22.0 Impact of Anthropogenic Pressures on Abundance and Distribution of Galliformes at Bedini-Ali, Nanda Devi Biosphere Reserve, Uttarakhand

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Introduction

The Pheasants of the Himalaya are one of the most charismatic and conspicuous of all fauna of this region. They are regarded as the most distinctive bird family of Himalaya due to their high endemicity and brightly coloured plumage (Ali, 1981). They are considered as indicators of habitat quality as they depend substantially on understorey and ground layer vegetation. They also form prey base for many carnivores. The pheasant populations have undergone heavy depletion due to excessive hunting and poaching, and a large tract of their natural habitat has been encroached upon for human needs.

Gaston *et al*. (1981, 1983), Sharma (1989), Gaston and Garson (1992), Gaston *et al*. (1993), Kaul and Garson (1993), Sharma (1993), Sathyakumar *et al.* (1993b), Sankaran (1993), Pandey (1993), Ramesh (1999), Jandrotia (1999) and Sathyakumar (2004) have presented information on status and distribution of pheasants in the western Himalaya based on short studies and/or surveys. Intensive studies on pheasants in the Western Himalaya were carried out by Kaul (1992) on Cheer pheasant in Kumaon, Uttarakhand; Sharma (1992) on Kalij in Garhwal, Uttarakhand and Ramesh (2003) on Western Tragopan, Himalayan monal and Koklass at Great Himalayan National Park (NP) in Himachal Pradesh. A few studies have been carried out to assess the ecological aspects of galliformes in subalpine and alpine areas of western Himalaya. Sathyakumar *et al* (1993a) gathered information on habitat use and relative abundance of pheasants; and Kumar (1997) documented winter habitat use by Himalayan monal in Kedarnath Wildlife Sanctuary (WS). Ramesh *et al.* (1999) investigated ecology of pheasants and discussed the effect of anthropogenic pressures on their abundance and distribution in Great Himalayan NP. All other information on pheasants in the western Himalaya are either from lower altitude or in the form of short studies, surveys or supplementary information collected from other faunal studies.

The Nanda Devi NP (625 km^2) is one of the least disturbed Protected Areas (PA) in the western Himalaya, and forms one of the core zones of the Nanda Devi Biosphere Reserve (BR) (5,860 km^2).The status and distribution of Himalayan monal and Koklass pheasants in Nanda Devi NP and BR are based on surveys conducted by Sankaran (1993) and Sathyakumar (2004). There is a lack of information on the status of wildlife particularly galliformes and their habitats in the buffer zones of Nanda Devi BR where several villages are located and a substantial human and livestock population depend upon the natural resources. To understand the effect of anthropogenic pressures on pheasants and their habitats, a study was carried out at Bedini-Ali located in the buffer zone of Nanda Devi BR during 2005-06. This study estimated the relative abundance of galliformes and assessed the distribution and habitat use by galliformes with reference to anthropogenic pressures in the study area. This paper presents the impacts of anthropogenic pressures on galliformes at Bedini- Ali, Nanda Devi BR, Uttarakhand.

Study Area

An intensive study area of *ca.* 20 km^2 was selected in the western region of Nanda Devi BR covering Bedini- Ali-Roopkund area (79°40' N, 30°12' E) which encompasses the upper temperate, subalpine and alpine regions (3,000 to 5,000 m), diverse slope and aspect categories along with a range of human and livestock use. Vegetation of the study area includes alpine meadows (herbs, forbs, grasses and sedges), treeline or *Krumholtz* zone dominated by *Rhododendron campanulatum* and Subalpine forests dominated by *Quercus semecarpifolia* and *Abies pindrow*. The average maximum temperature was recorded in the month of June (17.7°C) while the minimum was recorded in January (-10°C) at Bedini during the study period. The study area received over 200 mm rainfall during the month of August 2005. Wan and Didhna are the two main villages lying west and south west of the study area. The study area is used by resident as well as migratory livestock and by local people for their natural resource needs.

