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Cover: Nile Crocodile *Crocodylus niloticus* regulating body temperature on a warm day. Digital art on Procreate by © Aakanksha Komanduri.

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COMMUNICATION

Lotus *Nelumbo* cultivations of Beehama Ganderbal offer novel habitats for diversity and seasonal variation of wetland birds

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Abstract: Conversion of marshy paddy fields into *Nelumbo* (lotus) gardens by the farmers of Beehama Ganderbal, Jammu & Kashmir has not only increased their livelihood and economy but also started yielding ecological dividends although unintentionally, because these *Nelumbo* gardens, along with adjoining *Salix* cultivations are now serving as alternative and rich habitats for the thriving of wetland birds. The present study was designed to assess the wetland bird assemblages in these artificial *Nelumbo* gardens to understand the species composition and richness along with their seasonal variation from March 2023 to February 2025. The study revealed that these artificial *Nelumbo* gardens can act as potential alternative feeding and breeding grounds for the diversity of wetland birds when main wetlands are shrinking due to anthropogenic activities.

Keywords: Alternate breeding grounds, anthropogenic activities, artificial garden, bird assemblages, lotus cultivation, marshy paddy field, species composition, wetland bird diversity.

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Author contribution: STS is the main author of the paper who collected the entire data and clicked all the photographs. FAA did the statistical analysis of the paper including applying Shannon Weiner index and Simpson index and SAW accompanied the author for carrying out census of birds in different seasons.

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INTRODUCTION

Wetlands are transitional lands between terrestrial and aquatic ecosystems where the water table is usually at or near the surface or the land is covered by shallow water (Mitsch & Gosselink 1986). Wetlands provide a home for a diversity of wildlife such as birds, mammals, fish, frogs, insects, and plants (Buckton 2007). Thus, wetlands help maintain biodiversity of flora and fauna. Wetlands are complex and productive ecosystems that occupy about six per cent of the Earth's land surface (Maltby & Turner 1983; Maltby 1986; Unni 2002; Thomas et al. 2026). Hence, wetlands are known as "biological supermarkets" because of the extensive food chains and rich biodiversity that they support, providing unique habitats for a wide range of flora and fauna (Mitsch & Gosselink 2000). They are also important habitats for water birds, which use them for feeding, roosting, nesting and rearing young. In addition to being the most productive ecosystems, wetlands play a vital role in flood control, aquifer recharge, nutrient absorption and erosion control.

Lotus or golden lotus is a perennial plant that grows in lakes in many parts of the world, including Kashmir. In Kashmir, it naturally grows in Dal, Wular, Manasbal, and Anchar lakes. As the rhizome of the plant is used as a delicacy and food by the people of the valley, it is an economically important plant. So, people have also started cultivating it for their livelihood, and the land near lakes and wetlands is being brought under *Nelumbo* cultivation. In summer, these cultivations provide cover, food, and nesting habitat for birds, while in winter they provide food and open water areas. Hence, these cultivations attract birds in the summer as well as the winter. These man-made *Nelumbo* gardens not only provide alternatives for the cultivation of *Nelumbo*, reducing the anthropogenic pressure on the wetlands for harvesting *Nelumbo*, but also act as alternative safe feeding and breeding grounds for migratory and resident aquatic birds. As no study has yet been conducted on the avian diversity of these habitats, in this present study, an attempt has been made to document the species richness and diversity of the avifauna of these habitats.

Study area

The present study was carried out in the lotus (*Nelumbo*) cultivations of Beehama Ganderbal (34.207° N, 74.78° E). The study site is located about 18 km north of the capital city Srinagar on the west side of the Srinagar-Leh Highway at an altitude of approximately 1,585–1,619 m. The site used to be marshy paddy fields connected to the Pandach Wetland Reserve, which were converted into *Nelumbo* cultivations by the locals for better economic returns by selling *Nelumbo* rhizomes on the National Highway. These cultivations are not only yielding economic benefits to local farmers but also starting to yield ecological dividends by acting as alternative feeding and breeding habitats for resident and migratory wetland birds.

