R	OV	→
Order 11. Pelecaniformes							
101	Threskiornithid ae	Red-naped Ibis	<i>Pseudibis papillosa</i>	LC	R	CV	↓
102		Eurasian Spoonbill	<i>Platalea leucorodia</i>	LC	R	CV	?
103		Black-headed Ibis	<i>Threskiornis melanocephalus</i>	NT	R	CV	↓
104	Ardeidae	Grey Heron	<i>Ardea cinerea</i>	LC	R	CV	?
105		Purple Heron	<i>Ardea purpurea</i>	LC	R	CV	↓
106		Black-crowned night heron	<i>Nycticorax nycticorax</i>	LC	R	CV	↓
107		Great Egret	<i>Ardea alba</i>	LC	R	CV	?
108		Intermediate Egret	<i>Ardea intermedia</i>	LC	R	CV	↓
109		Little Egret	<i>Egretta garzetta</i>	LC	R	CV	↑
110		Indian Pond-Heron	<i>Ardeola grayii</i>	LC	R	OV	?
111		Cattle Egret	<i>Bubulcus ibis</i>	LC	R	CV	↑
Order 12. Cuculiformes							
112	Cuculidae	Greater Coucal	<i>Centropus sinensis</i>	LC	R	OV	→
113		Asian Koel	<i>Eudynamys scolopaceus</i>	LC	R	OV	→
114		Pied Cuckoo	<i>Clamator jacobinus</i>	LC	SV	IV	→
Order 13. Podicipediformes							
115	Podicipedidae	Little Grebe	<i>Tachybaptus ruficollis</i>	LC	R	CV	↓
Order 14. Apodiformes							
116	Apodidae	Little swift	<i>Apus affinis</i>	LC	R	IV	↑
Order 15. Columbiformes							
117	Columbidae	Eurasian Collared-Dove	<i>Streptopelia decaocto</i>	LC	R	GV	↑
118		Rock Pigeon	<i>Columba livia</i>	LC	R	GV	↓
119		Laughing Dove	<i>Streptopelia senegalensis</i>	LC	R	GV	→
120		Yellow-footed Green-Pigeon	<i>Treron phoenicopterus</i>	LC	R	FV	↑
121		Spotted Dove	<i>Streptoelia chinensis</i>	LC	R	GV	↑
122		Red Collared-Dove	<i>Streptopelia tranquebarica</i>	LC	R	GV	↓
Order 16. Piciformes							
123	Picidae	Black-rumped Flameback	<i>Dinopium benghalense</i>	LC	R	IV	→
124		Brown-headed Barbet	<i>Psilopogon zeylanicus</i>	LC	R	OV	→
Order 17. Psittaciformes							
125	Psittacidae	Rose-ringed Parakeet	<i>Psittacula krameri</i>	LC	R	FV	↑
Order 18. Strigiformes							
126	Strigidae	Spotted Owlet	<i>Athene brama</i>	LC	R	CV	→
Order 19. Falconiformes							
127	Falconidae	Laggar Falcon	<i>Falco jugger</i>	NT	R	CV	↓

LC - Least Concern | EN – Endangered | VU- Vulnerable | NT- Near Threatened | R - Resident | WV - Winter Visitor | CV- Carnivorous | GV- Granivorous | IV- Insectivorous | OV- Omnivorous | FV – Frugivorous | HV – Herbivorous | ↑ - Increasing | → - Stable | ↓ - Decreasing | ? - Unknown