Methods

Rapid assessment surveys were carried out at the beginning of the study to assess the status and distribution of pheasants, and their habitats, extent of human and livestock use in different parts of the study area. Following this, sampling was done along gradients of varying human use between 3,000 and 3,550m elevation. This involved laying and monitoring of trail/ transects (n=7; 1.6 to 2.1 km) [Table 1], call count stations (n=4) and wildlife habitat evaluation studies following Sathyakumar *et. al* (1993a), and Ramesh *et al*. (1999) [Fig.1]. These transects were sampled thrice a month for pheasant abundance and habitat use. Total count for livestock (cattle, buffaloes, goat, sheep, horses and mules) was also carried out once every month. Numbers of cut, lopped and debarked trees in 10 × 10m plots (n=312, 3 plots at every 100m interval along each transect) were used to estimate the anthropogenic pressure. The effects of species, season and spatial grazing pressure and their interactions on pheasant abundance was analyzed through general linear model.

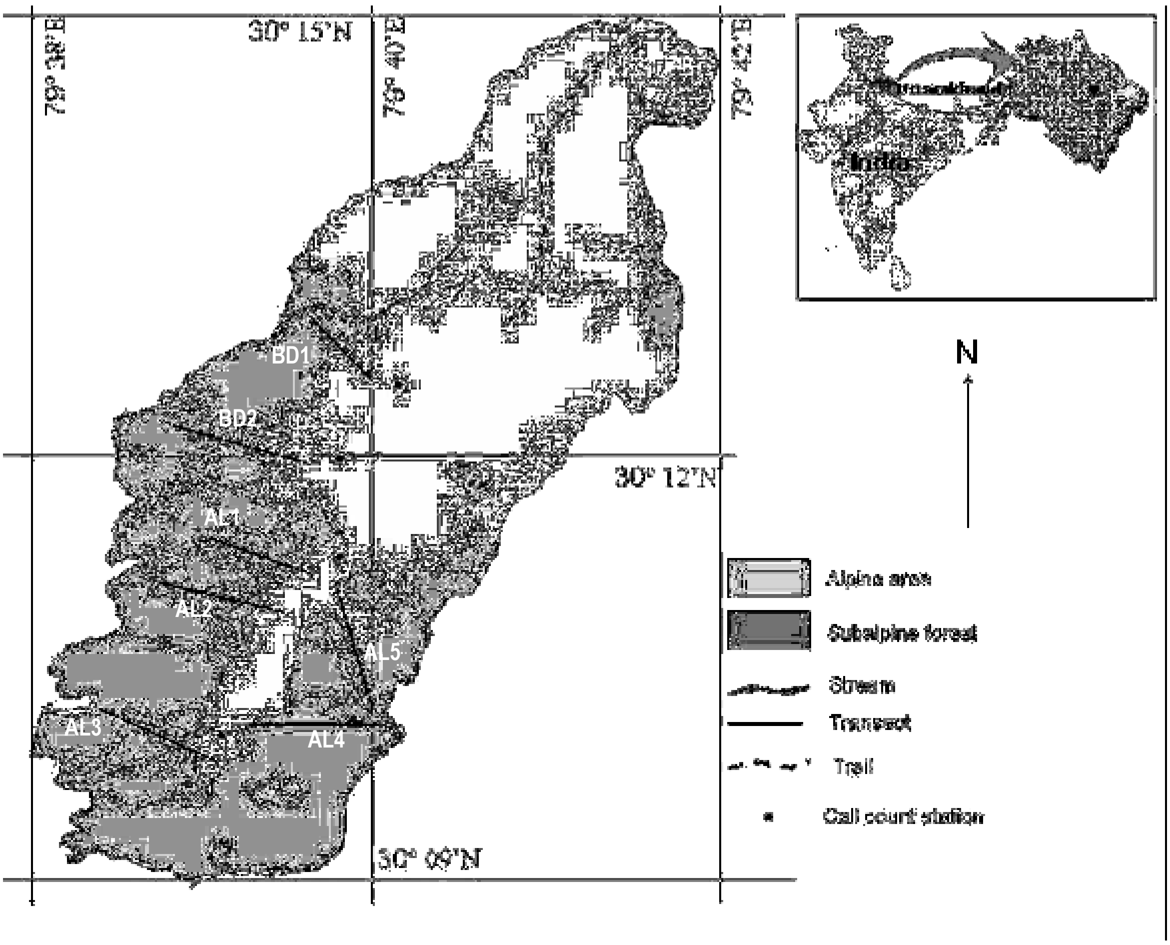

Figure 1. Map of Bedini-Ali meadows showing the transects and call count points

Habitat use

Integrating the 12 habitat parameters, Principal Component Analysis (PCA) extracted two components which accounted for 52 % of the variability in the data set (Table 7) for autumn and spring as both galliformes and livestock were present in the study area in these seasons. In this case, altitude and rock cover showed highest positive loading and grass cover showed negative loading to component 1 whereas anthropogenic pressures showed highest positive loading in component 2. The points are plotted in scatter plot to visualize the distribution of the sightings along the two components (Fig.4). Two different clusters were formed. There is an apparent difference in the use of habitat parameters between Snow partridge, Himalayan Snowcock, Himalayan monal and Koklass during autumn and spring. Himalayan Snowcock and Snow Partridge were ecologically separated from other galliformes as they used high altitude steep terrain where anthropogenic pressure was low. Himalayan monal and Koklass had to share the habitats with herded livestock during spring and autumn.

A comparison of abundance of monal and Koklass pheasants between the study area (Bedini-Ali) and other adjacent areas (Nanda Devi NP, Kedarnath WS) revealed that the abundance of monal is higher inside the Nanda Devi NP but similar to Tunganath region in Kedarnath WS, which is also subjected to anthropogenic pressures (Table 8). However, Koklass abundance estimate in Bedini is similar to Nanda Devi NP, but lower than Kedarnath WS.

