Species

Diversity of birds in the banks of the Bagmati River, Kathmandu, Nepal

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ABSTRACT

Background: The avian community structure reveals an area's ecological circumstances. In order to determine the diversity of bird species, species richness, relative abundance, seasonal status and national as well as worldwide conservation status, this study was undertaken in October 2021 and January 2022 during two visits (autumn and winter) along the banks of the Bagmati River. To incorporate all of the study area's various habitat types, the point-count approach was used. A total of 32 points were set up at four separate locations and birds were monitored for 20 minutes at each point within 200 meters of a fixed raising position and in a 20-meter-diameter circle. The surveys began at the peak bird activity times of the morning (7 a.m. to 10 a.m.) and the evening (16 p.m. to 18 p.m.). The Shannon-Weiner Diversity Index was used to analyze the data. *Results:* There were 563 different birds in total, representing 60 different species, nine orders and 24 different families. With 14 families and 39 species, Passeriformes was the most prevalent order. Very common (10), Common (20), Uncommon (9) and rare species had the highest relative abundance (21). There were 45 species total: 10 winter visitors, 5 summer visitors and 45 residents. Winter season (H′=1.378) has a higher overall species diversity than autumn season (H′=1.368). The sites with the most diversity was site 1 (Sundarijal; H′=3.654 & 3.536), site 4 (Chobhar; H′=3.466 & 3.336), site 3 (Pashupati; H′=3.234 & 3.132) and site 2 (Gokarneshwor; H′=3.163 & 3.064), which had the lowest diversity in both the winter and the autumn seasons. *Conclusion:* Diversity, evenness and richness of birds were higher in winter season than autumn may be due to the environmental condition and food availability. The highest density and richness of bird species were found at Sundarijal out of the four sites.

Keywords: Avifauna, Diversity, Species richness, Point count method, Season

1. INTRODUCTION

Birds not only contribute significantly to the preservation of ecological balance but also provide information about pollution levels (Bibi & Ali, 2013). Additionally, they aid in pollination and seed dissemination and perform scavenging duties (Mengesha & Bekele, 2008). Nepal is known around the world for its tremendous bird diversity. Nepal hosts 886 species of birds which constitutes nearly 8% of all bird species in the world (BCN & DNPWC, 2018). The wetlands of Nepal are home to about 200 species of birds. Bird Life International,

(2021) reports that out of the 886 species of birds that can be found in Nepal, 43 species have been listed on the IUCN Red List, which is a list of birds that are thought to be threatened globally. Of these 43 species, nine (20.96%) are critically endangered, nine (20.96%) are endangered and 25 (58.18%) are vulnerable (Bird Life International, 2021). In addition, 19 bird species are near-threatened (IUCN, 2018), 35 species are globally near-threatened and 167 species are threatened on a national level (Bird Life International, 2021). Spiny Babbler (*Acanthoptila nipalensis*) is the sole endemic bird of Nepal. Nine bird species are protected in Nepal under the NPWC Act of 1973, while 111 birds are recognized under the CITES category (DNPWC, 2018). Many of Nepal's resident bird species, which number about 550 out of 886 species, are seasonal altitudinal migrants that breed in higher elevations in the alpine region and migrate to lower elevations for wintering (Inskipp et al., 2016). Key species for wetland biodiversity are Water birds, both migratory and non-migratory (Wei & Mundkur, 2004).

There are mainly two kinds of migratory birds in Nepal, namely wetland birds and terrestrial birds. Again, terrestrial birds can be divided into two sub-groups, namely forest birds and grassland birds (Baral & Inskipp, 2005; Bhushal, 2013). With the onset of winter season, more than 150 species of winter migratory birds come to Nepal to avoid freezing cold in the Northern hemisphere (Jha, 2020). Similarly, when summer starts in Nepal, about 62 species of summer migratory birds from Sub-Saharan Africa, South-east Asia and South India arrive in Nepal in search of comparatively less hot areas and for breeding habitats (Bhushal, 2013; Jha, 2019).

