

REVIEW

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Birds of the Kangchenjunga Landscape, the Eastern Himalaya: status, threats and implications for conservation

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Abstract

Birds are reliable and widely used indicators for conservation planning and monitoring. We reviewed birds of the Kangchenjunga Landscape, a transboundary complex shared by Bhutan, India and Nepal in the Eastern Himalaya. Using 119 literature, we analyzed the bird survey efforts in the landscape, their taxonomic representation, global threat status, distribution patterns, and habitat preferences. We also discussed the potential threats and conservation challenges and documented current conservation efforts and government policies. Most of the bird surveys are carried out in India followed by Nepal and Bhutan. A total of 618 bird species belonging to 19 orders and 77 families are recorded. Passeriformes is the dominant order that constitutes 62% of the total records listed from the landscape. Among the families, Muscicapidae is the most common and diversely represented family. There are 41 species of birds that are categorized as threatened under IUCN Red List. Of the total birds occurring in the landscape, the highest number of bird species (95%) was documented from India, followed by Nepal (55%) and Bhutan (34%). Of them, 24% of the species were found to occur in the tropical zone. Forested habitat is widely used by 63% of the total species followed by wetlands (16%). Despite promising policies and legal provisions, the landscape faces numerous challenges including habitat loss and fragmentation, hunting and trapping, unsustainable extraction of natural resources, invasive alien species, unregulated tourism and global climate change. We suggest protection and management of birds through strengthening Important Bird and Biodiversity Areas, reduction in forest encroachment and habitat destruction, conservation awareness programmes and comprehensive bird surveys with long term monitoring to assess the impact of environmental change as some of the approaches to conserve the rich avifaunal diversity of the landscape.

Keywords: Avifauna, Transboundary landscape, Nepal, India, Bhutan, Biodiversity, Conservation

Background

Birds have been widely considered as an important tool in biodiversity conservation planning and monitoring (Kremen 1992; Chettri et al. 2001; Bregman et al. 2014) and for identifying conservation actions. Birds and their diversity provide strong bio-indication signals (Vielliard 2000; Bhatt and Joshi 2011; Urfi 2011; Bregman et al. 2014), and stand as surrogates for the health of ecosystem and status of biodiversity overall (Chettri 2010; Pakkala et al. 2014; Pierson et al. 2015). Anthropogenic drivers

of change have fomented large-scale habitat destruction, fragmentation and degradation, necessitating an assessment of the impacts of such change on birds (Wiens 1995; Chettri et al. 2001; McLaughlin 2011; Bregman et al. 2014). Understanding diversity of bird communities in different habitats is essential to understand the community structure and niche relationships, as well to delineate the importance of regional or local landscapes for avian conservation (Kattan and Franco 2004; Chettri 2010; Singh et al. 2013).

The Eastern Himalaya is a meeting ground for the Indo-Malayan, Palaearctic, and Sino-Japanese biogeographical realms. The area is known for diverse ecological and altitudinal gradients (CEPF 2005, 2007) and provides habitat for rich diversity of flora and fauna, including birds of the

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Oriental region (Crosby 1996). The Eastern Himalaya has been identified as a Priority I Endemic Bird Area (Birdlife International 2001), supporting 22 restricted-range bird species of which 19 are endemic to the region (Stattersfield et al. 1998; Jathar and Rahmani 2006; Acharya and Vijayan 2010). The region also represents one of the largest concentrations of globally threatened birds in Asia (Acharya and Vijayan 2010).

The Kangchenjunga Landscape (KL) is a transboundary landscape shared by Bhutan, India and Nepal, and one of the biologically richest landscapes in the Eastern Himalaya (Yonzon 2000; Chettri et al. 2008; ICIMOD et al. 2017). Located in the Himalayas, one of the 36 Global Biodiversity Hotspots, the landscape is one of the richest in terms of biodiversity, including birds. With about 43% of the total geographical area of Nepal and 54% of Bhutan, the landscape is reported to have almost equal number of birds as Bhutan and two-thirds of Nepal. In addition, with 22 Important Bird and Biodiversity Areas (IBAs) and 19 protected areas (ICIMOD et al. 2017), the landscape has the highest number of protected areas for biodiversity conservation and it is identified as one of the priority areas for biodiversity conservation in the Himalayan region (CEPF 2005). It encompasses a part of eastern Nepal; Sikkim and a part of West Bengal in India and the western and southwestern parts of Bhutan

(Fig. 1). The KL, being designated through a consultative process (from 2012 to 2015) and endorsed by the governments of Bhutan, India and Nepal, includes an area over 25,000 km² that surrounds Mount Kangchenjunga, the third highest mountain in the world (ICIMOD et al. 2017). Shared area by country is presented in Table 1.

The KL is situated between 26°21′40.49″–28°7′51.25″N and 87°30′30.67″–90°24′31.18″E. The KL's altitudinal range extends from 50 m a.s.l. in the south to 8586 m a.s.l.—the height of Mount Kangchenjunga. Based on its extreme altitudinal variation, the vegetation in the KL ranges widely: tropical, subtropical, warm temperate, cool temperate, subalpine, and alpine zones (Chaudhary et al. 2015; Uprety et al. 2016; ICIMOD et al. 2017). The different vegetation zones of the KL support a wide diversity of flora and fauna. More than 5000 species of flowering plants including more than 500 varieties of orchid and 40 varieties of rhododendron are recorded from the region (Kandel et al. 2016). Of the 160 recorded mammal species, four are endemic to this region (Chettri et al. 2008).

