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Diversity and Richness of Avian Species in Khata and Karnali Corridor, Nepal

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ABSTRACT

Nepal is rich in avian diversity and records more than 886 bird species with 23 orders and 97 families. The study was carried out to assess the species diversity of birds, types of habitats used and presence of birds in different habitats in the summer season in Khata and Karnali corridor forest of Bardia and Kailali districts respectively. This study aims to update avian diversity of Khata and Karnali corridor of Bardia National Park, Nepal, which is an important birds and biodiversity area of Nepal. Riverine Sissoo-Khair Forest, moist mixed forest and riverine grassland are prominent habitats in the study area. Index of diversity and species evenness indicate the high species diversity of birds in Khata corridor forest rather than Karnali corridor. By mobilizing volunteers, we monitored 79 transects (24 in Khata and 55 in Karnali) each with one km long in summer seasons of 2022. A total of 1,455 individuals of birds belonging to 153 species were recorded. 153 species of birds belonging to 12 orders and 40 families from the Khata and Karnali Corridor are recorded; out of which 137 species were recorded in Khata and 86 species in Karnali with 1,048 and 407 individuals respectively. Species richness and diversity of all birds was high in Khata corriodr rather than Karnali and showed significant variation along protected forest in Khata than unmanged Karnali. The globally threatened bird, Great Slaty Woodpecker (*Mulleripicus pulverulentus)* and White-rumped Vulture (*Gyps bengalensis)* were recorded in Karnali and Khata corridors respectively. Similarly, one Nepal protected bird; Black Stork *(Ciconia nigra)* was recorded in Khata corridor. Altogether 14 recorded bird species are included in CITES Appendices in which Oriental Pied-Hornbill *(Anthracoceros albirostris*) is recorded in Appendix I and rest are in Appendix II.

Keywords: Avifauna, Diversity, Richness, Abundance, Corridor, Habitat, Species diversity

1. INTRODUCTION

Birds (class Aves) are feathered, winged, bipedal, endothermic, egg-laying, vertebrates distributed widely all over the world. Zoo-geographically, Nepal falls between two great regions namely the Palaeartic in the north and Oriental to the south and Nepal enjoys one of the world's richest avian fauna (Shrestha, 1981). Although Nepal covers just 0.1% of the global land mass, it holds the more than

886 species of birds which is nearly the 8% of the world's bird species (BCN and DNPWC, 2018). A total of 43 species recorded in Nepal were identified as globally threatened (Bird Life International, 2021).

A total of 37 Important Birds and Biodiversity Areas (IBAs) have been identified in Nepal. Nineteen IBAs are within the protected areas where as the rest are outside the protected area system of Nepal (BCN, 2019). Bardia National Park (BNP) and its buffer zone is one of the IBAs in Nepal. Altogether, a total 513 species of birds are recorded representing 19 orders and 83 families in the Bardia National Park and its buffer zone (BCN and DNPWC, 2019). Among them, 25 species of birds are globally threatened. BNP is a very good habitat of birds, but less known about their richness especially along the corridors. Basanta Protected Forest in Kailali district is already studied as bird hotspot in the district which holds the 381 species from 78 families and 19 orders (Dangaura et al., 2020). Thus, the objective was to know the bird diversity and richness in Khata and Karnali corridor forest during the summer season.

Species diversity refers to the frequency and variety of species within a geographical area. Species diversity, most commonly used parameter in quantifying the biodiversity also depends on the richness and evenness. Species richness, Shannon information, and Simpson diversity are the three most commonly used nonparametric measures of species diversity. Avian diversity, is thus, measured through its richness and evenness in a certain habitat type or different habitat as a whole.

The corridors are crucial for the survival, development and mobility of birds and animals by linking the fragmented habitat. The corridor forest is home for many residential as well as migratory birds and animals. But it is difficult to determine precisely how frequently avifauna is using the biological corridors and the scientific data are not available in Khata corridor. Therefore, the research intends to prepare and update the check list of avifaunal diversity with their abundance and distribution in summer season in Khata and Karnali corridor between Bardia National Park of Nepal with Katarniaghat Wildlife Sanctuary of India.

By contrast, it has been shown that using birds can be a highly efficient way to identify a set of national conservation priorities (Baral and Inskipp, 2005) because they are very sensitive to little change in an ecosystem. The measurement of species diversity of birds and animals and their presence or absence in different habitat types undoubtedly reveal the present scenario of the corridor forest which has been using bird species diversity (alpha diversity) as a measure of biodiversity through this paper. The status of birds outside of protected areas are little known so that the article aims to assess the species diversity of the avifauna in the Khata and Karnali Corridor Forest and finds out the globally threatened and near-threatened species and estimates their number within the Khata and Karnali Corridor.

2. MATERIALS AND METHODS

Description of Study Area

Corridor plays a vital role for movement of all wild animals from one habitat to another. The Khata is so called Bardia-Katarniyaghat Corridor which connects from Bardia National Park, Nepal to Katarniyaghat Wildlife Sanctuary, India. Similarly, Karnali corridor is also one of the highly functional corridors in Nepal which link up between Churiya foothills and Terai environment. Khata-Karnali Corridor located in contiguous to Bardia National Park (Figure 1) in the western part of Terai Arc Landscape (TAL) Nepal in Bardia and Kailali districts and south western fringe of the country bordering India on the south and Banke, Kailali and Surkhet districts to the east, west and north, respectively. Khata covers about 83 sq. km whereas Karnali covers approximately 200 sq. km including Karnali and Geruwa river bed. The highest elevation is 361m towards the north and lowest elevation is 121m towards the south. The area constitutes Geruwa (eastern branch of Karnali) river and its flood plain in the southern part of BNP. It comprises of grasslands and riverine forests as important habitat for greater one horned rhino, tiger, elephant and other wildlife species.

Vegetation and Floral Diversity

The study area consists of deciduous vegetation. Dinerstein, (1979) classifies vegetation into six major types which was later modified into seven major types and types of grassland by Jnawali and Wegge (1993). Sharma, (1999) further classifies and describes 17 different sub-types. The most important vegetation type is sal forest, dominated by sal (*Shorea robusta).* Vegetation pattern is similar to BNP in Khata and Karnali corridor area, i.e., degraded sal forest, khair-sissoo forest, moist riverine forest, wooded grassland, open phanta and floodplain grassland.