Results

Estimation of anthropogenic pressures in the study area during 2005 -06 showed that the area along the transect AL-5 had highest percentage (41.99%) of livestock presence and BD-2 had highest percentage (23.84%) of use by local people and pilgrims. AL-5 had highest percentage of cut, lopped and debarked trees (43.66%). Overall estimate of anthropogenic pressures along different transects during different seasons showed that the presence of local people is the only major disturbance factor in winter. In spring and summer, livestock grazing and cutting, lopping and debarking of trees were the major anthropogenic pressures. More than 4,000 livestock (4,628 goat and sheep and 233 cattle) used the study area for grazing in the alpine regions (3,000 to 4,000m) from May to October.

Abundance estimates of galliformes

Among the galliformes, four species, Himalayan Monal *Lophophorus impejanus*, Koklass *Pucrasia macrolopha*, Snow Partridge *Lerwa lerwa* and Himalayan Snowcock *Tetraogallus himalayensis* were encountered in the study area. Himalayan Snowcock and Snow Partridge were encountered only in alpine habitat (>3,500m) whereas Himalayan monal and Koklass were found mainly in subalpine forest and treeline region (3,000 to 3,500m).

During 2005 and 2006, the Himalayan Monal was most commonly encountered in the subalpine forests, 'treeline' and alpine regions of the study area. It was sighted on 299 occasions (393 individuals) [Table 2]. The encounter rate for monal was 1.22±0.068 km^{-1} walk. Density estimate for monal was 36.37±2.69 km^2. Abundance of monal was estimated in four different seasons. Density and Encounter Rate both were highest during spring and lowest in summer (Table 3).

Koklass was sighted on 53 occasions (63 individual) and its encounter rate was 0.67±0.01 individual km^{-1} walk. Density estimates (km^2) for Koklass was 28.54±2.44. Abundance of Koklass was estimated in four different seasons. Density and Encounter Rate both were highest during spring and lowest in summer (Table 4). Density estimates were varying significantly between species, season and disturbance (Table 5). Call counts were done only for Koklass pheasant. Overall mean call count estimate for Koklass in spring, 2006 was 1.96 ±0.22 male sampling $stations^{-1}$ (n=26). Among the four calling stations (two in Ali meadow and two in Bedini meadow), mean call count estimate was highest in AL1 station and lowest in AL5 station (Table 6).