The KL supports wide diversity of birds, many of them endemic to the region (Chettri et al. 2008). Of the 19 endemic bird species of the Eastern Himalaya, 10 are found in Sikkim (India) alone. The KL also represents a relatively high number of threatened bird species: Of the

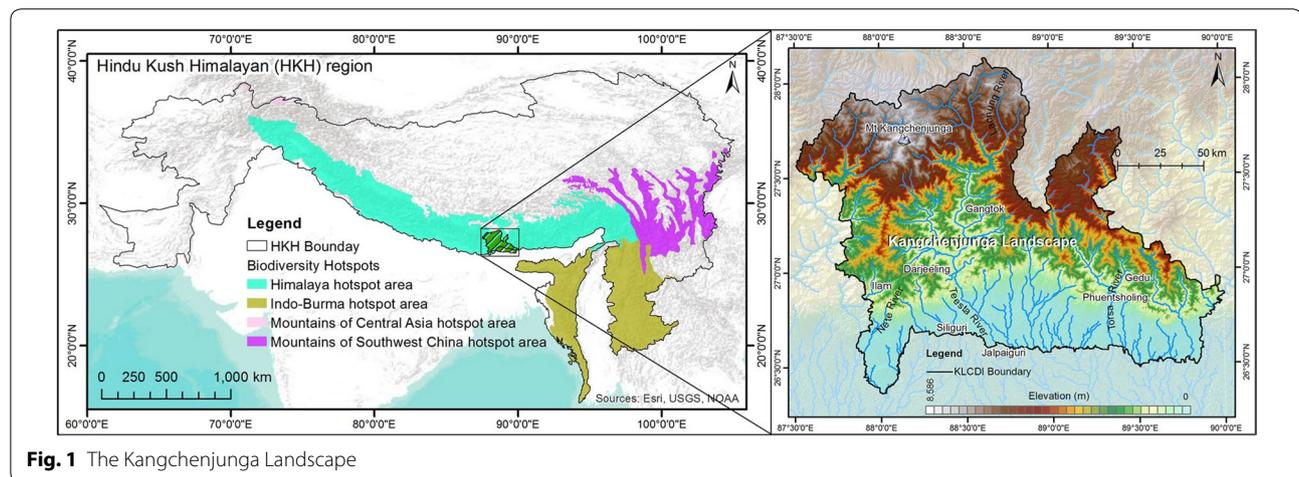


Fig. 1 The Kangchenjunga Landscape

Table 1 The Kangchenjunga Landscape area by country and percentage of total area

Country	Area (km ²)*	Percentage of total KL area* (%)	Total number of species	Number of threatened species
Bhutan	5834	23	210	4
India	14,062	56	585	39
Nepal	5190	21	342	15
Total	25,086	100		

*Source ICIMOD et al. (2017), other data from this study

78 threatened birds on the Indian Sub-continent, 17 (one endangered, three critically endangered and 13 vulnerable) occur in Sikkim (Acharya and Vijayan 2010). However, like many other landscapes worldwide, the KL is experiencing intense disturbances due to anthropogenic pressures such as logging, firewood collection, livestock grazing, development activities, and a growing tourism industry that may jeopardize its rich avifaunal diversity (Chettri et al. 2002, 2007a, b). These global changes also pose acute threats to biodiversity of the Himalayan landscape as they are rich in endemic species that have narrow and restricted ranges of distribution (Chettri 2010). Hence, documentation of bird communities, their patterns of distribution, habitat preferences, threats and conservation practices and policies are crucial for developing future conservation measures in the KL.

Documentation of bird communities in the KL dates back to 19th century and many preliminary accounts on birds from the region are extant (Bulger 1869; Blandford 1871, 1872; Gammie 1877; Brooks 1880; Ludlow and Kinnear 1937a, b; Mills 1944; Maclaren 1947, 1948; Sen 1948, 1957; Law 1953). However, despite these excellent volumes, information on birds in the KL are still limited and skewed in many respects. For instance, some areas including Sikkim and some protected areas (e.g., Kanchenjunga Conservation Area and Buxa Tiger Reserve) have been intensively catalogued while some protected areas (e.g., Mahananda Wildlife Sanctuary and Maenam Wildlife Sanctuary) lack even basic information such as species checklists. Furthermore, many literature in KL birds is not easily accessible as they are distributed among wide variety of sources. For example, unpublished student's theses held in libraries of universities and unpublished reports prepared by organizations working in the KL. For these reasons, we attempt to consolidate the knowledge on birds reported and documented from the KL, understand their distribution, identify conservation and management challenges, and note directions for future research.

Methods

We collected information using secondary sources run through a systematic review process. We reviewed published journals articles and books on the birds reported from the KL, and conducted several systematic web-based searches. Using 'Google Scholar', we searched literature using specific search terms including 'birds', 'avifauna', and 'Bhutan', 'Sikkim', 'Darjeeling', 'Jalpaiguri', 'India', 'Nepal' and 'Kangchenjunga Landscape'. Since the literature searches were done in 2017, we collected literature published till 2016. To account for publications that were not retrieved using these search terms, we searched literature using the name of protected areas found within

the landscape. We also conducted additional searches for technical reports, student theses, government publications, agency reports, websites and databases of ongoing projects, and synthesis papers or book chapters. For practicality, we included only English language literature. A total of 119 literature related to the birds of the KL were collected and considered for the review. To enlist the birds of the KL, we referred 23 literature whose references are given against each bird species in the database of the birds. The list of literature and the database of birds from the KL are provided as Additional files 1 and 2.

With the collated material, we prepared a database of bird species found in each country, noting each species by common name, Latin name, genus, species, order, family, distribution (by altitude in meters), habitat preferences, IUCN threat status, and country level protection. Oriental Bird Club codes as given by Inskipp et al. (1996) and reference of a literature for each species are also included in the database. The precision of our species identification is dependent on the clarity and presentation of the original sources. We verified nomenclature and conservation statuses from the International Union for the Conservation of Nature's (IUCN) online source (<http://www.iucnredlist.org/>) as well as in Inskipp et al. (1996). We used the altitudinal ranges and habitat preferences based on Grimmett et al. (1998). For some of the bird species that were not found in Grimmett et al. (1998), we searched in the IUCN's online source (<http://www.iucnredlist.org/>) to fill those gaps. For additional classification, we used five major altitudinal zones of the KL considering different zonation reported by Chaudhary et al. (2015), Uprety et al. (2016) and simplified to make distinct zones as also used by Ali (1962) namely (1) tropical (2) subtropical (3) temperate (4) subalpine and (5) alpine. To bring clarity, we combined warm temperate and cool temperate into one broad category as a temperate zone. Although it is difficult to confine altitudinal range of a bird due to its movement along large elevational gradient, we considered elevation range of individual species as reported in the literature for analysis. The habitat preference of each species has been sub-divided into eight categories: forest, wetland, scrub, cultivation, semi-desert, grassland, around habitation and open country (Grimmett et al. 1998). Finally, we analyzed the data to look into the patterns of distribution and identify habitat preferences of the general and threatened species.