METHODS

The study was carried out on these newly emerging habitats for two years, from May 2023 to April 2025. The study site is a continuous *Nelumbo* cultivation of about 6.89 lac sq ft in area with some patches filled for residential houses and some patches of deep open waters. The study area was visited weekly, and the birds were counted in all four seasons, viz., Spring (March–May), Summer (June–August), Autumn (September–November), and Winter (December–February). Therefore, the study site was visited 12 times in each season. Counting of birds was done using the Nikon binocular (22 x 50) and employing the point count, flock count, and group count method (Choudhary & Soni 2023), considering the landscape of the study site. We selected six vantage points in different cardinal directions of the study site, spending 5–10 minutes at each point, as this duration maximizes detection efficiency while minimizing bias (Bonthoux & Balent 2012) for bird counts. Species were identified using eBird/Clements Checklist (Clements et al. 2025), and data were collected species-wise. Surveys were abandoned on days with rain, snowfall and strong wind (Verner 1985; Bibby et al. 2000). Surveys were also halted during paddy agricultural disturbance periods, like one week in April during nursery preparation, one week in June during planting of saplings and one week in October during harvest. Double-counting was avoided by recording the birds that flew into and out of the plots during the census. Birds with fewer than 10 records were categorized as rare, those with 10–50 records as common, and those with more than 50 records as abundant (Bibby et al. 2000). Total abundance (number of birds observed from different counting points) and mean total abundance (total number of birds counted divided by total number of counting points) were also recorded. A checklist of species was also prepared. Birds were photographed using a Nikon D5600 camera with a 200–500 mm Nikkor lens. The data collected was compiled in Microsoft Excel. Shannon-Weiner index (H) and Simpson diversity index (D) were used to evaluate

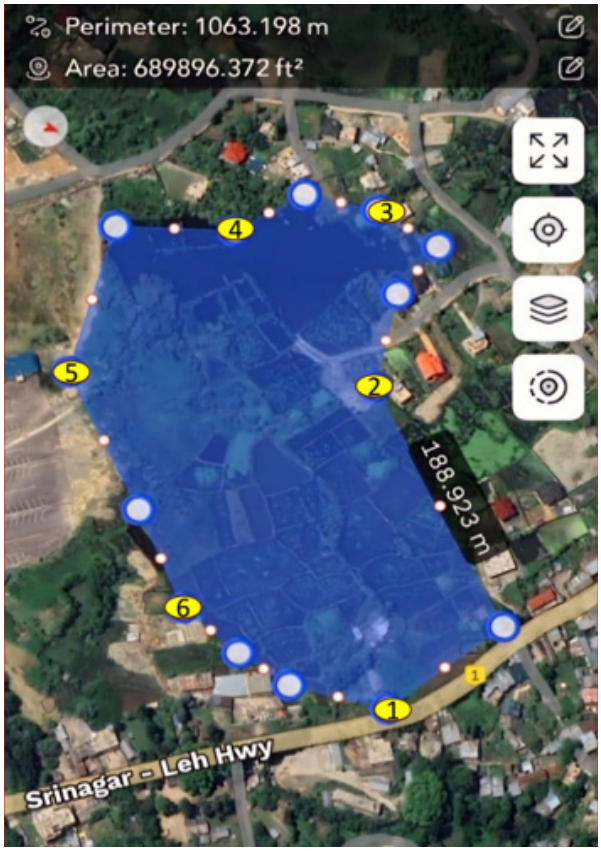

Image 1. Study site.

Image 2. Study site during summer season. © Sheikh Tanveer Salam.

Image 3. Study site during winter season. © Sheikh Tanveer Salam.

species diversity during different seasons of the study.

