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Research Article

Avifaunal Composition and Threats to Birds in Gaurishankar Conservation Area, Nepal

Kamal Raj Gosai[1*], Bijay Bashyal[2], Kiran Gosai[3], Narayan Prasad Koju[*4]

[1]Central Department of Environmental Science, Institute of Science and Technology, Tribhuvan University, Nepal

[2]Earth Journalism Network, Nepal

[3]Bird Conservation Nepal, Lazimpat, Kathmandu

[4]Center for Postgraduate Studies, Nepal Engineering College, Pokhara University, Nepal

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Abstract

Nepal is rich in avifaunal diversity with 892 species recorded in and outside protected areas. Gaurishankar Conservation Area (GCA), one of the protected areas of Nepal plays an important role in biodiversity conservation, but comprehensive research based on avian diversity and related threats has not been conducted yet. This study assessed the diversity and composition of birds, and threats to birds in Lapchi Valley, GCA in 2019, 2020, and 2021, following the fixed-radius (25 m) point count method with opportunistic observations. This study recorded 108 bird species belonging to 36 families. Among the bird species recorded, most were residents (n=98), four were winter visitors, two were summer visitors, and four were altitudinal migrants. Muscicapidae was the most diverse avian family in the study area (RDi value=15.74). Most species were insectivorous (66.67%), granivorous (19.44%), followed by carnivorous (7.14%), omnivorous (4.63%), and nectarivores (1.85%). One critically endangered and three near-threatened species were also observed. '*Beyul*' culture is practiced by the locals (particularly the Buddhists) of GCA and helps to the protection of biodiversity including birds. The ongoing road and hydropower construction might put birds and other biodiversity at stake. Nevertheless, Lapchi Valley of GCA could be a potential bird-based tourism site in the future attracting eco-tourists, and hence this type of tourism may also be promoted.

***Keywords**:* Avifauna, *Beyul* culture, conservation area, diversity, point count, threats

Introduction

The rich avian diversity of Nepal, comprising 892 species that account for approximately 9.5% of the world's bird species, emphasizes the nation's significant ecological importance despite its relatively small geographical size (BCN & DNPWC, 2022). Nepal homes 42 species listed in the IUCN Red List of globally threatened birds. Among these, 10 (23.8%) species are critically endangered, eight (19.0%) endangered, and 24 (57.1%) are listed as vulnerable. Similarly, as many as 172 species of birds in Nepal have been identified as nationally threatened including 68 (39.5%) critically endangered species, 38 (22.1%) endangered species, and 66 (38.4%) vulnerable species (BCN & DNPWC, 2022). Several factors affect birds in Nepal, like habitat degradation, illegal hunting and trade, chemical poisoning, overfishing, food scarcity, overgrazing, pollution from households and industrial discharges, and agricultural run-off (Inskipp et al., 2016). Additionally, some invasive alien weeds like Water Hyacinth *Pontederia crassipes* in wetlands (Basaula et al., 2023), and *Mikania micrantha* in grasslands and forests (Bellard et al., 2016) are growing serious concerns.

Gaurishankar Conservation Area (GCA), known for its distinct ecological characteristics and diverse habitats (Koju et al. 2023; Ollerton et al, 2020), is home to a variety of avian species, some of which are vulnerable to threats. Thus, the Gaurishankar Conservation Area (GCA), including Lapchi Valley, presents a unique research opportunity. Gaurishankar Conservation Area (GCA) is one of the newest protected areas in Nepal. Despite some exploratory works on mammalian diversity (Chetri et al., 2022), Lapchi Valley, GCA lacks research works directed towards avian species suggesting that the current knowledge of avian fauna is incomplete. Conducting a compositional study of bird species in Lapchi Valley, GCA is essential for several reasons. Firstly, it allows for identifying and documenting bird species present in the area, which is critical for effective conservation planning. Secondly, by assessing the threats to avian populations in Lapchi Valley, GCA will provide insights that can inform targeted conservation strategies. Hence, this study aimed to document the species richness, composition, threats, and conservation measures in trekking trails of Lapchi Valley of Gaurishankar Conservation Area (GCA) (Fig. 1) for broader conservation initiatives.