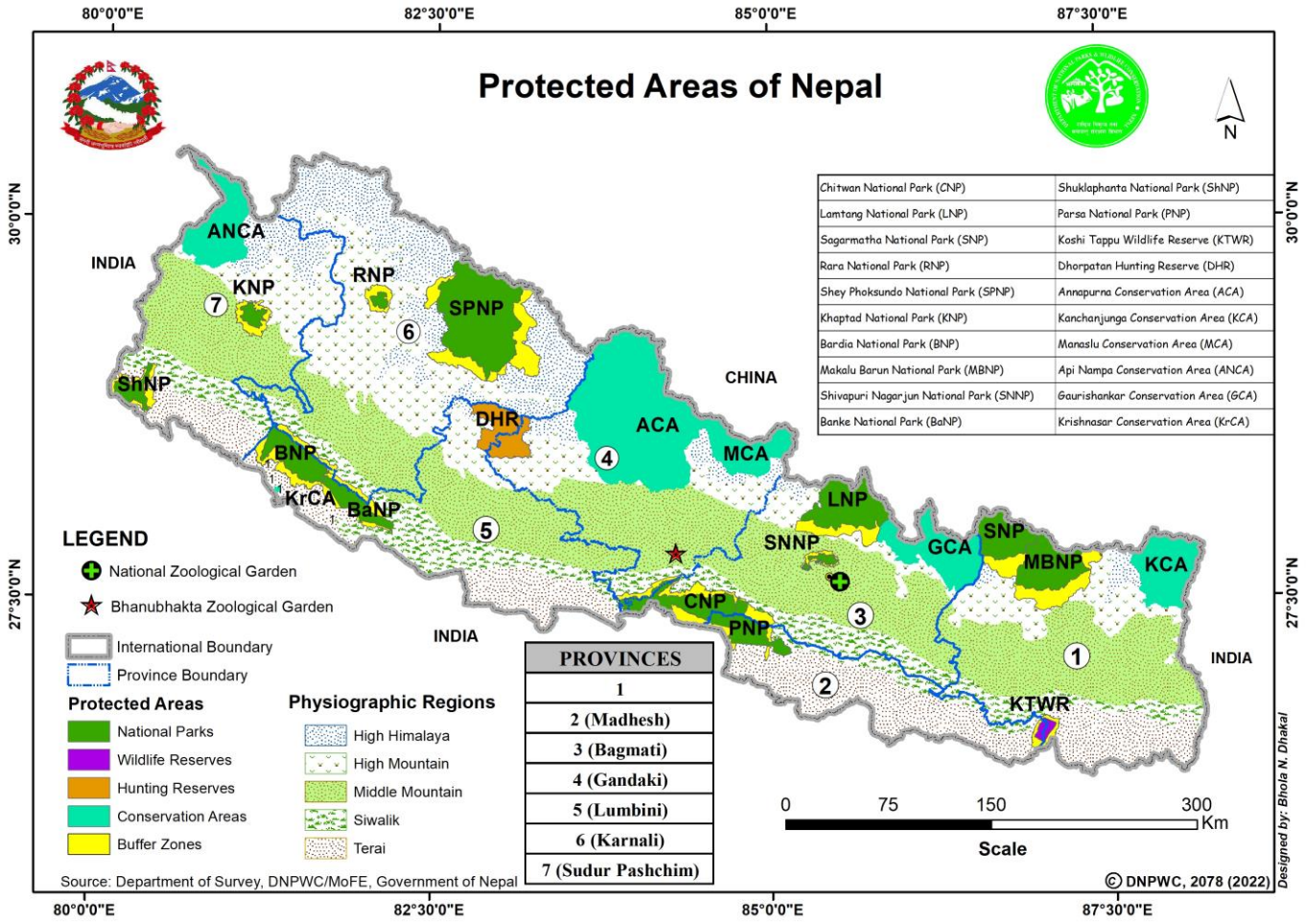

Figure 1a Map of Nepal showing the protected areas of Nepal (source DNPWC)

Sal association forest is highly dominated by regenerated Sal includes dense sal forest, open sal forest, sal wooded grassland and phanta. The dominant tree species are *Shorea robusta, Terminalia alata* and *Buchanania latifolia;* main grasses are *Desmotachya bipinnata, Imperata cylindrica* and *Vetiveria zizanoides.* The Khair-Sissoo association is dominated by early successional *Dalbergia sisoo* and *Acacia catechu* trees. Moist riverine forest is composed of species like *Syzigium cumini*, *Ficus racemosa*, *Trevia nudiflora* and *Mallotus phillipinensis*.

The grassland association includes two types of grassland: Phanta as open grassland (short grassland on abandoned cultivated fields) and floodplain grassland. The former is dominated by *Imperata cylindrica*, *Vetiveria zizanoides*, *Desmostachya bipinnata, Zizyphus rugosa* and *Cynondon dactylon* etc. whereas second are by *Phragmites karka, Saccharum spontaneum* and *S. bengalensis* species. They are submerged by water during the monsoon flooding.

Sampling Design and Data Analysis

Avian survey was conducted only once in the late summer season (10th July 2022 to 25 September 2022) using Mc-Kinnon list method (Mc-Kinnon and Phillips, 1993) in standard data sheet. The area was surveyed in total of 5 bird watchers with local bird experts and technicians. The survey was conducted in early of morning (7:00-10:00) and late evening (15:00 to 18:00) to maximize the detection probability of bird. If any species was replicated in the same list it was counted for relative abundance, but not listed as a new species in the existing list. Consecutively other list was prepared to generate the data of species abundance of the area. Direct visual observation was used as primary tool for identification and listing of birds with the aid of Nikon Monarch 7 8×42 ATB binoculars and coolpix p900 cameras. Songs and calls of birds were also used as identification tool in quite few occasions by using bird sound recorder.