Shannon-Weiner index

$$H = - \Sigma\, p_i\, ln(p_i)$$

where: Σ: A Greek symbol that means "sum", *ln*: Natural log, p_i: The proportion of the entire community made up of species *i*

Simpson index

$$D = 1 - \frac{\Sigma n\,(n-1)}{N\,(N-1)}$$

Where n = number of individuals of each species, N = total number of individuals of all species

RESULTS AND DISCUSSION

A total of 71 species of birds belonging to 12 orders and 29 families were recorded in the present study (Table 1). Passerines, represented by 35 species, contribute about 49.29% of the bird diversity of the study area. Of the total diversity, 43.66% (31 species) were summer migrants (SM), followed by 42.25% (30 species) of residents (R), 11.26% (8 species) of winter migrants (WM) and only 2.81% (2 species) of local altitudinal migrants (LAM). No passage migrant was observed. Among these, some like Mallard *Anas platyrhynchos*, Eurasian Teal *Anas crecca*, Northern Shoveller *Anas clypeata*, Common Moorhen *Gallinula chloropus*, Grey-headed Swamphen *Porphyrio poliocephalus* and Little Grebe *Tachybaptus ruficollis* are typical marsh-dwelling species, while some upland birds like Indian Pond Heron *Ardeola grayii*, Black-Crowned Night Heron *Nycticorax nycticorax*, Little Bittern *Ixobrychus minutus*, Eurasian Collared Dove *Streptopelia decaocto*, European Roller *Coracias garrulus*, etc., spend a great deal of their time in the lake for feeding but nest on adjoining trees and shrubs. A total of 592 species of resident and non-resident birds have been reported from Jammu & Kashmir (Kichloo et al. 2024). About 92 species have been recorded from the wetlands of Kashmir (Holmes & Parr 1988; Ahangar 2008). The present study clearly revealed that a good number of species are visiting these newly created habitats, thereby providing a ray of hope that these *Nelumbo* gardens can act as alternative feeding and breeding sites for different types of birds, besides providing economic benefits to the locals. The areas with floating vegetation like *Trapa*

Table 1. Checklist of birds identified in the study.