Discussion

There was a significant variation in anthropogenic pressures among transects ($p<0.05$, one way ANOVA) and similar transects were pooled to find how pheasants are responding to a spatial gradient of anthropogenic pressures. Pheasant abundance was lowest during summer when presence of human in the pheasant habitats was highest. During spring, abundance of pheasant was highest for both Himalayan monal and Koklass. Call counts for Koklass pheasant showed lowest estimate for male $station^{-1}$ along AL5 Transect, which was frequently visited by livestock accompanied by herders and shepherd dogs. Comparison between density estimates of pheasants (Monal and Koklass) in different transects during peak grazing season in the study area revealed significant difference ($p<0.05$, one way ANOVA) [Fig 2]. During non grazing seasons (winter, late spring and early autumn), no significant difference was found in the density estimates of pheasants (Monal and Koklass) along different transects of the study area ($P>0.83$, one way ANOVA) [Fig 3]. This result indicates that the pheasant populations were clumped in some undisturbed area of the study area (Transect AL1 and BD1) during the peak grazing season as most of their habitat was occupied by livestock. During the non grazing season, the absence of livestock from the study area may be the reason for the uniform distribution of pheasants in all available habitats (along all transects in the study area). Overall density estimates of pheasants showed that Himalayan monal was more abundant than koklass pheasant in the study area. Seasons and transects were indicators of grazing pressures and there was no significant difference in the interaction between individual species densities and grazing pressures. Hence, both the species were less abundant under higher grazing pressures, both spatially and temporally.

Table 1 : Characteristics of Transects laid in the Study Area

Transect ID	Elevation (m)	Length (km)	Aspect	Human use
AL1	3160-3500	1.5	West	Moderate
AL2	3150-3450	1.5	West	High
AL3	3090-3450	1.5	West	Low
AL4	3000-3525	1.5	East	Low
AL5	3000-3480	2.0	East	High
BD1	3200-3520	1.5	West	Low
BD2	3000-3475	1.2	West	Moderate

Table 2 : Galliformes sightings in the Study Area during 2005-06

Species	Sightings	Individuals	Group Size	
			Min	Max
Himalayan Monal	299	393	1	5
Koklass Pheasant	53	63	1	2
Himalayan Snowcock	14	25	2	5
Snow Partridge	23	43	4	10

Table 3 : Abundance of Himalayan Monal in different Seasons in the Study Area

Seasons	Sightings	Density (km^2)± SE	ER (#/km) ± SE
Summer	8	17.89±5.86	0.72±0.29
Autumn	91	34.14±5.95	0.95±0.13
Winter	80	33.14±4.45	1.05±0.97
Spring	120	44.43±5.25	1.45±0.13
Overall	299	36.37±2.69	1.22±0.07

Table 4 : Abundance of Koklass in the Study Area during different Seasons

Season	Sightings	Densitykm^2) ± SE	ER (#/km) ± SE
Summer	2	3.24±2.53	0.10±0.07
Autumn	20	31.69±4.57	0.69±0.03
Winter	19	36.09±4.21	0.65±0.01
Spring	12	38.27±5.60	0.68±0.02
Overall	53	28.54±2.44	0.67±0.01

Table 5 : Effects of species, season, grazing pressures and their interactions on pheasant density estimates

Source	SS	df	Mean Square	F	*p*
Corrected Model	6383.99	5	1276.80	9.92	0.00
Intercept	4172.87	1	4172.87	32.43	0.00
SPECIES	1543.50	1	1543.50	11.99	0.00
SEASON	913.69	1	913.69	7.10	0.01
Disturbance categories (DC)	698.41	1	698.41	5.43	0.03
SPECIES * SEASON * DC	650.75	2	325.38	2.53	0.10
Error	2831.21	22	128.69		
Total	**18199.21**	**28**			
Corrected Total	**9215.20**	**27**			

R Squared = .693

Table 6 : Call Count Estimates for Koklass in different Calling Stations in the Study Area