Review

Sampling efforts

Our review resulted in 119 literature on birds of the KL. Of these, 92 are journal articles and rest are books, book chapters, government documents and institutional reports (Additional file 1). Majority of the bird studies

in the KL are from India (83%) followed by studies from Nepal (9%) and Bhutan (8%). In India, 43% of the studies are carried out in Sikkim alone, while 57% are carried out in North Bengal, including Darjeeling, Jalpaiguri and Alipurduar districts. In Nepal, majority of the studies (71%) are carried out in the Kanchenjunga Conservation Area. This indicate that the bird studies in the KL skew to several specific areas or protected areas such as Sikkim and the Kanchenjunga Conservation Area.

Of the 92 journal articles, 57% are checklists that have used observation as a methodology to enlist the bird species. Around 26% are focused on the ecological research of the specific bird species. Around 17% of the studies are systematic investigation on species richness that have used point count method.

Taxonomic coverage

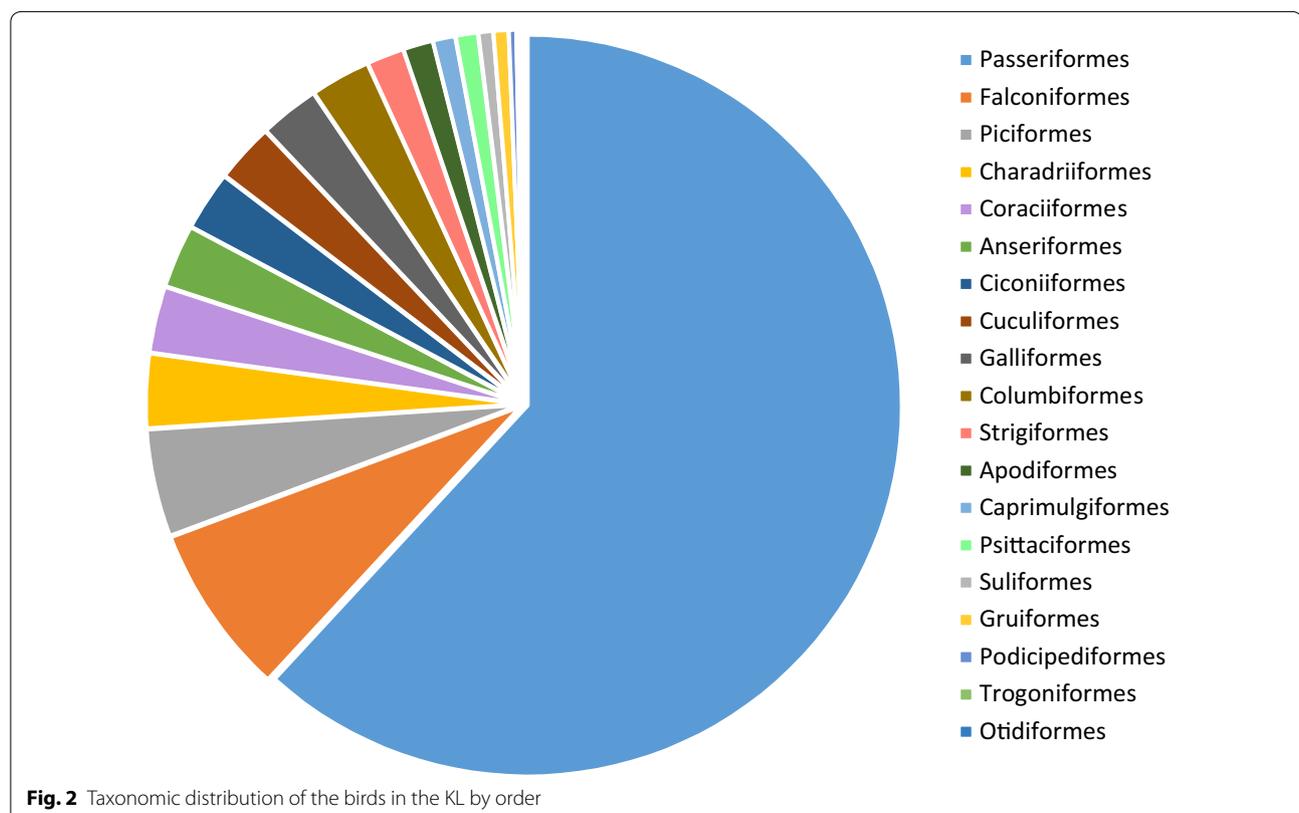
We collated a dataset of 618 bird species belonging to 19 orders and 77 families. This indicates that the KL is one of the richest areas in bird diversity in the Himalayan region. Passeriformes is the most dominant order, comprising 62% of the total records. Falconiformes is the second highest order, but only 8% of the total records. Figure 2 shows the taxonomic distribution of the dataset

by order. Supporting the local, regional and global trends, the landscape showed higher proportion of passerine birds as also revealed by Ali (1962), Inskipp et al. (1996) and Fjeldså et al. (2012).

Among families, Muscicapidae (26 genera and 71 species) emerges as the most diversely represented family, followed by Sylviidae (26 genera and 50 species), Accipitridae (19 genera and 36 species) and Fringillidae (11 genera and 30 species). Other species rich families include Corvidae (14 genera and 29 species), Timaliidae (11 genera and 26 species) and Picidae (14 genera and 23 species). The dataset includes 22 families representing only one genus and one species each (see Fig. 3 for those bird families with more than 10 species in the KL). Narwade et al. (2011) also found highest number of bird species from the family Muscicapidae in a study carried out in the birds of Northeast India.