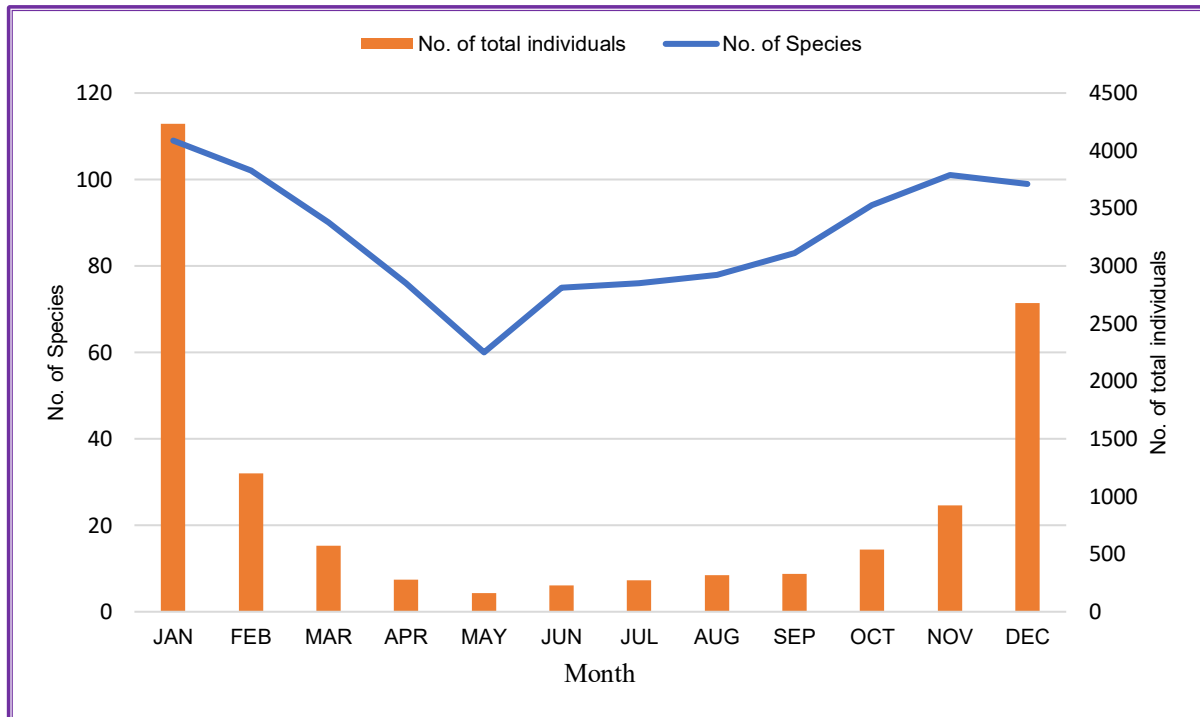


Figure 2: Monthly Variation in No. of Species and No. of total Individuals

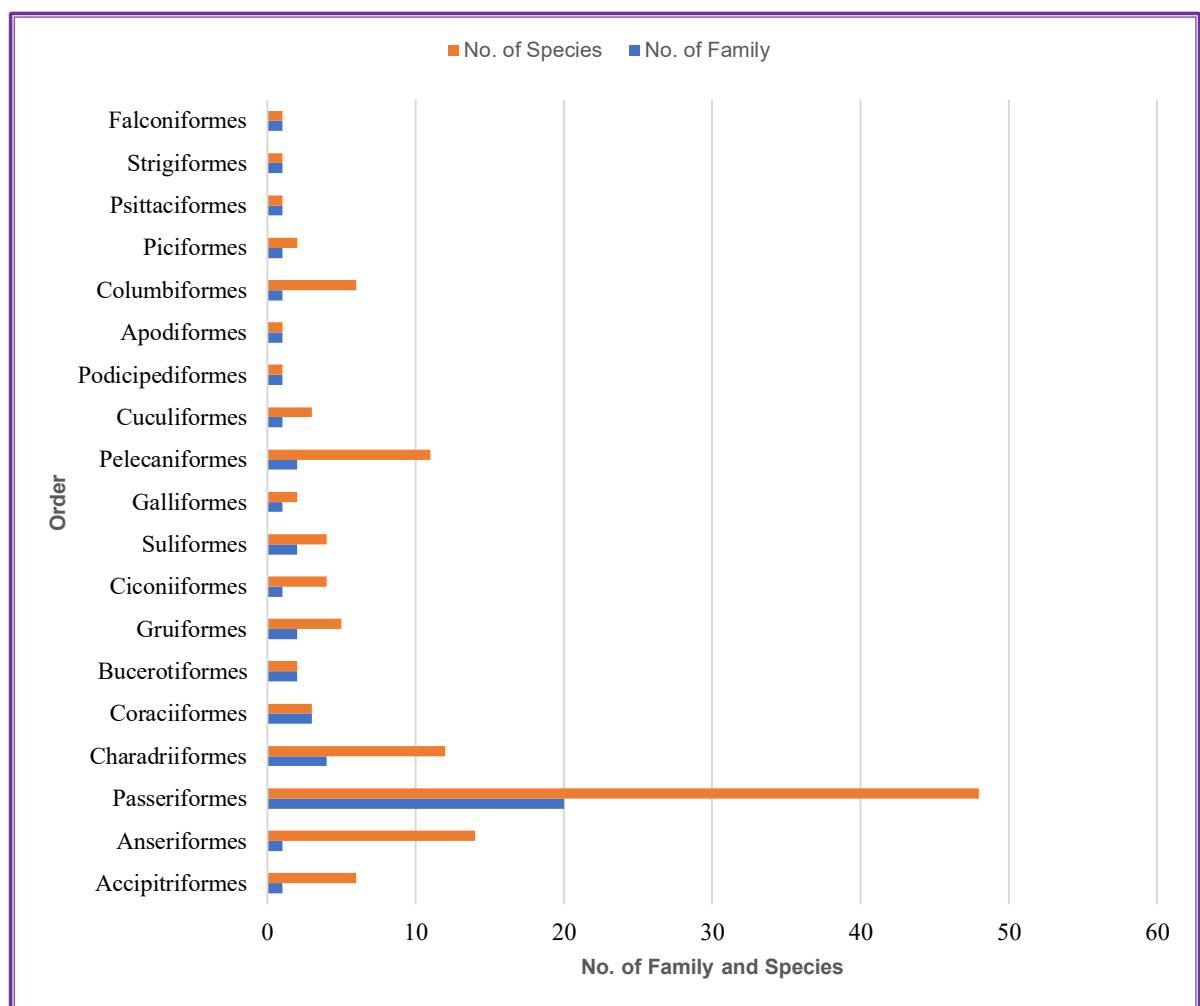


Figure 3: Composition of Avifaunal Community in Patna Bird Sanctuary

Table 2: Relative Diversity (RDI) of Bird Families

Family	No. of Species	RDI
Anatidae	14	11.02
Ardeidae	8	6.29
Motacillidae	7	5.51
Muscicapidae, Columbidae, Scolopacidae, Accipitridae	6	4.72
Sturnidae, Rallidae, Ciconiidae, Leiotrichidae	4	3.14
Cisticolidae, Corvidae, Phalacrocoracidae, Threskiornithidae, Cuculidae, Estrildidae, Charadriidae,	3	2.36
Pycnonotidae, Ploceidae, Phylloscopidae, Jacanidae, Phasianidae, Sylviidae, Picidae	2	1.57
Passeridae, Nectariniidae, Dicruridae, Zosteropidae, Hirundinidae, Recurvirostridae, Alcedinidae, Coraciidae, Meropidae, Upupidae, Bucerotidae, Anhingidae, Podicipedidae, Apodidae, Psittacidae, Oriolidae, Laniidae, Alaudidae, Strigidae, Gruidae, Falconidae	1	0.78

Table 3: Season-wise Ecological Indices of Birds of Patna Bird Sanctuary (Mean±SD).

Season	Species	Individuals	Shannon	Simpson	Margalef's	Evenness
Summer	75.25±12.26	310.25±182.58	3.71±0.09	0.98±0.01	13.15 ±1.07	0.80 ±0.15
Monsoon	82.75±8.06	363.75±120.07	3.93± 0.13	0.98± 0.00	13.93±0.67	0.76± 0.15
Winter	102.75±4.35	2258.25±1524.17	3.23±0.45	0.92 ±0.03	13.56± 1.06	0.27 ±0.13

