

Birds in Agroforestry Systems of Ayodhya District, Uttar Pradesh

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Authors' contributions

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

With the fast depletion of area under forest cover due to various anthropogenic factors, it is important that conservation of wild fauna must be focused in human-dominated landscapes such as agroforestry systems. It important to understand the bird diversity of agroforestry systems to develop a baseline to formulate policies encouraging trees in agricultural fields. Fixed radius point counts were placed across the agroforestry systems in Ayodhya district, Uttar Pradesh to determine the diversity and distribution of birds in these systems. A total of 148 bird species belonging to 53 families and 16 orders were recorded from the study area. Passeriformes (76) had the maximum number of bird species. Omnivore (51%) was the dominant feeding guild. According to their residential status, the maximum bird species were resident (76%), followed by winter visitors (21%) and summer visitors (3%). Out of the 148 bird species recorded, eight species were in the threatened category of IUCN Red List and 28 species were rarely sighted birds. This result proves that the agroforestry systems provide a good habitat for the terrestrial as well as waterbirds thus, highlighting the conservation value of this system. Such land use types must therefore be promoted and widely practiced all across the state.

Keywords: Avifauna; agro-ecosystems; threatened; conservation; foraging guild; feeding guild.

1. INTRODUCTION

The conservationists have started exploring areas outside protected areas, including human-dominated landscapes such as agroforestry systems for conservation of biodiversity [1]. The agroforestry systems are defined as integration of perennial woody crops and annual herbaceous crops with or without livestock in the same unit of land [2]. The tree species planted in different forms of agroforestry systems have evidenced to provide opportunities to conserve wildlife species by contributing nesting sites, temporary refuge, migratory route, protective or escape cover against predators, access to breeding territory and food resources in all seasons and encourage beneficial species such as pollinators [3]. Studies have shown that different types of agroforestry systems such as live fences [4], agrisilviculture [5], homegardens [6], etc. provide favourable habitats for birds.

Uttar Pradesh is very rich in terms of floral and faunal diversity. However, the decline in forest cover has been due to diversion of forest land for non-forest purposes in view of the increasing demands for roads, irrigation, power, drinking water, mining products etc. In addition to this, huge chunks of forest lands have been encroached upon and diverted illegally to non-forest uses, challenging the wildlife conservation. The forest cover in the state of Uttar Pradesh is only 6.15% of the total geographical area [7]. Agriculture forms the backbone of Uttar Pradesh state economy. As most of the state land is under agriculture, agroforestry is the best way to increase the forest cover in the state. Certain forms of agroforestry systems are practiced in the state. The most popular agroforestry system practiced in western Uttar Pradesh is the Poplar (*Populus deltoides*) – based system intercropped with paddy or wheat. In eastern Uttar Pradesh, some fast-growing species like *Eucalyptus sp.*, *Emblica officinalis*, bamboo etc. are preferred for planting on bunds and croplands [8]. In Ayodhya district, the most prominent agroforestry systems are agrisilviculture and kitchen gardens. In agrisilviculture systems trees such as *Eucalyptus sp.*, *Tectona grandis* and *Dalbergia sissoo* are planted on the bunds and trees such as *Mangifera indica*, *Madhuca longifolia* and *Syzygium cumini* are sometimes placed scattered in agricultural fields. In kitchen gardens, trees such as *Mangifera indica*, *Carica papaya*, *Ficus sp.* and *Artocarpus heterophyllus* are placed scattered along with seasonal

vegetables grown in open spaces just behind their homes. But the bird diversity present in these systems is not documented yet. As, agroforestry is the only solution for conservation of wildlife in an agriculture dominant state as Uttar Pradesh, it is the need of the hour, to evaluate the role of agroforestry systems in conservation of bird species by providing food, shelter, refuge cover and breeding space.

Studies conducted on bird diversity are restricted to agricultural fields [9,10,11], wetlands and bird sanctuaries [12-19]. But there have been no studies to understand the bird diversity and composition in agroforestry systems. The present study therefore, aims at assessing the contribution of agroforestry systems practiced in Ayodhya district, Uttar Pradesh towards the conservation of bird species.

2. MATERIALS AND METHODS

2.1 Study Area

This study was conducted in the Ayodhya district of Uttar Pradesh which consists of five tehsils (Figure 1). This district lies between 26.7730°N and 82.1458°E. This district is situated 93 m above MSL (Mean Sea Level) [20]. The climate of the district is tropical monsoon. The average temperature varies from 32°C in summers to 16°C in winters [20]. There are three distinct seasons – summer (March to June), rainy (July to October) and winter (November to February). The study area includes reserve forests, remnant vegetation patches, rivers, temple ponds, wetlands, gardens, paddy fields and human habitations.

2.2 Methods

The study was carried out from March 2020 to April 2021 with an aim to prepare a checklist of birds present in agroforestry systems of Ayodhya district, Uttar Pradesh. Fixed radius, point counts [21] were placed at fixed sites distributed across the agroforestry systems throughout the district. Surveys were conducted during summers (06:00 am to 09:00 am) and winters (after disappearance of fog). Bird species were recorded for 10 minutes at every point count using a pair of field binoculars (Nikon 7x35). The opportunistic sightings of birds during other time of day were also included. Grimmett [22] was referred for bird identification. For every species observed, the details such as the date, time, GPS location (Garmin GPS), species name,