Materials and Methods

Study area

The study was conducted in Lapchi Valley of Gaurishankar Conservation Area (GCA), one of the six

*Corresponding authors: *kamal.gosai@trc.tu.edu.np, npkoju.2003@gmail.com

conservation areas of Nepal with an area of 2,179 km^2 situated in the northern part of the Ramechhap, Dolakha, and Sindhupalchok districts of the Bagmati Province of Nepal (Bajracharya et al., 2011). The GCA extends between E 85°46.8' to 86°34.8' and N 27°34.2' to 28°10'. It shares a boundary with Langtang National Park (LNP) in the west and Sagarmatha National Park (SNP) in the east. The northern part of GCA shares a boundary with the Tibetan Autonomous Region of the People's Republic of China, which lies in the Sacred Himalayan Landscape (WWF Nepal, 2012). GCA's physiographic and climatic zones vary from mid-hills to high mountains and from sub-tropical to alpine regions. Lapchi Valley lies at the foot of the Lapchi Khang mountain range. The people of Lapchi Valley are Sherpa Buddhists and follow *Beyul* culture. Animal husbandry is their major occupation and observe a semi-nomadic lifestyle. Lumnang is their winter retreat place. Recently, the area has been connected with modern transportation and communication with the construction of access roads to hydropower. The bird survey was limited to the trekking trail from Lamabagar to Lapchi Gonpa and Lamabagar-Samling-Kukure Raja Danda (Fig. 1).