Conservation status

Out of 618 bird species in the KL, the region harbors 41 species (7%) that are globally threatened and are categorized according to the terms used on the IUCN Red List. Among these 41, five species are “critically endangered”: Baer’s Pochard (*Aythya baeri*), Bengal Florican



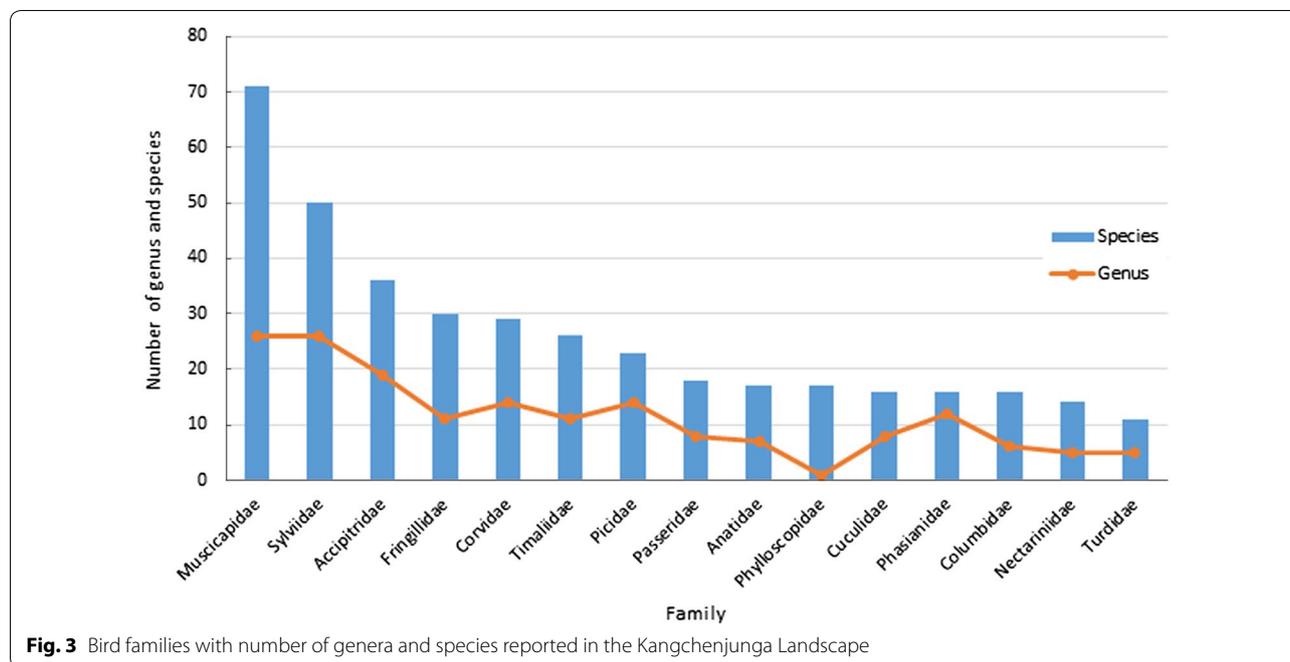


Fig. 3 Bird families with number of genera and species reported in the Kangchenjunga Landscape

Table 2 Threat status of birds of the Kangchenjunga Landscape

Threat status	Number of species	Percentage (%)
Critically endangered	5	0.81
Endangered	3	0.49
Vulnerable	19	3.07
Near threatened	14	2.27
Least concern	577	93.37

(*Houbaropsis bengalensis*), Red-headed Vulture (*Sarcogyps calvus*), Slender-billed Vulture (*Gyps tenuirostris*) and White-rumped Vulture (*Gyps bengalensis*). Three species are “endangered”: Lompobattang Flycatcher (*Ficedula bonthaina*), Saker Falcon (*Falco cherrug*) and Steppe Eagle (*Aquila nipalensis*). Nineteen species (0.81% of the total species listed) are considered ‘vulnerable.’ And fourteen (2.27%) are categorized as ‘near threatened.’ The remaining 577 species (93.37%) belong the category ‘least concern’ (Table 2).

The conservation policies of Bhutan, India, and Nepal, have provided protection to a number of bird species that reside in the KL. Among the nationally protected bird species of Bhutan, Common Raven (*Corvus corax*), Himalayan Monal (*Lophophorus impejanus*) and Rufous-necked Hornbill (*Aceros nipalensis*) are found in the landscape. There are 22 bird species in the KL that are protected by the government of India. Five species of birds, Satyr Tragopan (*Tragopan satyra*), Himalayan

Monal, Great Hornbill (*Buceros bicornis*), Bengal Florican, and Black Stork (*Ciconia nigra*), are found in the KL that are protected by the government of Nepal.

Distribution pattern

Distribution by country

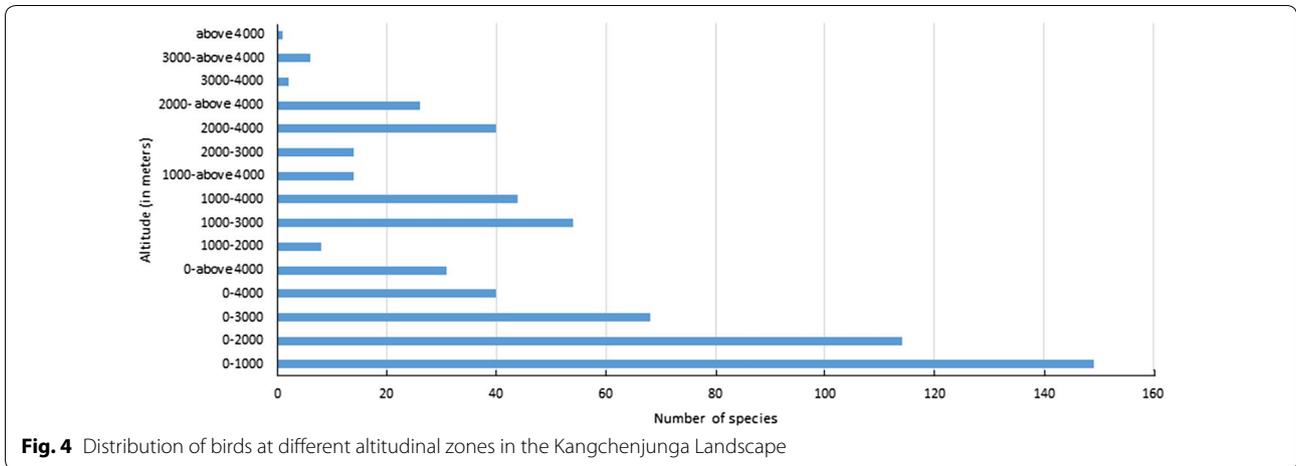
Of all the birds documented in the KL, 95% can be found in India, 55% in Nepal, and 34% in Bhutan. Similarly, of the total 41 threatened bird species present in the KL, 95% of these can be found in India, 37% in Nepal, and 10% in Bhutan (Table 1). The highest number of bird species in India followed by Nepal and Bhutan could be attributed to the largest part of the landscape area being covered by the KL-India (56.3%) followed by the KL-Nepal (23%) and the KL-Bhutan (21%).