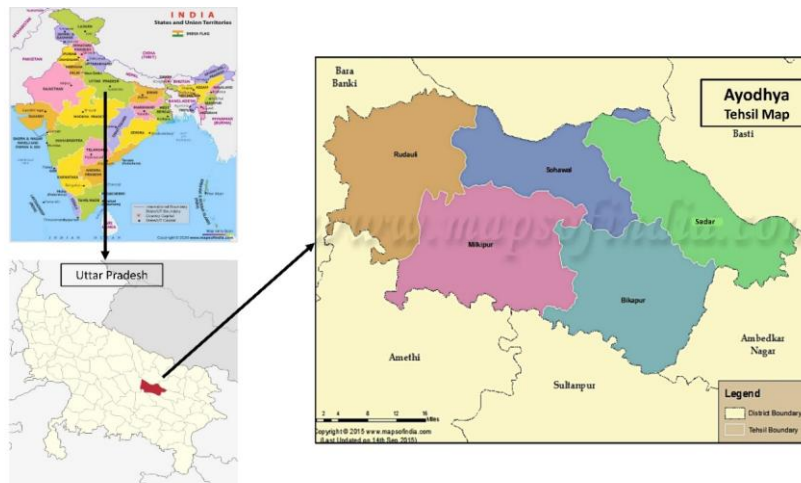


Fig. 1. Location map of study area

number of individuals, feeding habit and habitat were noted. Every species recorded was assigned the taxonomic position, common and scientific names following Praveen [23]. The IUCN Red List [24] was referred for assigning the threat status to each bird species recorded. The local status of each species was assigned on the percentage of frequency of sightings [25] as common (CO) – sighted 80-100%, fairly common (FC) – sighted 60-79.9%, uncommon (UC) – sighted 20-59.9% and rare (RA) – sighted less than 19.9% during field visits.

3. RESULTS AND DISCUSSION

A total of 148 bird species belonging to 53 families and 16 orders were recorded from the study area (Table 1). Bird diversity studies in agroforestry systems of Maharashtra have reported 71 bird species [26], which is much lower as compared to the results of the current study. Similar studies in agricultural landscapes of Aligarh, Uttar Pradesh have revealed 146 bird species [11]. This high diversity in agroforestry systems may be due to the diverse habitats and micro habitats that these systems provide. The trees such as teak, eucalyptus planted on bunds intermingled with rice fields, wetlands, guava and mango orchards, remanent vegetation patches, grasses provide diverse food, roosting and nesting sites to the birds. The cropping composition and intensity also affect the bird diversity in such study areas. These factors might have contributed to this high bird diversity in the study area. Amongst the order, Passeriformes (76 and 28) had the maximum number of species and family, followed by

Pelecaniormes (13 and 4) (Fig. 2). The family Accipitridae and Muscipidae (11) had the highest number of species followed by Columbidae, Cuculidae and Ardeidae (7) (Fig. 3). Passeriformes are known to be the most dominant order [27] and Muscipidae is known to be the most diverse family [28] in India.

Out of 148 bird species recorded, 112 species (76%) were resident, followed by 31 species (21%) winter visitors and the least five species (3%) were summer visitors (Fig. 4). Studies conducted in Harayana [29] have reported similar results. The occurrence of high amount of winter migrants may be due to the fact that this study area is a part of the Central Asian Flyway and therefore serves as wintering sites for migrants [30]. According to the feeding guilds, the 148 bird species recorded were classified into six foraging guilds. The maximum number of species recorded were Omnivores (51 species, 35%), followed by Insectivores (43 species, 29%) and the least number of species were nectarivores (1 species, 1%) (Fig. 5). This result is not in accordance with the study conducted by Kumar and Sahu [29], who have reported insectivores to be the most dominant foraging guild in agricultural fields. The presence of maximum number of omnivorous bird species in the study area reflects the diversity of food availability in the study area. This result implies that the diverse habitat provides not only insects but also plants, grains, nectar, mollusks, fish, rodents etc. which caters to the requirements of the omnivorous birds. The insectivorous birds also devour the insect pests thriving in these agroforestry areas.

Table 1. Checklist of birds recorded in agroforestry systems of study area

S/N	Order	Family	Order/Family/Common name	Scientific name	Residential status	Feeding guild	IUCN list (2021)	Local status
1	Accipitriformes	Accipitridae	Black Kite	<i>Milvus migrans</i> (Boddaert, 1783)	R	C	LC	FC
2	Accipitriformes	Accipitridae	Black-winged Kite	<i>Elanus caeruleus</i> (Desfontaines, 1789)	R	C	LC	UC
3	Accipitriformes	Accipitridae	Crested Serpent Eagle	<i>Spilornis cheela</i> (Latham, 1790)	R	C	LC	RA
4	Accipitriformes	Accipitridae	Egyptian Vulture	<i>Neophron percnopterus</i> (Linnaeus, 1758)	R	C	EN	RA
5	Accipitriformes	Accipitridae	Himalayan Vulture	<i>Gyps himalayensis</i> (Hume, 1869)	WV	C	NT	RA
6	Accipitriformes	Accipitridae	Indian Spotted Eagle	<i>Clanga hastata</i> (Lesson, 1831)	R	C	VU	RA
7	Accipitriformes	Accipitridae	Shikra	<i>Accipiter badius</i> (Gmelin, 1788)	R	C	LC	FC
8	Accipitriformes	Accipitridae	Short-toed Snake Eagle	<i>Circaetus gallicus</i> (Gmelin, 1788)	R	C	LC	RA
9	Accipitriformes	Accipitridae	Steppe Eagle	<i>Aquila nipalensis</i> (Hodgson, 1833)	WV	C	EN	RA
10	Accipitriformes	Accipitridae	Western Marsh-harrier	<i>Circus aeruginosus</i> (Linnaeus, 1758)	WV	C	LC	RA
11	Accipitriformes	Accipitridae	White-eyed Buzzard	<i>Butastur teesa</i> (Franklin, 1831)	R	C	LC	RA
12	Anseriformes	Anatidae	Cotton Pygmy-goose	<i>Nettapus coromandelianus</i> (Gmelin, 1789)	R	O	LC	UC
13	Anseriformes	Anatidae	Indian Spot-billed Duck	<i>Anas poecilorhyncha</i> (Forster, 1781)	R	O	LC	UC
14	Anseriformes	Anatidae	Lesser Whistling Duck	<i>Dendrocygna javanica</i> (Horsfield, 1821)	R	O	LC	UC
15	Bucerotiformes	Bucerotidae	Indian Grey Hornbill	<i>Ocyrceros birostris</i>	R	O	LC	FC