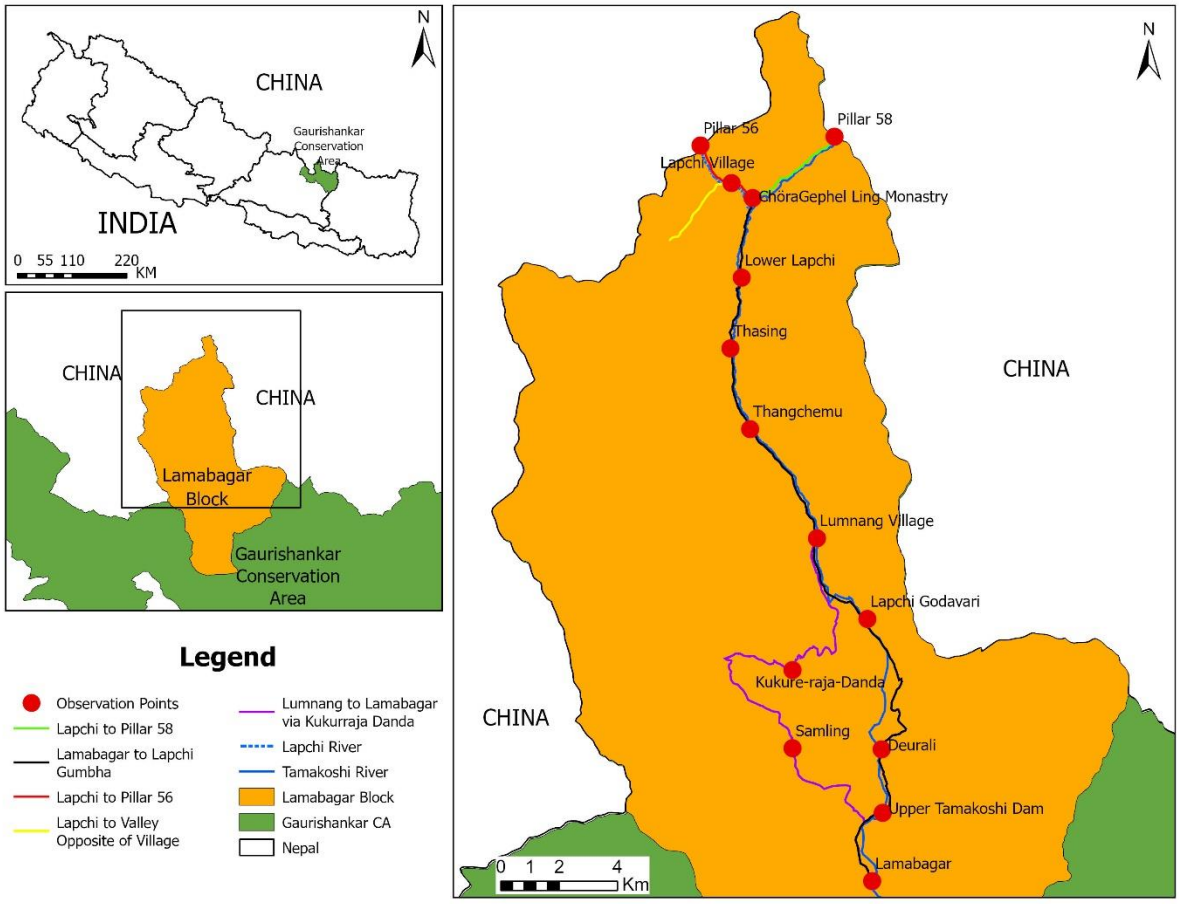

Figure 1. Map showing trekking trails and point count stations along the Lapchi Valley, Gaurishankar Conservation Area

Birds survey

Avifaunal surveys were carried out for a month: 11 days in 2019, 12 days in 2020, and 11 days in 2021 on the trekking trails. Along the trekking trails, points count stations with a 25 m radius (Bibby et al. 2000, Sutherland 2006) were placed in key locations. Each station was surveyed for 30 minutes (sometimes, during less visibility the duration extended up to 3 hours in a few stations) to record bird species (seen or heard) in the morning (8 am to 11 am) or in the afternoon (1 pm to 4 pm). In addition, opportunistic observations of birds at other times and places were also noted. Binocular (Nikon 10×42) and camera (Canon 80D with 150-600mm G2 lens) were used for bird observation and taking pictures. For the identification of birds, Helm Field Guides- Birds of Nepal was used (Grimmett et al., 2016).

Threats assessment

Potential threats to birds were qualitatively assessed based on direct observations made in several visits in three consecutive years, six focus group discussions at Lamabagar Village, Lumnang Village, Samlling Village,

Thang-Chemo Village, Thasing Village, and Lapchi Village) and seven Key Informant Interviews (conservation officials, local youths, farmers, local herders, and monks).

Data analysis

The systematic position (order and family), common name, scientific name, feeding guild, body size, and migration pattern of each species were based on Grimmett et al., 2016. Body sizes less than 10cm in body length were considered small, 11-20cm were considered medium, and more than 20 cm were considered large (Gosai et al., 2021). Information on the global and national red list status of birds was based on DNPWC & BCN, 2022. The relative diversity index (RDi) of families was calculated using the following formula (Torre-Cuadros et al. 2007):

$$RDi = \frac{No.of\ bird\ species\ in\ the\ family}{Total\ no.of\ species} \times 100$$

Results and Discussion

Species Diversity

This study recorded 108 species of birds (approximately 12.11% of the total species in Nepal) with 830 individuals, belonging to 9 orders and 36 families (Suppliment 1), though this study did not cover all the areas of GCA. National Trust for Nature Conservation (NTNC) recorded 235 species of birds in GCA (National Trust for Nature Conservation, 2022) and 892 species in Nepal (DNPWC & BCN, 2022). The number of avifaunal species recorded in this study was approximately half of the species recorded by NTNC.

Passeriformes was the most diversely represented order with 90 species (83.33%), followed by the order Accipitriformes with five species (4.63%), and four species (3.7%) of order Columbiformes (Fig. 2). The reproduction rate of Passeriformes is high in a forested area (Hoyo et al., 2014) and are the most diverse avian community in the world (Ericson et al., 2003; Selvatti et al., 2015). Since most of the point count stations were in forests, birds of this order might have been recorded more in this study, demonstrating the global trend.

Similarly, among the bird families, the Muscicapidae family was the most diverse avifauna (17 species, RDi=15.74), followed by Fringillidae (12 species, RDi=11.11), while 14 families were poorly represented, with only a single species each (RDi=0.93) (Table 1). Muscicapidae family might have been observed in this study more because the species in this family habitat in almost all areas, mostly preferring forests, scrubland, and agricultural areas making them one of the largely distributed avian families (Sangster et al., 2010; Zhao et al., 2023).