Distribution along elevation

Most KL bird species (24%) can be found in the tropical zone below 1000 m a.s.l. (Fig. 4) and 19% are found in the altitudinal zones from tropical to subtropical (0–2000 m a.s.l.) (see Fig. 4 for a comprehensive representation of the birds in relation to elevation). The results are in line with the trend of having less species diversity as we move higher elevation as also revealed by Acharya et al. (2011), Chettri et al. (2001) and Chettri (2010).

Habitat preferences

Sixty-three percent of KL bird species inhabit forests, while 16% can be found in wetlands (Fig. 5). Approximately 11% of the species were found in scrub land and

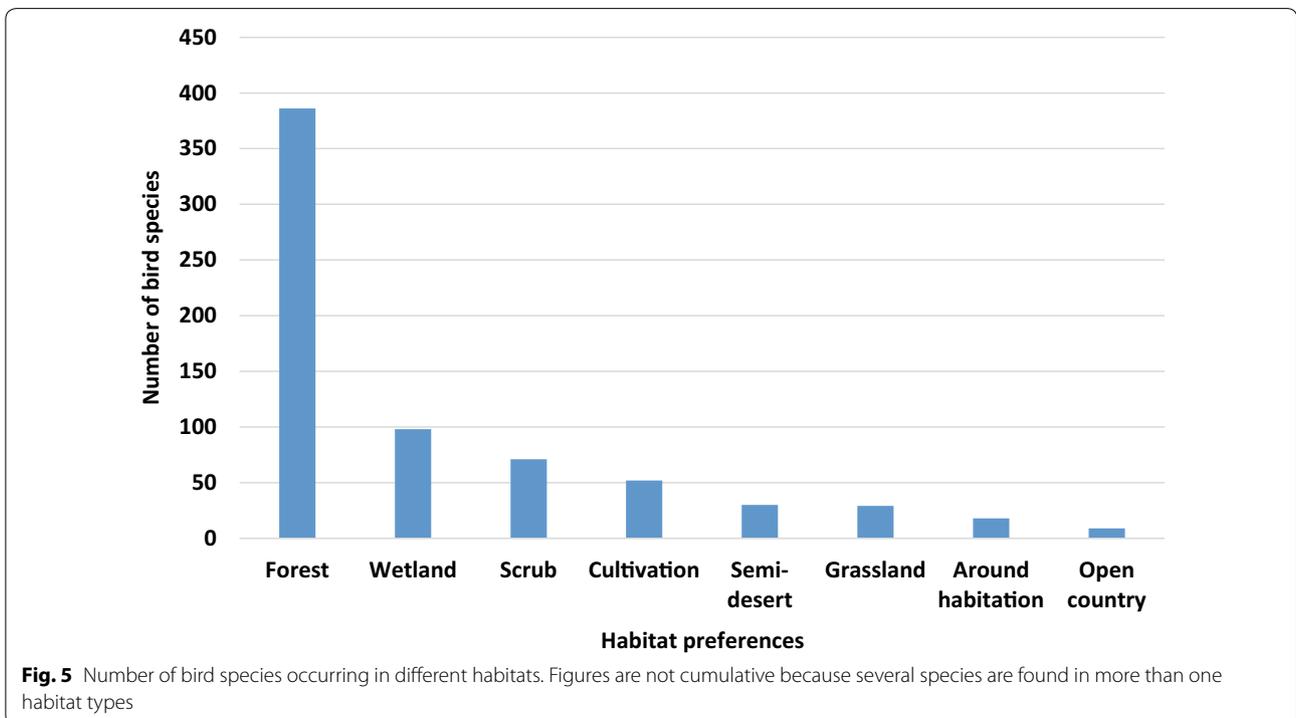


just 15 was found in open country. If we consider only threatened bird species, 34% inhabit forests and 34% inhabit wetlands, 12% live in grasslands. Three species each inhabit scrub land, open country, and around habitation areas.

Important Bird and Biodiversity Areas

There are 22 IBAs in the KL (see Table 4 and Fig. 6 for a detailed description of the IBAs). Among them, three are in Nepal, five in Bhutan, and 14 in India (Ganguli-Lachungpa et al. 2007; Chaudhary et al. 2015; Bird-life International 2016). These IBAs provide shelter to

a number of endemic bird species such as Chestnut-breasted Partridge (*Arborophila mandellii*), Rusty-bellied Shortwing (*Brachypteryx hyperythra*) and White-naped Yuhina (*Yuhina bakeri*), restricted range species like Hoary-throated Barwing (*Actinodura nipalensis*) and Ward’s Trogon (*Harpactes wardii*) that are endemic to the KL. These IBAs also provide either permanent or temporary habitats for a number of threatened bird species including the critically endangered and globally threatened species. Globally significant bird species that are present in the IBAs of the KL are given in Table 3.