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16	Caprimulgiformes	Apodidae	Asian Palm Swift	(Scopoli, 1786) <i>Cypsiurus balasiensis</i> (Gray, 1829)	R	I	LC	UC
17	Caprimulgiformes	Apodidae	Indian House Swift	<i>Apus affinis</i> (Gray, 1830)	R	I	LC	UC
18	Caprimulgiformes	Upupidae	Common Hoopoe	<i>Upupa epops</i> (Linnaeus, 1758)	R	O	LC	CO
19	Charadriiformes	Charadriidae	Red-wattled Lapwing	<i>Vanellus indicus</i> (Boddaert, 1783)	R	O	LC	CO
20	Charadriiformes	Charadriidae	Yellow-wattled Lapwing	<i>Vanellus malabaricus</i> (Boddaert, 1783)	R	C	LC	FC
21	Charadriiformes	Glareolidae	Small Pratincole	<i>Glareola lactea</i> (Temminck, 1820)	R	I	LC	UC
22	Charadriiformes	Jacanidae	Bronze-winged Jacana	<i>Metopidius indicus</i> (Latham, 1790)	R	O	LC	UC
23	Charadriiformes	Jacanidae	Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i> (Scopoli, 1786)	R	O	LC	RA
24	Columbiformes	Columbidae	Eurasian Collared Dove	<i>Streptopelia decaocto</i> (Frisvaldszky, 1838)	R	G	LC	FC
25	Columbiformes	Columbidae	Laughing Dove	<i>Streptopelia senegalensis</i> (Linnaeus, 1766)	R	G	LC	CO
26	Columbiformes	Columbidae	Oriental Turtle Dove	<i>Streptopelia orientalis</i> (Latham, 1790)	WV	G	LC	FC
27	Columbiformes	Columbidae	Red Collared Dove	<i>Streptopelia tranquebarica</i> (Hermann, 1804)	R	G	LC	FC
28	Columbiformes	Columbidae	Rock Pigeon	<i>Columba livia</i> (Gmelin, 1789)	R	G	LC	CO
29	Columbiformes	Columbidae	Spotted Dove	<i>Streptopelia chinensis</i> (Scopoli, 1786)	R	G	LC	FC
30	Columbiformes	Columbidae	Yellow-footed Green Pigeon	<i>Treron</i>	R	F	LC	UC

S/N	Order	Family	Order/Family/Common name	Scientific name	Residential status	Feeding guild	IUCN list (2021)	Local status
31	Coraciiformes	Alcedinidae	Common Kingfisher	<i>phoenicopterus</i> (Latham, 1790) <i>Alcedo atthis</i> (Linnaeus, 1758)	R	C	LC	UC
32	Coraciiformes	Alcedinidae	White-throated Kingfisher	<i>Halcyon smyrnensis</i> (Linnaeus, 1758)	R	C	LC	CO
33	Coraciiformes	Coraciidae	Indian Roller	<i>Coracias benghalensis</i> (Linnaeus, 1758)	R	C	LC	FC
34	Coraciiformes	Meropidae	Blue-tailed Bee-eater	<i>Merops philippinus</i> (Linnaeus, 1767)	SV	I	LC	UC
35	Coraciiformes	Meropidae	Green Bee-eater	<i>Merops orientalis</i> (Latham, 1801)	R	I	LC	CO
36	Cuculiformes	Cuculidae	Asian Koel	<i>Eudynamys scolopaceus</i> (Linnaeus, 1758)	R	O	LC	FC
37	Cuculiformes	Cuculidae	Common Hawk Cuckoo	<i>Hierococcyx varius</i> (Vahl, 1797)	R	O	LC	RA
38	Cuculiformes	Cuculidae	Greater Coucal	<i>Centropus sinensis</i> (Stephens, 1815)	R	O	LC	CO
39	Cuculiformes	Cuculidae	Grey-bellied Cuckoo	<i>Cacomantis passerinus</i> (Vahl, 1797)	SV	I	LC	UC
40	Cuculiformes	Cuculidae	Indian Cuckoo	<i>Cuculus micropterus</i> (Gould, 1838)	SV	O	LC	UC
41	Cuculiformes	Cuculidae	Pied Cuckoo	<i>Clamator jacobinus</i> (Boddaert, 1783)	SV	O	LC	UC
42	Cuculiformes	Cuculidae	Sirkeer Malkoha	<i>Taccocua leschenaultii</i> (Lesson, 1830)	R	O	LC	RA
43	Falconiformes	Cuculidae	Common Kestrel	<i>Falco tinnunculus</i> (Linnaeus, 1758)	WV	C	LC	UC
44	Galliformes	Phasianidae	Grey Francolin	<i>Francolinus</i>	R	O	LC	CO

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45	Galliformes	Phasianidae	Indian Peafowl	<i>pondicerianus</i> (Gmelin, 1789) <i>Pavo cristatus</i> (Linnaeus, 1758)	R	O	LC	CO
46	Gruiformes	Gruidae	Sarus Crane	<i>Antigone antigone</i> (Linnaeus, 1758)	R	O	VU	UC
47	Gruiformes	Rallidae	White-breasted Waterhen	<i>Amauornis phoenicurus</i> (Pennant, 1769)	R	O	LC	UC
48	Passeriformes	Acrocephalidae	Blyth's Reed Warbler	<i>Acrocephalus dumetorum</i> (Blyth, 1849)	WV	O	LC	UC
49	Passeriformes	Acrocephalidae	Booted Warbler	<i>Iduna caligata</i> (Lichtenstein, 1823)	WV	I	LC	UC
50	Passeriformes	Aegithinidae	Common Iora	<i>Aegithina tiphia</i> (Linnaeus, 1758)	R	O	LC	UC
51	Passeriformes	Alaudidae	Ashy-crowned Sparrow-Lark	<i>Eremopterix griseus</i> (Scopoli, 1786)	R	O	LC	RA
52	Passeriformes	Alaudidae	Bengal Bushlark	<i>Mirafra assamica</i> (Horsfield, 1840)	R	O	LC	RA
53	Passeriformes	Alaudidae	Crested Lark	<i>Galerida cristata</i> (Linnaeus, 1758)	R	O	LC	RA
54	Passeriformes	Alaudidae	Sand Lark	<i>Alaudala raytal</i> (Blyth, 1845)	R	O	LC	UC
55	Passeriformes	Campephagidae	Indian Cuckooshrike	<i>Coracina macei</i> (Lesson, 1831)	R	I	LC	UC
56	Passeriformes	Campephagidae	Long-tailed Minivet	<i>Pericrocotus ethologus</i> (Bangs & Phillips, 1914)	WV	I	LC	UC
57	Passeriformes	Campephagidae	Small Minivet	<i>Pericrocotus cinnamomeus</i> (Linnaeus, 1766)	R	I	LC	UC
58	Passeriformes	Cisticolidae	Ashy Prinia	<i>Prinia socialis</i> (Sykes,	R	I	LC	FC

