Check List the journal of biodiversity data

LISTS OF SPECIES

Check List 12(2): 1874, 17 April 2016 doi: http://dx.doi.org/10.15560/12.2.1874
ISSN 1809-127X

Bird diversity of the Amrutganga Valley, Kedarnath, Uttarakhand, India with an emphasis on the elevational distribution of species

Soham Dixit[1*], **Viral Joshi**[2] and **Sahas Barve**[3]

1 Rheinische Friedrich Wilhelms-Universität Bonn, Institut für Evolutionsbiologie und Ökologie , An der Immenburg 1, Bonn, Germany 53121
2 Bombay Natural History Society, Hornbill House, Dr. Salim Ali Chowk, Shahid BhagatSingh Road, Mumbai, Maharashtra, India 400001
3 Department of Ecology and Evolutionary Biology, Cornell University, Ithaca, NY, USA 14850
* Corresponding author. E-mail: sohamsanjaydixit@gmail.com

Abstract: A unique aspect of montane birds is the elevational stratification they show in their distribution, but in the Himalayas, a subset of the species show elevational migration, making bird communities on these mountains especially dynamic. Thus, understanding the elevational distribution and movement of species across seasons is important to fully understand broad-scale community patterns. In this study, we compile a comprehensive checklist of birds along a 2,300 m Himalayan elevational gradient in the Amrutganga Valley, Kedarnath Wildlife Division, Uttarakhand, India. We recorded 244 species including 34 species new for the area and two new species for the state. Most importantly, we describe the elevational distribution of more than a 200 species and the dates of first sighting for several summer migrants in the season. We also studied changes in species richness and turnover at multiple elevations across seasons. We hope that this study provides a baseline for future research on elevational distribution of birds in the Western Himalayas.

Key words: Western Himalayas; Avifauna; Kedarnath; elevational migration; elevational distribution

INTRODUCTION

Tropical and subtropical mountains around the world are home to a disproportionately high number of species compared to other regions (Freeman et al. 2014). Along the elevational gradient, several environmental conditions such as temperature, moisture and oxygen partial pressure change vary from low valleys to mountain summits. These changes lead to restriction of habitats, and the species inhabiting them, to specific elevations. This turnover in species and habitats results in mountains having higher diversity than other habitats of equivalent area (Graham et al. 2014). Due to the high species richness and turnover, montane regions are a significant conservation priority especially with the imminent threat of climate change (Sekercioglu et al. 2008).

Birds inhabiting mountains show a large variety of distributional patterns. While some species are elevationally restricted to narrow elevational bands, others are relatively broadly distributed. Some hardy species eke out a living in cold high elevations year round (Price et al. 2011). Others migrate short distances from high elevations, where they breed, to warmer lower elevations where they spend the winters. In most high mountains of the world, a few species of long-distance latitudinal migrants take advantage of the food rich, mild summers of the high elevations for breeding and spend the winters at warmer latitudes (McCain and Christy 2009).

The Himalayas are the highest mountains in the world. They are juxtaposed between the high Tibetan plateau and the warm floodplains of the Ganges and Bramhaputra rivers and are a hotspot of bird diversity (Price et al. 2011). In the Western Himalayas, mid- and high-elevation habitats experience high species turnover between winters and summers (Somveille et al. 2013). Here, in addition to many year-round residents, several Tibetan plateau and other high-elevation migrants move below the snowline in the winter. As these species leave in the summer for higher elevations, summer migrants from the foothills and peninsular India invade the mountains to breed alongside the residents. This lends a unique, dynamic nature to the avian community of this region.

Like most montane systems, natural habitats in the Western Himalayas are threatened with a host of anthropogenic pressures, from local habitat conversions for agriculture to global climate change that is predicted to have extreme affect on the Himalayan environment (Pandit et al. 2013). These threats warrant a detailed description of natural communities along the whole elevational gradient, which may serve to guide local

conservation policy and form a baseline dataset to quantify the effects of climate change at a global level.

In this study we document the avifauna of the Amrutganga Valley of the Kedarnath region, India. We inventory bird species occurring in the region during both winter and summer. We also describe elevational distribution and elevational migration for several species and report dates of first sightings of several migratory species at different seasons and various elevations. We discuss other published checklists for the region and comment on significant species additions and absences in our survey. Finally, our study is the first published multi-year study of the temporal and elevational distribution of bird species in the Amrutganga Valley of Kedarnath.

MATERIALS AND METHODS

Study area

Data were collected in the Amrutganga Valley (Mandal) of Kedarnath Wildlife Division (Figure 1). The elevational gradient between 1,500 m and 3,800 m above sea level (a.s.l.) was sampled, which correspond to the lowest and highest elevations, respectively, in the valley. The tree line in the area is between 3,100 m and 3,400 m, depending on the aspect of the slope, with negligible study area permanently under snow. However, large areas (over 2,300 m) experience regular snowfall in the winter, which severely restricted sampling in winter. Natural habitats up to 2,200 m are dominated by Banjh Oak (*Quercus leucotrichophora*) forest. Higher elevations are dominated by Moru Oak (*Quercus floribunda*) and Kharsu Oak (*Quercus semicarpifolia*). Alpine meadows cover most of the areas above 3,200 m.

Data collection and analysis

Bird checklists were meticulously maintained for five locations: Siroli (1,500 m a.s.l.), Khikhan (1,700 m a.s.l.), Ansuya (2,100 m a.s.l.), Kanchala (2,600 m a.s.l.) and Chopta (2,800 m a.s.l.). An exhaustive bird lists was made during monthly visits (and additional visits) at each of these locations between May and June 2012 and 2013 and January to June 2014 and 2015. Checklists for other areas, especially areas above 2,800 m a.s.l. were made during opportunistic visits. Both vocalizations and direct sightings were used for bird identification. Our list was compared with other collated checklists such as Singh (2003) and Mohan and Sondhi (2015). Dates of the first sighting of a species at a location were recorded for summer migrants. We used 15 March as the transition date between winter and summer because at elevations up to 2,000 m, several passerine species sing to establish territories around this date. Based on our inventories, we calculated the species richness at various sampled locations in all seasons. We also calculated species turnover across seasons at elevations. For species' identifications, we consulted Grimmett et al. (2011).