Order	Family	Common name	Scientific name	Status*	Abundance
Podicipediformes	Podicipedidae	Little Grebe	*Tachybaptus ruficollis* Pallas, 1764	R	Common
Ciconiiformes	Ardeidae	Little Egret	*Egretta garzetta* Linnaeus, 1766	R	Common
		Indian Pond Heron	*Ardeola grayii* Sykes, 1832	R	Abundant
		Black-crowned Night Heron	*Nycticorax nycticorax* Linnaeus, 1758	R	Rare
		Little Bittern	*Ixobrychus minutus* Linnaeus, 1766	SM	Rare
Anseriformes	Anatidae	Mallard	*Anas platyrhynchos* Linnaeus, 1758	WM	Abundant
		Northern Shoveler	*Anas clypeata* Linnaeus, 1758	WM	Abundant
		Eurasian Teal	*Anas crecca* Linnaeus, 1758	WM	Abundant
Falconiformes	Accipitridae	Black Kite	*Milvus migrans* Boddaert, 1783	R	Abundant
		Common Buzzard	*Buteo buteo* Linnaeus, 1758	WM	Rare
		Long-legged Buzzard	*Buteo rufinus* Cretzschmar, 1827	WM	Rare
		Eurasian Sparrowhawk	*Accipiter nisus* Linnaeus, 1758	WM	Rare
		Western Marsh Harrier	*Circus aeruginosus (Linnaeus, 1758)*	WM	Rare
Gruiformes	Rallidae	Ruddy-breasted Crake	*Porzana fusca* Linnaeus, 1766	SM	Rare
		Grey-headed Swamphen	*Porphyrio poliocephalus* Linnaeus, 1758	R	Abundant
		Common Moorhen	*Gallinula chloropus* Linnaeus, 1758	R	Abundant
		Common Coot	*Fulica atra* Linnaeus, 1758	WM	Abundant
Charadriiformes	Scolopacidae	Common Sandpiper	*Actitis hypoleucos* Linnaeus, 1758	R	Common
		Green Sandpiper	*Tringa ochropus* Linnaeus, 1758	R	Common
	Laridae	Whiskered Tern	*Chlidonias hybrida* Pallas, 1811	SM	Rare
	Charadriidae	Red wattled Lapwing	*Vanellus indicus (Boddaert, 1783)*	SM	Rare
		Northern Lapwing	*Vanellus vanellus (Linnaeus, 1758)*	SM	Rare
Columbiformes	Columbidae	Blue Rock Pigeon	*Columba livia* Gmelin, 1789	R	Abundant
		Eurasian Collared-Dove	*Streptopelia decaocto* Frivaldszky, 1838	SM	Common
		Oriental Turtle-Dove	*Streptopelia orientalis* (Latham, 1790)	SM	Rare
Psittaciformes	Psittacidae	Rose-ringed Parakeet	*Psittacula krameri* Scopoli, 1769	R	Rare
Cuculiformes	Cuculidae	Common Cuckoo	*Cuculus canorus* Linnaeus, 1758	SM	Rare
		Pied Crested Cuckoo	*Clamator jacobinus* Boddaert, 1783	SM	Rare
Coraciiformes	Alcedinidae	Common Kingfisher	*Alcedo atthis* Linnaeus, 1758	R	Abundant
		White-breasted Kingfisher	*Halcyon smyrnensis* Linnaeus, 1758	R	Abundant
		Lesser Pied Kingfisher	*Ceryle rudis* Linnaeus, 1758	R	Rare
	Coraciidae	European Roller	*Coracias garrulus* Linnaeus, 1758	SM	Rare
	Upupidae	Common Hoopoe	*Upupa epops* Linnaeus, 1758	SM	Common
Piciformes	Picidae	Himalayan Pied Woodpecker	*Dendrocopos himalayensis* Jardine & Selby, 1831	R	Common
		Brown-fronted Pied Woodpecker	*Dendrocopos auriceps* Vigors, 1831	R	Rare
		Large Scaly-bellied Green Woodpecker	*Picus squamatus* Vigors, 1831	R	Rare
Passeriformes	Passeridae	House Sparrow	*Passer domesticus* Linnaeus, 1758	R	Abundant
	Hirundinidae	Common Swallow	*Hirundo rustica* Linnaeus, 1758	SM	Common
	Motacillidae	White Wagtail	*Motacilla alba* Linnaeus, 1758	R	Common
		Citrine Wagtail	*Motacilla citreola* Pallas, 1776	R	Common
		Grey Wagtail	*Motacilla cinerea* Tunstall, 1771	R	Common
		Rosy Pipit	*Anthus roseatus* Blyth, 1847	SM	Rare
		Water Pipit	*Anthus spinoletta* Linnaeus, 1758	SM	Rare
		Oriental Tree Pipit	*Anthus hodgsoni* Richmond, 1907	SM	Rare
	Campephagidae	Long-tailed Minivet	*Pericrocotus ethologus* Bangs & Phillips, 1914	SM	Rare