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59	Passeriformes	Cisticolidae	Common Tailorbird	1832) <i>Orthotomus sutorius</i> (Pennant, 1769)	R	I	LC	FC
60	Passeriformes	Cisticolidae	Plain Prinia	<i>Prinia inornata</i> (Sykes, 1832)	R	I	LC	FC
61	Passeriformes	Cisticolidae	Zitting Cisticola	<i>Cisticola juncidis</i> (Rafinesque, 1810)	R	I	LC	FC
62	Passeriformes	Corvidae	House Crow	<i>Corvus splendens</i> (Vieillot, 1817)	R	O	LC	CO
63	Passeriformes	Corvidae	Large-billed Crow	<i>Corvus macrorhynchos</i> (Wagler, 1827)	R	O	LC	CO
64	Passeriformes	Corvidae	Rufous Treepie	<i>Dendrocitta vagabunda</i> (Latham, 1790)	R	O	LC	CO
65	Passeriformes	Dicaeidae	Thick-billed Flowerpecker	<i>Dicaeum agile</i> (Tickell, 1833)	R	O	LC	RA
66	Passeriformes	Dicruridae	Black Drongo	<i>Dicrurus macrocercus</i> (Vieillot, 1817)	R	C	LC	CO
67	Passeriformes	Estrildidae	Indian Silverbill	<i>Euodice malabarica</i> (Linnaeus, 1758)	R	G	LC	FC
68	Passeriformes	Estrildidae	Red Munia	<i>Amandava amandava</i> (Linnaeus, 1758)	R	O	LC	FC
69	Passeriformes	Estrildidae	Scaly-breasted Munia	<i>Lonchura punctulata</i> (Linnaeus, 1758)	R	O	LC	FC
70	Passeriformes	Hirundinidae	Barn Swallow	<i>Hirundo rustica</i> (Linnaeus, 1758)	WV	I	LC	RA
71	Passeriformes	Hirundinidae	Plain Martin	<i>Riparia paludicola</i> (Vieillot, 1817)	R	I	LC	RA
72	Passeriformes	Hirundinidae	Red-rumped Swallow	<i>Cecropis daurica</i> (Laxmann, 1769)	R	I	LC	UC
73	Passeriformes	Hirundinidae	Streak-throated Swallow	<i>Petrochelidon fluvicola</i> (Vlyth, 1855)	R	I	LC	RA

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74	Passeriformes	Hirundinidae	Wire-tailed Swallow	<i>Hirundo smithii</i> (Leach, 1818)	R	I	LC	CO
75	Passeriformes	Laniidae	Bay-backed Shrike	<i>Lanius vittatus</i> (Valenciennes, 1826)	R	C	LC	FC
76	Passeriformes	Laniidae	Brown Shrike	<i>Lanius cristatus</i> (Linnaeus, 1758)	WV	C	LC	UC
77	Passeriformes	Laniidae	Long-tailed Shrike	<i>Lanius schach</i> (Linnaeus, 1758)	R	C	LC	FC
78	Passeriformes	Leiothrichidae	Common Babbler	<i>Argya caudata</i> (Dumont, 1823)	R	O	LC	FC
79	Passeriformes	Leiothrichidae	Jungle Babbler	<i>Argya striata</i> (Dumont, 1823)	R	O	LC	FC
80	Passeriformes	Leiothrichidae	Striated Babbler	<i>Turdoides earlei</i> (Blyth, 1844)	R	O	LC	UC
81	Passeriformes	Monarchidae	Indian Paradise-flycatcher	<i>Terpsiphone paradisi</i> (Linnaeus, 1758)	SV	I	LC	UC
82	Passeriformes	Motacillidae	Citrine Wagtail	<i>Motacilla citreola</i> (Pallas, 1776)	WV	I	LC	FC
83	Passeriformes	Motacillidae	Grey Wagtail	<i>Motacilla cinerea</i> (Tunstall, 1771)	WV	I	LC	FC
84	Passeriformes	Motacillidae	Paddyfield Pipit	<i>Anthus rufulus</i> (Vieillot, 1818)	R	C	LC	UC
85	Passeriformes	Motacillidae	Western Yellow Wagtail	<i>Motacilla flava</i> (Linnaeus, 1758)	WV	I	LC	UC
86	Passeriformes	Motacillidae	White Wagtail	<i>Motacilla alba</i> (Linnaeus, 1758)	WV	I	LC	FC
87	Passeriformes	Motacillidae	White-browed Wagtail	<i>Motacilla maderaspatensis</i> (Gmelin, 1789)	R	I	LC	FC
88	Passeriformes	Muscicapidae	Black Redstart	<i>Phoenicurus ochruros</i> (Gmelin, 1774)	WV	I	LC	UC
89	Passeriformes	Muscicapidae	Bluethroat	<i>Luscinia svecica</i> (Linnaeus, 1758)	WV	I	LC	RA