The Bagmati River has abundant cultural, natural, historical and economic value for the people of Nepal (Milner et al., 2015). People utilize the Bagmati River to transport tiny amounts of water to their homes for ritual purposes, take baths and use it to pay their respects to their ancestors and pray to the gods (Adhikari et al., 2019). In the past, the Bagmati River and the riparian habitats in its surroundings have provided a good habitat for wildlife and a crucial route for migrating birds (Thakuri & Thapa, 2009). There is still some suitable habitat left on the bank of a relatively small number of river segments. Thapa et al., (2008) and Thakuri & Thapa, (2009) studied on the avifauna of Bagmati river corridor. Despite these works, some areas of Bagmati river corridor remained unexplored, therefore, present study was undertaken and purpose of this study is to explore the seasonal diversity, species richness, seasonal status, IUCN status, relative abundance and habitat of birds.

2. MATERIALS AND METHODS

Study area

The Bagmati River runs through the Kathmandu valley of Nepal, originates from the Shivapuri Nagarjun National Park and flows to Bihar, India where it joins the Koshi River and finally joins the Ganges River (Milner et al., 2015). The water flowing in the Bagmati River is considered as holy by both Hindus as well as Buddhists and is used for ceremonies practiced at the many temples located along its banks. The Bagmati Basin lies between the latitudes N26°23'18" and N27°49'11" and longitudes E85°1'25" and E85°57'10". The length of the river within Nepal is 204km (Manjan & Aggarwal, 2014). The study was carried out along the Bagmati river corridor starting from Sundarijal to Chobhar which includes about 32 Km in length (Figure 1). The altitude ranges from 1350 m - 1300 m from sea level. The climate of Bagmati River is mild and generally warm and temperate. Autumn is much rainier than the winter (Sharma & Shakya, 2006). The temperature of autumn ranges from 19°-28°C and an average relative humidity is 79%. The temperature of winter ranges from 3°-20°C and average relative humidity is 35% (Department of Hydrology and Meteorology 2019, Government of Nepal)**.** There isn't a particularly thick area of vegetation at the research site, but there are small pockets of mixed forest, which are primarily made up of native tree species like Painyu (*Prunus cerasoides*), Lapsi (*Choerospondias axillaris*), etc. Similar to these, there are also some exotic species, like Bains (*Salix babylonica*), Gulmohar (*Delonix regia*) and Lahare Pipal (*Populus deltoides*), among others (Thapa et al., 2008). In addition, some clumps of bamboos, reeds, banmara etc. are also found (Joshi & Joshi, 2005).

Field methods

The study was carried out in October 2021 (autumn season) and January 2022 (winter season). To encompass all of the study area's various habitat types, the point count method (Sarkar et al., 2009) was used. A total of 32 points were set up at four separate locations: Upstream (at Sundarijal), middle stream (at Gokarneshwor and Pashupati) and downstream (at Chobhar). For each site, eight points were created; the distance between each point and the next was roughly one kilometer and the distance between each site and the next was roughly eight kilometers. All birds observed and heard throughout the survey were meticulously noted within a radius of 200 meters from a fixed raising location and within a circle with a radius of 20 meters for a predetermined amount of time (20 minutes) at each point. Every season, field surveys were conducted between the hours of 16 p.m. and 18 p.m., when avian activity is at its height (Katuwal et al., 2016; Kandel et al., 2018). Mist nets were not used to catch the birds or handle them and brightly colored clothes were avoided because they can easily frighten birds (Jha, 2019). According to McKinnon and

Phillips (1993), the results from each survey were evaluated for relative abundance based on the number of sightings: Very Common (VC) – sighted more than 10 times, Common (C) – sighted 7-9 times, Uncommon (UC) – sighted 3-6 times and Rare (R) – sighted once or twice.