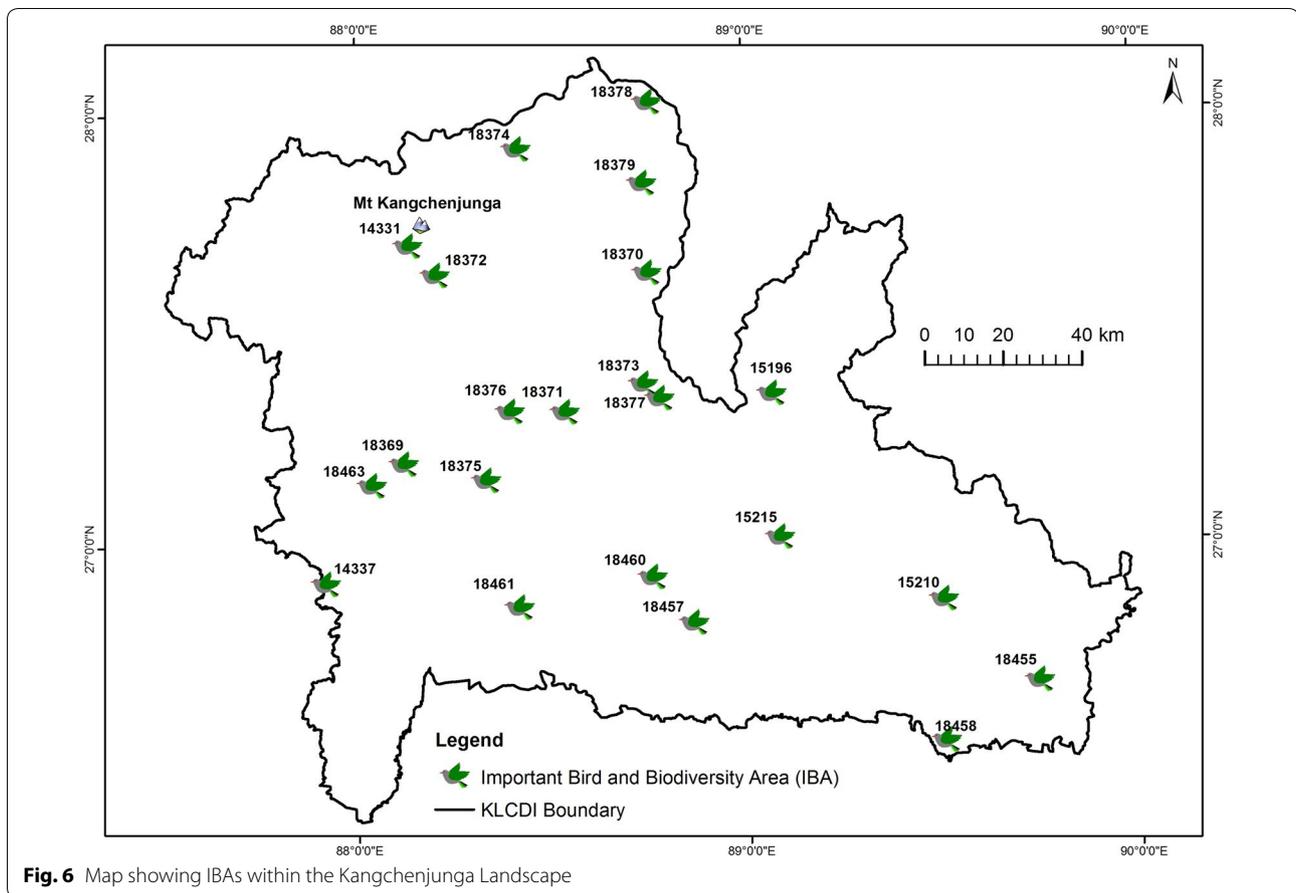


Fig. 6 Map showing IBAs within the Kangchenjunga Landscape

Threats and conservation challenges

Despite the global biological significance, the region faces numerous challenges for biodiversity conservation and sustainable development. While some of these issues are at the local and national levels, others occur at the transboundary level. Habitat loss and fragmentation pose major factors in the decline in population of threatened and endemic birds in the Himalaya and elsewhere (Crosby 1996; Chettri et al. 2001, 2005; Pandit et al. 2007). Various human activities common in the KL such as deforestation, forest encroachment for expansion of agricultural land and overgrazing affect the bird community structure in the landscape (Chettri et al. 2005). Many ethnic communities in the forested highlands of the KL continue to clear forested land and practice slash-and-burn agriculture (shifting cultivation), which drives habitat loss at higher altitudes, particularly in KL-Nepal where the practice is considered illegal (Inskipp et al. 2008; Aryal et al. 2010). Slash-and-burn agriculture with lesser annual cycle has a significant negative impact on bird diversity (Inskipp et al. 2008).

Hunting plays a significant role in the culture, tradition and subsistence economies of the people living in the KL

and is still commonly practiced in the region (Inskipp et al. 2008; Sathyakumar et al. 2010; Inskipp et al. 2013). It poses a serious threat to game birds (Galliformes), water birds, and large-bodied species such as hornbills (Keane et al. 2005; Velho et al. 2012). Hunting practices also imperil a number of threatened species, including Satyr Tragopan and Himalayan Monal. For instance, Himalayan Monal has been hunted in the Kanchenjunga Conservation Area for generations and in a survey conducted by Inskipp et al. (2008) only one individual species was located despite an extensive suitable habitat. Similarly, owls and pheasants are popular targets for hunters and trappers in some parts of the landscape (Sathyakumar et al. 2010; Inskipp et al. 2013).