Calling Stations	N	No. of Male Station^{-1}± SE
AL1	8	2.86±0.26
AL5	6	0.83±0.40
BD1	7	2.38±0.18
BD2	5	1.40±0.60
Overall	26	1.96±0.22

Table 7 : Component matrix of PCA of habitat parameters used by Galliformes in the Study Area

Sl no.	Habitat Parameters	Component 1	Component 2
1	Slope	-0.245	-0.112
2	Altitude	0.837	-0.040
3	Grass cover	0.846	0.183
4	Grass height	0.843	-0.076
5	Herb cover	0.113	0.232
6	Herb height	0.221	0.079
7	Litter depth	-0.703	0.248
8	Rock cover	0.321	0.310
9	Barren	-0.814	-0.361
10	Cut	-0.219	0.770
11	Lopped	-0.094	0.836
12	Debarked	-0.135	0.745

Table 8 : Comparison of Encounter Rate (#km^{-1} walk) of Pheasants in Bedini-Ali with Other Protected Areas of Uttarakhand

Species	Bedini-Ali	Nanda Devi NP[1]	Kedarnath WS[2]
Monal	0.7 - 1.45	0 - 2.28	1.4
Koklass	0-2 males calling station^{-1}	0-1 male calling station^{-1}	4-5 males calling station^{-1}*

[1] Sathyakumar 2004, [2]Sathyakumar *et al.*1992; *Sathyakumar (2005, *pers.comm.*).

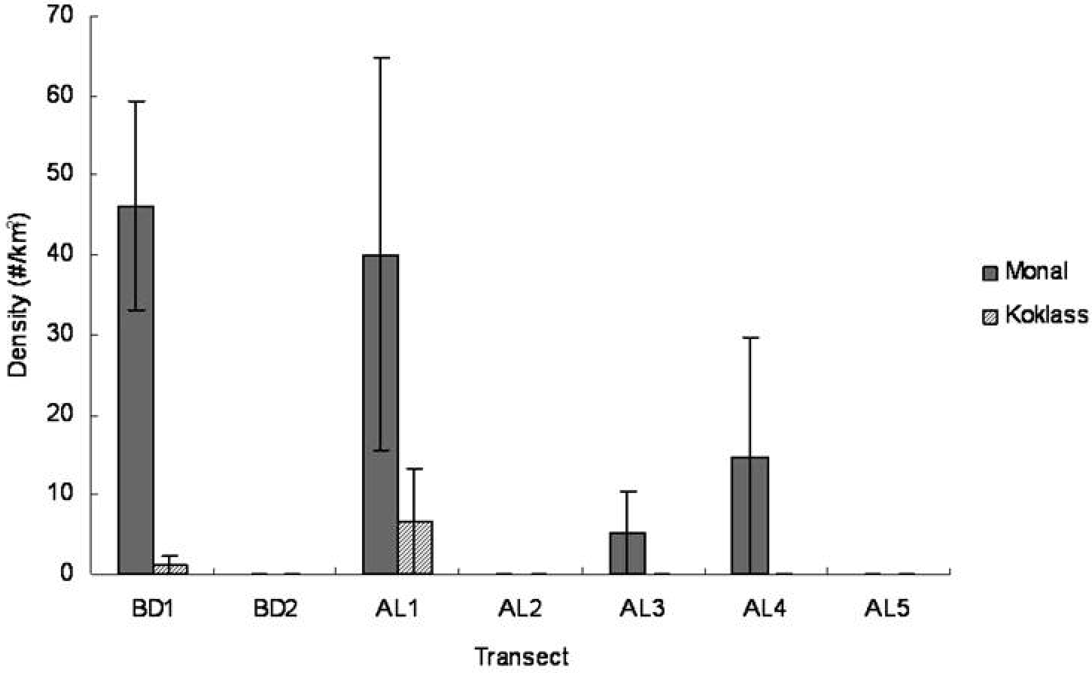

Figure 2. Density of pheasants in different transects during peak grazing season (summer)