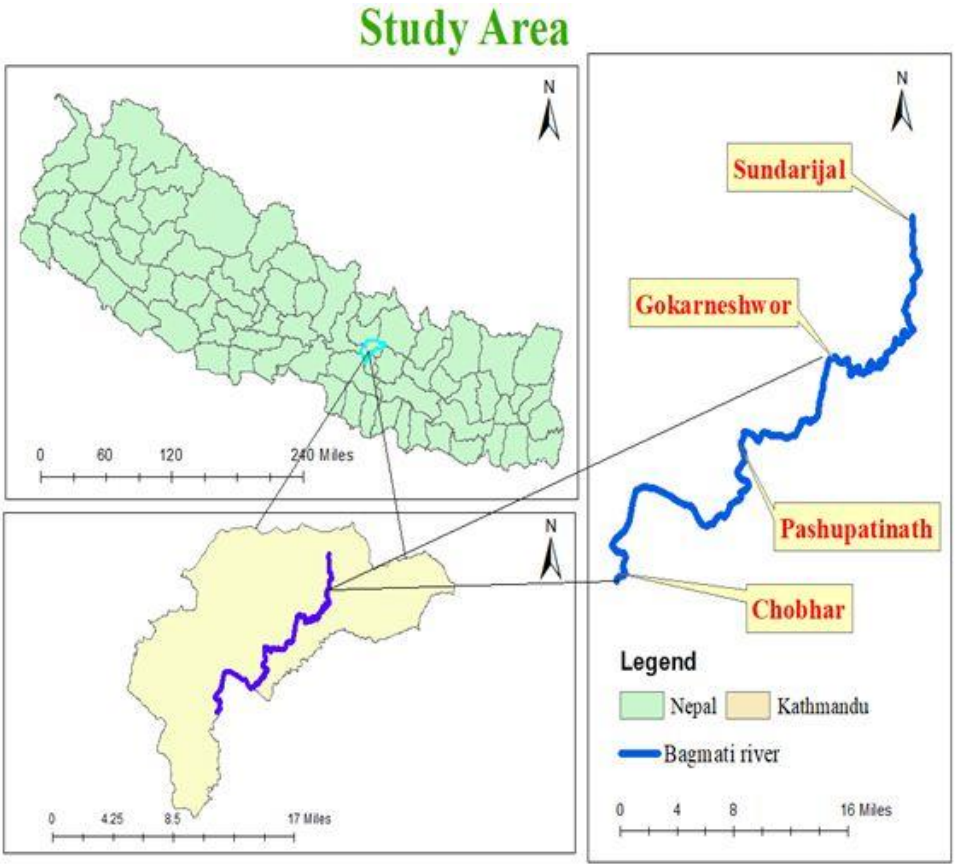

Figure 1 Location Map of Study Area

Based on an analysis of the other factors and the presence-or-absence technique, the seasonal status of birds such as resident, winter migrant and summer migratory was assessed (Thakur et al., 2010). Counting the number of bird species seen during each season allowed researchers to assess the variety of bird species. In both the autumn and winter season, each point-counting location was visited once pair of 10x42 Bushnell waterproof binoculars were used to watch the birds visually and a Canon Power shot 5x40 HS camera was used to take pictures and video of the birds. Birds of the Indian Subcontinent (Grimmett et al., 2011) and Birds of Nepal (Grimmett et al., 2016) were used as field guides to help identify the birds seen in the research area. To compare the domestic and worldwide status of birds, the IUCN Red List of Threatened Species (version 2017) and the Nepal Red List of Birds were utilized.

Data analysis

Shannon-Weiner Index (H′) was used to know the species diversity based on species abundance using the Shannon & Weaver (1949) formula:

$$H' = - [\sum (P_i * \ln P_i)]$$

Where H′ is the Diversity Index, Pi is the proportion of each species in the sample and ln (Pi) is the natural logarithm of this proportion.

Evenness of bird's species compares the similarity of the population size of each species. Evenness Index (E) (Kiros et al., 2018) was calculated using the ratio of observed diversity to maximum diversity using the equation.

E= (H′/Hmax)

Where H′ is the Shannon Wiener Diversity index and Hmax is the natural log of a total number of species.

3. RESULTS

In the current study, 563 birds from two seasons, representing 60 species, 9 orders and 24 families, were recorded (Table 2). Passeriformes, which contains 39 species and 14 families, has the most species diversity. Other major orders included the Charadiiformes, which had three families and seven species, the Columbiformes, which had one family and three species, the Pelecaniformes, which had one family and three species, the Strigiformes, which had one family and one species, the Acciptriformes, which had one family and three species, the Coraciformes, which had one family and two species and the Apodiformes, which had one family and one species (Figure 2).