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90	Passeriformes	Muscicapidae	Brown Rockchat	<i>Oenanthe fusca</i> (Blyth, 1851)	R	I	LC	CO
91	Passeriformes	Muscicapidae	Indian Robin	<i>Copsychus fulvicatus</i> (Linnaeus, 1766)	R	C	LC	CO
92	Passeriformes	Muscicapidae	Oriental Magpie Robin	<i>Copsychus saularis</i> (Linnaeus, 1758)	R	C	LC	FC
93	Passeriformes	Muscicapidae	Pied Bushchat	<i>Saxicola caprata</i> (Linnaeus, 1766)	R	I	LC	CO
94	Passeriformes	Muscicapidae	Red-breasted Flycatcher	<i>Ficedula parva</i> (Bechstein, 1792)	WV	I	LC	UC
95	Passeriformes	Muscicapidae	Siberian Rubythroat	<i>Calliope calliope</i> (Pallas, 1776)	WV	I	LC	RA
96	Passeriformes	Muscicapidae	Siberian Stonechat	<i>Saxicola maurus</i> (Pallas, 1773)	WV	I	LC	RA
97	Passeriformes	Muscicapidae	Taiga Flycatcher	<i>Ficedula albicilla</i> (Pallas, 1811)	WV	I	LC	FC
98	Passeriformes	Muscicapidae	Tickell's Blue Flycatcher	<i>Cyornis tickelliae</i> (Blyth, 1843)	R	I	LC	UC
99	Passeriformes	Nectariniidae	Purple Sunbird	<i>Cinnyris asiaticus</i> (Latham, 1790)	R	N	LC	CO
100	Passeriformes	Oriolidae	Black-hooded Oriole	<i>Oriolus xanthornus</i> (Linnaeus, 1758)	R	O	LC	UC
101	Passeriformes	Oriolidae	Indian Golden Oriole	<i>Oriolus kundoo</i> (Sykes, 1832)	R	O	LC	UC
102	Passeriformes	Paridae	Cinereous Tit	<i>Parus cinereus</i> (Vieillot, 1758)	R	I	LC	FC
103	Passeriformes	Passeridae	House Sparrow	<i>Passer domesticus</i> (Linnaeus, 1758)	R	O	LC	CO
104	Passeriformes	Passeridae	Yellow-throated Sparrow	<i>Gymnoris xanthocollis</i> (Burton, 1838)	R	O	LC	UC
105	Passeriformes	Phylloscopidae	Blyth's Leaf Warbler	<i>Seicercus reguloides</i> (Blyth, 1842)	WV	I	LC	FC
106	Passeriformes	Phylloscopidae	Common Chiffchaff	<i>Phylloscopus collybita</i>	WV	I	LC	FC

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107	Passeriformes	Phylloscopidae	Greenish Leaf Warbler	(Vieillot, 1817) <i>Seicercus trochiloides</i> (Sundevall, 1837)	WV	I	LC	UC
108	Passeriformes	Phylloscopidae	Hume's Leaf-warbler	<i>Abrornis humei</i> (Brooks, 1878)	WV	I	LC	FC
109	Passeriformes	Ploceidae	Baya Weaver	<i>Ploceus philippinus</i> (Linnaeus, 1766)	R	O	LC	FC
110	Passeriformes	Ploceidae	Black-breasted Weaver	<i>Ploceus benghalensis</i> (Linnaeus, 1758)	R	O	LC	UC
111	Passeriformes	Pycnonotidae	Red-vented Bulbul	<i>Pycnonotus cafer</i> (Linnaeus, 1766)	R	O	LC	CO
112	Passeriformes	Pycnonotidae	Red-whiskered Bulbul	<i>Pycnonotus jocosus</i> (Linnaeus, 1758)	R	O	LC	CO
113	Passeriformes	Sittidae	Chestnut-bellied Nuthatch	<i>Sitta castanea</i> (Lesson, 1830)	R	O	LC	UC
114	Passeriformes	Stenostiridae	Grey-headed Canary Flycatcher	<i>Culicicapa</i> <i>ceylonensis</i> (Swainson, 1820)	WV	I	LC	UC
115	Passeriformes	Sturnidae	Asian Pied Starling	<i>Gracupica contra</i> (Linnaeus, 1758)	R	O	LC	FC
116	Passeriformes	Sturnidae	Bank Myna	<i>Acridotheres</i> <i>ginginianus</i> (Latham, 1790)	R	O	LC	FC
117	Passeriformes	Sturnidae	Brahminy Starling	<i>Sturnia pagodarum</i> (Gmelin, 1789)	R	O	LC	UC
118	Passeriformes	Sturnidae	Common Myna	<i>Acridotheres tristis</i> (Linnaeus, 1766)	R	O	LC	CO
119	Passeriformes	Sturnidae	Common Starling	<i>Sturnus vulgaris</i> (Linnaeus, 1758)	WV	O	LC	UC
120	Passeriformes	Sturnidae	Jungle Myna	<i>Acridotheres fuscus</i> (Wagler, 1827)	R	O	LC	UC
121	Passeriformes	Turdidae	Black-throated Thrush	<i>Turdus atrogularis</i> (Jarocki, 1819)	WV	G	LC	UC