RESULTS

Due to its largely intact natural habitats, the Amrutganga Valley boasts an amazing species richness within the small area surveyed (ca. 40 km^2). A total of 244 species were recorded, which represents more than one-third of the approximately 700 species that have been recorded from Uttarakhand state (Mohan and Sondhi 2003). Patterns in bird species richness varied greatly across seasons. In winter, species richness decreased precipitously with elevation (Figure 2). Although species richness was consistently highest in the lowest elevations, in the summer the high elevations also showed relatively high richness (Figure 2). There was also a large amount of species turnover at each location between seasons that demonstrates substantial elevational and seasonal migration (Figure 3). This was

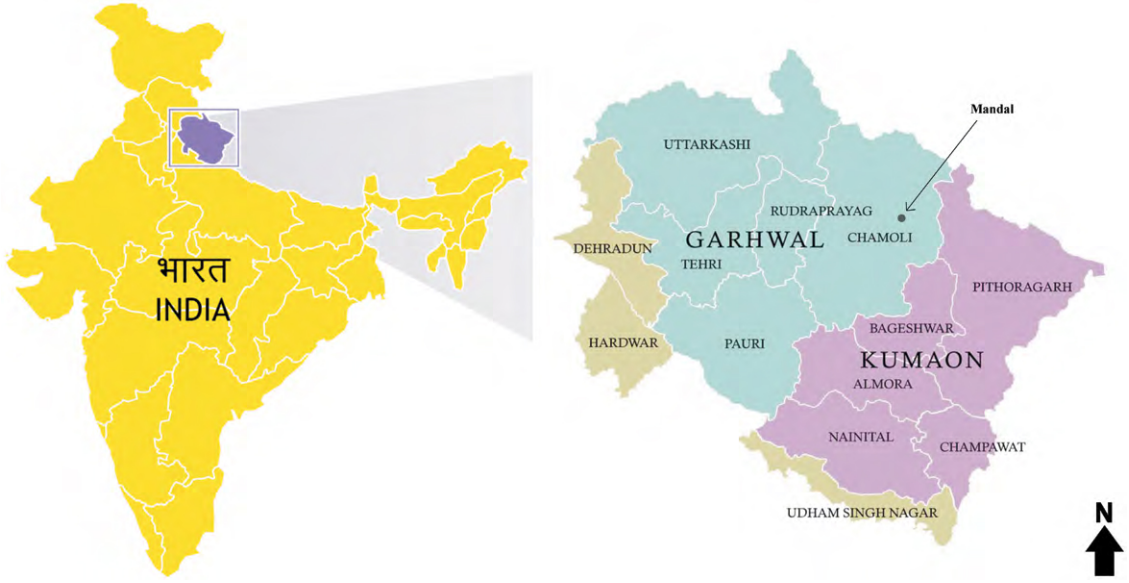

Figure 1. Map showing location of study area.

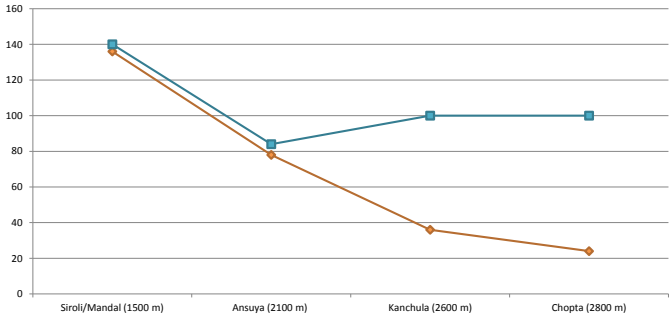

Figure 2. Species richness along the elevational gradient in summer (blue) and winter (orange). Pattern of species richness along the elevational gradient is drastically different across seasons.

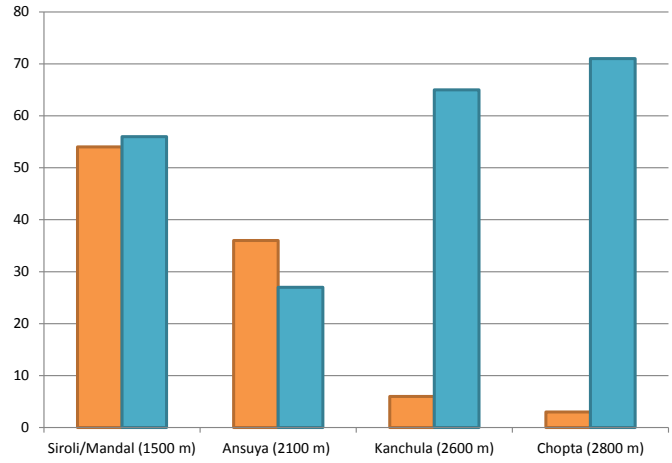

Figure 3. Species turnover at sampled elevations in summer (blue) and winter (orange). Lower elevations have similar turnover across seasons. High elevations have several summer migrants but very few winter migrants.

most notable at the highest elevations. Although few species were recorded at high elevations in winter, high-elevaton locations receive a large number of migrants in summer that results in significant differences in species' richness between seasons. We recorded a number of ornithologically interesting species. We briefly describe some of these below.

Horned Lark (*Eremophila alpestris*) (Figure 5B), two males, were recorded on the 10th of February 2015, and was the first record of this species for the state of Uttarakhand. They were seen foraging in the fallow fields. The closest sighting of this species is in the Tibet-Mansarovar area and in Pin-valley National Park in Himachal Pradesh (Shenoy 2014).

Merlin (*Falco columbarius*) was seen near Chopta and is also a first record from Uttarakhand. The closest record is from Spiti, Himachal Pradesh (Suryawanshi 2014). Unfortunately, we were unable to photograph the bird that was sighted at 2,700 m in *Rhododendron* forest.

Mallards (*Anas platyrhynchos*): Two males and one female of this species were spotted on 4 February 2015 in the Amrut Ganga River, which flows through Mandal Valley. The birdswere seen for about one week and generally near water.

Himalayan Wood Owl (*Strix nivicola*): The distribution of this species, recently split from the Tawny Owl (*Strix alco*), is poorly known in the Western Himalayas. One individual, seen perching on tree branches overhanging a river, was seen and heard on 19 March 2015 in Mandal.

Eurasian Woodcock (*Scolopax rusticola*) (Figure 4D) is known to breed in the study area, and on 23 January 2014, in a village drain in Ansuya (2,100 m a.s.l.) we recorded the first record of this bird wintering in the study area. The constant organic waste generated by the village might have been sustaining this bird through the cold winter.(Barve 2014)

Scarlet Finches (*Haematospiza sipahi*) (Figure 5F), Red-headed Bullfinches (*Pyrrhula erythrocephala*) (Figure 5D), European Goldfinches (*Carduelis carduelis*), Red-fronted Serin (*Serinus pusillus*) (Figure 5C) and Altai Accentors (*Prunella himalayana*) were seen at high elevations in Mandal during extreme weather events. Extreme weather of short duration are common but understudied in the Himalayas.