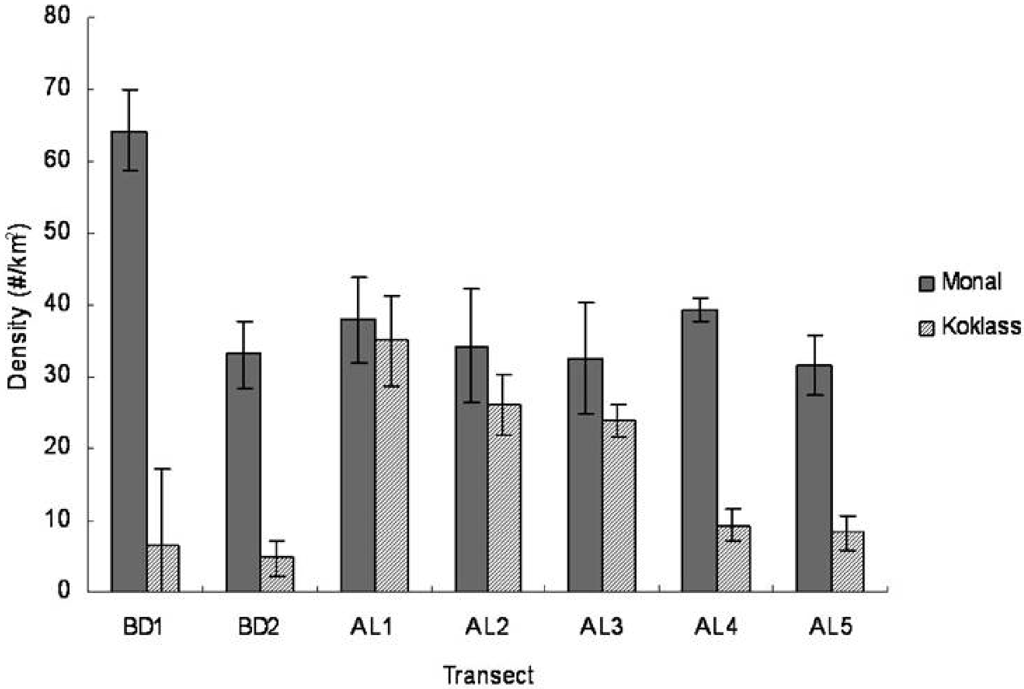

Figure 3. Density of pheasants in different transects during non grazing seasons (autumn, winter, spring)

