Distribution and abundance of Galliformes in response to anthropogenic pressures in the buffer zone of Nanda Devi Biosphere Reserve

TAPAJIT BHATTACHARYA, S. SATHYAKUMAR* and G.S. RAWAT
Wildlife Institute of India, P.O. Box 18, Chandrabani, Dehradun 248001, Uttaranchal, India.
*Correspondence author - ssk@wii.gov.in

Paper presented at the 4th International Galliformes Symposium, 2007, Chengdu, China.

Abstract Prior to this study, information on the status of Galliformes and habitat availability in the buffer zones of Nanda Devi Biosphere Reserve (NDBR) was lacking. An assessment of distribution patterns and abundance of Galliformes in response to anthropogenic pressures was carried out during 2005 – 2006 by surveying transects and point call count locations. A variety of measures were taken to estimate anthropogenic pressure. Himalayan monal was the most encountered pheasant (n = 299), then koklass (n = 53). Abundance estimates of monal and koklass were highest during spring and lowest during summer when anthropogenic activities were highest. Density of monal varied due to disturbance and season whereas koklass varied with season but not disturbance. Himalayan monal and koklass use habitats with herded livestock during spring and autumn, and grass cover and livestock presence were negatively related to pheasant occurrence during spring and autumn. Uncontrolled medicinal plant extraction, human disturbance, livestock and associated shepherd dogs are thought to all have an adverse impact on Galliformes and their habitats.

Keywords Abundance, distribution, Galliformes, habitat sharing, livestock grazing

Introduction

Pheasants in the Himalaya are the most charismatic and conspicuous fauna of the region. They are regarded as the most distinctive bird family due to their brightly coloured plumage (Ali, 1981) and are considered indicators of habitat quality. They also form prey base for many carnivores. Numerous galliform species of the area have experienced decreases in abundance due to excessive hunting and as large areas of their natural habitat are utilised by people (Ramesh, 2003).

The Nanda Devi National Park (625 km^2) is one of the least disturbed protected areas in the western Himalaya and forms one of the core zones of the Nanda Devi Biosphere Reserve [NDBR] (5860 km^2). The status and distribution of Himalayan monal and koklass pheasants in Nanda Devi National Park and Biosphere Reserve 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 NDBR where several villages are located and a substantial human and livestock population depend upon natural resources. To understand the effect of anthropogenic pressures on pheasants and their habitats, a study was carried out with two objectives: an estimation of Galliformes abundance, as well as an investigation of the affects of anthropogenic pressures on the abundance; and an assessment of the distribution and habitat use by Galliformes.

Methods

Study Area

An intensive study area of approximately 20 km^2 was selected in the western region of Nanda Devi Biosphere Reserve covering the Bedini-Ali-Roopkund area (79°40′ N, 30°12′ E). This area represented a good example of the upper temperate, sub-alpine and alpine regions covering 3,000 m to 5,000 m altitude a diverse slope and aspect, and a range of human and livestock use. Vegetation of the study area included alpine meadows a tree zone dominated by *Rhododendron campanulatum* & sub-alpine forests dominated by *Quercus semecarpifolia* and *Abies pindrow*. The average temperature of the area ranges between 18 and -10°C and it receives around 200 mm of rainfall during the monsoon (July to September). Wan and Didhna are the two main villages lying west and south west of the study area. The whole area is used by village residents and their livestock for grazing and natural resources.

Bird surveys
Initially, rapid assessment surveys were conducted in different parts of the study area to identify key areas. Following this, sampling was undertaken along a gradient of human use between 3,000 and 3,550 m elevation. Seven transects (1.2 to 2 km) were established along existing footpaths and at the higher elevations a 7.2 km alpine trail was used. The transects and trail (FIG. 1) were surveyed within 2 hours of sunrise and data on galliform species, number, sex, composition, sighting angle and sighting distance were recorded. In addition, because koklass *Pucrasia macrolopha* are more visually secretive but produce loud breeding calls, call counts (open radius circular plots [Gaston 1980]), were also used. To avoid double counts, the location (distance from the point and direction) of the calling bird and time were recorded. Transects, call count points (during breeding season only) and one trail were sampled three times a month.

Habitat and disturbance surveys
To assess habitat use, altitude, aspect, slope, broad vegetation classes, shrub cover, grass cover, grass height, herb cover, herb height, rock cover, litter depth and livestock presence was sampled. Three 10 × 10 m sample plots spaced 30 m apart were placed within each 100 m section of the line transects. This gave a total of 312 sampling plots.

For the estimation of anthropogenic pressures the total count of livestock (cattle, buffaloes, goat, sheep, horses and mules) present in the alpine and subalpine zone of the study area was carried out once every month. Disturbance variables (e.g. cutting, lopping and debarking of trees) in 10 × 10m plots (n=312, 3 plots at every 100m interval along each transect) and human presence along transects were recorded once a season.

Statistical analysis
Galliformes encounter rate (number of birds/km) and density estimates (number of birds/km^2) were calculated for four seasons (summer, autumn, winter and spring) using DISTANCE 5.0 (Thomas et al., 2005). Detection probability for both Himalayan monal *Lophophorus impejanus* and koklass along the transects in each season was estimated using PRESENCE 2.0 (Hines, 2006).

