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43/2 Varadarajulu Nagar, 5th Street West, Ganapathy, Coimbatore, Tamil Nadu 641006, India
Registered Office: 3A2 Varadarajulu Nagar, FCI Road, Ganapathy, Coimbatore, Tamil Nadu 641006, India
Ph: +91 9385339863 | www.threatenedtaxa.org
Email: sanjay@threatenedtaxa.org

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Cover: Green Sea Turtle *Chelonia mydas* watercolour by Elakshi Mahika Molur.

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COMMUNICATION

Assessment of diversity, abundance, and seasonal variations of bird species in Bengaluru District, India during COVID-19 lockdown

H. Hemanth [1], Rajalakshmi K.S. Vinanthi [2] & Kuppusamy Alagesan Paari [3]

[1,2,3] Department of Lifesciences, CHRIST (Deemed to be University), Dharmaram College Road, Hosur Road, Bengaluru, Karnataka 560029, India.
[1] hemanth.h@res.christuniversity.in, [2] vinanthi.rajalakshmi@res.christuniversity.in, [3] paari.ka@christuniversity.in (corresponding author)

Abstract: The study investigates bird population dynamics in Bengaluru, India, post-lockdown, focusing on occurrence, seasonal abundance, species diversity, richness, dominance, and evenness. It covers 55 bird species across 52 genera, grouped into 32 families within 13 orders, with a notable peak in winter. Various indices, including Shannon Wiener, Margalef's, Pielou's, and Simpson's, reveal significant seasonal differences in bird population characteristics. The Rock Pigeon *Columba livia* dominates, while the Black-headed Ibis *Threskiornis melanocephalus* is less prevalent. The study identifies Near Threatened species like Black-headed Ibis and Oriental Darter *Anhinga melanogaster*, along with Least Concern species per the IUCN Red List. Common species include Rock Pigeon, Large-billed Crow *Corvus macrorhynchos*, House Crow *Corvus splendens*, Black Drongo *Dicrurus macrocercus*, Brown Shrike *Lanius cristatus*, Common Myna *Acridotheres tristis*, Jungle Myna *Acridotheres fuscus*, Red-whiskered Bulbul *Pycnonotus jocosus*, and Streak-throated Swallow *Petrochelidon fluvicola*. The study aims to inform improved management and conservation strategies for Bengaluru's diverse bird species.

Keywords: Avian abundance, bird diversity, conservation, lockdown effects, pollution indices, species evenness, species richness, threatened species, water bodies.