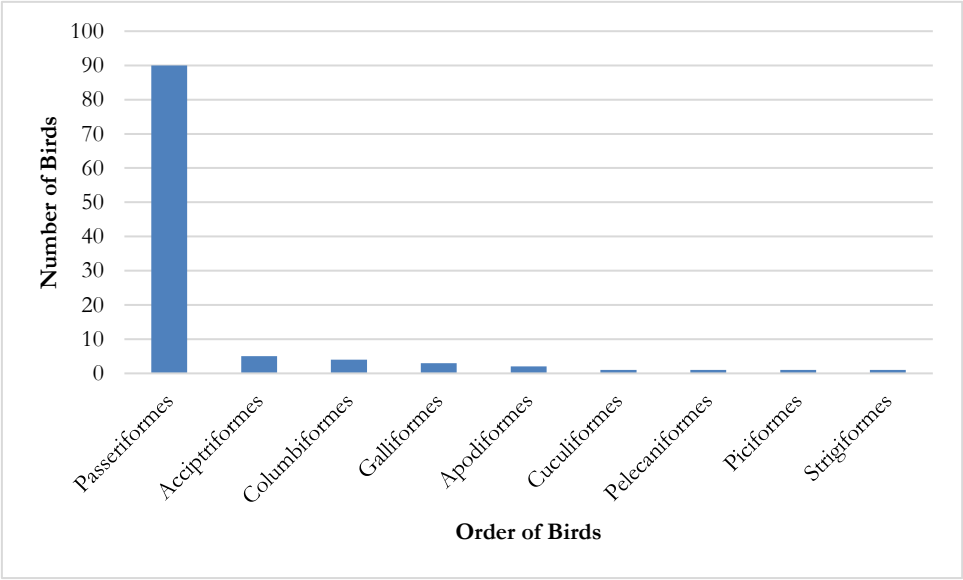

Figure 2. Order-wise distribution of birds of Lapchi valley, GCA

Feeding guild

This dominance of the insectivorous family is also reciprocated by the feeding guild analysis of the study with the dominance of insectivorous species (72 species, 66.67%). The presence of higher insectivores might also signify a good presence of insect communities in the area (Lamichhane et al., 2021). The other feeding guilds recorded in the study area were granivores (21 species, 19.44%), carnivores (8 species, 7.14%), omnivores (5 species, 4.63%) and nectarivores (2 species, 1.85%). The granivorous and nectarivorous birds play an important role in seed dispersal and pollination of plant species

(Ollerton et al., 2019), whereas carnivores, omnivores, and insectivores act as natural pest controls (Bibi & Ali, 2013; Grima et al., 2016) making birds an important part of the ecosystem.

Body size

Regarding the body size, most of the species were medium-sized (n=66, 61.11%), followed by large-sized species (n=34, 31.48%) and small-sized species (n=8, 7.41%) (Fig. 4). The body size of birds affects the detectability of the birds (Callaghan et al., 2021a), with a higher detection probability for large-sized birds (Callaghan et al., 2021b).

Migration status

Among the recorded birds, 98 species (90.74%) were resident birds, four species (3.70%) each were winter visitors and altitudinal migrants, and two species (1.85%) were summer visitors (Table 2). Nepal, being a part of the Central Asian Flyway shelters 150 winter visitors and 62 summer visitors as seasonal birds (Inskipp et al., 2016). High climatic variations in short geographical distances within Nepal provide good habitat for these migratory birds. However, the conservation of their breeding grounds, passage routes, and stop-by sites is much needed to maintain the flow of migratory species in Nepal (Lamichhane et al., 2021). These different compositions of bird communities (order, family, feeding guilds, and migratory status) can be used as indicators for ecological health (Gregory et al., 2003; Pakkala et al., 2014; Reynaud & Thioulouse, 2000) as birds play an important role in maintaining ecosystems.