During their return migrations, many members of the family Sylviidae, such as Greenish Warblers (*Phylloscopus trochiloides*), Green Warblers (*Phylloscopus nitidus*), Blyth's Reed Warbler (*Acrocephalus dumetorum*), were seen in large numbers for a short period between the second and third weeks of March in Mandal and around mid-April in Kanchula. The area of the Kedarnath Wildlife Sanctuary is also on the migration route of several other species such as the Southern Grey Shrike (*Lanius meridionalis*) (Figure 4B), Hen Harrier (*Circus cyaneus*), Black Stork (*Cico nianigra*) and Eurassion Wryneck (*Jynx torquilla*).

In 2003, an annotated checklist for this area was compiled by Arun Singh, in which was recorded 251 species (Singh 2003). This annotated checklist was created using data from seven older checklists made between 1986 and 2003. Twenty-seven species that were in the older checklist were not seen during our study, and 34 new species were added, out of which two are an addition to the state bird list, namely the Horned Lark (*Eremophila alpestris*) and Merlin (*Falco columbarius*). A few species such as the Greater Yellownape (*Chrysophlegma flavinucha*), Himalayan Buzzard (*Buteo burmanicus*) (Figure 4F), Jungle Babbler (*Turdoides striata*) that were frequently saw during our survey, were not recorded in any of the earlier lists.

We provide a complete checklist of bird species seen during our survey, along with dates, locations, and season of the first sighting, of the calendar year, of a few important bird species (Table 1).

Figure 4. Photographic records of some species of Amrutganga Valley, Uttarakhand. **A**: Himalayan Monal (Aditya Chavan photo), **B**: Southern Grey Shrike (Sahas Barve photo), **C**: Red-fronted Rosefinch (Sahas Barve photo), **D**: Eurassion Woodcock (Sahas Barve photo), **E**: Snow Partridge (Pratik Joshi photo) and **F**: Himalayan Buzzard (Soham Dixit photo).

Figure 5. Photographic records of some species of Amrutganga Valley, Uttarakhand. **A**: Yellow-rumped Honeyguide, **B**: Horned Lark, **C**: Red-fronted Serin, **D**: Red-headed Bullfinch, **E**: Golden Bush Robin and **F**: Scarlet Finch. All photos by Soham Dixit.

Table 1. A complete list of species recorded during the study. First sighting dates for specific elevations are included for important elevational and latitudinal migrants. Elevational distribution for species regularly seen in the study area : * All Seasons, # Summer, $ Winter, α Passage migrant, and β Vagrant.

Common Name	Scientific Name	Siroli/Mandal 1500 m	Khikan 1700 m	Ansuya 2100 m	Kanchala 2600 m	Chopta 2800 m
Snow Partridge	*Lerwa lerwa* (Hodgson, 1833)				*	*
Black Francolin	*Francolinus francolinus* (Linnaeus, 1766)	#	#			
Hill Partridge	*Arborophila torqueola* (Valenciennes, 1825)					*
Rufous-throated Partridge	*Arborophila rufogularis* (Blyth, 1849)	$	$	$		
Koklass Pheasant	*Pucrasia macrolopha* (Lesson, 1829)			*	*	*
Himalayan Monal	*Lophophorus impejanus* (Latham, 1790)				*	*
Kalij Pheasant	*Lophura leucomelanos* (Latham, 1790)	*	*	*	*	
Mallard	*Anas platyrhynchos* (Linnaeus, 1758)	β	β			
Black Stork	*Ciconia nigra* (Linnaeus, 1758)					β
Oriental Honey Buzzard	*Pernis ptilorhynchus* (Temminck, 1821)					#
Black-eared Kite	*Milvus migrans lineatus* (Boddaert, 1783)	*				
Bearded Vulture	*Gypaetus barbatus* (Linnaeus, 1758)				*	*
Himalayan Vulture	*Gyps himalayensis* (Hume, 1869)	*	*	*	*	*
Griffon Vulture	*Gyps fulvus* (Hablizl, 1783)	$	$	$		
Crested Serpent Eagle	*Spilornis cheela* (Gmelin, 1788)	$		#	#	#
Shikra	*Accipiter badius* (Gmelin 1788)	*	*	*	*	*
Eurasian Sparrowhawk	*Accipiter nisus* (Linnaeus, 1758)	$	$	$	*	*
Northern Goshawk	*Accipiter gentilis* (Linnaeus, 1758)	$			$	$
Himalayan Buzzard	*Buteo burmanicus* (Hume, 1875)	$				#
Long-legged Buzzard	*Buteo rufinus* (Cretzschmar, 1829)	$				
Black Eagle	*Ictinaetus malayensis* (Temminck, 1822)	*	#	#	*	*
Golden Eagle	*Aquila chrysaetos* (Linnaeus, 1758)			#	*	*
Bonelli's Eagle	*Aquila fasciata* (Vieillot, 1822)					
Changeable Hawk-Eagle	*Nisaetus limnaetus* (Gmelin 1788)		$			
Mountain Hawk-Eagle	*Nisaetus nipalensis* (Hodgson, 1836)	*	*	*	#	
Common Kestrel	*Falco tinnunculus* (Linnaeus, 1758)	*	#			
Merlin	*Falco columbarius* (Linnaeus, 1758)					
Oriental Hobby	*Falco severus* (Horsfield, 1821)	# 27-03			# 12-04	
Peregrine Falcon	*Falco peregrinus* (Temminck, 1829)	*	*			
Hen Harrier	*Circus cyaneus* (Linnaeus, 1766)	#				α
Eurasian Woodcock	*Scolopax rusticola* (Linnaeus, 1758)			$ 23-01	# 09-04	# 25-04
Common Pigeon	*Columba livia* (Gmelin, 1789)	*				
Snow Pigeon	*Columba leuconota* (Vigors, 1831)	$	$		#	#
Speckled Wood Pigeon	*Columba hodgsonii* (Vigors, 1832)	*	*		#	#
Ashy Wood Pigeon	*Columba pulchricollis* (Blyth, 1846)			$		
Oriental Turtle Dove	*Streptopelia orientalis* (Latham, 1790)	*		#	#	
Eurasian Collared Dove	*Streptopelia decaocto* (Frivaldszky, 1838)	#				
Red Turtle Dove	*Streptopelia tranquebarica* (Hermann, 1804)	#				
Spotted Dove	*Stigmatopelia chinensis* (Scopoli, 1786)	*				
Common Emerald Dove	*Chalcophaps indica* (Linnaeus, 1758)	#				
Wedge-tailed Green Pigeon	*Treron sphenurus* (Vigors, 1832)	#	#	#		
Rose-ringed Parakeet	*Psittacula krameri* (Scopoli, 1769)	#				
Slaty-headed Parakeet	*Psittacula himalayana* (Lesson, 1832)	*	*			
Plum-headed Parakeet	*Psittacula cyanocephala* (Linnaeus, 1766)	#	#			
Large Hawk-Cuckoo	*Hierococcyx sparverioides* (Vigors, 1831)	# 07-04		# 31-03	# 09-04	# 21-04
Indian cuckoo	*Cuculus micropterus* (Gould, 1837)	# 12-04		# 17-04	# 21-04	
Lesser Cuckoo	*Cuculus poliocephalus* (Latham, 1790)					# 25-04
Eurasian Cuckoo	*Cuculus canorus* (Linnaeus, 1758)	# 07-04		# 31-03	# 09-04	# 25-04
Himalayan Cuckoo	*Cuculus saturatus* (Blyth, 1843)	# 07-05		# 13-04	#09-04	
Grey-Bellied Cuckoo	*Cacomantis passerinus* (Vahl, 1797)	# 21-03				
Mountain Scops Owl	*Otus spilocephalus* (Blyth, 1846)	*	*	*	*	*
Spot-bellied Eagle-Owl	*Bubo nipalensis* (Hodgson, 1836)	*		*		
Tawny Fish Owl	*Ketupa flavipes* (Hodgson, 1836)	*				
Himalayan Wood Owl	*Strix nivicolum* (Blyth, 1845)	#				
Collared Owlet	*Glaucidium brodiei* (Burton, 1836)	*	*	*	*	*
Asian Barred Owlet	*Glaucidium cuculoides* (Vigors, 1831)	*	*	*		
Grey Nightjar	*Caprimulgus jotaka* (Temminck & Schlegel, 1845)	#		#	#	#
White-throated Needletail	*Hirundapus caudacutus* (Latham, 1802)	$		#	#	
Fork-tailed Swift	*Apus pacificus* (Latham, 1802)			#		