ಪ್ರಸ್ತಾವನೆ: ಈ ಅಧ್ಯಯನವು ಭಾರತದ ಬೆಂಗಳೂರಿನಲ್ಲಿನ ಕೋವಿಡ್-೧೯ ಲಾಕ್‌ಡೌನ್ ನಂತರದ ಪಕ್ಷಿಗಳ ಜನಸಂಖ್ಯಾ ಡೈನಾಮಿಕ್ಸ್ ಅನ್ನು ತನಿಖೆ ಮಾಡುತಿದ್ದು, ಮುಖ್ಯವಾಗಿ ಪಕ್ಷಿಗಳ ಸಂಭವಿಸುವಿಕೆ, ಕಾಲೋಚಿತ ಸಮೃದ್ಧಿ, ಜಾತಿಯ ವೈವಿಧ್ಯತೆ, ಶ್ರೀಮಂತಿಕೆ, ಪ್ರಾಬಲ್ಯತೆ ಮತ್ತು ಸಮತೆಯ ಮೇಲೆ ಕೇಂದ್ರೀಕರಿಸುತ್ತದೆ. ಇವುಗಳು ೫೨ ಕುಲಗಳಿಗೆ ಸೇರುವ ೫೫ ಜಾತಿಗಳನ್ನು ಒಳಗೊಂಡಿದ್ದು, ೧೩ ಗಣಗಳು, ೩೨ ಕುಟುಂಬಗಳಾಗಿ ವರ್ಗೀಕರಿಸಲಾಗಿದೆ, ಚಳಿಗಾಲದಲ್ಲಿ ಗಮನಾರ್ಹವಾದ ಉತ್ತುಂಗವನ್ನು ಹೊಂದಿದೆ. ಶಾನನ್ ವೀನರ್, ಮಾರ್ಗಲೆಫ್ಸ್, ಪೈಲೌ ಮತ್ತು ಸಿಂಪ್ಸನ್ ಸೇರಿದಂತೆ ವಿವಿಧ ಸೂಚ್ಯಂಕಗಳು ಪಕ್ಷಿಗಳ ಜನಸಂಖ್ಯೆಯ ಗುಣಲಕ್ಷಣಗಳಲ್ಲಿ ಗಮನಾರ್ಹವಾದ ಕಾಲೋಚಿತ ವ್ಯತ್ಯಾಸಗಳನ್ನು ಬಹಿರಂಗಪಡಿಸುತ್ತಿವೆ. ಗುಡ್ಡದ ಪಾರಿವಾಳ (ಕೊಲಂಬಾ ಲಿವಿಯಾ)ವು ಹೆಚ್ಚು ಪ್ರಾಬಲ್ಯತೆ ಹೊಂದಿದ್ದು, ಬಳಿ ಕೆಂಬರಲು (ಥ್ರೆಸ್ಕಿಯೋರ್ನಿಸ್ ಮೆಲನೊಸೆಫಾಲಸ್) ಕಡಿಮೆ ಪ್ರಚಲಿತದಲ್ಲಿರುವುದು ಕಂಡುಬಂದಿದೆ. ಐಯುಸಿಎನ್ ಕೆಂಪು ಪಟ್ಟಿಯ ಆಧಾರದ ಮೇಲೆ ಬಳಿ ಕೆಂಬರಲು ಮತ್ತು ಹಾವ್ಹಕ್ಕಿ (ಅನ್ಹಿಂಗಾ ಮೆಲನೋಗಾಸ್ಟರ್)ಗಳನ್ನು ಆತಂಕಕ್ಕೆ ಸಮೀಪವಿರುವ ಪಕ್ಷಿಗಳೆಂದು ಹಾಗೂ ಉಳಿದವುಗಳನ್ನು ಕಡಿಮೆ ಕಾಳಜಿಯ ಪಕ್ಷಿಗಳೆಂದು ಅಧ್ಯಯನವು ಗುರುತಿಸುತ್ತದೆ. ಗುಡ್ಡದ ಪಾರಿವಾಳ, ದೊಡ್ಡ ಕೊಕ್ಕಿನ ಕಾಗೆ (ಕಾರ್ವಸ್ ಮ್ಯಾಕ್ರೋರಂಚೋಸ್), ಬೂದು ಕಾಗೆ (ಕಾರ್ವಸ್ ಸ್ಪ್ಲೆಂಡೆನ್ಸ್), ಕಾಜಾಣ (ಡಿಕ್ರುರಸ್ ಮ್ಯಾಕ್ರೋಸೆರ್ಕಸ್), ಕಂದು ಕಳಿಂಗ (ಲ್ಯಾನಿಯಸ್ ಕ್ರಿಸ್ಟಾಟಸ್), ಗೊರವಂಕ (ಅಕ್ರಿಡೋಥೆರ್ಸ್ ಫುಸ್ಕಸ್), ಕೆಮ್ಮೀಸೆ ಪಿಕಳಾರ (ಪಿಕ್ನೋನೋಟಸ್ ಜೋಕೋಸಸ್), ಮತ್ತು ಕವಲುತೋಕೆ (ಪೆಟ್ರೋಚೆಲಿಡಾನ್ ಫ್ಲುವಿಕೋಲಾ)ಗಳನ್ನು ಸಾಮಾನ್ಯವಾಗಿ ಕಂಡುಬರುವ ಪಕ್ಷಿಜಾತಿಗಳೆಂದು ಪರಿಗಣಿಸಲಾಗಿದೆ. ಈ ಅಧ್ಯಯನವು ಬೆಂಗಳೂರಿನ ವೈವಿಧ್ಯಮಯ ಪಕ್ಷಿ ಪ್ರಭೇದಗಳಿಗೆ ಸುಧಾರಿತ ನಿರ್ವಹಣೆ ಮತ್ತು ಸಂರಕ್ಷಣಾ ಕಾರ್ಯತಂತ್ರಗಳನ್ನು ತಿಳಿಸುವ ಗುರಿಯನ್ನು ಹೊಂದಿದೆ.

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Author details: H. Hemanth and Rajalakshmi K.S. Vinanthi are currently pursuing their doctoral studies in zoology at the Department of Lifesciences, CHRIST (Deemed to be University), Bengaluru. Dr. Kuppusamy Alagesan Paari is working as an assistant professor at the Department of Lifesciences, CHRIST (Deemed to be University), Bengaluru.

Author contributions: HH carried out surveys, photography and identification of birds. RKSV make substantial contributions to acquisition of theoretical data, compilation of data and manuscript preparation. KAP have contributed towards the conception, designing of ideas and critical revision that has helped in the formation of the present research manuscript. All the authors reviewed and approved the final manuscript.