S/N	Order	Family	Order/Family/Common name	Scientific name	Residential status	Feeding guild	IUCN list (2021)	Local status
122	Passeriformes	Vangidae	Common Woodshrike	<i>Tephrodornis pondicerianus</i> (Gmelin, 1789)	R	I	LC	UC
123	Passeriformes	Zosteropidae	Indian White-eye	<i>Zosterops palpebrosus</i> (Temminck, 1824)	R	I	LC	UC
124	Pelecaniformes	Ardeidae	Black-crowned Night-heron	<i>Nycticorax nycticorax</i> (Linnaeus, 1758)	R	O	LC	UC
125	Pelecaniformes	Ardeidae	Cattle Egret	<i>Bubulcus ibis</i> (Linnaeus, 1758)	R	C	LC	CO
126	Pelecaniformes	Ardeidae	Grey Heron	<i>Ardea cinerea</i> (Linnaeus, 1758)	WV	C	LC	RA
127	Pelecaniformes	Ardeidae	Indian Pond-heron	<i>Ardeola grayii</i> (Sykes, 1832)	R	C	LC	CO
128	Pelecaniformes	Ardeidae	Intermediate Egret	<i>Ardea intermedia</i> (Wagler, 1827)	R	C	LC	UC
129	Pelecaniformes	Ardeidae	Little Egret	<i>Egretta garzetta</i> (Linnaeus, 1766)	R	C	LC	UC
130	Pelecaniformes	Ardeidae	Purple Heron	<i>Ardea purpurea</i> (Linnaeus, 1766)	R	C	LC	UC
131	Pelecaniformes	Ciconiidae	Asian Openbill	<i>Anastomus oscitans</i> (Boddaert, 1783)	R	C	LC	UC
132	Pelecaniformes	Ciconiidae	Painted Stork	<i>Mycteria leucocephala</i> (Pennant, 1769)	WV	C	NT	RA
133	Pelecaniformes	Ciconiidae	Woolly-neck Stork	<i>Ciconia episcopus</i> (Boddaert, 1783)	R	C	NT	UC
134	Pelecaniformes	Phalacrocoracidae	Indian Cormorant	<i>Phalacrocorax fuscicollis</i> (Stephens, 1826)	WV	C	LC	UC
135	Pelecaniformes	Phalacrocoracidae	Little Cormorant	<i>Microcarbo niger</i> (Vieillot, 1817)	R	C	LC	FC
136	Pelecaniformes	Threskiornithidae	Red-naped Ibis	<i>Pseudibis papillosa</i>	WV	C	LC	FC

S/N	Order	Family	Order/Family/Common name	Scientific name	Residential status	Feeding guild	IUCN list (2021)	Local status
137	Piciformes	Picidae	Black-rumped Flameback	(Temminck, 1824) <i>Dinopium benghalense</i>	R	O	LC	UC
138	Piciformes	Picidae	Brown-capped Pygmy Woodpecker	(Linnaeus, 1758) <i>Dendrocopos moluccensis</i> (Gmelin, 1788)	R	I	LC	RA
139	Piciformes	Picidae	Yellow-fronted Pied Woodpecker	<i>Dendrocopos mahrattensis</i> (Latham, 1801)	R	O	LC	RA
140	Piciformes	Ramphastidae	Brown-headed Barbet	<i>Psilopogon zeylanicus</i> (Gmelin, 1788)	R	F	LC	FC
141	Piciformes	Ramphastidae	Coppersmith Barbet	<i>Psilopogon haemacephalus</i> (Muller, 1776)	R	F	LC	FC
142	Psittaciformes	Psittaculidae	Alexandrine Parakeet	<i>Psittacula eupatria</i> (Linnaeus, 1766)	R	F	NT	RA
143	Psittaciformes	Psittaculidae	Plum-headed Parakeet	<i>Psittacula cyanocephala</i> (Linnaeus, 1766)	R	F	LC	UC
144	Psittaciformes	Psittaculidae	Rose-ringed Parakeet	<i>Psittacula krameri</i> (Scopoli, 1769)	R	F	LC	CO
145	Strigiformes	Strigidae	Brown Fish Owl	<i>Ketupa zeylonensis</i> (Gmelin, 1788)	R	C	LC	RA
146	Strigiformes	Strigidae	Jungle Owlet	<i>Glaucidium radiatum</i> (Tickell, 1833)	R	C	LC	UC
147	Strigiformes	Strigidae	Mottled Wood Owl	<i>Strix ocellata</i> (Lesson, 1839)	R	C	LC	RA
148	Strigiformes	Strigidae	Spotted Owlet	<i>Athene brama</i> (Temminck, 1821)	R	C	LC	CO

IUCN: International Union for Conservation of Nature and Natural Resources; R: Resident, WV: Winter Visitor, SV: Summer Visitor; C: Carnivorous; O: Omnivorous; I: Insectivorous; F: Frugivorous; G: Granivorous; N: Nectarivore; LC: Least Concern; EN: Endangered; VU: Vulnerable; NT: Near Threatened; CO: Common; FC: Fairly common; UC: Uncommon; RA: Rare