Continued

Table 1. *Continued.*

Common Name	Scientific Name	Siroli/Mandal 1500 m	Khikan 1700 m	Ansuya 2100 m	Kanchala 2600 m	Chopta 2800 m
House Swift	*Apus nipalensis* (Hodgson, 1836)	#				
White-throated Kingfisher	*Halcyon smyrnensis* (Linnaeus, 1758)	*				
Common Kingfisher	*Alcedo atthis* (Linnaeus, 1758)	#				
Crested Kingfisher	*Megaceryle lugubris* (Temminck, 1834)	*				
Eurasian Hoopoe	*Upupa epops* (Linnaeus, 1758)	#				
Great Barbet	*Megalaima virens* (Boddaert, 1783)	*	*	*	*	*
Blue-throated Barbet	*Megalaima asiatica* (Latham, 1790)	*	*			
Yellow-rumped Honeyguide	*Indicator xanthonotus* (Blyth, 1842)	*		*		
Eurasian Wryneck	*Jynx torquilla* (Linnaeus, 1758)			#		
Speckled Piculet	*Picumnus innominatus* (Burton, 1836)	*				
Rufous-bellied Woodpecker	*Dendrocopos hyperythrus* (Vigors, 1831)	*	*	*	*	
Fulvous-breasted Woodpecker	*Dendrocopos macei* (Vieillot, 1818)	$				
Brown-fronted Woodpecker	*Dendrocopos auriceps* (Vigors, 1831)	*	*	*	*	
Himalayan Woodpecker	*Dendrocopos himalayensis* (Jardine & Selby, 1835)	*	*	*		
Greater Yellownape	*Chrysophlegma flavinucha* (Gould, 1834)		#			
Lesser Yellownape	*Picus chlorolophus* (Vieillot, 1818)		#	#		
Scaly-bellied Woodpecker	*Picus squamatus* (Vigors, 1831)		*	*	*	*
Grey-headed Woodpecker	*Picus canus* (Gmelin 1788)	*	*	*	*	
Bar-winged Flycatcher-shrike	*Hemipus picatus* (Sykes, 1832)	$	$	$		
Black-winged Cuckooshrike	*Coracina melaschistos* (Hodgson, 1836)	#		#	#	
Long-tailed Minivet	*Pericrocotus ethologus* (Bangs & Phillips, 1914)	*	*	$	*	#
Long-tailed Shrike	*Lanius schach* (Linnaeus, 1758)	*				
Southern Grey Shrike	*Lanius meridionalis* (Temminck, 1820)			$		
Indian Golden Oriole	*Oriolus kundoo* (Linnaeus, 1758)	#				
Black-hooded Oriole	*Oriolus xanthornus* (Linnaeus, 1758)	#				
Maroon Oriole	*Oriolus traillii* (Vigors, 1832)	*		*		
Ashy Drongo	*Dicrurus leucophaeus* (Vieillot, 1817)	$ 12-03		# 16-04	# 09-04	# 25-04
Lesser Racket-tailed Drongo	*Dicrurus remifer* (Temminck, 1823)	#				
White-throated Fantail	*Rhipidura albicollis* (Vieillot, 1818)	*				
Asian Paradise Flycatcher	*Terpsiphone paradisi* (Linnaeus, 1758)	#				
Eurasian Jay	*Garrulus glandarius* (Linnaeus, 1758)	*	*	*	#	
Black-headed Jay	*Garrulus lanceolatus* (Vigors, 1831)	*	*	*	#	
Yellow-billed Blue Magpie	*Urocissa flavirostris* (Blyth, 1846)	*	*	*	#	
Red-billed Blue Magpie	*Urocissa erythroryncha* (Boddaert, 1783)	*	*	*	#	
Grey Treepie	*Dendrocitta formosae* (Swinhoe, 1863)	*				
Red-billed Chough	*Pyrrhocorax pyrrhocorax* (Linnaeus, 1758)				*	*
Large-billed Crow	*Corvus macrorhynchos* (Wagler, 1827)	*	*	*	*	*
Yellow-bellied Fantail	*Chelidorhynx hypoxantha* (Blyth, 1843)	$	$	$	#	#
Grey-headed Canary-flycatcher	*Culicicapa ceylonensis* (Swainson, 1820)	$ 10-03	#	#	#	#
Rufous-vented Tit	*Periparus rubidiventris* (Blyth, 1847)				*	*
Coal Tit	*Periparus ater* (Linnaeus, 1758)			$	*	*
Grey Crested Tit	*Lophophanes dichrous* (Blyth, 1845)				*	*
Great Tit	*Parus cinereus* (Vieillot, 1818)	*				
Green-backed Tit	*Parus monticolus* (Vigors, 1831)	*	*	*	*	*
Himalayan Black-lored Tit	*Parus xanthogenys* (Vigors, 1831)	*	*	#		
Yellow-browed Tit	*Sylviparus modestus* (Burton, 1836)	*	*	*	*	#
Fire-capped Tit	*Cephalopyrus flammiceps* (Burton, 1836)				#	#
Black-throated Tit	*Aegithalos concinnus* (Gould, 1855)	*	*	*	#	
White-throated Tit	*Aegithalos niveogularis* (Gould, 1855)					*
Wire-tailed Swallow	*Hirundo smithii* (Leach, 1818)	#	#			
Nepal House Martin	*Delichon nipalense* (Horsfield & Moore, 1854)				#	
Himalayan Bulbul	*Pycnonotus leucogenys* (Gray, 1835)	*	*	*		
Red-vented Bulbul	*Pycnonotus cafer* (Linnaeus, 1766)	*	*	#		
Himalayan Black Bulbul	*Hypsipetes leucocephalus* (Gmelin, 1789)	*	*	*		
Striated Prinia	*Prinia crinigera* (Hodgson, 1836)					
Grey-breasted Prinia	*Prinia hodgsonii* (Blyth, 1844)	*				
Brown-flanked Bush Warbler	*Cettia fortipes* (Hodgson, 1845)	#19-03		$ 09-03		
Chestnut-crowned Bush Warbler	*Cettia major* (Horsfield & Moore, 1854)					#
Grey-sided Bush Warbler	*Cettia brunnifrons* (Hodgson, 1845)	$				# 09-04
Aberrant Bush Warbler	*Cettia flavolivacea* (Blyth, 1845)	$	$		#	#