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INTRODUCTION

Bengaluru, the fifth largest city in India, is known as the Garden City owing to its natural vegetation, rich parks, gardens, lakes, and streets lined with large canopied flowering trees (Rajashekara & Venkatesha 2016). Rapid urbanization and massive increase in population density have affected the existence and diversity of wildlife (Ramachandra et al. 2017; Yang et al. 2022). Birds are common inhabitants and are an important component of any ecosystem as they are involved in several trophic levels in the food web (Blair 1999). In the urban ecosystem, the development of huge green spaces contributed to the sustainable conservation of bird species (Campbell et al. 2022; Choudaj et al. 2023). The abundance of bird species and their variety within a specific region can have consequences for both terrestrial and aquatic ecosystems, which are interconnected within the broader food web (Turner 2003). The declining abundance of bird species in specific regions, particularly urban areas, is a cause for concern, especially when considering metrics related to urbanization and pollution (Donaldson et al. 2007).

Factors such as climatic stability and seasonality have a positive influence on avian diversity and are important determinants of avian diversity (Graham et al. 2006). In urban areas, compared to previous years, an increase in the daily mean number and visibility of a new proportion of bird species were witnessed during the COVID-19 pandemic seasons (Basile et al. 2021). The avifaunal diversity reported in Bangladesh during lockdown revealed the relative abundance and detectability of Red-vented Bulbul *Pycnonotus cafer* which was directly related to their breeding season during the seasons from March to August (Shome et al. 2021). The diversity of biological resources depends on climatic, physical conditions, topographic features, altitudinal differences between highland and lowland areas, and the geological history of a region (Parmesan & Yohe 2003). Anthropogenic climate change has a widespread impact on many biological processes and migratory patterns of birds due to the unavailability of primary requirements of food, shelter, roosting, and nesting sites for birds which vary during different seasons (Cockrem 1995). A study by Shome et al. (2021) during the summer and rainy times of Covid pandemic seasons revealed the altered species composition of migratory birds belonging to the family Cuculidae. The restricted human activities and food limitations during the COVID-19 pandemic had an impact on the progressive decline and in the abundance of *Columbia livia* in open feeding hotspots (Soh et al. 2021).

Biotic assemblages are significantly influenced by urbanization factors, leading to restricted turnover rates of bird species and reduced richness of native species due to human settlements (Godefroid 2001). The impact of COVID-19 on bird species, including richness, abundance, and diversity, has been substantial. Recent studies have highlighted the effects of lockdowns on avifauna populations, with observations of nearly 24 bird species' abundance during the spring of 2020 in North America (Schrimpf et al. 2021). Uncommon species like the Black-rumped Flameback *Dinopium benghalense*, not reported in 2019 or the pre-period of 2020, became abundant during the lockdown in Bengaluru. Similarly, the Large-billed Crow was predominantly detected in the post-lockdown period of 2020 in New Delhi (Madhok & Gulati 2022). A study by Estela et al. (2021) on the nocturnal birds of Cali City, Colombia, revealed a decreased species richness of 40–58 % during lockdown restrictions.

The overnight limitations of anthropogenic activities (anthropause) led to the lag between the lockdown and species diversity which exhibited the gradual recovery of species. Though databases such as citizen sciences, iNaturalist, and eBird offer data on population statistics of bird species, scientific evidence concerning the pandemic impact on avifaunal diversity, and seasonal variation detectability is scarce. Therefore, the present article aims to focus on the occurrence, seasonal abundance, species diversity, species richness, species dominance, and species evenness of bird population in different seasons during the pandemic lockdown season. This generated data could be useful for designing high throughput conservation strategies for better management of the avian population.

MATERIALS AND METHODS

Study area and data collection

The research was conducted at Hinnakki Village Lake in the Bengaluru district of Karnataka, India (Figure 1), situated at 12.774N & 77.678E, with an altitude of 889 m (2,918 ft) in the southern part of Karnataka. The average annual rainfall in the region is approximately 1,958.6 mm, with maximum and minimum annual temperatures recorded at 36.7 °C and 13.9 °C, respectively. The dominant vegetation type in the selected study area is tropical deciduous. The study encompassed the lake region and adjacent habitats, including agroforestry, agricultural fields, and anthropogenic regions, as part

Figure 1. The study area, Hinnakki village lake, Bengaluru (extracted from Google maps).

of a systematic examination of the seasonal abundance of birds. Four seasons—winter (December–February), summer (March–May), monsoon (June–August), and retreating monsoon (September–November)—were considered for the study (Girma et al. 2017). The survey employed a point transect method (Newson et al. 2009), with four regions covering 12 spots spaced at least 300 m apart. The study period extended from December 2021 to November 2022, with surveys conducted in the morning (0630–0830 h) and early evening (1630–1830 h) during each site visit. Each spot was visited seasonally 20 times, and bird identification was conducted using CASON 8 x 40 binoculars. Bird frequency was categorized as rare (R), uncommon (UC), common (C), and very common (VC) following the protocol by Kumar & Gupta (1970). Photographs of birds were captured using a Sony DSCHX 400V 20MP camera, and bird identification and checklists were meticulously performed (Ali 2002; Manakadan et al. 2011; Grimmett et al. 2016).