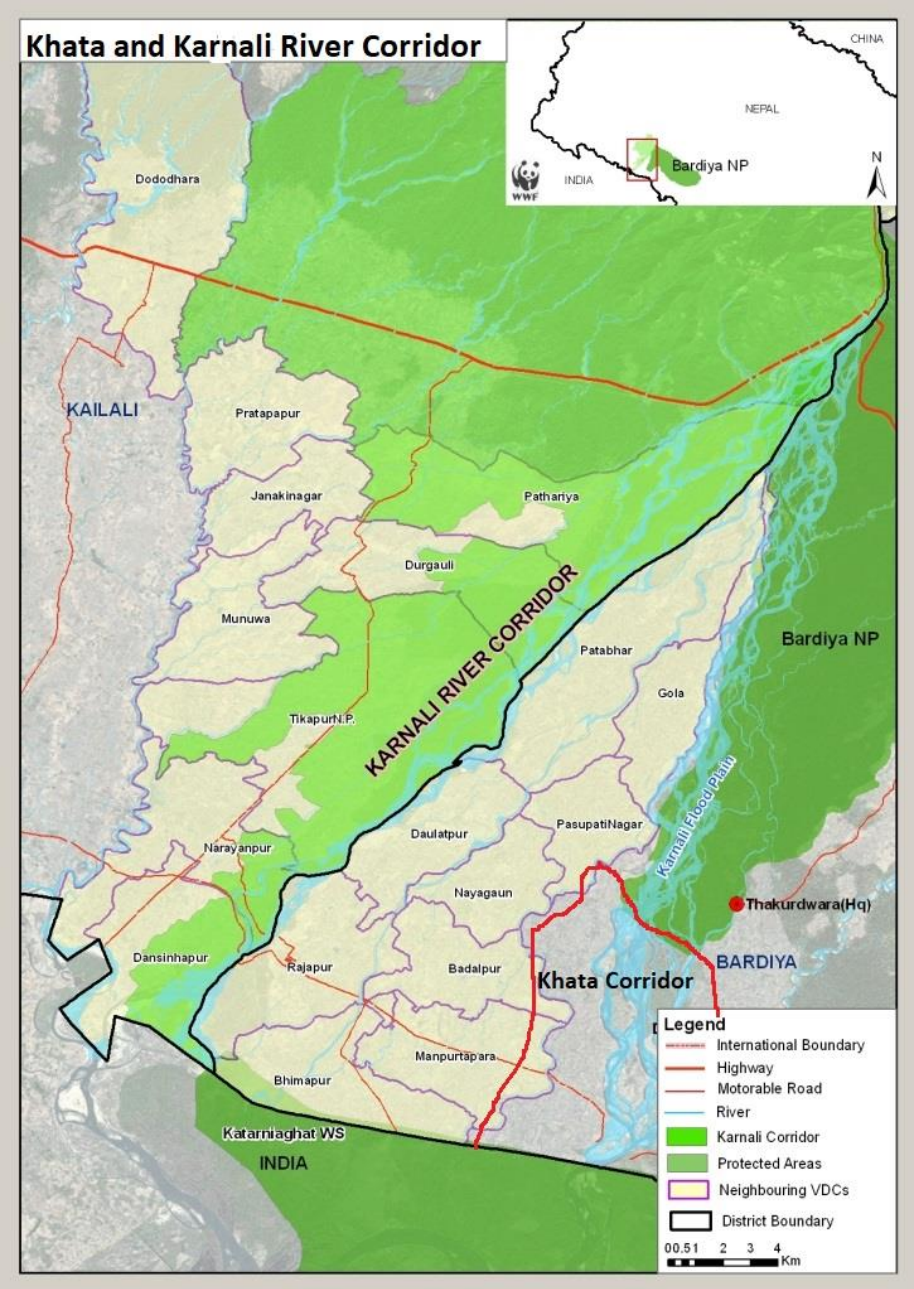

Figure 1b Map of Khata and Karnali river corridor (Source: WWF)

The relative abundance of each species was estimated using Mc-Kinnon list. Index of relative abundance was estimated base on the frequency of occurrence. The relative abundance measure for each species is the proportion of lists it occurs in (Mc-Kinnon and Phillip, 1993). Species occurrence was categorized into five different categories according to the index of relative abundance. The following three different field methodologies were adapted for the Mc-Kinnon list.

A) Simple point counts along an encounter transect (RIC, 1999)

The field research design includes setting up forest trails and human trails as transects in the study area, called encounter transects. A total of 79 transect (24 in Khata and 55 in Karnali) each with one km long was laid. All of the transects were surveyed on foot at an average speed of 2 km/hr. Along the transects, number of simple point counts were taken in point stations at an interval of 500 meter at best possible sites following the purpose of maximizing species detection and diversity with consideration of habitat description as well. A total of 3750 hrs (750 hrs in Khata and 3000 hrs in Karnali) sampling effort was done for better bird recording (Annex3). Data collection involved recording the species count and listing at both point stations and in between the stations while walking in the Mc-Kinnon list. Shorter time period was preferred to at each station to avoid repeated sighting and counting.

B) Area search by sweeping out

Focusing on areas with inaccessible and difficult terrains, transect survey on foot was replaced with area search method by sweeping out. Those sites included areas with dense vegetation, deep river and dense forests with canopy cover over 90%. Following the methodology, species counting and listing were carried out by random walking on the area of forest with due consideration of area proportionate to time.

C) Direct Observation

It includes lists of bird prepared through direct observation during bird watching trips by bird experts and researchers. It was followed by the track of wild animals in forest adjoining to agriculture land. Opportunistic sightings recorded during the study period were also included.

3. RESULTS AND DISCUSSION

Altogether, one hundred fifty-three (153) species of birds, 17.42 % of national species count (Annexure 1) with forty families (40) and twelve (12) orders in Khata and Karnali Corridor were recorded. Out of them, 137 species were recorded in Khata and 86 species in Karnali with 1048 and 407 individuals, respectively. The detection rate of bird was 6 species with 44 individuals in Khata corridor whereas there were only one third (2) species of this with 8 individuals in Karnali corridor.

Annexure 1 Birds of Khata and Karnali corridor identified during the survey periods in summer 2022

S. No.	Order/Family/English Name	Scientific Name	CITES	Status	Number Recorded in Summer 2022		
			Appendix		Khata	Karnali	Total
	Galliformes						
	Phasianidae						
1	Black Francolin	*Francolinus francolinus*		br, 1	2	1	3
2	Common Quail	*Coturnix coturnix*		w, m, 5	1		1
3	Red Junglefowl	*Gallus gallus*		br, 1	1		1
4	Indian Peafowl	*Pavo cristatus*		br, 1	2	1	3
	Piciformes						
	Picidae						
5	Brown-capped Pygmy Woodpecker	*Yungipicus nanus*		br, 1	5	2	7
6	Grey-capped Pygmy Woodpecker	*Yungipicus canicapillus*		r, 4	1		1
7	Brown-fronted Woodpecker	*Dendrocoptes auriceps*		br, 1	1		1
8	Fulvous-breasted Woodpecker	*Dendrocopos macei*		r, 3	21	7	28
9	Yellow-crowned Woodpecker	*Leiopicus mahrattensis*		r, 4	1		1
10	Streak-throated Woodpecker	*Picus xanthopygaeus*		br, 1		1	1
11	Himalayan Flameback	*Dinopium shorii*		br, 2	16	7	23
12	Black-rumped Flameback	*Dinopium benghalense*		br, 1	11	6	17
13	Greater Flameback	*Chrysocolaptes guttacristatus*		br, 2		7	7
14	Great Slaty Woodpecker **VU*	*Mulleripicus pulverulentus*	II	br, 3		1	1
	Megalaimidae						
15	Brown-headed Barbet	*Psilopogon zeylanicus*		br, 1	3	1	4
16	Lineated Barbet	*Psilopogon lineatus*		br, 4		1	1
17	Coppersmith Barbet	*Psilopogon haemacephalus*		br, 2	1		1
	Bucerotiformes						
	Bucerotidae						
18	Indian Grey-Hornbill	*Ocyceros birostris*		br, 2	1		1
19	Oriental Pied-Hornbill	*Anthracoceros albirostris*	I	br, 1	1		1
	Upupiformes						
	Upupidae						