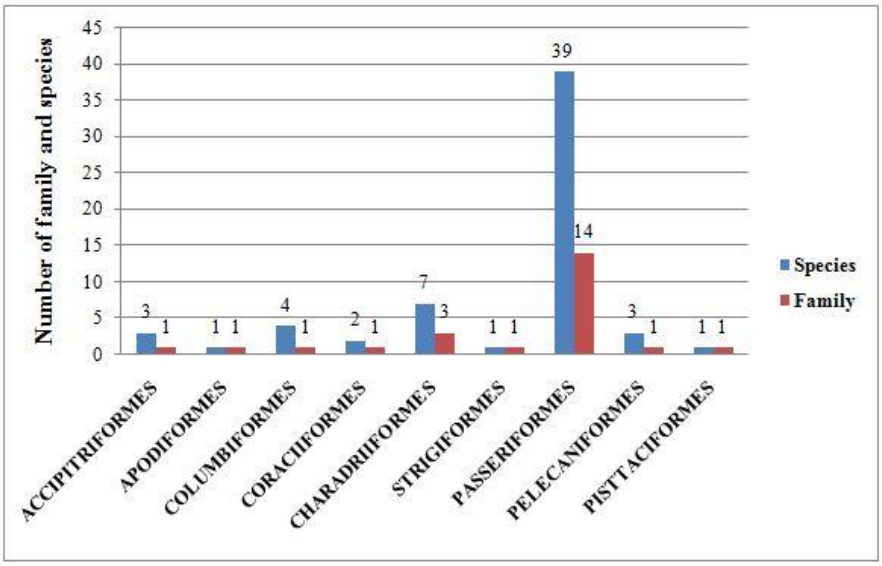

Figure 2 Order-wise Distribution of Family and Species

The Sundarijal's species richness (45 species) peaked in the winter, followed by Chobhar's (42 species), Pashupati's (36 species), and Gokarneshwor's (36 species) (33 species). Similarly in the autumn season, the highest number of bird species was found in the Sundarijal, followed by Chobhar, Pashupati and Gokarneshwor, where there were 37, 32, 28 and 25 bird species, respectively (Figure 3).

The seasonal status of the species (Figure 4) was winter (53) and autumn (44). As a result, the diversity of birds was greater in the winter season than in the autumn season.

According to the Shannon-Weiner Variety Index, there was overall more bird diversity during the winter season (H′=1.378) than during the fall season (H′=1.368). The Evenness index also revealed that the distribution of the birds was more even in the winter (E=0.361) than in the autumn (E=0.357). The information in Table 1 showed that in both seasons, Sundarijal had the greatest Shannon-Weiner diversity index (H′), followed by Chobhar, Pashupati and Gokarneshwor. Similar to that, Sundarijal had the most evenness (E) in both seasons, followed by Chobhar, Gokarneshwor and Pashupati (Table 1).