Mathematical formulation for data analysis

Data analysis was carried out using the following equations:

- Shannon Wiener index-The type of diversity used was α- diversity which is the diversity of species within a community or habitat. (Wiener diversity index 1949).
  Diversity index: $H = -\sum Pi \ln Pi$
  where $Pi = S / N$
  S = number of individuals of one species
  N = total number of all individuals in the sample
  ln = logarithm to base e
- Margalef's index was used as a simple measure of species richness (Margalef 1958).
  Margalef's index = $((S - 1))/\ln N$
  S = total number of species
  N = total number of individuals in the sample
  ln = natural logarithm
- Pielou's Evenness Index (e) was used to calculate the evenness of species (Pielou 1966).
  Pielou's Evenness Index = $e = H / \ln S$
  H = Shannon – Wiener diversity index
  S = total number of species in the sample
- Simpson's diversity index (D) was used to calculate the species dominance (Simpson 1949).
  Simpson index = $D = 1 - (\text{sum } n * (n - 1) / N * (N - 1))$
  n = number of individuals of each species
  N = total number of individuals of all species
- Relative abundance

$$\text{Relative abundance} = \frac{\text{Number of checklists in which a bird is recorded}}{\text{Total number of checklists}} \text{ X } 100$$

RESULTS AND DISCUSSION

The ecology of birds is intricately tied to rainfall and vegetation, where fluctuations in these environmental factors have direct and indirect effects on avian abundance. Demographic parameters further contribute to the biodiversity shift in birds. In the study area, the total recorded rainfall was 1958.6 mm, with the highest monthly rainfall of 131.6 mm occurring in September.

Summer temperatures ranged from a maximum of 36.7°C to a minimum of 24.2°C in April, while winter temperatures ranged from a maximum of 19.6°C to a minimum of 13.9°C in November. The highest diurnal temperature variation was 17°C in February (max = 33°C, min = 16°C), while the lowest was 1.8°C in December (max = 19.6°C, min = 17.8°C). The harsh environment significantly impacts vital rates in the avian population, with factors such as heat stress and hypothermia affecting survival and population trends. Rainfall, in particular, correlates with breeding success and factors associated with migratory bird assemblages. The study validates a positive correlation between environmental metrics and avian diversity and richness (Saracco et al. 2018).

A total of 55 species of birds belonging to 52 genera belonging to 32 families of 13 orders were recorded during the post-lockdown period in the study area (Imags 1–55; Figure 2). Among the observed bird species, 53 are classified as 'Least Concern,' while two species fall under the category of 'Near Threatened,' namely the Black-headed Ibis and the Oriental Darter (Table 1). The documentation included a total of 18 aquatic birds and 37 terrestrial birds. The Rock Pigeon was identified as the most commonly found species, constituting 6.935% of the observed bird population, owing to its behavioral adaptability to urban settings and resilience to anthropogenic disturbances (Polyavina et al. 2022). The Black-headed Ibis was found to be the most uncommon species (0.012%), which might be due to their preferred habitat and foraging areas such as shallow seasonal or permanent wetlands, marshlands, and water-logged crop fields (Barik et al. 2021). The decrease in marshy vegetation in the current study area due to the alteration of the landscape, which involves the construction of concrete buildings, and roads and also turning paddy fields into dry agricultural lands, affected the avian diversity. The order Passeriformes exhibited the highest relative abundance at 38.18%, attributed to Passerines' predominant diet, which includes insects, nuts, seeds, nectar, berries, and fruits (Bhatti et al. 2017). Most of the passerines were found feeding on Indian Banyan *Ficus bengalensis,* Sacred Fig *Ficus religiosa,* Bur Flower-tree *Neolamarckia cadamba,* Jamaican Berry *Muntingia calabura,* and Bamboo *Dendrocalamus* sp. The family Ardeidae, encompassing herons and egrets, registered the highest relative abundance at 12.7%. The reason for their abundance might be due to the number of water bodies surrounded by a huge number of trees and bushes, which facilitate the nesting of birds. The abundance and richness of Ardeidae species depend on the quality of water bodies, vegetation cover, and the availability of food (Ahlam et al. 2019).