S. No.	Order/Family/English Name	Scientific Name	CITES	Status	Number Recorded in Summer 2022		
			Appendix		Khata	Karnali	Total
20	Common Hoopoe	*Upupa epops*		w, m, 2	1		1
	Coraciiformes						
	Coraciidae						
21	Indian Roller	*Coracias benghalensis*		br, 1	3	1	4
22	Dollarbird	*Eurystomus orientalis*		bs 1		1	1
	Alcedinidae						
23	Common Kingfisher	*Alcedo atthis*		br, 1	3	2	5
	Dacelonidae						
24	White-throated Kingfisher	*Halcyon smyrnensis*		br, 1	2		2
	Cerylidae						
25	Pied Kingfisher	*Ceryle rudis*		br, 2	7	51	58
	Meropidae						
26	Blue-bearded Bee-eater	*Nyctyornis athertoni*		r, 4	5		5
27	Asian Green Bee-eater	*Merops orientalis*		br, s, 2	7	2	9
28	Blue-tailed Bee-eater	*Merops philippinus*		bs, 2	8	5	13
29	Chestnut-headed Bee-eater	*Merops leschenaulti*		bs, 3	23	12	35
	Cuculiformes						
	Cuculidae						
30	Common Hawk Cuckoo	*Hierococcyx varius*		br, 1	5		5
31	Indian Cuckoo	*Cuculus micropterus*		bs, 1	6	2	8
32	Grey-bellied Cuckoo	*Cacomantis passerinus*		br, 1	1		1
33	Square-tailed Drongo Cuckoo	*Surniculus lugubris*		bs, 3	2		2
34	Asian Koel	*Eudynamys scolopacea*		bs, 2	1		1
35	Green-billed Malkoha	*Phaenicophaeus tristis*		br, 4	1		1
	Centropodidae						
36	Greater Coucal	*Centropus sinensis*		br, 1	3	1	4
37	Lesser Coucal	*Centropus bengalensis*		bs, r, 2		1	1
	Psittaciformes						
	Psittacidae						
38	Alexandrine Parakeet	*Psittacula eupatria*	II	br, 1	6	1	7
39	Rose-ringed Parakeet	*Psittacula krameri*		br, 1	16	3	19
40	Plum-headed Parakeet	*Psittacula cyanocephala*	II	br, 1	7	1	8
	Strigiformes						
	Strigidae						
41	Oriental Scops Owl	*Otus sunia*	II	r, 2		1	1
42	Jungle Owlet	*Glaucidium radiatum*	II	br, 1	5	2	7
43	Spotted Owlet	*Athene brama*	II	br, 2	3	1	4
44	Brown Hawk-Owl	*Ninox scutulata*	II	br, 2	1		1
	Columbiformes						
	Columbidae						
45	Oriental Turtle Dove	*Streptopelia orientalis*		w, 2	5	1	6
46	Spotted Dove	*Streptopelia chinensis*		br, 1	13	1	14
47	Eurasian Collared Dove	*Streptopelia decaocto*		br, 1	2	1	3
48	Red Collared Dove	*Streptopelia tranquebarica*		br, 2		1	1
49	Asian Emerald Dove	*Chalcophaps indica*		br, 1	3	1	4

S. No.	Order/Family/English Name	Scientific Name	CITES	Status	Number Recorded in Summer 2022		
			Appendix		Khata	Karnali	Total
50	Orange-breasted Green Pigeon	*Treron bicinctus*		r, 3	1		1
51	Yellow-footed Green Pigeon	*Treron phoenicoptera*		r, 2	7	1	8
	Gruiformes						
	Rallidae						
52	White-breasted Waterhen	*Amaurornis phoenicurus*		br, 1	1		1
	Ciconiiformes						
	Scolopacidae						
53	Common Greenshank	*Tringa nebularia*		w, 1	2		2
54	Green Sandpiper	*Tringa ochropus*		w, 1	1		1
55	Common Sandpiper	*Actitis hypoleucos*		w, 1	3	1	4
	Charadriidae						
56	Little Ringed Plover	*Charadrius dubius*		r, w, 2	8	4	12
57	River Lapwing	*Vanellus duvaucelii*		br, 2	16	6	22
58	Red-wattled Lapwing	*Vanellus indicus*		br, 1	1		1
	Accipitridae						
59	Oriental Honey-buzzard	*Pernis ptilorhyncus*		r, 1	3	1	4
60	Black-shouldered Kite	*Elanus caeruleus*	II	r, 2	1		1
61	Black Kite	*Milvus migrans*	II	w, r, 2	1		1
62	White-rumped Vulture * *CR*	*Gyps bengalensis*	II	br, 3	3		3
63	Crested Serpent Eagle	*Spilornis cheela*	II	br, 1	1		1
	Falconidae						
64	Eurasian Kestrel	*Falco tinnunculus*	II	w, 3	3	1	4
	Ardeidae						
65	Little Egret	*Egretta garzetta*		br, 1		1	1
66	Intermediate Egret	*Ardea intermedia*		br, 2	1		1
67	Cattle Egret	*Bubulcus ibis*		br, 1	4	2	6
68	Indian Pond Heron	*Ardeola grayii*		br, 1	2	1	3
69	Little Heron	*Butorides striatus*		r, 2	1		1
70	Black-crowned Night Heron	*Nycticorax nycticorax*		br, 3	1		1
71	Cinnamon Bittern	*Ixobrychus cinnamomeus*		bs, r, 3	1	2	3
	Threskiornithidae						
72	Red-naped Ibis	*Pseudibis papillosa*		br, 2	18	2	20
	Ciconiidae						
73	Painted Stork	*Mycteria leucocephala*		s, r, 4	2	3	5
74	Black Stork	*Ciconia nigra*	II	w, 3	1		1
75	Woolly-necked Stork	*Ciconia episcopus*		r, 2	3		3
	Passeriformes						
	Pittidae						
76	Indian Pitta	*Pitta brachyura*		bs, r, 3	3	1	4
	Irenidae						
77	Golden-fronted Leafbird	*Chloropsis aurifrons*		r, 3	5	1	6
	Laniidae						
78	Long-tailed Shrike	*Lanius schach*		br, 1	1		1
	Corvidae						
79	Rufous Treepie	*Dendrocitta vagabunda*		br, 1	16	4	20