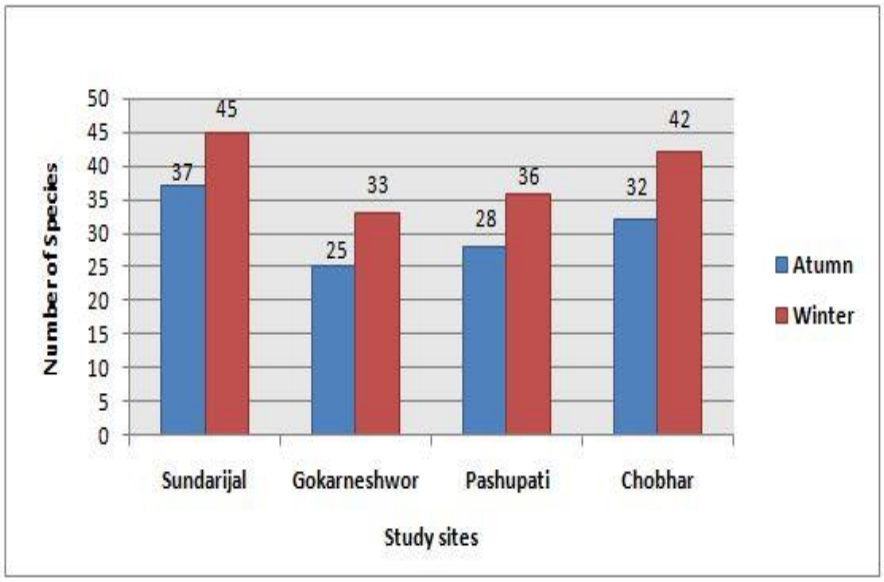

Figure 3 Site-wise Distribution of Bird Species in Different Seasons

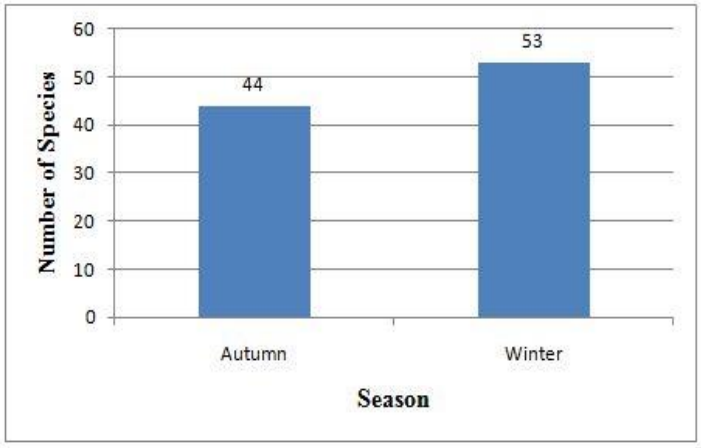

Figure 4 Seasonal status of Bird Species

Table 1 Shannon-Weiner Index values for bird diversity in different sites

Site	Season	S	N	∑pi(n/N)	∑ln(pi)	∑[pi*ln(pi)]	H′	H_{max}	Evenness
Sundarijal	Autumn	36	112	1	-130.719	-3.536	3.536	3.583	0.986
	Winter	44	155	1	-172.365	-3.654	3.654	3.784	0.965
GGokarneshwor	Autumn	25	77	1.026	-84.926	-3.064	3.064	3.218	0.951
	Winter	33	114	1	-125.202	-3.163	3.163	3.496	0.904
Pashupati	Autumn	28	84	1	-98.309	-3.132	3.132	3.332	0.940
	Winter	36	120	1	-139.244	-3.234	3.234	3.583	0.902
Chobhar	Autumn	31	91	1	-109.389	-3.336	3.336	3.434	0.971
	Winter	41	146	1	-162.208	-3.466	3.466	3.713	0.933

The relative abundance of species was Very Common (10) 16.67%, Common (20) 33.33%, Uncommon (9) 15% and Rare (21) 35% (Figure 5). Rare was the category with the most species, followed by Common, Very Common and Uncommon.

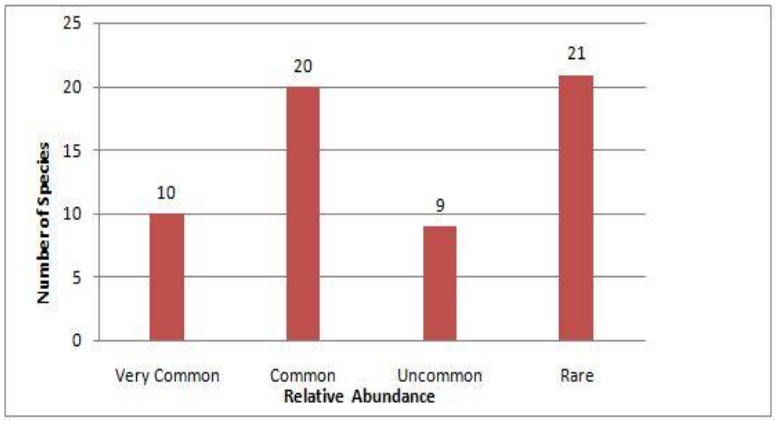

Figure 5 Relative Abundance of Bird Species

Out of a total of 60 species documented from the research region, 45 (or 75%) were residents, ten (11) 17% were winter visitors, and five (or 8%) were summer visitors, according to the examination of the data on residential status. 97% (58) of the 60 bird species present in the research area are classified as Least Concern (LC), 2% (one) as Near Threatened (NT) and 2% (one) as Vulnerable (VU) on a national and international level (Table 2).

Table 2 check list of birds

	Order/Family/ Common name	Scientific name	No. of Birds				Seasonal Status/ Relative abundance	National status	IUCN
			Autumn	Sites	Winter	Sites			
A	ACCIPITRIFORMES								
	Accipitridae								
1	Black Eagle	*Ictinaetus malayensis* (Temminck, 1822)	9	S, G, P, C	11	S, G, P, C	R, VC	LC	LC
2	Booted Eagle	*Hieraaetus pennanatus* (Gmelin, 1788)	5	S, G	6	S, P, G, C	R, C	LC	LC
3	Steppe Eagle	*Aquila nipalensis* (Hodgson, 1833)			1	C	WM, UC	VU	EN
B	APODIFORMES								
	Apodidae								
4	House Swift	*Apus nepalensis* (Hodgson, 1836)	15	S, G, P, C	9	S, G, P, C	R, C	LC	LC
C	COLUMBIFORMES								
	Columbidae								
5	Rock Dove	*Columba livia* (Stejneger, 1903)	35	S, G, P, C	63	S, G, P, C	R, VC	LC	LC
6	Spotted Dove	*Stigmatopelia chinensis* (Scopoli, 1786)	9	S, G, P, C	5	S, G, P	R, C	LC	LC
7	Oriental Turtle Dove	*Streptopelia orientalis* (Latham, 1790)	11	S, P, G, C	13	S, P, G, C	R, C	LC	LC
8	Wedge-tail Green Pigeon	*Treron sphenurus* (Vigors, 1823)	3	S, P			SM, R	LC	LC
D	CORACIIFORMES								
	Alcedinidae								
9	Common Kingfisher	*Alcedo atthis* (Linnaeus, 1758)	7	S, P, G, C	4	S, P, G, C	R, C	LC	LC