The current observation held during the winter season showed the richness of bird species such as Grey-headed Swamphen *Porphyrio poliocephalus,* Black-winged Stilt *Himantopus himantopus,* Pied Kingfisher *Ceryle rudis,* White-cheeked Barbet *Psilopogon viridis,* and Rosy Starling *Pastor roseus.* In the summer season, Indian Spot-billed Duck *Anas poecilorhyncha,* Indian Golden Oriole *Oriolus kundoo,* and Black-headed Ibis have been found (Figure 3). The significant variation in avifaunal diversity and abundance in different seasons could be due to seasonal migration patterns, habitat changes, and

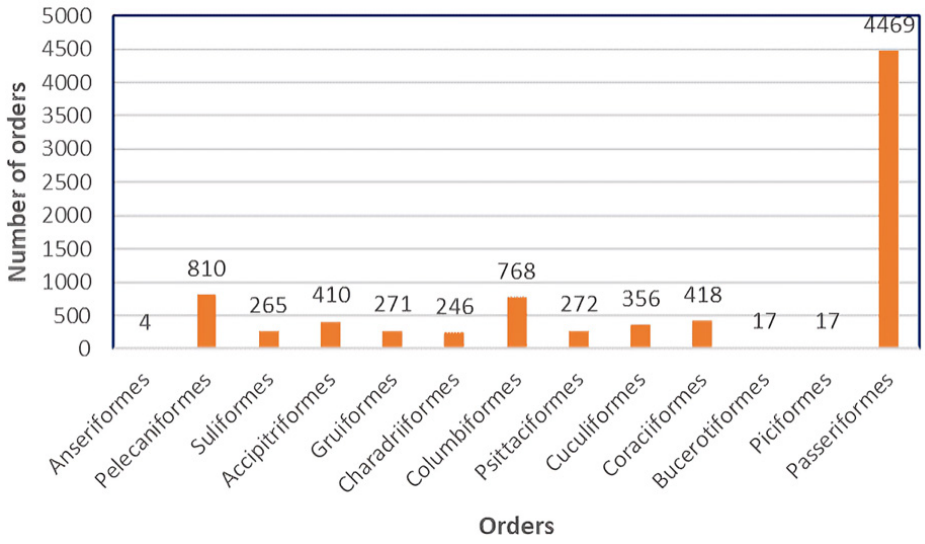

Figure 2. Representation of the bird count belonging to respective orders.

Table 1. Encounter rates, occurrence, conservation status, and the diet type of avian communities reported in the study area.

Scientific name	Common name	Conservation status \ IUCN	Frequency of observation	Winter season	Summer season	Monsoon season	Retreating monsoon season	Total	Relative abundance
Anas poecilorhyncha	Indian Spot-billed Duck	LC	R	0	4	0	0	4	0.048
Threskiornis melanocephalus	Black-headed Ibis	NT	R	0	0	0	1	1	0.012
Egretta garzetta	Little Egret	LC	R	6	12	18	10	46	0.558
Ardea cinerea	Grey Heron	LC	R	5	8	2	2	17	0.206
Ardea purpurea	Purple Heron	LC	R	30	51	38	20	139	1.688
Mesophoyx intermedia	Intermediate Egret	LC	UC	50	77	85	60	272	3.303
Bubulcus ibis	Cattle Egret	LC	R	10	20	22	15	67	0.813
Ardeola grayii	Indian Pond Heron	LC	UC	40	59	75	55	229	2.781
Ardea alba	Great Egret	LC	R	5	10	15	9	39	0.473
Phalacrocorax fuscicollis	Indian Cormorant	LC	UC	80	60	70	50	260	3.158
Anhinga melanogaster	Oriental Darter	NT	R	3	2	0	0	5	0.061
Elanus caeruleus	Black-winged Kite	LC	R	1	2	0	0	3	0.036
Milvus migrans	Black Kite	LC	UC	58	62	51	55	226	2.745
Haliastur indus	Brahminy Kite	LC	UC	47	45	39	43	174	2.113
Accipiter badius	Shikra	LC	R	2	3	1	1	7	0.085
Amaurornis phoenicurus	White-breasted Waterhen	LC	UC	88	44	26	53	211	2.562
Porphyrio poliocephalus	Grey-headed Swamphen	NE	R	10	0	0	0	10	0.121
Fulica atra	Eurasian Coot	LC	R	5	10	20	15	50	0.607
Himantopus himantopus	Black-winged Stilt	LC	R	5	0	0	0	5	0.061
Vanellus indicus	Red-wattled Lapwing	LC	UC	65	50	60	66	241	2.927
Columba livia	Rock Pigeon	LC	VC	148	150	135	138	571	6.935
Spilopelia chinensis	Spotted Dove	LC	UC	50	62	45	40	197	2.393
Psittacula krameri	Rose-ringed Parakeet	LC	UC	50	60	84	78	272	3.303
Centropus sinensis	Greater Coucal	LC	UC	38	48	58	35	179	2.174
Eudynamys scolopacea	Asian Koel	LC	UC	59	45	40	33	177	2.149
Coracias benghalensis	Indian Roller	LC	R	20	5	8	15	48	0.583
Halcyon smyrnensis	White-throated Kingfisher	LC	UC	78	39	45	65	227	2.757
Ceryle rudis	Pied Kingfisher	LC	R	4	0	0	0	4	0.048
Merops philippinus	Blue-tailed Bee-eater	LC	R	35	39	31	34	139	1.688
Ocyceros birostris	Indian Grey Hornbill	LC	R	2	8	0	0	10	0.121
Upupa epops	Hoopoe	LC	R	4	3	0	0	7	0.085
Dinopium benghalense	Black-rumped Flameback	LC	R	2	0	0	0	2	0.024
Psilopogon viridis	White-cheeked Barbet	LC	R	5	0	0	0	5	0.061
Psilopogon haemacephalus	Coppersmith Barbet	LC	R	8	2	0	0	10	0.121
Lanius cristatus	Brown Shrike	LC	C	90	100	60	85	335	4.068
Oriolus kundoo	Indian Golden Oriole	LC	R	0	6	0	0	6	0.072
Dicrurus macrocercus	Black Drongo	LC	VC	180	210	75	50	515	6.255
Corvus splendens	House Crow	LC	C	110	113	60	70	353	4.287