S. No.	Order/Family/English Name	Scientific Name	CITES	Status	Number Recorded in Summer 2022		
			Appendix		Khata	Karnali	Total
80	House Crow	*Corvus splendens*		br, 2	40	47	87
81	Large-billed Crow	*Corvus macrorhynchos*		br, 1		1	1
82	Ashy Woodswallow	*Artamus fuscus*		r, 3	10		10
83	Indian Golden Oriole	*Oriolus kundoo*		bs, 3	1	1	2
84	Black-hooded Oriole	*Oriolus xanthornus*		br, 1	7	3	10
85	Large Cuckooshrike	*Coracina macei*		br, 1	8	3	11
86	Black-winged Cuckooshrike	*Lalage melaschistos*		br, 3	2		2
87	Small Minivet	*Pericrocotus cinnamomeus*		br, 1	6	1	7
88	Long-tailed Minivet	*Pericrocotus ethologus*		w, 2	1		1
89	Bar-winged Flycatcher-shrike	*Hemipus picatus*		br, 2	3		3
90	White-throated Fantail	*Rhipidura albicollis*		br, 2	1		1
91	Black Drongo	*Dicrurus macrocercus*		br, 1	6	2	8
92	Ashy Drongo	*Dicrurus leucophaeus*		r, 2		1	1
93	White-bellied Drongo	*Dicrurus caerulescens*		br, 1	4	1	5
94	Crow-billed Drongo	*Dicrurus annectans*		s, 4	3	1	4
95	Lesser Racket-tailed Drongo	*Dicrurus remifer*		w, 4	9	1	10
96	Greater Racket-tailed Drongo	*Dicrurus paradiseus*		br, 1	4	3	7
97	Black-naped Monarch	*Hypothymis azurea*		bs, 3	2		2
98	Indian Paradise-flycatcher	*Terpsiphone paradisi*		bs, 3	1		1
99	Common Iora	*Aegithina tiphia*		br, 1	1		1
100	Large Woodshrike	*Tephrodornis virgatus*		r, 4		1	1
101	Common Woodshrike	*Tephrodornis pondicerianus*		br, 2	11	1	12
	Muscicapidae						
102	Tickell's Thrush	*Turdus unicolor*		w, 3	1		1
103	Slaty-blue Flycatcher	*Ficedula tricolor*		w, 2	2		2
104	Verditer Flycatcher	*Eumyias thalassina*		w, 3	3		3
105	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*		w, 2	1		1
106	Oriental Magpie Robin	*Copsychus saularis*		br, 1	3	1	4
107	White-rumped Shama	*Copsychus malabaricus*		br, 2	6	1	7
108	White-tailed Robin	*Myiomela leucura*		br, 2	1		1
109	Siberian Stonechat	*Saxicola maurus*		w, 1	1		1
110	Pied Bushchat	*Saxicola caprata*		br, 1	1		1
	Sturnidae						
111	Chestnut-tailed Starling	*Sturnus malabaricus*		br, 2	84	37	121
112	Brahminy Starling	*Sturnus pagodarum*		br, 3	5		5
113	Common Starling	*Sturnus vulgaris*		w, m, 2	1		1
114	Indian Pied Starling	*Gracupica contra*		br, 1	3		3
115	Common Myna	*Acridotheres tristis*		br, 1	202	54	256
116	Jungle Myna	*Acridotheres fuscus*		br, 1	7		7
	Sittidae						
117	Chestnut-bellied Nuthatch	*Sitta cinnamoventris*		br, 1	15	3	18
	Paridae						
118	Cinereous Tit	*Parus cinereus*		br, 1	4	2	6
	Hirundinidae						
119	Pale Sand Martin	*Riparia diluta*		m, 4	22	8	30

S. No.	Order/Family/English Name	Scientific Name	CITES	Status	Number Recorded in Summer 2022		
			Appendix		Khata	Karnali	Total
120	Barn Swallow	*Hirundo rustica*		r, w, 1	22	2	24
	Pycnonotidae						
121	Black-crested Bulbul	*Rubigula flaviventris*		r, 3		1	1
122	Red-whiskered Bulbul	*Pycnonotus jocosus*		br, 1	43	2	45
123	Red-vented Bulbul	*Pycnonotus cafer*		br, 1	3	1	4
	Cisticolidae						
124	Zitting Cisticola	*Cisticola juncidis*		br, 1	3	1	4
125	Golden-headed Cisticola	*Cisticola exilis*		br, 2	1		1
126	Grey-breasted Prinia	*Prinia hodgsonii*		br, 1	5	1	6
127	Jungle Prinia	*Prinia sylvatica*		br, 3	3		3
128	Yellow-bellied Prinia	*Prinia flaviventris*		br, 2	4	1	5
129	Ashy Prinia	*Prinia socialis*		br, 1	3		3
130	Plain Prinia	*Prinia inornata*		br, 1	7		7
	Zosteropidae						
131	Indian White-eye	*Zosterops palpebrosus*		br, 1	1	1	2
	Sylviidae						
132	Chestnut-crowned Bush Warbler	*Cettia major*		w, 5		2	2
133	Common Tailorbird	*Orthotomus sutorius*		br, 1	3	1	4
134	Smoky Warbler	*Phylloscopus fuligiventer*		w, 2	1		1
135	Yellow-vented Warbler	*Phylloscopus cantator*		w, 2	1		1
136	Grey-hooded Warbler	*Seicercus xanthoschistos*		w, 3	1		1
137	Puff-throated Babbler	*Pellorneum ruficeps*		r, 5		1	1
138	Jungle Babbler	*Turdoides striatus*		br, 1	9	2	11
	Alaudidae						
139	Sand Lark	*Alaudala raytal*		br, 1		4	4
	Nectariniidae						
140	Thick-billed Flowerpecker	*Dicaeum agile*		r, 2	2	1	3
141	Purple Sunbird	*Cinnyris asiatica*		br, 1	1		1
142	Crimson Sunbird	*Aethopyga siparaja*		r, 4	1		1
	Passeridae						
143	House Sparrow	*Passer domesticus*		br, 3	12		12
144	Eurasian Tree Sparrow	*Passer montanus*		r, 4	2		2
145	Yellow-throated Sparrow	*Gymnoris xanthocollis*		br, 1	40	20	60
146	White-browed Wagtail	*Motacilla maderaspatensis*		br, 2	14	4	18
147	Grey Wagtail	*Motacilla cinerea*		w, 3	2		2
148	Paddyfield Pipit	*Anthus rufulus*		br, 1	15	1	16
149	Baya Weaver	*Ploceus philippinus*		r, 1	20		20
150	Scaly-breasted Munia	*Lonchura punctulata*		br, 2	24	30	54
151	Tricolored Munia	*Lonchura malacca*		r, 4	1		1
	Fringillidae						
152	Common Rosefinch	*Carpodacus erythrinus*		w, 2	1		1
153	Crested Bunting	*Melophus lathami*		w, 2	3		3

The globally threatened bird, Great Slaty Woodpecker (*Mulleripicus pulverulentus)* and White-rumped Vulture (*Gyps bengalensis)* were recorded at Easting-519621, Northing-3162898 of sal mixed forest in Karnali corridor and at Easting-520517, Northing-3137739 of riverine woody mixed forest of Khata corridor, respectively. Similarly, one Nepal protected bird; Black Stork *(Ciconia nigra)* was

recorded in Khata corridor. From the observation, altogether 14 bird species were included in CITES Appendices in which Oriental Pied-Hornbill *(Anthracoceros albirostris*) is recorded in Appendix I and the rest are in Appendix II (Annexure 2). In Nepal, 23 orders, 97 families and 886 species of bird have been recorded. Among them 153 species from 12 orders and 40 families are enlisted in Khata and Karnali corridors.