Passeriformes	Pycnonotidae	Himalayan Bulbul	*Pycnonotus leucogenys* Gray, 1835	R	Abundant
		Black Bulbul	*Hypsipetes leucocephalus* P.L.S. Muller, 1776	LAM	Common
	Laniidae	Rufous-backed Shrike	*Lanius schach* Linnaeus, 1758	SM	Common
	Troglodytidae	Winter Wren	*Troglodytes troglodytes* Linnaeus, 1758	LAM	Rare
	Muscicapidae	Blue Whistling-Thrush	*Myiophonus caeruleus* Scopoli, 1786	R	Abundant
		Tickell's Thrush	*Turdus unicolor* Tickell, 1833	SM	Rare
		Spotted Forktail	*Enicurus maculatus* Vigors, 1831	SM	Rare
		Streaked Laughingthrush	*Garrulax lineatus* Vigors, 1831	SM	Common
		Indian Great Reed-Warbler	*Acrocephalus stentoreus* Hemprich & Ehrenberg, 1833	SM	Common
		Indian Paradise Flycatcher	*Terpsiphone paradisi* Linnaeus, 1758	SM	Rare
		Siberian Stonechat	*Saxicola maurus* Linnaeus, 1766	SM	Common
		Common Chiffchaff	*Phylloscopus collybita* Vieillot, 1817	SM	Common
		Lemon-rumped Warbler	*Phylloscopus chloronotus* G.R. Gray & J.E. Gray, 1846	SM	Rare
		Hume's Warbler	Phylloscopus humei (Brooks, 1878)	SM	Rare
	Paridae	Coal Tit	*Parus ater* Linnaeus, 1758	SM	Rare
		Great Tit	*Parus major* Linnaeus, 1758	R	Common
	Certhiidae	Bar-tailed Tree-Creeper	*Certhia himalayana* Vigors, 1832	R	Rare
	Sturnidae	Common Starling	*Sturnus vulgaris* Linnaeus, 1758	SM	Common
		Common Myna	*Acridotheres tristis* Linnaeus, 1766	R	Abundant
	Oriolidae	Indian Golden Oriole	*Oriolus oriolus* Linnaeus, 1758	SM	Rare
	Dicruridae	Black Drongo	*Dicrurus macrocercus* Vieillot, 1817	SM	Common
		Ashy Drongo	*Dicrurus leucophaeus* Vieillot, 1817	SM	Common
	Corvidae	Yellow-billed Blue Magpie	*Urocissa flavirostris* (Blyth, 1846)	R	Abundant
		Eurasian Jackdaw	*Corvus monedula* Linnaeus, 1758	R	Abundant
		House Crow	*Corvus splendens* Vieillot, 1817	R	Abundant
		Jungle Crow	*Corvus macrorhynchos* Wagler, 1827	R	Common

*—Each species was classified according to its residential status, R—Residents | SM—Summer migrants | WM—Winter migrants | LAM—Local altitudinal migrants, based on field evidence and corroborated with authentic online datasets (Bates & Lowther 1952; Swati & Swati 2026).

natans, *Nymphoides* sp., and *Potomogeton* were used for nesting by birds like Little Grebe and Whiskered Tern *Chlidonias hybrida*. The emergent macrophytic vegetation, *Phragmites communis*, *Typha angustata*, *Scirpus palustis*, *Sparganium ramosum*, and *Butomus umbellatus* were used for nesting by birds like Mallard, Little Bittern, Indian Great Reed-Warbler *Acrocephalus stentoreus*, Common Moorhen and Wagtails, while the peripheral trees served as the nesting sites for a number of upland species like Herons, Doves, Rollers, Indian Golden Oriole *Oriolus oriolus*, Rufous-Backed Shrike *Lanius schach*, and Indian Paradise Flycatcher *Terpsiphone paradisi*. These findings are consistent with earlier studies from the region (Bates & Lowther 1952; Ali 2002; Ahanger 2008; Fazili et al. 2017).

The diversity of birds assembling at the *Nelumbo* gardens varied among different seasons. Diversity was found to be relatively higher during early Spring (H = 3.961; D = 0.9586) and late Winter (H = 3.811; D = 0.9572), followed by Summer (H = 3.376; D = 0.8706), and the least diversity was reported in Autumn (H = 3.267; D = 0.8281). The highest diversity during spring can be attributed to the assemblage of early summer migrants and already staying late winter migrants, besides the resident species, increasing the diversity of avifauna during Spring. The reason for the lowest diversity during autumn can be due to the presence of only residents in these sites during this period (Table 2) because during Autumn, summer migrants migrate to their feeding grounds, and most of the resident birds also move

Table 2. Avian diversity in different seasons of the study.

Diversity index	Spring (Mar–May)	Summer (Jun–Aug)	Autumn (Sep–Nov)	Winter (Dec–Feb)
Shannon-Weiner index (H)	3.961	3.376	3.267	3.811
Simpson index (D)	0.9586	0.8706	0.8281	0.9572

Image 4. Northern Shoveler pair.

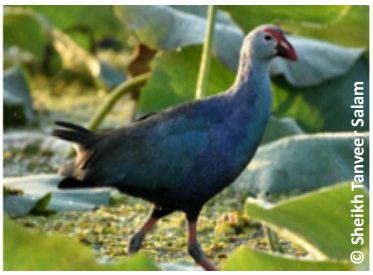

Image 5. Grey-headed Swamphen.