Continued

Table 1. *Continued.*

Common Name	Scientific Name	Siroli/Mandal 1500 m	Khikan 1700 m	Ansuya 2100 m	Kanchala 2600 m	Chopta 2800 m
West-Himlayan Bush Warbler	*Locustella kashmirensis* (Blyth, 1845)				#	#
Hume's Bush Warbler	*Horornis brunnescens* (Hume, 1872)					#
Blyth's Reed Warbler	*Acrocephalus dumetorum* (Blyth, 1849)	α	α	α	α 09-04	
Grey-bellied Tesia	*Tesia cyaniventer* (Hodgson, 1837)	#				
Chestnut-headed Tesia	*Tesia castaneocoronata* (Burton, 1836)	*	*	#	#	#
Common Chiffchaff	*Phylloscopus collybita* (Vieillot, 1817)	$	$			
Tickell's Leaf Warbler	*Phylloscopus affinis* (Tickell, 1833)			# 04-05		
Lemon-rumped Warbler	*Phylloscopus chloronotus* (Gray & Gray, 1846)	$	$	$	# 09-04	# 25-04
Buff-barred Warbler	*Phylloscopus pulcher* (Blyth, 1845)	#		#	#	#
Ashy-throated Warbler	*Phylloscopus maculipennis* (Blyth, 1867)	$	$	$	#	# 09-04
Hume's Leaf Warbler	*Phylloscopus humei* (Brooks, 1878)				#	#
Greenish Warbler	*Phylloscopus trochiloides* (Sundevall, 1837)	# 16-03			# 09-04	#
Green Warbler	*Phylloscopus nitidus* (Blyth, 1843)	$ 13-03				
Western Crowned Warbler	*Phylloscopus occipitalis* (Blyth, 1845)	#			# 09-04	
Blyth's Leaf Warbler	*Phylloscopus reguloides* (Blyth, 1842)	# 28-03				# 09-04
Black-faced Warbler	*Abroscopus schisticeps* (Gray, 1846)	*	*	*		
Whistler's Warbler	*Seicercus whistleri* (Ticehurst, 1925)	$	$	$	#	#
Chestnut crowned warbler	*Seicercus castaniceps* (Hodgson, 1845)			#		
Tytler's Warbler	*Phylloscopus tytleri* (Brooks, 1872)					#
Grey-hooded Warbler	*Phylloscopus xanthoschistos* (Gray, 1846)	*	*	*	# 09-04	
White-browed Fulvetta	*Fulvetta vinipectus* (Hodgson, 1837)	$	$	$	*	*
Scaly-breasted Wren-babbler	*Pnoepyga albiventer* (Hodgson, 1837)	$	$	$	#	#
Nepal Wren-babbler	*Pnoepyga immaculata* (Martens & Eck, 1991)	$				#
Black-chinned Babbler	*Stachyridopsis pyrrhops* (Blyth, 1844)	*	*			
Rusty-cheeked Scimitar Babbler	*Pomatorhinus erythrogenys* (Vigors, 1832)	*	*	*		
White-browed Scimitar Babbler	*Pomatorhinus schisticeps* (Hodgson, 1836)	*	*			
Streak-breasted Scimitar Babbler	*Pomatorhinus ruficollis* (Hodgson, 1836)	*				
Puff-throated Babbler	*Pellorneum ruficeps* (Swainson, 1832)					
Jungle Babbler	*Turdoides striata* (Dumont, 1823)	*				
White-throated Laughingthrush	*Garrulax albogularis* (Gould, 1836)	*	*	*	#	
Striated Laughingthrush	*Garrulax striatus* (Vigors, 1831)	*	*	*	#	
Variegated Laughingthrush	*Trochalopteron variegatum* (Menegaux, 1923)	$	$	$	#	#
Spotted Laughingthrush	*Garrulax ocellatus* (Vigors, 1831)					#
Streaked Laughingthrush	*Trochalopteron lineatum* (Vigors, 1831)	*	*	*	#	#
Chestnut-crowned Laughingthrush	*Trochalopteron erythrocephalum* (Vigors, 1832)	*	*	*	#	#
Bar-throated Siva	*Minla strigula* (Hodgson, 1837)	$	$	*	#	*
White-browed Shrike-babbler	*Pteruthius ripleyi* (Biswas 1960)	$			#	#
Green Shrike-babbler	*Pteruthius xanthochlorus* (Gray, 1846)				#	#
Rufous Sibia	*Heterophasia capistrata* (Vigors, 1831)	*	*	*	#	#
Whiskered Yuhina	*Yuhina flavicollis* (Hodgson, 1836)	*	*	*		
Stripe-throated Yuhina	*Yuhina gularis* (Hodgson, 1836)	$			*	*
Oriental White-eye	*Zosterops palpebrosus* (Temminck, 1824)	#				
Goldcrest	*Regulus regulus* (Linnaeus, 1758)				*	*
Eurasian Wren	*Troglodytes troglodytes* (Linnaeus, 1758)			$	*	*
Brown Dipper	*Cinclus pallasii* (Temminck, 1820)	*				
Chestnut-bellied Nuthatch	*Sitta cinnamoventris* (Blyth, 1842)	#				
White-tailed Nuthatch	*Sitta himalayensis* (Jardine & Selby, 1835)	*	*	*	*	#
Wallcreeper	*Tichodroma muraria* (Linnaeus, 1766)	$ 12-02				
Bar-tailed Treecreeper	*Certhia himalayana* (Vigors, 1832)	*		*	#	#
Hodgson's Treecreeper	*Certhia hodgsoni* (Brooks, 1873)				#	#
Rusty-flanked Treecreeper	*Certhia nipalensis* (Blyth, 1845)	$	$		#	#
Jungle Myna	*Acridotheres fuscus* (Wagler, 1827)	#				
Common Myna	*Acridotheres tristis* (Linnaeus, 1766)	*		#		#
Chestnut-tailed Starling	*Sturnia malabarica* (Linnaeus, 1766)	$				
Blue Whistling Thrush	*Myophonus caeruleus* (Scopoli, 1786)	*	*	*	#	#
Pied Thrush	*Zoothera wardii* (Blyth, 1842)	# 29-04		#		
Plain-backed Thrush	*Zoothera mollissima* (Blyth, 1842)			# 19-03		#
Long-tailed Thrush	*Zoothera dixoni* (Seebohm, 1881)	$				
Scaly Thrush	*Zoothera dauma* (Latham, 1790)	#	#	#	#	#
Long-billed Thrush	*Zoothera monticola* (Vigors, 1832)			# 19-03	#	#