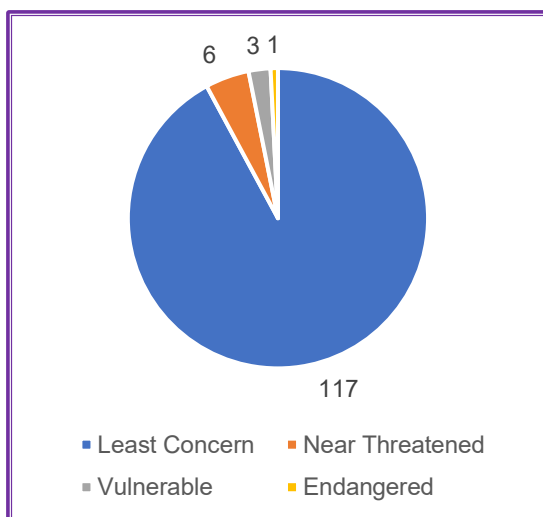


Figure 4: Distribution according to their IUCN conservation status

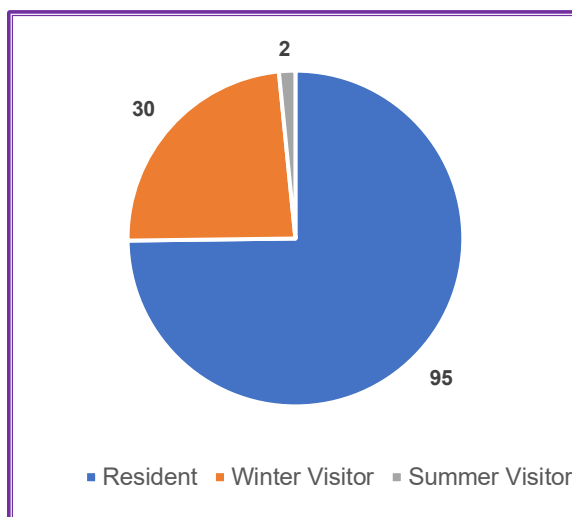


Figure 5: Distribution according to their Resident status

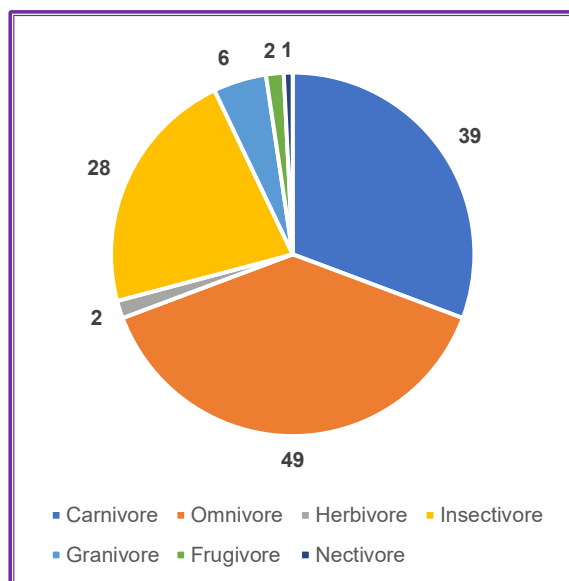


Figure 6. Distribution according to their feeding habits

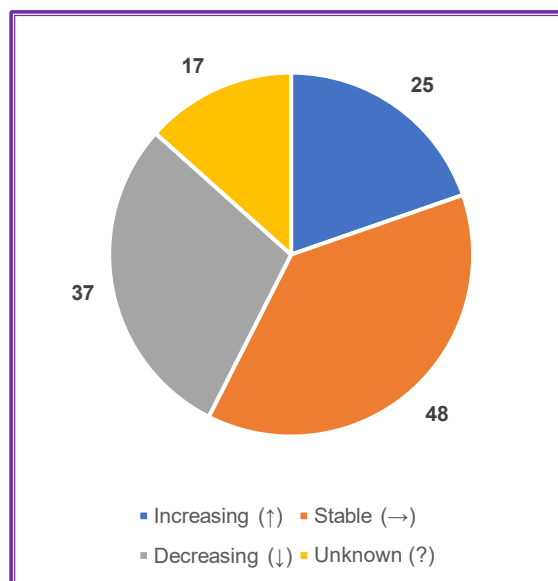


Figure 7: Distribution according to their Global Population trend.