Table 1. Relative diversity (RDi) of various avian families in Lapchi Valley, Gaurishankar Conservation Area

Family	No. of species	RDi
Muscicapidae	17	15.74
Fringillidae	12	11.11
Turdidae	7	6.48
Paridae	6	5.56
Accipitridae	5	4.63
Columbidae	4	3.70
Corvidae	4	3.70
Phylloscopidae	4	3.70
Sylviidae	4	3.70
Zosteropidae	4	3.70
Leiothrichidae	3	2.78
Motacillidae	3	2.78
Phasianidae	3	2.78
Apodidae	2	1.85
Dicruridae	2	1.85
Hirundinidae	2	1.85
Nectariniidae	2	1.85
Passeridae	2	1.85
Prunellidae	2	1.85
Sittidae	2	1.85
Stenostiridae	2	1.85
Timaliidae	2	1.85
Aegithalidae	1	0.93
Campephagidae	1	0.93
Certhiidae	1	0.93
Cettiidae	1	0.93
Cinclidae	1	0.93
Cuculidae	1	0.93
Laniidae	1	0.93

Phalacrocoracidae	1	0.93
Picidae	1	0.93
Pnoepygidae	1	0.93
Pycnonotidae	1	0.93
Strigidae	1	0.93
Troglodytidae	1	0.93
Vireonidae	1	0.93