Continued

Table 1. *Continued.*

Common Name	Scientific Name	Siroli/Mandal 1500 m	Khikan 1700 m	Ansuya 2100 m	Kanchala 2600 m	Chopta 2800 m
White-collared Blackbird	*Turdus albocinctus* (Royle, 1840)	$	$		#	#
Grey-winged Blackbird	*Turdus boulboul* (Latham, 1790)	*	*	*		
Tickell's Thrush	*Turdus unicolor* (Tickell, 1833)	# 19-03		# 14-04		
Chestnut Thrush	*Turdus rubrocanus* (Hodgson, 1846)					#
Mistle Thrush	*Turdus viscivorus* (Linnaeus, 1758)	$	$	$		$
Dark-throated Thrush	*Turdus atrogularis* (Jarocki, 1819)	$		$	$	
Indian Blue Robin	*Luscinia brunnea* (Hodgson, 1837)	# 07-05				#
Himalayan Bluetail	*Tarsiger rufilatus* (Pallas, 1773)	$	$	$	#	#
Golden Bush Robin	*Tarsiger chrysaeus* (Hodgson, 1845)	$ 09-01	$ 04-03	# 03-04	# 09-04	#03-05
Oriental Magpie-Robin	*Copsychus saularis* (Linnaeus, 1758)	#				
Blue-capped Redstart	*Phoenicurus caeruleocephala* (Vigors, 1831)			$	$	
Plumbeous Water Redstart	*Rhyacornis fuliginosa* (Vigors, 1831)	*				
White-capped Redstart	*Chaimarrornis leucocephalus* (Vigors, 1831)	*			#	#
Blue-fronted Redstart	*Phoenicurus frontalis* (Vigors, 1832)	$				#
Little Forktail	*Enicurus scouleri* (Vigors, 1832)	*		#	#	#
Spotted Forktail	*Enicurus maculatus* (Vigors, 1831)	*	*	*	#	#
Black-backed forktail	*Enicurus immaculatus* (Hodgson, 1836)					#
Siberian Stonechat	*Saxicola maurus* (Linnaeus, 1766)	*				
Pied Bush Chat	*Saxicola caprata* (Linnaeus, 1766)	*				
Grey Bush Chat	*Saxicola ferreus* (Gray, 1846)	$	$			
Chestnut-bellied Rock Thrush	*Monticola rufiventris* (Jardine & Selby, 1833)	*				
Rusty-tailed Flycatcher	*Muscicapa ruficauda* (Swainson, 1838)	# 06-04				
Rufous-gorgeted Flycatcher	*Ficedula strophiata* (Hodgson, 1837)	$ 04-03			#	#
Snowy-browed Flycatcher	*Ficedula hyperythra* (Blyth, 1843)			*		
Ultramarine Flycatcher	*Ficedula superciliaris* (Jerdon, 1840)	# 15-03		#	#	#
Rufous-bellied Niltava	*Niltava sundara* (Hodgson, 1837)	$	$			
Slaty Blue Flycatcher	*Ficedula tricolor* (Hodgson, 1845)	#	#	#	#	
Small Niltava	*Niltava macgrigoriae* (Burton, 1836)	*				
Fire-breasted Flowerpecker	*Dicaeum ignipectus* (Blyth, 1843)	*	*			
Mrs. Gould's Sunbird	*Aethopyga gouldiae* (Vigors, 1831)			#	#	
Green-tailed Sunbird	*Aethopyga nipalensis* (Hodgson, 1837)	*	*	*	#	#
Fire-tailed Sunbird	*Aethopyga ignicauda* (Hodgson, 1837)					#
House Sparrow	*Passer domesticus* (Linnaeus, 1758)	*				
Russet Sparrow	*Passer rutilans* (Temminck, 1835)	*	*	*		
Scaly-breasted Munia	*Lonchura punctulata* (Linnaeus, 1758)	$	#			
White-rumped Munia	*Lonchura striata* (Linnaeus, 1766)	#				
Alpine Accentor	*Prunella collaris* (Scopoli, 1769)	#			*	*
Altai Accentor	*Prunella himalayana* (Blyth, 1842)	#				
Rufous-breasted Accentor	*Prunella strophiata* (Blyth, 1843)	$		$		
Black-throated accentor	*Prunella atrogularis* (von Brandt, 1843)	$				
Grey Wagtail	*Motacilla cinerea* (Tunstall, 1771)					
White Wagtail	*Motacilla alba* (Linnaeus, 1758)					
Upland Pipit	*Anthus sylvanus* (Blyth, 1845)	$				
Rosy Pipit	*Anthus roseatus* (Blyth, 1847)	$				#
Olive-backed Pippit	*Anthus hodgsoni* (Richmond, 1907)	$			#	#
Common Chaffinch	*Fringilla coelebs* (Linnaeus, 1758)	$			#	
Yellow-breasted Greenfinch	*Carduelis spinoides* (Vigors, 1831)	*	*		#	
European Goldfinch	*Carduelis carduelis* (Linnaeus, 1758)	$			#	
Plain Mountain Finch	*Leucosticte nemoricola* (Hodgson, 1836)			$	#	#
Red-fronted rosefinch	*Carpodacus puniceus* (Blyth, 1845)				# 09-04	# 25-04
Dark-breasted Rosefinch	*Carpodacus nipalensis* (Hodgson, 1836)	$ 08-03	$ 04-03	# 02-04	# 09-04	# 25-05
Common Rosefinch	*Carpodacus erythrinus* (Hodgson, 1837)	#				
Pink-browed Rosefinch	*Carpodacus rodochroa* (Vigors, 1831)	$	$	$	#	#
Spot-winged Rosefinch	*Carpodacus rodopeplus* (Vigors, 1831)	$	$	$		
Red-fronted Serin	*Serinus pusillus* (Pallas, 1811)	$				
Scarlet Finch	*Haematospiza sipahi* (Hodgson, 1836)	*			#	#
Brown Bullfinch	*Pyrrhula nipalensis* (Hodgson, 1836)			#		
Red-headed Bullfinch	*Pyrrhula erythrocephala* (Vigors, 1832)	$	$			
Collared Grosbeak	*Mycerobas affinis* (Blyth, 1855)	#	#			
Spot-winged Grosbeak	*Mycerobas melanozanthos* (Hodgson, 1836)	#	#			