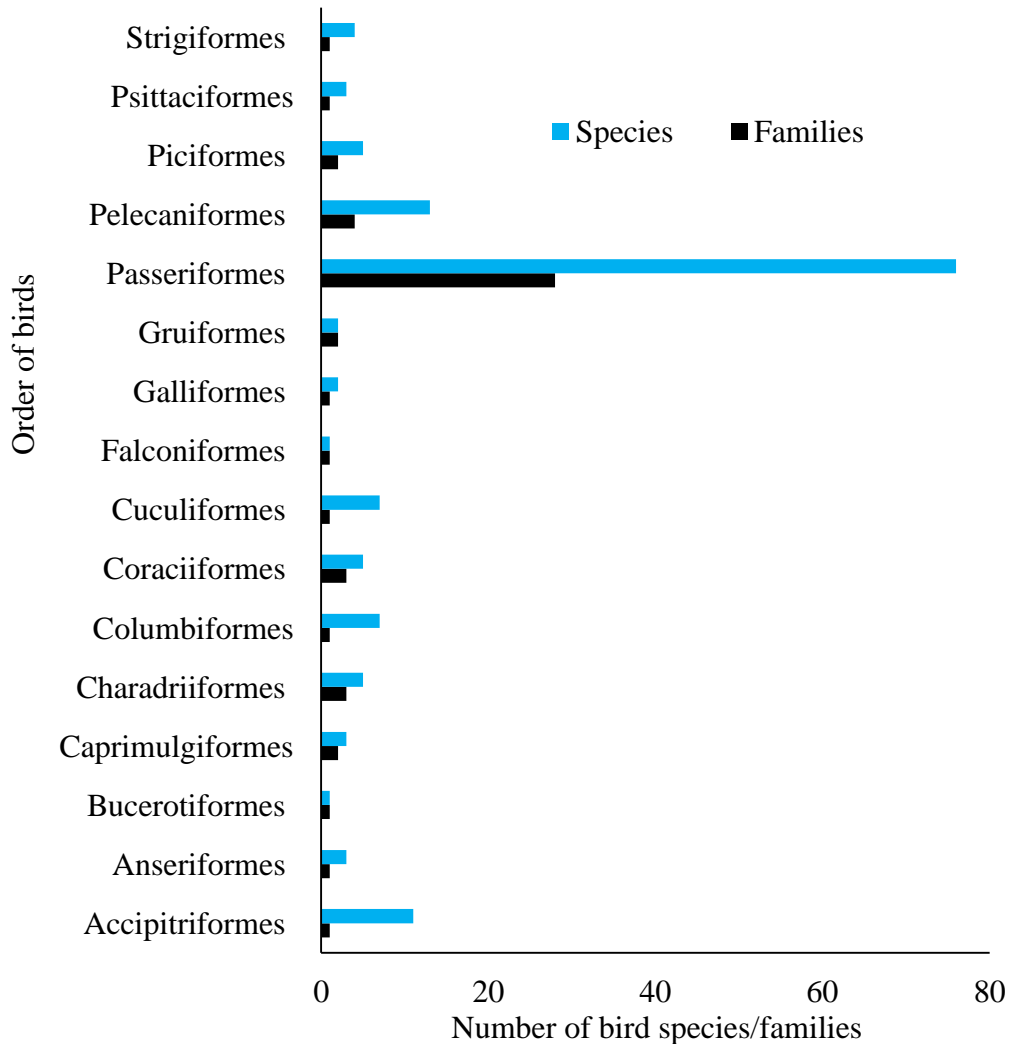


Fig. 2. Order wise bird community composition in agroforestry systems of study area

According to the IUCN Red List (2021), out of the 148 bird species recorded, two species each (1.35%) were 'Endangered' and 'Vulnerable', 4 species were 'Near Threatened' and the rest 140 species (94.59%) were 'Least Concern' (Table 1). Two species namely, *Neophron percnopterus* and *Aquila nipalensis* were Endangered, *Clanga hastata* and *Antigone Antigone* were Vulnerable and four species *Gyps himalayensis*, *Mycteria leucocephala*, *Ciconia episcopus* and *Psittacula eupatria* were Near Threatened. Assessment of local status of bird species revealed that 26 species (17%) were common, 38 species (26%) were fairly common, 56 species (38%) were uncommon and 28 species (19%) were rare in the study area (Fig. 6). Similar results have been

reported from studies done in agricultural landscapes [29].

This result reveals that rare and threatened bird species are present in the agroforestry systems, highlighting its conservation value. This might be because the trees present in agroforestry systems provide nesting sites for the heronries [5], the agricultural fields provide the required nesting material, foraging area all in close proximity. All these factors enhance the value of agroforestry systems in bird species conservation. Thus, these systems must be prioritized for long-term monitoring of birds from a global perspective.

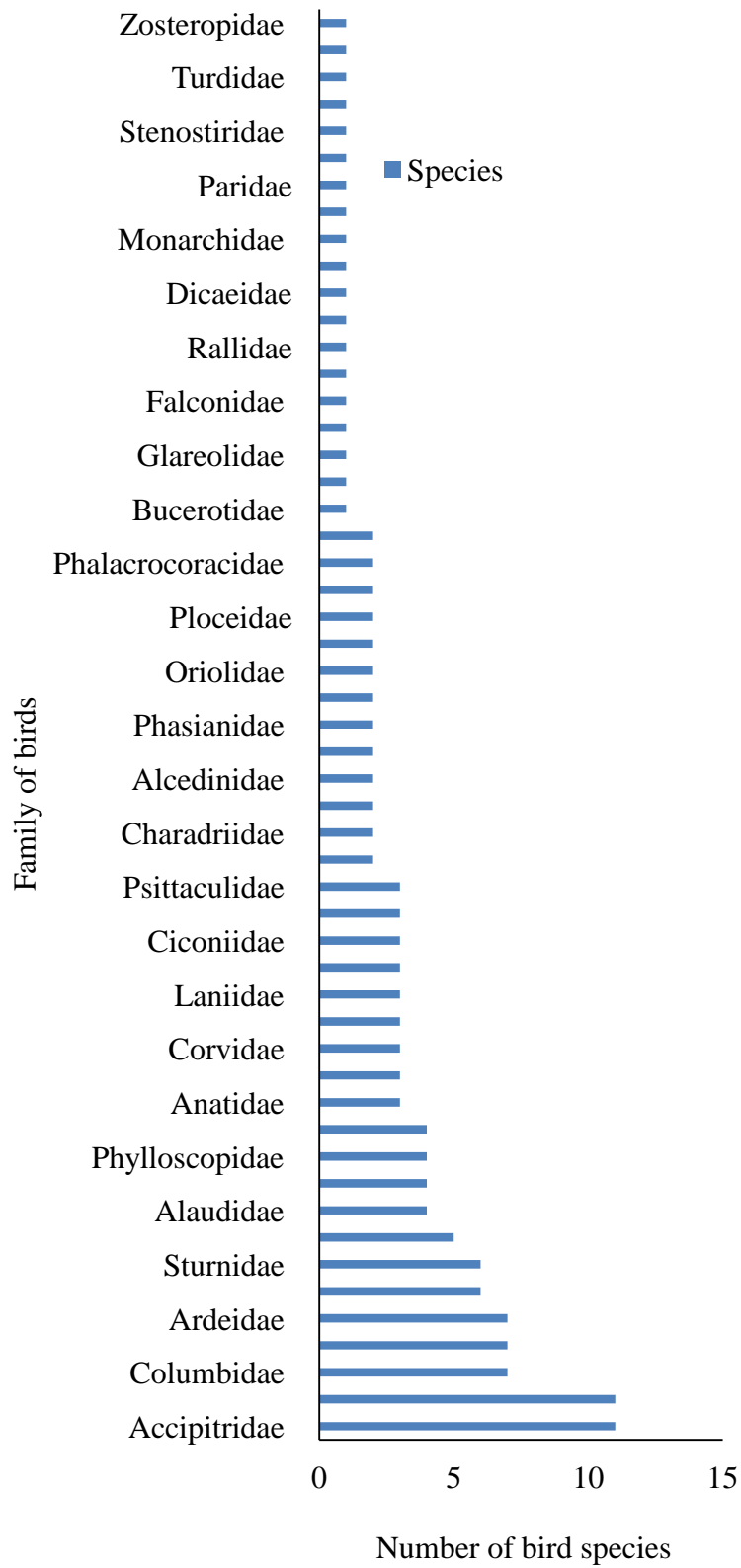


Fig. 3. Family wise bird community composition in agroforestry systems of study area