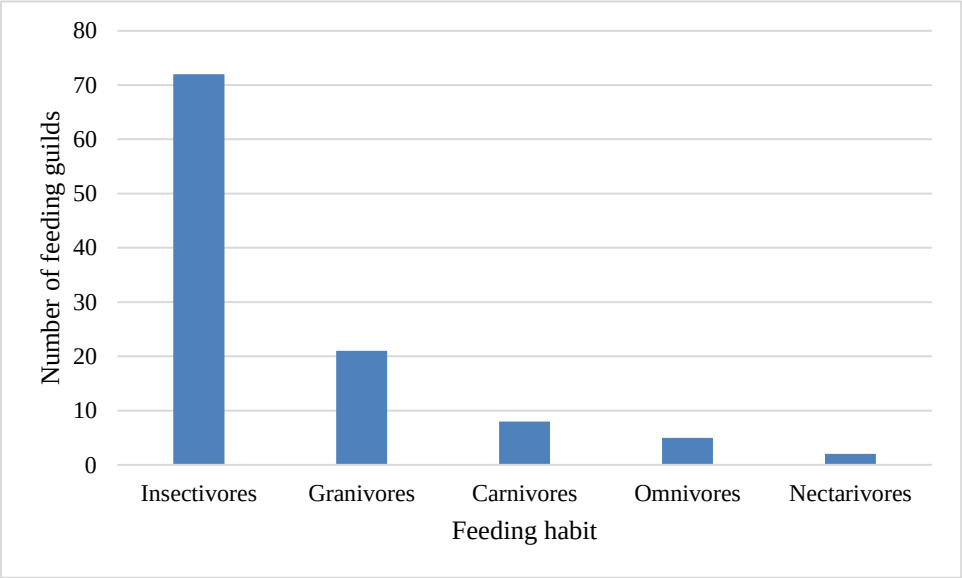

Figure 3. Feeding guild of birds of Lapchi Valley, GCA

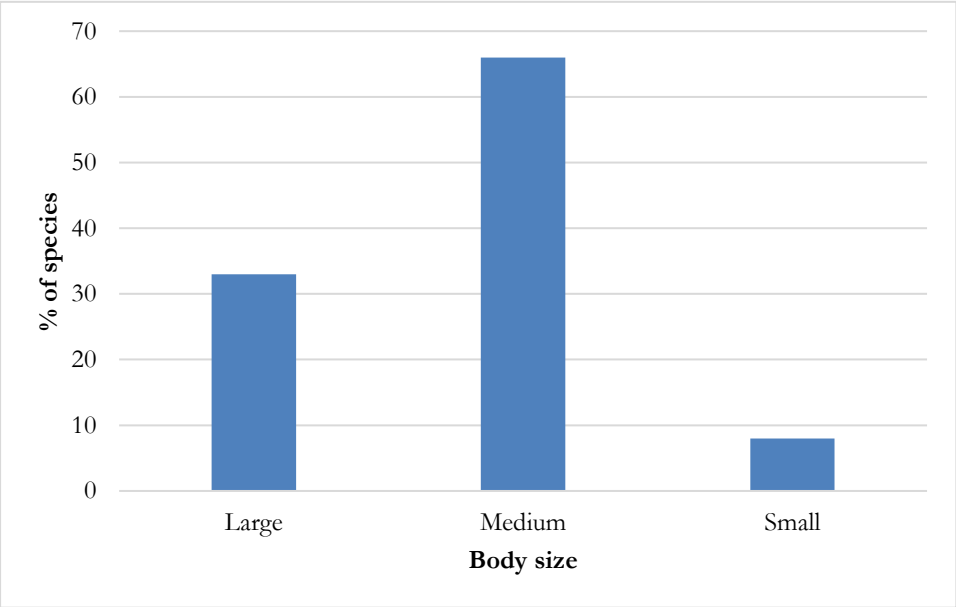

Figure 4. Body size of birds of Lapchi Valley, GCA

Table 2. Global IUCN status and migration group of bird species

	Global IUCN status					Grand
Migration Group	**CR**	**EN**	**VU**	**NT**	**LC**	**Total**
Altitudinal migrant	0	0	0	0	4	4
Resident	1	0	0	2	95	98
Summer migrant	0	0	0	0	2	2
Winter migrant	0	0	0	1	3	4
Grand Total	**1**	**0**	**0**	**3**	**104**	**108**

CR: Critically endangered, EN: Endangered, VU: Vulnerable, NT: Near Threatened, LC: Least Concern.

Conservation Status

Among the bird species recorded, only one species (Red Headed Vulture [*Sarcogyps calvus*]) falls under the IUCN critically endangered (CR) category, three species (Bearded Vulture *Gypaetus barbatus*, Cinereous vulture *Aegypius monachus*, Himalayan Vulture *Gyps himalayensis*) fall under the IUCN near threatened (NT) category and the remaining species (104) fall under the IUCN least concern (LC) category (Table 2). Similarly, two species (Cinereous vulture *Aegypius monachus*, Red Headed Vulture *Sarcogyps calvus*) fall under the nationally endangered (EN) category, four species (Bearded Vulture *Gypaetus barbatus*, Himalayan Vulture *Gyps himalayensis,* Yellow-bellied Warbler *Abroscopus superscilliaris,* Black-chinned Yuhina *Yuhina nigrimenta*) fall under the nationally vulnerable (VU) category, two species (Great Cormorant *Phalacrocorax carbo*, Himalayan Monal *Lophophorus impejanus*) fall under the nationally near threatened (NT) category and all remaining 100 species fall under the nationally least concerned (LC) category (Table 3). Nepal hosts 42 globally threatened bird species and 172 of the birds in Nepal are nationally threatened (BCN & DNPWC, 2022). Among the recorded birds in the study, only the Red-headed Vulture *Sarcogyps calvus* was a globally critically endangered species. However, in Nepal, it is an endangered species with the primary threat of habitat loss, degradation, and fragmentation due to forest degradation, pesticides, and diclofenac use (Inskipp et al., 2016). Similarly, among the nine species protected by the law of Nepal (BCN & DNPWC, 2022), Himalayan Monal *Lophophorus impejanus* was the only species recorded in the study area. Though being the national bird, *L. impejanus* faces threats of habitat loss, degradation, and fragmentation and over-exploitation with increasing forest degradation, disturbance to its habitat, and hunting and poaching (Inskipp et al., 2016). Not only these threatened and protected bird species, but overall avian species around the world face a series of threats like habitat loss and degradation due to agricultural expansion and forest degradation, overexploitation, invasive species, and climate change (BirdLife International, 2022).

Table 3. National IUCN status and migration group of bird species

	National IUCN status				
Migration Status	**EN**	**LC**	**NT**	**VU**	**Grand Total**
Altitudinal	-	4	-	-	4
Resident	1	92	1	4	98
Summer	-	2	-	-	2
Winter	1	2	1	-	4
Grand Total	**2**	**100**	**2**	**4**	**108**

EN: Endangered, VU: Vulnerable, NT: Near Threatened, LC: Least Concern.

Threats to avifauna in GCA

Development of hydropower stations and other infrastructures

Two hydropower projects are under construction around GCA: the Rolwaling River Hydroelectric Project (22 MW) and the Lapchi River Hydroelectric Project (160 MW). Hydropower development though is a necessary step to meet the power demand of the country, on the other hand, poses a significant risk to birds and other biodiversity (Inskipp et al., 2016). Hydropower along with other associated development activities like dam construction, access roads, and transmission lines alter microclimate and result in habitat degradation and fragmentation threatening the existence of biodiversity (Alho, 2020; Inskipp et al., 2016). The transmission lines also pose the risk of electrocution and collision, especially for large birds and migratory birds (Hamal et al., 2023). Understanding the possible environmental adversities and impacts on birds and other biodiversity is important in biodiversity management and planning.