Discussion

The Patna Bird Sanctuary possesses abundant and sustainable bird diversity, with high potential for ecotourism. Almost 10% of Indian avifauna and 23% of the recorded bird species in Uttar Pradesh can be observed in this sanctuary. Table 1 provides a checklist of the birds of Patna Bird Sanctuary, including their common and scientific names along with their IUCN status. Efforts have also been made to include the resident/migratory status of these birds and their feeding habits, so that a complete picture can emerge regarding the status of avifauna in this protected area. A total of 127 species have been listed in this table. Table 2 summarises the number of families to which these birds belong, with the highest representation from the family *Anatidae* ($RDi = 11.02$), and the lowest ($RDi = 0.78$) spread across 21 families. The high frequency of *Anatidae* is attributed to the shallow perennial water, which enables its members to survive and feed comfortably in this sanctuary. *Anatidae* includes migratory birds such as the Northern Shoveler, Northern Pintail, Greylag Goose, which are visible in the sanctuary from November to March. Resident birds such as the Indian Spot-billed Duck, Little Grebe, Grey-headed Swamphen, Eurasian Moorhen, Grey Heron, and Purple Heron are invariably present in the wetland. The effective count of total birds' peaks during the winter, as this wetland serves as a favourable wintering ground due to ample food availability and protection from anthropogenic encroachment. Larger birds such as the Black-necked Stork and Painted Stork are present in very low numbers, likely because the sanctuary is surrounded by palm trees and lacks large trees with dense vegetation, which discourages large birds from nesting. A large population of Painted Storks has been observed within a 100 km radius of Patna Bird Sanctuary, particularly at Keoladeo National Park (Ahmed and Urfi, 2024). Species richness reaches 102.75 during the winter months, whereas in the lean summer months it declines to 75.25. Fluctuations in species dominance across the three seasons have been observed, with evenness tending to decline in winter, as shown in Table 3. No rare bird species have been recorded. Among the 127 species, 95 are resident, 30 are winter visitors, and 2 are summer visitors. Most migratory birds appear during the winter months and come from overseas, while those in the summer are typically local migrants. The composition of these birds by major feeding guilds shows omnivores (49 species) as the most represented, followed by carnivores (39 species). Due to their omnivorous diet, species belonging to the *Anatidae* family are particularly well-adapted to Patna Bird Sanctuary. This wetland is expected to support rich avian diversity, as reflected in this study, and the present inventory will serve as baseline data for the state forest department to undertake necessary actions for its management and conservation.

As Agra is a major tourist hotspot for the Taj Mahal and other heritage monuments, developing Patna Bird Sanctuary as an ecotourism site will enhance the tourism potential of the Taj Trapezium Zone. The Taj Trapezium Zone was established to protect one of the eight wonders of the world, the Taj Mahal. Various conservation activities have been undertaken to protect the Taj and the surrounding habitats. In this context, wetlands and associated protected forests play a crucial role in the Taj Trapezium Zone. Some of the already recognised Ramsar sites—Keoladeo National Park and Soor Sarovar Bird Sanctuary—also fall within the Taj Trapezium Zone. In the present study, Patna Bird Sanctuary, which covers 109 hectares and demonstrates equally high species richness, abundance, a healthy habitat, and sustainable food availability in all seasons, is being proposed for consideration as another Ramsar site and ecotourism hotspot.

Conclusion

The Patna Bird Sanctuary is spread over an area of 109 hectares and lies at the cusp of the semi-arid biogeographical zone. The richness and abundance of the bird population are high due to its healthy habitat, further supported by the fact that thousands of migratory birds use it as a stopover during the winter season, as it lies along the Central Asian Flyway. The Patna Bird Sanctuary was declared in 1990, but its importance grew after the designation of the Taj Trapezium Zone. Currently, efforts are being made to popularise the location as a hub for environmental education, species conservation, and to provide opportunities for avian research and ecotourism development.

Conflict of Interest

The authors declare that they have no competing interests.

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