Scientific name	Common name	Conservation status \ IUCN	Frequency of observation	Winter season	Summer season	Monsoon season	Retreating monsoon season	Total	Relative abundance
Corvus macrorhynchos	Large-billed Crow	LC	VC	180	200	90	100	570	6.923
Pycnonotus jocosus	Red-whiskered Bulbul	LC	C	85	78	60	77	300	3.643
Pycnonotus cafer	Red-vented Bulbul	LC	UC	70	50	30	50	200	2.429
Petrochelidon luvicola	Streak-throated Swallow	LC	C	100	135	50	80	365	4.433
Argya striata	Jungle Babbler	LC	R	6	3	2	3	14	0.171
Sturnia pagodarum	Brahminy Starling	LC	R	4	8	0	0	12	0.145
Acridotheres tristis	Common Myna	LC	VC	180	153	86	93	512	6.218
Acridotheres fuscus	Jungle Myna	LC	C	120	105	50	60	335	4.068
Pastor roseus	Rosy Starling	LC	R	150	0	0	0	150	1.821
Copsychus saularis	Oriental Magpie Robin	LC	R	30	21	22	20	93	1.129
Saxicoloides fulicatus	Indian Robin	LC	R	28	24	20	23	95	1.153
Terpsiphone paradisi	Indian Paradise Flycatcher	LC	R	1	2	0	0	3	0.036
Cinnyris asiaticus	Purple Sunbird	LC	R	20	12	5	8	45	0.546
Nectarinia zeylonica	Purple-rumped Sunbird	LC	R	15	10	5	5	35	0.426
Passer domesticus	House Sparrow	LC	UC	55	42	30	35	162	1.967
Motacilla maderaspatensis	White-browed Wagtail	LC	UC	79	74	63	67	283	3.437
Anthus rufulus	Paddy Field Pipit	LC	R	20	33	15	18	86	1.044

Rdi: 0–1.75% as rare (R), 1.76–3.5% as uncommon (UC), 3.6–5.25% as common(C), 5.26–7% as very common (VC)
IUCN Red List: Least Concern (LC), Near Threatened (NT).

Table 2. Avian diversity in different seasons.

Biodiversity indices	Winter season	Summer season	Monsoon season	Retreating monsoon Season
Shannon Wiener index (Species diversity)	3.434	3.379	3.408	3.4
Margalef's index (Species richness)	6.506	6.052	5.112	5.228
Pielou evenness index (Species evenness)	0.869	0.873	0.93	0.922
Simpson's index (Species dominance)	0.04	0.043	0.038	0.038
Number of encounters	2446	2359	1691	1737
Number of species	52	48	39	40

climatic conditions (Aynalem & Bekele 2008). Invasive exotic species such as Common Lantana *Lantana camara,* Alligator Weed *Alternanthera phyloxiroides,* Parthenium Weed *Parthenium hysterophorus,* Water Hyacinth *Eichhornia crassipes, and* Water Lettuce *Pistia stratiotes* was also observed. Biological invasion in water bodies can cause significant damage to the abundance of aquatic communities such as fish, zooplankton, and aquatic invertebrates (Schirmel et al. 2016). The biological oxygen demand of water bodies may, in turn, affect the bird population (Klemetsen et al. 2013; Mallin et al. 2016).