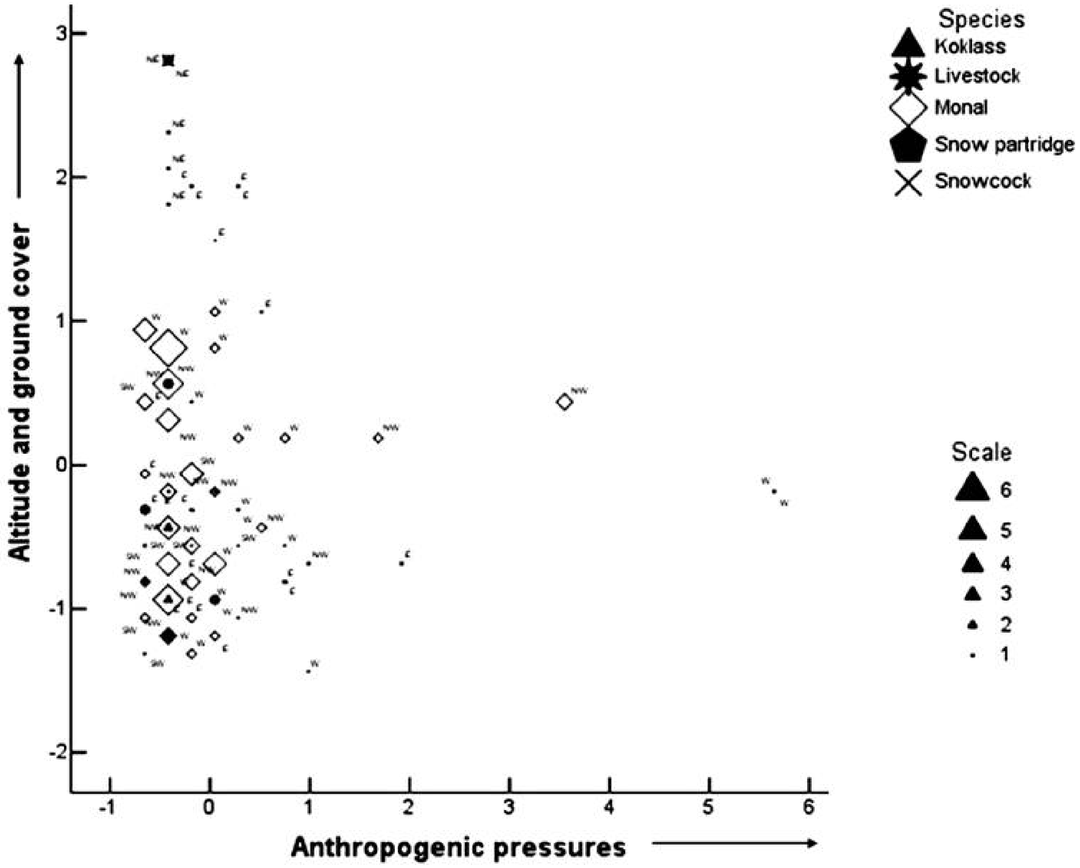

Figure 4. Distribution of Galliformes sighting along two principal habitat components

Conservation Implications

Galliformes in Bedini-Ali are using habitats which are subjected to different forms of anthropogenic pressures such as livestock grazing, NWFP collection and tourism. NWFP collection includes fodder grasses, montane bamboo, nuts, fruits, and medicinal and aromatic herbs. Fodder collection is practised throughout Bedini-Ali without any restriction. During the month of May, extraction of *Cordyceps sinensis* (rare medicinal fungi, highly demanded by Tibetan traders) from the alpine region and glacial moraines of the study area causes disturbances to the wildlife and their habitats. During May 2006, 13 camps of the fungi collectors and more than 500 people including local villagers and outsiders were observed collecting fungus in the habitat used by Himalayan Snowcock and Snow Partridge. Along with this, another economically important mushroom *Morchella esculenta*, lichen *Chaerophyllum* sp. and montane bamboo *Arundineria spathiflora* collection by local people from the subalpine forests also causes removal of ground, tree and shrub cover. These uncontrolled NWFP extraction particularly during April-May (spring season), may cause adverse impacts to galliformes and their habitats as it is the breeding season also. Ramesh *et al*. (1999) observed a sharp decline in pheasant abundance estimates in Great Himalayan NP, Himachal Pradesh, presumably, due to breeding loss because of extreme level of disturbance caused by uncontrolled mushroom collection activities. These activities need to be regularly monitored and restricted to minnimize their impact on galliformes and their habitats.

Large number of tourists visits the study area from April to December. During the period August 2005 to June 2006, a total of 129 tourist groups along with 383 pack animals visited the study area particularly Bedini meadow and Himalayan snowcock habitat of Kurumtoli and Baguabasa as these areas are part of the trekking route to Roopkund. Camping and littering in these areas caused considerable damage particularly in Bedini meadow as well as other parts of the study area.

The impact of livestock grazing on wild animals and their habitats has been reported by Sathyakumar *et al.* (1993b). Increasing use of livestock grazing has led to decreasing Himalayan musk deer and goral densities (Sathyakumar 1994) in Kedarnath WS. Similarly, presence of livestock along with people and shepherd dogs has an adverse impact on the galliformes populations in the subalpine forests and alpine rangelands. A further increase in the livestock population will negatively affect the rangeland and galliformes populations in the Bedini Ali region. Management authorities need to address all the constituents *i.e.,* the requirements of local residents (villagers of Wan, Ballan, Kuling and other villages situated in Dewal block) and their livestock, and the conservation of the wildlife in this area. Therefore, participatory planning is essential to rationalize realistic goals of both pastoral production and wildlife conservation in the area.

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