10	White-throated Kingfisher	*Halcyon smyrnenis* (Linnaeus, 1758)	8	S, P	10	S, G, P	R, UC	LC	LC
E	CHARADRIIFORMES								
	Charadriidae								
11	Long-billed Plover	*Charadrius placidus* (Gray and Gray, 1836)	3	S, C	6	S, G, C	R, R	LC	LC
	Scolopacidae								LC
12	Common Sandpiper	*Actitis hypoleucos hypoleucus* (Cramp and Simmons, 1997-1994)	2	S	6	G, P, C	R, R	LC	LC
13	Green Sandpiper	*Tringa ochropus* (Linnaeus, 1758)	4	S, P	6	G, P, C	R, R	LC	LC
14	Common Greenshank	*Tringa nebularia* (Gunnerus, 1767)			8	G, P, C	WM, UC	LC	LC
15	Little Stint	*Calidris minuta* (Leisler, 1812)	6	G, P, C			SM, C	LC	LC
16	Temminicks Stint	*Calidris temminckii* (Temminick, 1815)			5	S, C	WM, UC	LC	LC
	Laridae								
17	White Winged Tern	*Chlidonias leucopterus* (Temminick, 1815)			2	p	WM, R	LC	LC
F	STRIGIFORMES								
	Strigidae								
18	Asian Barred Owlet	*Glaucidium cuculoides* (Vigors, 1831)	2	S	3	S, C	R, R	LC	LC
G	PASSERIFORMES								
	Cisticolidae								
19	Common Tailorbird	*Orthotomus sutorius* (Pennant, 1769)			9	S, G, C	WM, VC	LC	LC
20	Streaked Fantail Warbler	*Cisticola juncidis* (Rafinesque,1810)	2	C			SM, UC	LC	LC
	Corvidae								
21	House Crow	*Crovus splendens* (Vieillot, 1817)	23	S, G, P, C	42	S, G, P, C	R, VC	LC	LC
22	Large-billed Crow	*Crovus macrorhynchos* (Wagler, 1827)	11	S, P, G, C	9	S, P, G, C	R, C	LC	LC
	Dicrueidae								
23	Ashy Drongo	*Dicrurus leucophaeus* (Vieillot, 1817)	3	S	6	S, G, P, C	R, R	LC	LC
24	Black Drongo	*Dicrurus macrocercus* (Vieillot, 1817)	10	S, G, P, C	6	S, P, C	R, R	LC	LC
	Laniidae								
25	Grey-backed Shrike	*Lanius tephronotus* (Vigors,1831)			2	P	WM, R	LC	LC
26	Brown Shrike	*Lanius cristatus* (Linnaeus, 1758)	1	P	4	S, G	R, R	LC	LC
	Motacillidae								
27	Olive-backed Pipit	*Anthus hodgsoni* (Richmond, 1907)	8	S, P, C	8	S, G, P, C	R, C	LC	LC
28	Rosy Pipit	*Anthus roseatus* (Blyth,1847)	2	S	3	S	R, R	LC	LC