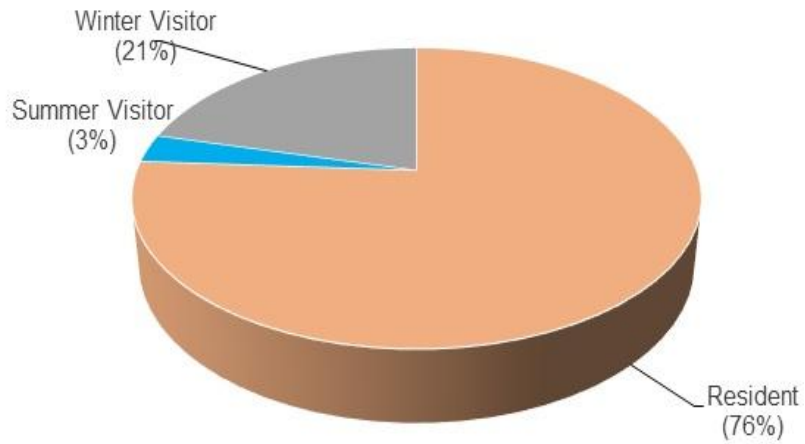


Fig. 4. Seasonal status of bird species in agroforestry systems of study area

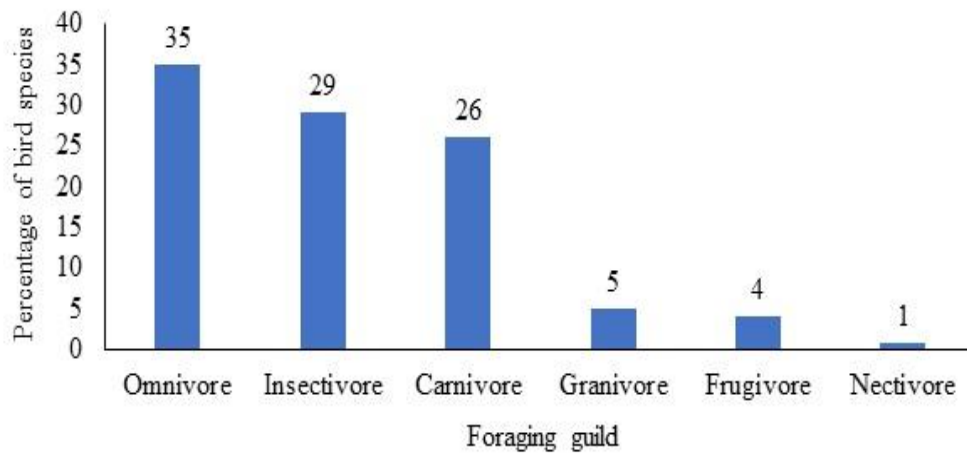


Fig. 5. Foraging guild-based classification of bird species in agroforestry systems of study area

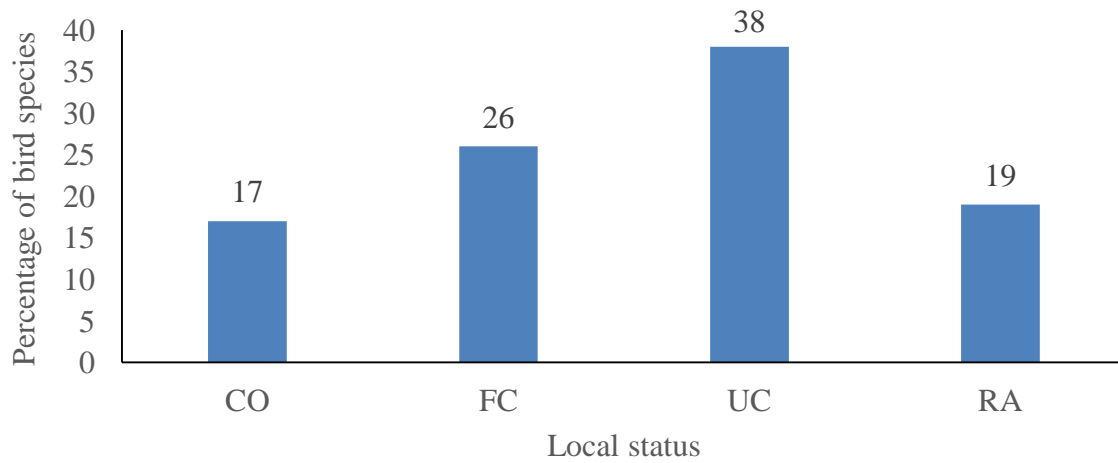


Fig. 6. Local status of bird species in agroforestry systems of study area

4. CONCLUSION

From the present study, it can be concluded that the agroforestry systems provide a good habitat for the conservation of terrestrial as well as waterbirds. It attracts a lot of resident, migratory, rare as well as threatened bird species. In Uttar Pradesh, this system must be further explored by diversifying the trees and conducting long-term studies on the utility of this land use by birds for their breeding and nesting purposes. The interactions of these birds with the humans can also be studied in-depth. Such models must be promoted by the policy makers and government departments elsewhere in the state such that the forest cover and faunal loss can be fairly compensated.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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