Annexure 2 Globally threatened (CR- Critically Endangered, VU-Vulnerable), Nepal protected and CITIES Appendices I, II recorded birds of Khata and Karnali corridor identified during the survey periods in summer 2022

S. No.	English Name	Scientific Name	Consevation Status	CITES/Appendix	Corridor
1	Great Slaty Woodpecker *VU	*Mulleripicus pulverulentus*	Globally Threatened	II	Karnali
2	Oriental Pied-Hornbill	*Anthracoceros albirostris*		I	Khata
3	Alexandrine Parakeet	*Psittacula eupatria*		II	Both
4	Plum-headed Parakeet	*Psittacula cyanocephala*		II	Both
5	Oriental Scops Owl	*Otus sunia*		II	Karnali
6	Jungle Owlet	*Glaucidium radiatum*		II	Both
7	Spotted Owlet	*Athene brama*		II	Both
8	Brown Hawk-Owl	*Ninox scutulata*		II	Khata
9	Black-shouldered Kite	*Elanus caeruleus*		II	Khata
10	Black Kite	*Milvus migrans*		II	Khata
11	White-rumped Vulture * *CR*	*Gyps bengalensis*	Globally Threatened	II	Khata
12	Crested Serpent Eagle	*Spilornis cheela*		II	Khata
13	Common Kestrel	*Falco tinnunculus*		II	Both
14	Black Stork	*Ciconia nigra*	Nepal Protected	II	Khata

Most of the species of order Passeriformes were recorded by 17 families. Similarly, 7 and 5 families of the order Ciconiiformes and Coraciiformes are noted, respectively. Among 12 orders of bird, the majority of orders (7) were recorded only one family (Figure 2).

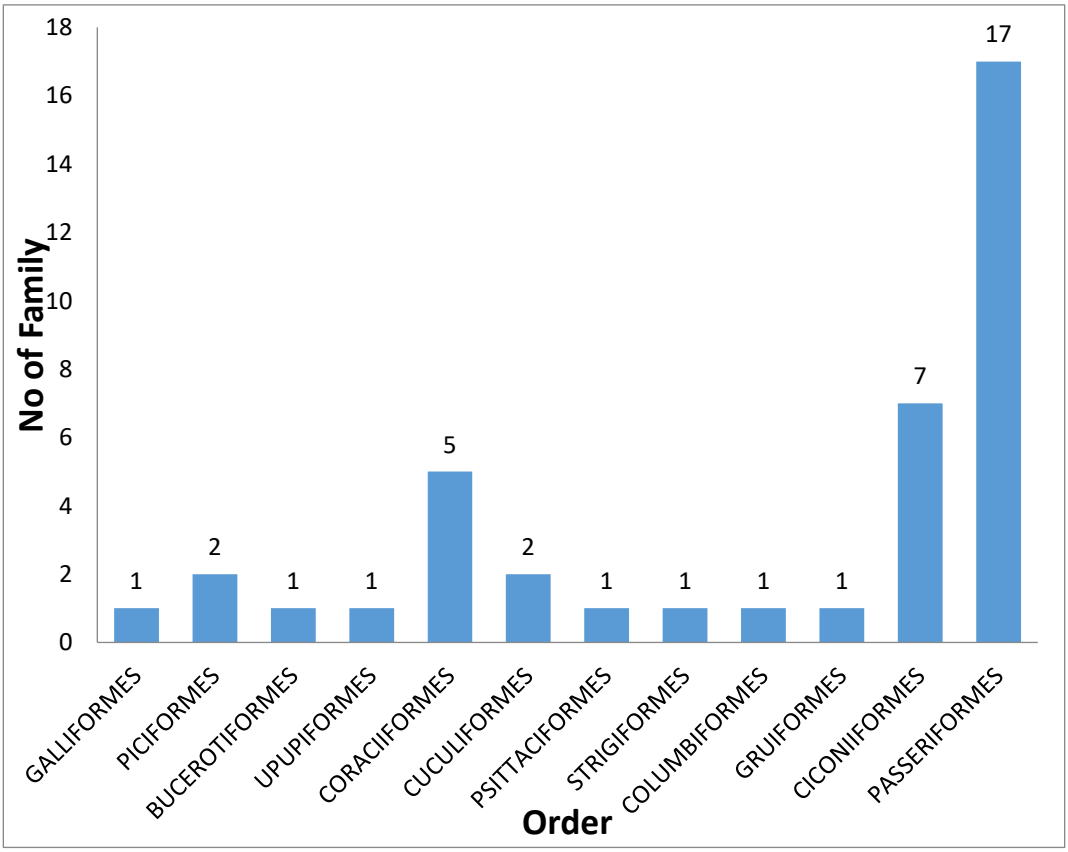

Figure 2 Order of birds with family number recorded in Khata and Karnali corridor