Continued

Table 1. *Continued.*

Common Name	Scientific Name	Siroli/Mandal 1500 m	Khikan 1700 m	Ansuya 2100 m	Kanchala 2600 m	Chopta 2800 m
Black and Yellow Grosbeak	*Mycerobas icterioides* (Vigors, 1831)					#
White-winged grosbeak	*Mycerobas carnipes* (Hodgson, 1836)				#	
Crested Bunting	*Emberiza lathami* (Gray, 1831)	#				
Rock Bunting	*Emberiza cia* (Linnaeus, 1766)	*				
Horned Lark	*Eremophila alpestris* (Linnaeus, 1758)	β 10-02				

DISCUSSION

Our study presents important ecological information on the avifauna of a mostly intact elevational gradient between 1,500 m and 3,700 m a.sl.l. in the Amrutganga Valley, Kedarnath Wildlife Division, Uttarakhand, India, based on data collected over four years. We recorded 244 species from a small area (ca. 40 km^2), compared to the 251 species previously reported from the region (Singh 2003), highlighting the incredible species richness of this landscape.

The western Himalayas receive much more snow than lower elevations than the eastern Himalayas. The amount of snow cover directly affects habitat use by birds, especially undergrowth birds (Jones 2001). In Kedarnath, most high-elevation birds show some elevational movement in winter. Several species such as the Whistler's Warbler (*Seicercus whisterli*), Variegated Laughingthrush (*Garrulax variegatus*) and Himalayan Bluetail (*Tarsiger rufilatus*) (Table 1) use low elevations in the winter and move to higher elevations in the summer for breeding. Many of these species, however, are partial migrants, whereby some individuals live at high elevations year round (e.g., Variegated Laughing Thrush), while others show complete elevational migration (e.g., Blue-fronted Redstart, *Phoenicurus frontalis*). The extent of movement might be related to the extent of snow cover on the ground, the habitat of the bird, and ambient temperatures. Our data show in the winter that high elevations above 2,100 m generally have low species richness.

The wintering habitats of a number of cryptic birds are poorly understood. Bush-warblers belonging to the genera *Cettia* and *Bradypterus* are easily detectable due to their distinct song in the breeding season but are difficult to observe in winter. Six species of bush-warblers are known to breed in the study area. We found that the Grey-sided Bush-warbler (*Cettia brunnifrons*), Abberrant Bush-warbler (*Cettia flavolivacea*) and Brown-flanked Bush-warbler (*Cettia fortipes*) were present in the study site throughout the year but were restricted to the low elevations (ca. 1,500 m) in the winter; these species probably do not leave the study area . Similarly, both Eurasian Woodcock (*Scolopax rusticola)* and Long-billed Thrush (*Zoothera monticola)* were found at 2,000 m in winter in food-rich village drains. Most records for these species from winter are from lower elevations.

The most comprehensive checklist for the Kedarnath area an Important Bird Area (Islam and Rahmani 2004) was collated more than a decade ago, and although our surveys are from a much smaller part of the Kedarnath area, we recorded almost as many species. Some birds that are notably missing from our checklist include the Great Parrotbill (*Conostoma aemodium),* Black-throated Parrotbill (*Suthora nipalensis),*Grandala (*Grandala coelicolor)* and Collared Falconet (*Microhierax caerulescens*) despite multiple visits to specific known sites for these species. Although the reasons behind these absences are not clear, Kedarnath lies on the western edges of these species' ranges and these species might occur at low densities or only sporadically there. Similarly, a few vagrants and passage migrants were recorded. Passage migrants such as Blyth's Reed Warbler (*Acrocephalus dumetorum),* Eurasian Wryneck (*Jynx torquilla*) and Hen Harrier might move through the area briefly each year, while vagrants such as Horned Lark (*Eremophila alpestris)*, Black Stork (*Cico nianigra)* and Southern Grey Shrike (*Lanius meridionalis)* might be rare occurrences. Other additions include birds that are difficult to detect such as the Himalayan Wood Owl (*Strix nivcolum).* Such species are known to occur in the general region but not have been reported from the Kedarnath landscape.

Some common low elevation species such as Jungle Babbler (*Turdoides striata*), Crested Serpent Eagle (*Spilornis cheela*), Common Kingfisher (*Alcedo atthis*), and Greater Yellownape (*Chrysophlegma flavinucha*) were observed but were not listed by Singh (2003). This suggests that either the low elevations were poorly sampled during those surveys or that these species have recently expanded their elevational range, possibly due to habitat conversions and warming temperatures.

Climate change has had disastrous effects on the breeding success of warblers in the temperate regions of the world (Johanna and Helund 2015). Nine of the 12 species of warblers in the genus *Phylloscopus* recorded in the study migrate to the Himalayas from Peninsular India for breeding. Knowledge of dates when the bird species were seen for the first time in the year along with measures of food abundance can be used to study the effect of climate change in the mountains. We report first sighting dates for a number of warbler and other bird species in their breeding grounds in Kedarnath. Although based on our methodology, these dates, might not be the absolute arrival dates for these species,

especially in the high elevations localities, our frequent visits mean that these dates are a fair indication of arrival of a certain species at a given elevation. These data might be used as a baseline for future studies.