CONCLUSION

The present research provides information on the status of the bird population in the Bengaluru district. The conversion of green spaces into concrete structures due to urbanization has influenced bird diversity. Urbanization has varying control over the avian population. The study identified a reduction in the wetland bird population. A biodiversity shift was observed in the avian population of species such as *Columba livia*, *Corvus macrorhynchos*, and *Corvus splendens,* were seen in common wherein the density

Table 3. Representation of the number of species belonging to each family observed in the study area.

Orders	Family	No. of genera	No. of species	Abundance
Anseriformes	Anatidae	1	1	1.81
Pelecaniformes	Threskiornithidae	1	1	1.81
	Ardeidae	5	7	12.7
Suliformes	Phalacrocoracidae	1	1	1.81
	Anhingidae	1	1	1.81
Accipitriformes	Accipitridae	4	4	7.27
Gruiformes	Rallidae	3	3	5.45
	Recurvirostridae	1	1	1.81
Charadriiformes	Charadriidae	1	1	1.81
Columbiformes	Columbidae	2	2	3.63
Psittaciformes	Psittacidae	1	1	1.81
Cuculiformes	Cuculidae	2	2	3.63
Coraciiformes	Coraciidae	1	1	1.81
	Alcedinidae	2	2	3.63
	Meropidae	1	1	1.81
Bucerotiformes	Bucerotidae	1	1	1.81
	Upupidae	1	1	1.81
Piciformes	Picidae	1	1	1.81
	Megalaimidae	1	2	3.63
Passeriformes	Laniidae	1	1	1.81
	Oriolidae	1	1	1.81
	Dicruridae	1	1	1.81
	Corvidae	1	2	3.63
	Pycnonotidae	1	2	3.63
	Hirundinidae	1	1	1.81
	Sturnidae	3	4	7.27
	Muscicapidae	3	3	5.45
	Nectariniidae	2	2	3.63
	Leiothrichidae	1	1	1.81
	Passeridae	2	2	3.63
	Motacillidae	1	1	1.81
13	32	49	55	

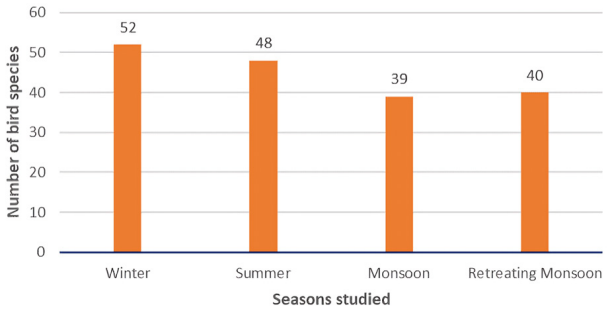

Figure 3. Effect of seasonal variations on the number of bird species.

of the Near Threatened *Threskiornis melanocephalus* and *Anhinga melanogaster* populations was lower. Factors such as the magnitude of human activity during lockdown, pollution indices such as agricultural runoff, air and noise quality parameters, and food availability also influenced the migration pattern of birds. Regular monitoring of the wetland's biodiversity is an important prerequisite to tracking the changes in avian population and diversity. The study also discussed the importance of confounding factors such as seasonal variations in the avian population. The involvement and support of residents are critical in conserving the vegetation, which can have a direct impact on the avian population and diversity.

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Image 1–16. Representation of bird species noted in the study area: 1—*Anas poecilorhyncha* | 2—*Threskiornis melanocephalus* | 3—*Egretta garzetta* | 4—*Ardea cinerea* | 5—*Ardea purpurea* | 6—*Mesophoyx intermedia* | 7—*Bubulcus ibis* | 8—*Ardeola grayii* | 9—*Ardea alba* | 10—*Phalacrocorax fuscicollis* | 11—*Anhinga melanogaster* | 12—*Elanus caeruleus* | 13—*Milvus migrans* | 14—*Haliastur indus* | 15—*Accipiter badius* | 16—*Amaurornis phoenicurus*. © H. Hemanth.