The majority of local people in the KL relies upon natural resources for meeting their essential requirements for fuel, livestock fodder, timber, and other basic materials (Chettri and Sharma 2006). The unsustainable, and often illegal, harvest of these resources is another major concern in the KL. Unsustainable harvesting of resources in the forests has caused thinning of woodlands, and affects vegetation structure and composition, which in turn influences occupancy and resource use patterns of birds

Table 3 Important Bird and Biodiversity Areas in the Kangchenjunga Landscape

IBA*	Country	Protected area	Significant bird species
Jigme Khesar Strict Nature Reserve (BT002) (formerly known as Toorsa Strict Nature Reserve)	Bhutan	✓	Chestnut-breasted Partridge Wood Snipe Rufous-necked Hornbill
Samtse (BT003)	Bhutan		Rufous-necked Hornbill
Chele La (BT004)	Bhutan		Wood Snipe
Paro wetlands (BT005)	Bhutan		Wood Snipe
Kamji (BT007)	Bhutan		Rufous-necked Hornbill
Lava-Neora Valley National Park (IN322)	India	✓	Eastern-imperial Eagle Pale-capped Pigeon Rufous-necked Hornbill Black-breasted Parrotbill Beautiful Nuthatch
Mahananda Wildlife Sanctuary (IN323)	India	✓	White rumped Vulture Slender-billed Vulture Bengal Florican Swamp Francolin Lesser Adjutant Rufous-necked Hornbill Black-breasted Parrotbill
Singhalila National Park (IN325)	India	✓	Chestnut-breasted Partridge Greater-spotted Eagle Wood Snipe Beautiful Nuthatch
Barsey Rhododendron Sanctuary (IN327)	India	✓	Pallas's Fish-eagle Black-breasted Parrotbill
Dombang Valley-Lachung-Lema-Tsungthang (IN328)	India		Wood Snipe Beautiful Nuthatch
FambongLho Wildlife Sanctuary-Himalayan Zoological Park-Ratey Chu Reserve Forest (IN329)	India	✓	White rumped Vulture Slender-billed Vulture Chestnut-breasted Partridge Rufous-necked Hornbill Beautiful Nuthatch
Khangchendzonga National Park and Biosphere Reserve (IN330)	India	✓	Baer's pochard Pallas's Fish-eagle Black-breasted Parrotbill
Kyongnosla Alpine Sanctuary-Tsomgo-Tamze-Chola Complex (IN331)	India	✓	Greater-spotted Eagle Pallas's Fish-eagle Wood Snipe
Lhonak Valley (IN332)	India		Wood Snipe Black-necked Crane
Lowland forests of South Sikkim (IN333)	India		White rumped vulture Slender-billed Vulture Chestnut-breasted Partridge Rufous-necked Hornbill Grey-crowned Prinia Slender-billed Babbler Black-breasted Parrotbill Beautiful Nuthatch

Table 3 continued

IBA*	Country	Protected area	Significant bird species
Maenam Wildlife Sanctuary-Tendong Reserve Forest (IN334)	India	✓	Chestnut-breasted Partridge Blyth's Tragopan Greater-spotted Eagle Rufous-necked Hornbill Beautiful Nuthatch
Pangolakha Wildlife Sanctuary-Zuluk-Bedang Tso-Natula Complex (IN335)	India	✓	Chestnut-breasted Partridge Greater-spotted Eagle Pallas's Fish-eagle Wood Snipe Rufous-necked Hornbill Grey-crowned Prinia Slender-billed Babbler Black-breasted Parrotbill
Tso Lhamo Plateau-Lashar-Sebu La-Yumesandong Complex (IN336)	India		Greater-spotted Eagle Wood Snipe Black-necked Crane
Yumthang-Shingba Rhododendron Wildlife Sanctuary (IN337)	India	✓	Wood Snipe
Kangchenjunga Conservation Area (NP010)	Nepal	✓	Wood Snipe Spiny Babbler
Mai Valley Forests (NP015)	Nepal		White Rumped Vulture Slender-billed Vulture Red-headed Vulture Wood Snipe Greater-spotted Eagle Lesser Adjutant Spiny Babbler
Tamur Valley and Watershed (NP026)	Nepal		Spiny Babbler

*Numbers indicate IBA code numbers. The Latin names of all these species are in Additional file 2

(Chettri et al. 2005). Similarly, riverbed mining and the unsustainable extraction of sand, gravel and stones poses a serious threat to those bird species that breed in river areas (Acharya et al. 2010).

Some invasive and alien species, including Waterhyacinth (*Eichhornia crassipes*), Bittervine (*Mikania micrantha*), Lantana (*Lantana camara*) and Crofton Weed (*Ageratina adenophora*) have invaded tropical and subtropical ecosystems in the landscape and pose serious threats to the bird diversity of the KL (Baral 2002; Dahal 2007).

Unregulated tourism is another factor that poses immense pressure on local vegetation and birds of the Himalayan region, including the KL leading to increased fragmentation and deterioration of wildlife and their habitats (Chettri et al. 2001, 2002; Laiolo 2004).

Global climate change also poses strong negative impacts on avifaunal populations of tropical mountains, including Himalayas, leading to bird species changing their nesting and migratory patterns, changing breeding seasonality and shifting their distribution range to obtain

optimum food resources necessary for their survival (Ali 1962; Both et al. 2006; Acharya and Chettri 2012).

Current conservation efforts

The KL forms a part of the Eastern Himalaya which is identified as a part of the Himalayan biodiversity hotspot, one of 36 hotspots in the world (Conservation International 2017). The hotspot is home to the world's highest mountains including Mount Everest (highest) and Mount Kangchenjunga (third-highest), as well as important populations of numerous large birds and mammals including vultures, tigers, elephants, rhinos, and snow leopards. A rich variety of gene pools, species and ecosystems of global significance are found only in the region and most of them are under a high degree of threat (Mittermeier et al. 2004).