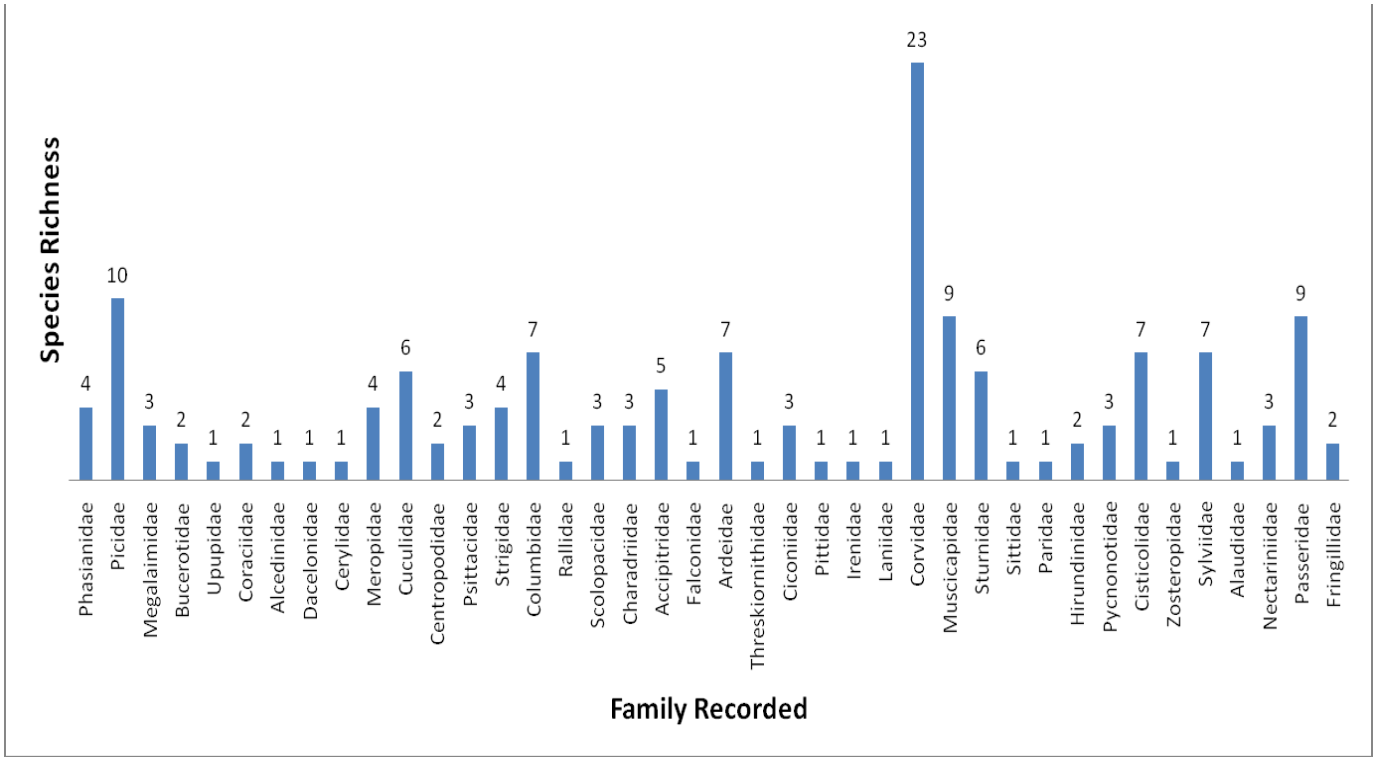

Figure 3 Family vs. species of bird recorded in Khata and Karnali corridor in summer 2022

The highest species (23) was recorded from Corvidae family. The majority of family was recorded by 7 to 10 species of bird during the study period (Figure 3). This study shows that Khata corridor is more functional and rich in avifaunal diversity than Karnali corridor. The landscape in Khata corridor is ecologically rich in itself with connectives shared between Bardiya NP in North and Katarniyaghat WS in South supporting large and migratory birds. The survey indicates that avian species richness is recorded as 61% and 39% in Khata and Karnali corridor, respectively (Figure 4). A total of 137 species were recorded in the Khata corridor which corresponds to 15.60 % of total bird species in Nepal. It can be correlated with the presence of diverse habitat types, micro-habitat and forest types inside Khata corridor. Greater habitat complexity can be one of the causative factors in greater bird diversity (Pan et al., 2016; Hu et al., 2018). Forests, riverine grasslands, riverine forests and wetlands were major habitat types in the area. Khauraha River and Karnali floodplains constitute the major ground for wader and wetland dependent birds inside the area.

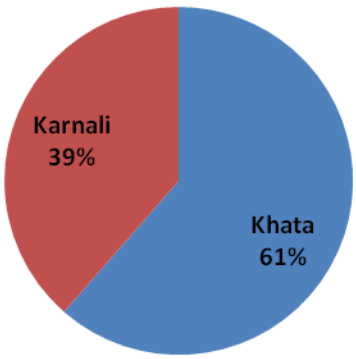

Figure 4 Bird species richness in Khata and Karnali corridor

Altogether 153 bird species were recorded during the study period in both corridors, in which it was recorded by 137 and 86 bird species in Khata and Karnali corridor, respectively with 1048 and 497 bird individuals (Figure 5). The result showed that birds were recorded as common, fairly common, occasional, uncommon and rare by 43%, 29%, 16%, 9% and 3%, respectively (Figure 6).