Some birds show sporadic, large-scale movements that make their movements hard to predict. These include species suchaas the Dark-throated Thrush (*Turdus atrogularis*), which was sighted several times during the winter, of 2014 but was not sighted at all in the winter of 2015. Other birds with similar movement patterns include three species of grosbeaks, namely Collared Grosbeak (*Mycerobas affinis*), Spot-winged Grosbeak (*Mycerobas melanozanthos*), Back-and-yellow Grosbeak (*Mycerobas icterioides*), Red-headed Bullfinches (*Pyrrhula erythrocephala*) and Eurasian Goldfinches (*Carduelis carduelis*). These species probably fly across large elevational gradients easily because they were seen at lower elevations during spells of bad weather but were not detected regularly.

The Himalayas in Uttarakhand are plagued with threats such as habitat conversion and climate change. Our paper underscores the terrific species richness that a small valley in the Himalayas can hold. We believe that our data can be used in the future as a baseline for the conservation of Himalayan fauna in the Kedarnath region. Ecotourists, recording their sightings in citizen science programs such as Ebird should ensure that they record the elevations of their sightings so as to continue the collection of data on the elevational distribution of birds in the region.

ACKNOWLEDGEMENTS

We thank the Uttarakhand State Forest Department for making this study possible, as well as Dr. Dhananjai Mohan and Dr. Raman Kumar for helping us find literature reguarding the bird diversity for the region. We also thank Harish Maithani, Pratik Joshi, Sartaj Singh Ghuman, Supriya K., Himani Nautiyal, Alissa Barnes, Anisha Jayadevan, Chris Bowden, Vijay Ramesh, Gaurav Nalkur, Shailee Shah, Andre Dhondt, Keila Dhondt, Aditya Chavan and Pramod Bisht for assistance with fieldwork and for providing photographs.

LITERATURE CITED

Barthlott, W., W. Lauer and A. Placke. 1996. Global distribution of species diversity on vascular plants: towards a world map of phytodiversity. Erdkunde 50: 317–327.

Conservation India. (2015). Eurasian Woodcock, Kedarnath, Uttarakhand. Accessed at http://conservationindia.org/gallery/eurasian-woodcock-kedarnath-uttarakhand/, 29 November 2015.

Freeman, B.G. and A.M.C. Freeman. 2014. Rapid upslope shifts in New Guinean birds illustrate strong distributional responses of tropical montane species to global warming. Proceedings of the National Academy of Sciences of the United States of America 111(12): 4490–4494. doi: 10.1073/pnas.1318190111

Graham, C.H., A.C. Carnaval, C.D. Cadena, K.R. Zamudio, T.E. Roberts, J.L. Parra, C.M. McCain, R.C.K. Bowie, C. Mortiz, S.B. Baines, C.J. Schnider, J. VanDerWal, C. Rahbek, C.H. Kozak and N.J. Sanders. 2014. The origin and maintenance of montane diversity: integrating evolutionary and ecological processes. Ecography 37(8): 711–719. doi: 10.1111/ecog.00578

Grimmett, R., C. Inskipp, T. Inskipp and R. Allen. 2011. Birds of the Indian Subcontinent. London: Christopher Helm.480 pp.

Hedlund, J. 2015. Climate change effects on migratory birds and on the ecology and behaviour of the willow warbler (*Phylloscopus trochilus*) [Ph.D. thesis]. Stockholm: Stockholm University. 121 pp. http://su.diva-portal.org/smash/record.jsf?pid=diva2%3A852581

Jones, J. 2001. Habitat selection studies in avian ecology: a critical review. The Auk 118(2): 557–562. doi: 10.1642/0004-8038(2001)118[0557:HSSIAE]2.0.CO;2

Koparde, P. and S.Manchi,2013. Avifaunal records from Chalis Ek, North Andaman Island: insights into distribution of some Andaman Island birds. Check List 9(1): 34–41. doi: 10.15560/9.1.34

McCain, C.M. 2009. Global analysis of bird elevational diversity. Global Ecology and Biogeography 18(3): 346–360. doi: 10.1111/j.1466-8238.2008.00443.x

Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A.B. Da Fonseca and J. Kent. 2000. Biodiversity hotspots for conservation priorities. Nature 403(24): 853–858. doi: 10.1038/35002501

Olson, D.M. and E. Dinerstein. 2002. The Global 200: priority ecoregions for global conservation. Annals of the Missouri Botanical Garden 89(2): 199–224

Olson, D.M., E. Dinerstein, E.D. Wikramanayke, N.D. Burgess, G.V.N. Powell, E.C. Underwood, J.A. D›amico,I. Itoua, H.E. Strand, J.C. Morrison, C.J. Loucks, T.A. Allnutt, T.H. Ricketts, Y. Kura, J.F. Lamoreux, W.W. Wetengel, P. Hedao and K.R. Kassem. 2001. Terrestrial ecoregions of the world: a new map of life on earth. BioScience 51(11): 993–1038. doi: 10.1641/0006-3568(2001)051[0933:TEOTWA]2.0.CO;2

Pandit, M.K. and V. Kumar. 2013. Land-use change and conservation challenges in the Indian Himalaya; pp. 123–133, in: P.H. Raven, N. S. Sodhi and L. Gibson (eds.). Conservation biology: voices from the tropics. Oxford, UK: John Wiley & Sons. doi: 10.1002/9781118679838.ch15

Price, T.D., D. Mohan, D.T. Tietze, D.M. Hooper, C.D.L. Orme and P.C. Rasmussen. 2011. Determinants of northerly range limits along the Himalayan bird diversity gradient. American Naturalist 178(4): 97–108. doi: 10.1086/661926

Sekercioglu, C.H., S.H. Schneider, J.P. Fay and S.R. Loarie. 2008. Climate change, elevational range shifts, and bird extinctions. Conservation Biology 22(1): 140–150. doi: 10.1111/j.1523-1739.2007.00852.x

Shenoy, S. 2014. eBird: An online database of bird distribution and abundance. eBird, Ithaca, New York. Accessed at http://www.ebird.org, 29 September 2015.

Singh, A.P. 2003. Delhibird — The Northern India Bird Network. Accessed at http://www.delhibird.com/Checklists/Kedarnath.html, 15 December 2015.

Somveille, M., A. Manica, S.H.M. Butchart and A.S.L. Rodrigues. 2013. Mapping global diversity patterns for migratory birds. PLoS One 8(8): e70907. doi: 10.1371/journal.pone.0070907

Suryawanshi, K. 2014. eBird: An online database of bird distribution and abundance. eBird, Ithaca, New York. Accessed at http://www.ebird.org, 29 Spetember 2015 .

Uttaranchal.org. (2015). Uttarakhand. Retrieved 23 November 2015, from http://www.uttaranchal.org/uttarakhand.html

Author contributions: SD, VJ and SB collected the data, SD and SB did data analysis and wrote the manuscript.

Received: 16 December 2015
Accepted: 8 March 2016
Academic editor: Nárgila Gomes Moura