Image 6. Mallard pair.

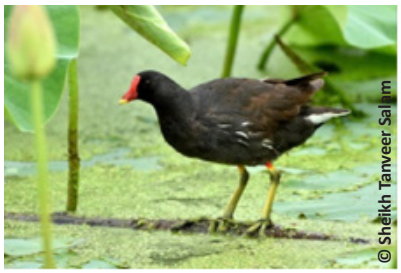

Image 7. Common Moorhen.

Image 8. Ashy Drongo.

Image 9. Ruddy-breasted Crake.

Image 10. Little Bittern.

Image 11. Little Egret.

Image 12. Common Teal pair.

Image 13. Reed Warbler.

Image 14. Indian Pond Heron.

Image 15. White-throated Kingfisher.

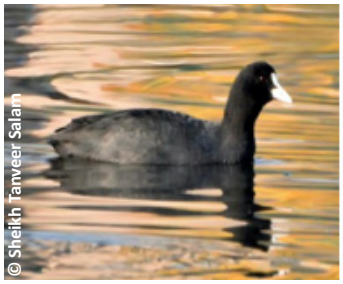

Image 16. Common Coot.

Image 17. Common Kingfisher.

Image 18. Whiskered Tern.

Image 19. Common Cuckoo.

towards residential areas and nearby paddy fields (Byju et al. 2023). Besides this, there is a huge disturbance to birds during late autumn and early winter due to intensive harvesting of *Nelumbo* stems locally called *Nadru* for selling them on small stalls at the adjoining Srinagar-Leh National Highway. The observations in the present study are in line with earlier observations from the wetlands of the adjoining states (Choudhary & Soni 2023).

With respect to abundance, 18 species (25.35%) were abundant, 22 species (30.98%) were common, and 31 species were rare (43.66%). The maximum total abundance (1908 individuals) was recorded in the winter season, with a mean abundance of 477 individuals. The minimum total abundance (184 individuals) was recorded in the autumn season with a mean abundance of 46 individuals.

These newly emerging habitats are facing serious anthropogenic threats due to the filling of these wetlands for making residential plots. Besides this, demarcations of the different plots by the owners using nets threaten and repel the birds. Harvesting of grass along footpaths within these *Nelumbo* gardens by the local women for cattle fodder may significantly disturb avifaunal communities inhabiting these wetlands and can lead to degradation of nesting habitats.

CONCLUSION

Conversion of less productive full-time water-logged paddy fields into productive *Nelumbo* (lotus) gardens, as revealed from the survey of the households involved in this venture, represents a sustainable land-use alternative with significant economic and ecological advantages. Economically, this practice offers higher and more stable returns compared to conventional paddy cultivation under water-logged conditions, thereby improving livelihood opportunities for local farmers by selling the rhizomes of the lotus on the adjacent Srinagar-Leh National Highway. Ecologically, these sites are emerging as structurally diverse wetland habitats that support rich biodiversity by attracting a wide range of resident and migratory bird species for feeding, breeding and shelter. A good avifaunal diversity observed at the study site underscores the role of *Nelumbo* gardens in enhancing ecosystem services, and this land use-transformation aligns agricultural productivity with wetland conservation goals, suggesting that *Nelumbo-based* systems can serve as a viable mode for sustainable management of water-logged agricultural landscapes. These systems can be managed to optimize both livelihood benefits and biodiversity outcomes through an integrated, eco-sensitive approach by engaging local communities, particularly women, for promoting sustainable harvesting by providing incentives for conservation-friendly practices. Identify and mapping of key nesting and roosting sites to establish temporary exclusion zones during breeding periods. Maintain optimal and stable water levels to support both *Nelumbo* growth and avifaunal requirements, and retain patches of open water interspersed with *Nelumbo* to support diverse bird guilds like waders, dabblers and diving birds. Encourage a mosaic of native macrophytes alongside *Nelumbo* to increase structural complexity and food availability for sustaining higher bird diversity. There is an immediate need to integrate these systems into wetland conservation policies and rural development schemes to ensure institutional backing for sustainable management.

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