29	Paddy Field Pipit	*Anthus rufulus* (Vieillot, 1818)	4	S, P	2	S	R, R	LC	LC
30	Grey Wagtail	*Motacilla cinerea* (Tunstall, 1771)	9	S, G, P, C	4	S, C	R, C	LC	LC
31	White-browed wagtail	*Motacilla maderaspatensis* (Gmelin,1789)			9	S, G, P	WM, VC	LC	LC
32	White Wagtail	*Motacilla alba* (Linnaeus, 1758)			12	S, P, C	WM, C	LC	LC
	Turdidae								
33	Blue Whistling-thrush	*Myophonus caeruleus* (Scopoli,1786)	5	S, P	5	S, C	R, R	LC	LC
34	Dark-throated Thrush	*Turdus ruficollis* (Latham, 1790)			3	S, C	WM, R	LC	LC
35	Scaly Thrush	*Zoothera douma* (Latham,1790)			5		WM, C	NT	LC
	Muscicapidae								
36	Oriental Magpie Robin	*Copsychus saularis* (Linnaeus, 1758)	11	S, G, P, C	12	S, P, G, C	R, C	LC	LC
37	Slaty Blue Flycatcher	*Ficedula tricolor* (Hodgson, 1845)	6	S, G, C			SM, C	LC	LC
38	Hodgson's Redstart	*Phoenicurus hodgsoni* (Hodgson, 1845)			5	S, P, C	WM, C	LC	LC
39	White-capped Water-redstart	*Phoenicurus leucocephalus* (Vigors, 1831)	4	S, C	4	S, C	R, UC	LC	LC
40	Little Forktail	*Enicurus scouleri* (Vigors, 1832)	12	S, G, P, C	19	S, G, P, C	R, VC	LC	LC
41	Spotted Forktail	*Enicurus maculatus* (Vigors, 1831)	11	S, G, P, C	14	S, G, P, C	R, C	LC	LC
	Passeridae								
42	Eurasian Tree Sparrow	*Passer montanus* (Linnaeus, 1758)	11	S, G, P, C	17	S, G, P, C	R, C	LC	LC
43	Field Sparrow	*Spizella pusilla* (Wilson, 1810)	5	S, C	7	S, C	R, UC	LC	LC
44	House Sparrow	*Passer domesticus* (Linnaeus, 1758)	17	S, P, G, C	19	S, P, G, C	R, VC	LC	LC
	Phyllocospidea								
45	Blyth's Reed Warbler	*Phylloscopus reguloids* (Blyth, 1849)	5	S, G	3	S, C	R, R	LC	LC
46	Greenish Warbler	*Phyllscopus trochiloides* (Sundevall,1837)	5	S, P	19	S, P, G, C	R, C	LC	LC
47	Hume's Leaf Warbler	*Phylloscopus humei* (Brooks, 1878)			5	S, P	WM, C	LC	VU
48	Grey Hooded Warbler	*Phylloscopus xanthoschistos* (Gray, 1846)			8	S, G, P	WM, VC	LC	LC
49	Tickell's Leaf Warbler	*Phylloscopus affinis* (Tickell, 1833)	7	S, P, C	3	S	R, VC	LC	LC
	Pycnonotidae								
50	Black Bulbul	*Hypsipetes leucocephalus* (Gmelin, 1789)	11	S, G, C	18	S, P, G, C	R, VC	LC	LC
51	Red Vented Bulbul	*Pcynonotus cafer* (Linnaeus, 1766)	12	S, G, P, C	4	G.P.C	R, R	LC	LC

	Sturnidae								
52	Common Mynah	*Acridotheres tristis* (Linnaeus, 1766)	22	S, G, P, C	19	S, P, G, C	R, VC	LC	LC
53	Jungle Mynah	*Acridotheres fuscus* (Wagler, 1827)	14	S, G, P, C	26	S, G, P, C	R, C	LC	LC
	Sittidae								
54	Wall creeper	*Tichodroma muraria* (Linnaeus, 1766)			3	S, C	WM, R	LC	LC
	Aegithalidae								
55	Black–throated Tit	*Aegithalus concinus* (Gould, 1855)			3	S, C	WM, UC	LC	LC
	Picidae								
56	Eurasian Wryneck	*Jynx torquilla* (Linnaeus, 1758)	3	C			SM, UC	LC	LC
H	PELECANIFORMES								
	Ardeidae								
57	Cattle Egret	*Bulbulcus ibis* (Linnaeus, 1758)	4	G, C	11	S, G, P, C	R, C	LC	LC
58	Little Egret	*Egretta garzetta* (Linnaeus, 1766)	8	P, C	24	S, G, P, C	R, C	LC	LC
59	Pond Heron	*Ardeola grayii* (Skyes,1832)	8	S, P, C			SM, C	LC	LC
I	PISTTACIFORMES								
	Pisttaculidae								
60	Rose-ringed Parakeet	*Psittacula krameri* (Scopoli, 1769)	3	S, G			SM, R	LC	LC