Habitat degradation

Lapchi Valley of the GCA area is also facing risk from the construction of roads in various places like Lamabagar, Yuluk, Thang-Chemo, and Thasing. Camps placed for road constructors for several months may affect the habitat of birds. Blasting occurs very frequently and various equipment like diesel generators, excavators, rollers, bulldozers, etc. are in continuous use which adds noise pollution thus disturbing avifauna. In addition, the camps are also the source of municipal waste (human excreta and food waste). Human excreta and food wastes are not managed scientifically which might also affect birds and other biodiversity. Though road constructions play an important role in increasing accessibility and connectivity between villages and even between countries, the impacts caused by them on biodiversity should be curbed. According to the local people, the government of Nepal also intends to build a road via the village of Lapchi to connect Nepal and China. Despite the need for these infrastructures, the construction of linear structures like roads highly degrades the habitat of birds and are bigger threats (BirdLife International, 2022; Inskipp et al., 2016), and the ineffective implementation of environmental impact assessment (EIA) of these roads (Inskipp et al., 2017) intensifies the possible risk of these linear structures to birds of Lapchi Valley.

Solid waste in settlement area

GCA has also been receiving international and domestic tourists in an increasing trend, most probably due to increased accessibility, development of infrastructures, and accommodation facilities like homestays. This has, though unintentional, increased solid waste generation in the Lamabagar area, along the trekking trails, resting places, villages, and Lapchi village. It is also likely that the wetland-dependent birds of Lapchi Valley might be affected (Dhakal et al., 2020; Inskipp et al., 2016) because of pollution caused by open drainage and garbage deposition which will ultimately pollute Lapchi River.

Likewise, about 67000 people are living inside the GCA (Gaurishankar Conservation Area, 2013; Chetri 2021) who are dependent on biodiversity and other resources creating anthropogenic pressure on the available resources of the conservation area. When resources are overexploited that becomes a major threat to birds (Inskipp et al., 2016). As discussed above, Kandel et al. (2018) also mentioned habitat loss and fragmentation, hunting and trapping, unsustainable extraction of natural resources, invasive alien species, unregulated tourism, and global climate change as the prominent threats to birds in Kanchenjunga landscape, an area that is similar to GCA. Hence, sufficient conservation awareness, impactful laws and policies, and habitat conservation measures need to be combined for bird conservation in the area.

Cultural efforts to protect avifauna and nature

Despite the threats prevalent in Lapchi Valley of the GCA, the culture and social norms of the people residing in the area contribute towards biodiversity, as well as bird conservation. GCA spreads across 2 municipalities and 8 rural municipalities of the three districts. Among them, *Bigu* Rural Municipality holds Lapchi Village which comprises 33 households (semi-nomadic pastoralists following traditional practices, rearing domestic yak as their livelihood, under a shifting grazing system). The people here belong to the Sherpa community and follow a unique culture called the *Beyul culture* of Nyingmapa Buddhism. The culture emphasizes the holiness of a landscape of sacred valleys (*Beyul*). Culture prohibits people from harming any living things. This unique culture/practice inspired by *Beyul culture* in GCA definitely might have helped in the protection of avifauna and other wildlife and their habitats of the region (Sacherer, 2011), the contribution of this research for the protection of living things including birds could be an avenue for further research.

Conclusions

Lapchi Valley of the Gaurishankar Conservation Area is one of the avifaunal-rich valleys. Though '*Beyul*' culture is still practiced in Lapchi Valley, the locals also report about the hunting of animals. Baits were observed in a few forests near human settlements is of concern. GCA is undergoing various changes due to the construction of roads and hydropower stations and its amenities. These may threaten avifauna and other biodiversity. On the brighter side, the road access might also help to make Lapchi Valley, a potential destination for birders, bird-based tourists, and researchers. In this scenario, there should be a fine balance between development and conservation to promote avifauna-focused ecotourism in GCA.

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Conflict of Interests: The authors declare no conflict of interest.

Data Availability Statement: The data of this study are available from the corresponding author, upon reasonable request.

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