Because of these multiple challenges to bird life and habitats in the KL, several conservation efforts have been devised and launched to protect vulnerable populations and environment. There are 19 protected areas in the KL of which nine are transboundary in nature (see Kandel

Table 4 A summary of national policies, laws and international conventions of the countries that share the Kangchenjunga Landscape (in chronological order)

	Bhutan	India	Nepal
Some national policies	National Forest Policy 1974 Master plan for forest development 1990 Biodiversity Action plan 1994 National Environment Strategy ("The Middle Path") 1998 Biodiversity Action Plan 2002 Revision of Forest Policy draft 2010	Forest Policy 1952 National conservation Strategy and Policy Statement, India 1992 National Forest Policy 1998 National Wildlife Action Plan (2002–2016) National Action Plan on Climate Change 2008 National Biodiversity Strategy and Action Plan 2009	New Forest Policy 1978 National Conservation Strategy 1988 which is later revised as Nature Conservation National Strategic Framework for Sustainable development (2015–2030) Environment Policy and action Plan 1993 Tenth Plan (2002–2007) Nepal Biodiversity Strategy 2002 Sustainable Development Agenda for Nepal 2003 Nepal Biodiversity Strategy Implementation Plan 2006 National Bio-safety framework 2006 Three-year Interim Plan (2007–2010) National Agriculture Policy 2004 Rangeland Policy 2012 National Wetland Policy 2012 Vulture Conservation Action Plan (2009–2013) National Biodiversity Strategy and Action Plan (2014–2020)
Some national laws	Bhutan Forest Act 1969 Forest and Nature Conservation Act 1995 Environment Assessment Act 2002 Forest and Nature Conservation Rules Volumes I & II 2002 National Biodiversity Act 2003 Land Act of Bhutan 2007 National Environment Protection Act 2007	Indian Forest Act 1927 and its successive amendments 1980 Wildlife (Protection) Act 1972 (last amended in 2013) Environment Protection Act 1986 Panchayati Raj (Extension to Scheduled Areas) Act 1996 Biological Diversity Act 2002	Nepal Legal Code "the muliki ain" 1854 Nepal Forest Nationalization Act 1957 Nepal Forest Act 1962 its amendments 1968 Forest Act 1993 National Parks and Wildlife Conservation Act, Nepal 1972 and amendment 2002
International conventions	Ramsar Convention 1971 United Nations Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) 1975 Convention on Biological Diversity (CBD) 1992 United Nations Framework Convention on Climate Change (UNFCCC) 1992 United Nations Convention to Combat Desertification (UNCCD) 1994	Ramsar Convention 1971 UNESCO's Man and Biosphere Programme 1971 CITES 1975 Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1983 CBD 1992 UNFCCC 1992 UNCCD 1994	Ramsar convention 1971 CITES Bonn convention 1983 CBD 1992 UNFCCC 1992 UNCCD 1994 Kyoto Protocol to the UNFCCC
IBAs	23 (8 within protected area network)	465 (279 with in protected areas network and 16 are listed as Ramsar sites)	27 (13 within protected areas network)

et al. 2016 for details on the protected areas). These protected areas cover 30% of the total landscape area. All of these protected areas, except two, are located in KL-India—one in KL-Bhutan and one KL-Nepal. These protected areas provide habitat to many charismatic floral and faunal species, including more than 500 bird species (Chettri et al. 2008; Chaudhary et al. 2015).

There is one Ramsar site—the Mai Pokhari Ramsar in the KL which is located in Ilam district in the eastern Nepal. Given its global significance as an important waterfowl habitat, it was declared as a Ramsar Site (No. 1850) during the 10th Conference of Parties to the Ramsar Convention (COP10) at Changwon, the Republic of Korea, on 28 October 2008. Located in Mai Pokhari VDC of Ilam district at an altitude of 2100 m, it has a catchment area of 12 hectares (WWF 2007). Mai Pokhari is a major habitat and breeding ground for more than 300 species of birds and some indigenous fauna such as the Tree Frog (*Polypedates maculatus*) and Himalayan Newt (*Tylototriton verrucosus*) (Chaudhary et al. 2015).

Government policies

A comparison of government policies of Bhutan, India and Nepal reveal that all three countries have supportive policies for bird conservation in place. Bhutan's national policy stipulates that 60% of the country maintain forests, many of which are large areas of pristine Himalayan forests and alpine habitats. These forests support threatened species such as Blyth's Tragopan and Chestnut-breasted Partridge. The forests on the lower slopes of the Bhutan are particularly important, as low-altitude forests have been extensively cleared in Nepal and parts of northeast India. This makes Bhutan a stronghold for birds such as Rufous-necked Hornbill.

Similarly, the Government of India has an extensive body of constitutional provisions, laws and policies in place to protect biodiversity and their habitats. The Wildlife (Protection) Act 1972 (last amended in 2013) is an important statute that provides a powerful legal framework for protecting and managing wildlife habitats, and regulating and controlling trade in products derived from protected areas. In Nepal, the National Parks and Wildlife Conservation Act, 1973 (last amended in 1991) is the primary legislation that forms the basis for Nepal's biodiversity conservation programme. In Table 4, we provide a more comprehensive list and description of other government legislation and policies that support conservation of wildlife and their habitats in the KL.

Conclusions

In this paper, we reviewed birds of the KL using 119 literature, and made a comprehensive documentation on species lists by taxonomy, threat status, distribution patterns

at country levels, altitudinal zones and habitat preferences along with a list of IBAs. We found 618 bird species belonging to 19 orders, 77 families, and 41 species are identified as globally threatened species under IUCN red list status. We found the majority of bird species occupying the tropical zones and in forested areas.

Despite the immense biological significance and continuous efforts of KL countries to conserve the rich biodiversity of the landscape, the region still faces numerous local, national, and transboundary challenges. Major constraints to long-term conservation in the region include habitat loss and fragmentation, hunting and trapping, unsustainable extraction of natural resources, invasive alien weeds, unregulated tourism, and global climate change. Protection and suitable management of IBAs could safeguard the survival of many threatened bird species in the landscape. Considering the cultural traditions for hunting and the low awareness level about wildlife conservation that prevail in the KL, conservation awareness programmes among students and community groups, as well as systematic and comprehensive bird surveys, particularly in the less explored areas of the KL that are identified as most intact and extensive habitat, are recommended. Long-term monitoring and assessment considering various drivers of change including climate change and their impacts on bird species could also fill existing knowledge gaps regarding Himalayan birds.

Additional files

Additional file 1. List of references.

Additional file 2. Bird database.

Authors' contributions

All authors contributed to developing the ideas and writing the manuscript. All authors have read and approved the final version of the manuscript.

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Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

All data generated or analysed during this study are included in this article as supplementary information files.

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