4. DISCUSSION

The famed Bagmati River in Nepal is known for its holistic qualities and is regarded as a natural habitat for a variety of flora and wildlife (Thapa et al., 2008). From this survey a total of 60 species of birds belonging to nine orders and 24 families were observed. Out of them, 53 species of birds were detected in the winter season and 44 bird species were found during the autumn. Species richness of winter (53) was higher than autumn (44). Flowering in the arrival of winter causes availability of food which is an essential cause for high species richness in spring, despite the decreased vegetation thickness (Jha, 2020). According to Natarajan, (1992), the population of birds varies throughout time depending on the availability of food and the climate. The same tendency was observed between the winter and autumn seasons, with the winter season having higher Shannon-Weiner diversity index (H'= 1.378) and evenness (E= 0.361) than autumn season (H'=1.368) and (E=0.357) respectively.

Thapa et al., (2008) recorded a total number of 100 species of birds in Bagmati river corridor. Thakuri & Thapa, (2009) also recorded a total of 112 species of birds belonging to 12 orders and 34 families. There is difference in the number of bird species due to limitation of study area as well as previous studies were done decade ago and many environmental changes has been occurred since then. Out of 60 species of the birds 45 (75%) were residents, ten (17%) winter migrants and five (8%) summer migrants. By the record of a very low number of winter migratory birds in the research area, it is evident that the bird's habitat in the Bagmati river corridor has significantly deteriorated. The presence of migratory birds suggests a number of environmental and ecological issues in the area in question (Chandel et al., 2014). The winter migratory birds identified in this study were the Wallcreeper (*Tichodroma muraria)*, Black-throated Tit (*Aegithalus concinus)*, Steppe Eagle (*Aquila nipalensis)*, Scaly Thrush *(Zoothera douma)* and others. Wedge-tail Green Pigeon (*Treron sphenura*), Little Stint (*Calidris minuta)*, Rose- ringed Parakeet (*Psittacula krameri)*, Pond Heron *(Ardeola grayii*) etc. were other species that frequented the area during the summer.

Most birds were seen at Sundarijal among the four locations in both seasons, followed by Chobhar, Gokarneshwor and Pashupati. The most observed species of birds in Sundarijal might be due to large variety of plants which provide shelter as well as food and safety for birds. The lack of bird species seen in Gokarneshwor and Pashupati may be attributable to human intervention, construction work, noise from traffic and the lack of marshy ground because large areas of the Bagmati River's bank are made of cement, which reduces the amount of food available for birds. The Pashupati area's Bagmati riverbanks were determined to have

the highest levels of human disturbance since they are closer to the Pashupati temple, crematorium and Tilganga eye facility. This proved that the Pashupati location wasn't an appropriate habitat for avifauna. The fact that Chobhar has a higher diversity of bird species than Gokarneshwor and Pashupati may be attributed to the lack of densely populated areas, sufficient marshy terrain, dense foliage and neighboring fields that provide food for birds.

5. CONCLUSION

In terms of bird diversity, the Bagmati river corridor is the most abundant. A total of 563 individuals belonging to 60 species, 9 orders and 24 families were recorded, among which Passeriformes had the highest number of the family (14) and bird species (39). In comparison to autumn, the winter season has more diversity, evenness and richness of bird species. The relative abundance of species was Very Common (10), Common (20), Uncommon (9) and Rare (21). The diversity of bird species was discovered in four different locations: Sundarijal, Gokarneshwor, Pashupati and Chobhar. With both to density and bird diversity, Sundarijal has the highest levels. Species richness of winter (53) was higher than autumn (44).

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Declarations

Authors' contributions

ND designed and carried out the research, collected data, involved in analysis and interpretation of data and manuscript writing. PKJ suggested the concept of the work, designed the study and involved in analysis of data and manuscript writing. Both authors read and approved the final manuscript.

Abbreviations

BCN: Bird Conservation Nepal
DNPWC: Department of National Parks and Wildlife Conservation
IUCN: International Union for Conservation of Nature
R: Resident
SM: Summer Migrant
WM: Winter Migrant
VC: Very Common
C: Common
UC: Uncommon
S: Sundarijal
G: Gokarneshwor
P: Pashupati
C: Chobhar
LC: Least Concern
EN: Endangered
VU: Vulnerable
CR: Critically Endangered
R: Rare

Ethical approval

Birds' diversity from the banks of the Bagmati River, Kathmandu, Nepal was observed in the study. The ethical guidelines are followed in the study for species observation & identification.

Informed consent

Not applicable.

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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