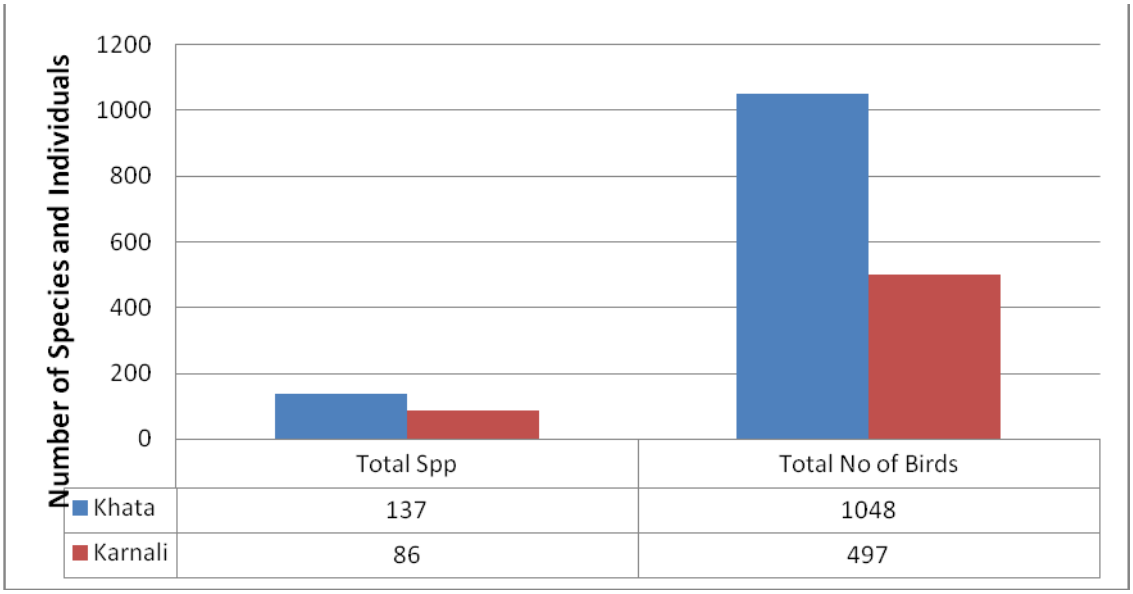

Figure 5 Number of bird species recorded in Khata and Karnali corridor

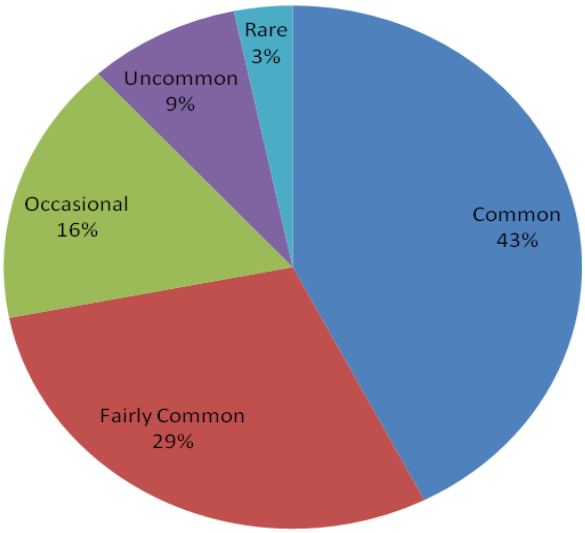

Figure 6 Abundance ratings of birds in Khata and Karnali corridor

In the rare category, we recorded the common quail (*Coturnix coturnix*) and puff-throated babbler (*Pellorneum ruficeps*). Common quail is a rare winter visitor and passage migrant in the low land of Nepal. However, it is interesting to be recorded in the summer season. It could be remarkable indicator for habitat changing due to climate change. Although puff-throated babbler (*Pellorneum ruficeps*) is residential for the study area, but observed very rarely.

More than 70% of birds were found as residential as breeding confirmed to corridor from the intensive survey in sample study area. Besides that, 16% were recorded as winter migrant, but being as residential for the habitat since the recent year. On the other hand, 10% of birds were observed as seasonal migrant in summer for breeding in the corridor (Figure 7).

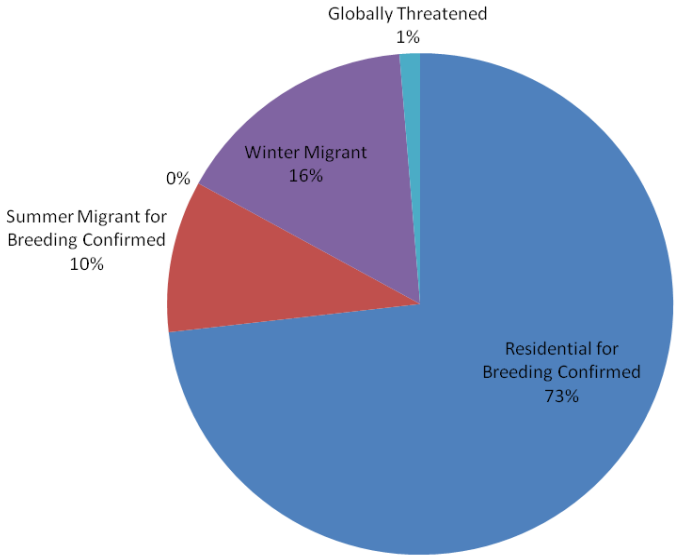

Figure 7 Status of birds recorded in Khata and Karnali corridor

Comparative habitat analysis of Khata and Karnali corridor with reference to bird diversity

As Khata corridor is more functional (Yadav, 2014; Wegge et al., 2016) with floral and faunal diversity in comparison to Karnali corridor, it is more diverse than Karnali. Khata lies in between two protected areas (BNP in north and KWS in south) whereas Karnali lies outside of the protected area having great pressure of local for collection of natural resources collection and heavy grassing (Subedi et al., 2021). The Karnali corridor provides north-south connectivity which will be of particular help in the western stretches of the Churia hills to lowland of BNP. There are many challenges in Karnali corridor such as forest encroachment, poaching, unsustainable harvesting of river and forest resources, illegal and intensive fishing, over-grazing, forest fires and problems of invasive plant species. Therefore, the forests are in the process of deterioration. As it is connected to Chure, there might be summer migrant birds in comparison to Khata. But, due to high pressure of humans, even the summer migratory birds use the Khata corridor via Karnali River.

The vegetation compositions are more or less same in both corridors. But there is less riverine forest composition in Karnali rather than Khata which supports less for bird diversity. Pure sal forest is composed in Karnali whereas there is mixed sal forest which supports for bird diversity in Khata corridor rather than Karnali corridor. Different types of grassland support for grassland birds in Khata whereas absence of grassland habitat does not support for grassland birds in Karnali.

Annexure 3 Details of Site wise Bird encounter rate

S. No	Sampling Effort Days	Sampling Effort Time (Hrs)	Number of Bird Watchers	Site	Total Bird Species	Total individuals of Birds	Area Sq. km	Transect Length in KM	Spp Detection Rate	Individuals Number detection rate	Encounter Rate/Hr
1	5 Days	30	5	Khata (Kailashi BZCF, Dalla BZCF, Dhanaura CF and National Forest)	137	1048	83	24	5.70833333	43.66666667	4.566667
2	10 Days	60	5	Karnali (Community Forest and National Forest)	86	407	227	55	1.56363636	7.4	1.433333

4. CONCLUSION AND RECOMMENDATIONS

Khata corridor forest harbours a very diverse avifauna than Karnali corridor in the summer season. Shannon–Weiner's diversity index indicates that the Khata corridor is rich in avifaunal diversity. Shannon's diversity index for birds of the Riverine cum Sissoo-Khair Forest is the highest among all the habitat types. Khata corridor forest represents different habitat type which supports different groups of birds. Higher numbers of birds were observed in riverine Sissoo-Khair Forest than other habitat because this habitat type covers large portion of the Khata and Karnali corridor. But, higher numbers of bird species were observed in riverine

grassland. Frugivores were more concentrated in moist mixed forest because of the fruiting season of trees and understory vegetation that bears fruits. Shore and wader birds were found to share swallow water and floodplain grassland along the river with more species. Snares were main threats of birds. Local people use snares to capture large sized birds in Karnali corridor for the meat purpose. Children kill small sized forest birds due to lack of awareness. The present study provides basic information on birds of the corridors. However, further species wise information is suggested. Distribution and detail threats identification of globally threatened and nationally protected species are recommended study for both the corridors.

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Author's contribution

Conceptualization: SKY, KPB, SKT. Data curation: SKY, SKT, RK, KPB. Formal analysis: SKY, KPB, UP. Writing original draft: SKY, KPB. Review: SKY, KPB.

Informed consent

Not applicable.

Ethical approval

The Animal ethical guidelines are followed in the study for species observation & identification.

Conflicts of interests

The authors declare that there are no conflicts of interests.

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Data and materials availability

All data associated with this study are present in the paper.

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