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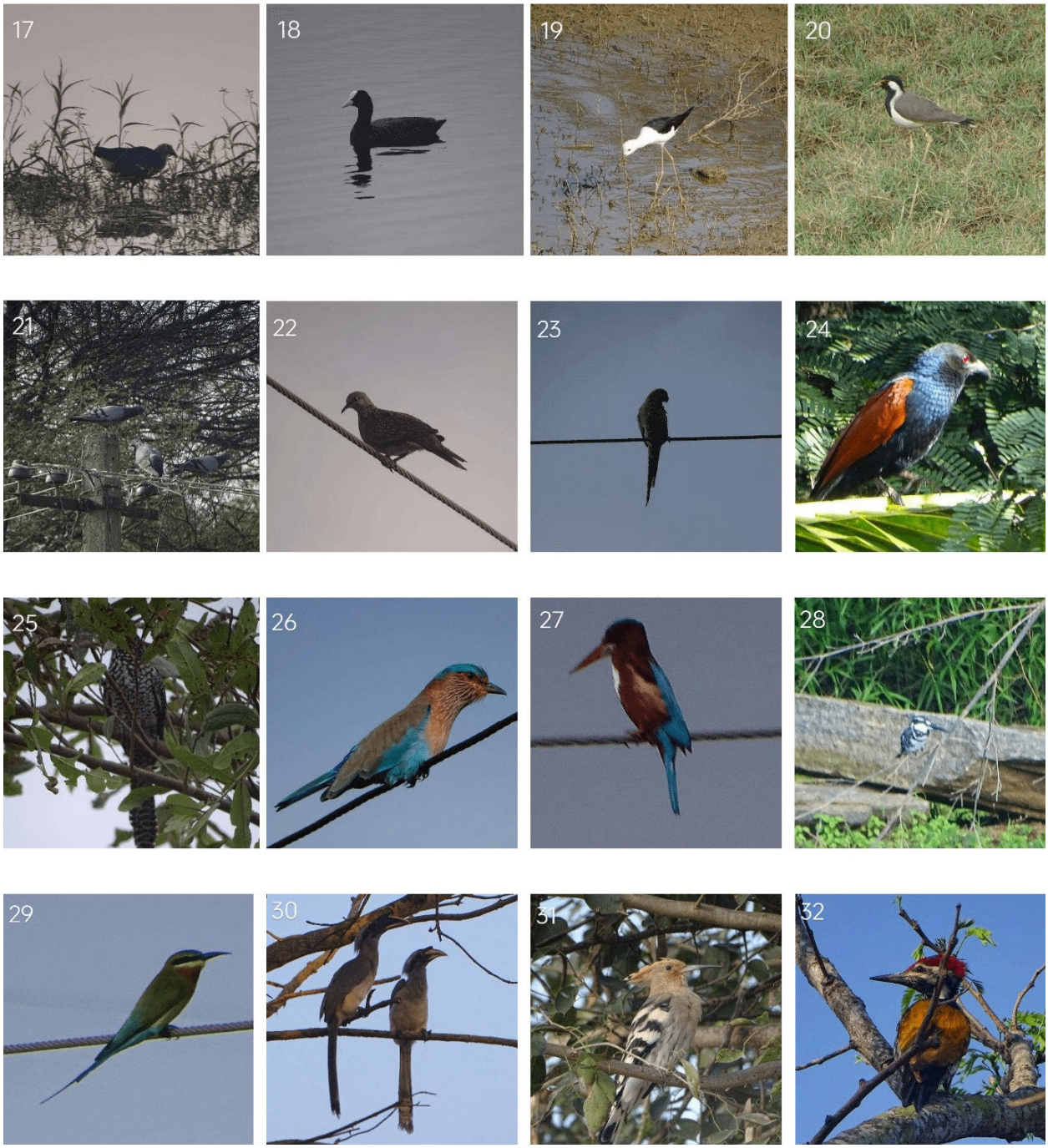

Image 17–32. Representation of bird species noted in the study area (continued): 17—*Porphyrio poliocephalus* | 18—*Fulica atra* | 19—*Himantopus himantopus* | 20—*Vanellus indicus* | 21—*Columba livia* | 22—*Spilopelia chinensis* | 23—*Psittacula krameri* | 24—*Centropus sinensis* | 25—*Eudynamys scolopacea* | 26—*Coracias benghalensis* | 27—*Halcyon smyrnensis* | 28—*Ceryle rudies* | 29—*Merops philippinus* | 30—*Ocyceros birostris* | 31—*Upupa epops* | 32—*Dinopium benghalense*. © H. Hemanth.

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Image 33–48. Representation of bird species noted in the study area (continued): 33—*Psilopogon viridis* | 34—*Psilopogon haemacephalus* | 35—*Lanius cristatus* | 36—*Oriolus kundoo* | 37—*Dicrurus macrocercus* | 38—*Corvus splendens* | 39—*Corvus macrorhynchos* | 40—*Pycnonotus jocosus* | 41—*Pycnonotus cafer* | 42—*Petrochelidon luvicola* | 43—*Argya striata* | 44—*Sturnia pagodarum* | 45—*Acridotheres tristis* | 46—*Acridotheres fuscus* | 47—*Pastor roseus* | 48—*Copsychus saularis*. © H. Hemanth.

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Image 49–55. Representation of bird species noted in the study area (continued): 49—*Saxicoloides fulicatus* | 50—*Terpsiphone paradisi* | 51—*Cinnyris asiaticus* | 52—*Nectarinia zeylonica* | 53—*Passer domesticus* | 54—*Motacilla maderaspatensis* | 55—*Anthus rufulus*. © H. Hemanth.

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