A disturbance index along the transects was calculated using a Principal Component Analysis that considered cutting, lopping and debarking of trees, using the covariance method within SPSS 16. The principal component, with livestock and human presence, was analyzed further using the correlation method within Principal Component Analysis. The effects of season and disturbance on the density of Himalayan monal and koklass were analyzed using a general linear model (GLM) within SPSS 16. GLM was also used to find the relationship between disturbance and season using a regression approach.

The average of each habitat variable from the three plots within each 100 m section was considered as a random habitat data point. These averaged habitat variables (arcsine transformed as appropriate) and the pheasant records were compared against random habitat use through binary (presence vs. random) logistic regression using SPSS 16 (Nourousis, 1990).

Results

Assessment of anthropogenic pressure
Assessment of anthropogenic pressures showed that the presence of local people was the only significant disturbance during winter and livestock grazing and cutting, lopping and debarking of trees in spring and summer. Overall, 4628 goat and sheep and 233 cattle used the alpine regions (3,000 to 4,000 m) of the study site from May to October. Principal co-ordinate of overall disturbance was classified into three classes, low (<-0.04), moderate (≥-0.04 to <0) and high (≥0) (TABLE 1).

Abundance estimates of galliformes
Four species of Galliformes, Himalayan monal, koklass, 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 (above 3,500 m) whereas Himalayan monal and koklass were found in subalpine forest and treeline region (3,000 to 3,500 m) during autumn and spring. In winter monal moved to lower altitudes. Himalayan monal was the most commonly encountered pheasant (TABLE 2). The detection probability of monal and koklass did not vary significantly between seasons (F_3 = 0.19, P = 0.90), but overall the detection probability of monal was always higher than koklass (F_1 = 13.32, P = 0.04) (TABLE 3).

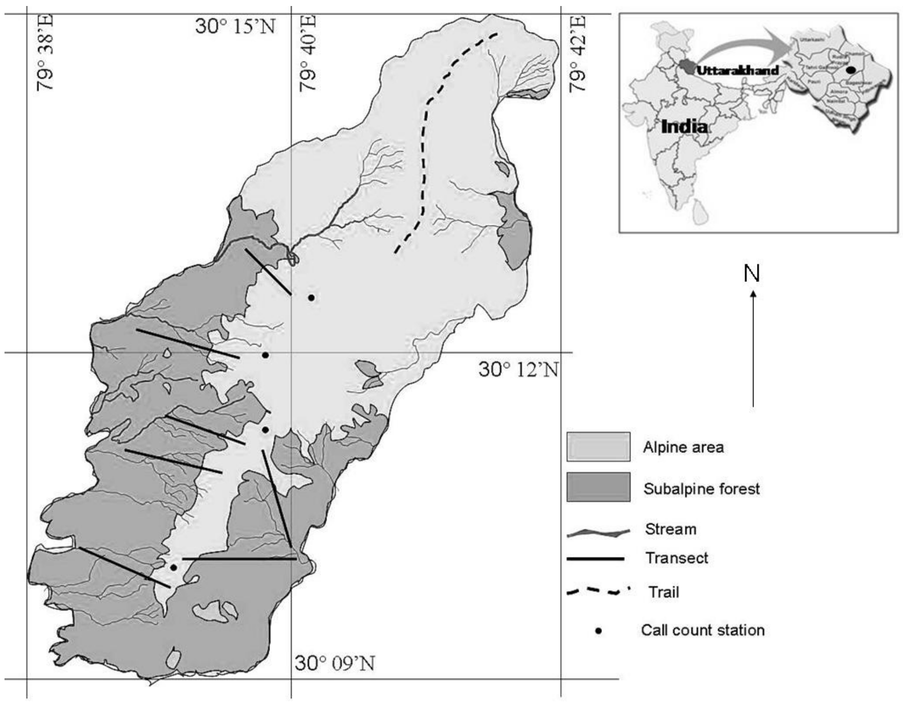

FIG. 1 Map of Bedini Ali meadows showing the transects and call count points

TABLE 1 Characteristics of transects during this study.

Transect ID	Elevation (m)	Length (km)	Aspect	Human use	Disturbance index
AL1	3160-3500	1.5	West	Low	-0.41
AL2	3150-3450	1.5	West	High	0.55
AL3	3090-3450	1.5	West	Low	-0.43
AL4	3000-3525	1.5	East	Moderate	-0.32
AL5	3000-3480	2.0	East	High	1.20
BD1	3200-3520	1.5	West	Low	-0.42
BD2	3000-3475	1.2	West	Moderate	-0.16

TABLE 2 Galliformes sightings and abundance at Nanda Devi Biosphere Reserve during 2005/6.

Species	Sightings (Individuals)	Density ± s.e.	Encounter rate ± s.e.	Group size	
				Min	Max
Himalayan Monal *Lophophorus impejanus*	299 (393)	36.37 ± 2.69	1.22 ± 0.07	1	5
Koklass Pheasant *Pucrasia macrolopha*	53 (63)	28.54 ± 2.44	0.67 ± 0.01	1	2
Himalayan Snowcock *Tetraogalus himalayensis*	14 (25)	----	0.10 ± 0.03	2	5
Snow Partridge *Lerwa lerwa*	23 (43)	----	0.18 ± 0.02	4	10

TABLE 3 Detection probabilities (± s.e.) of monal and koklass in different seasons during 2005/06.

Species	Autumn	Winter	Spring	Summer
Monal	0.80± 0.05	0.86± 0.05	0.86± 0.05	0.48± 0.1
Koklass	0.30± 0.08	0.19± 0.05	0.23± 0.06	0.38± 0.18

The abundance of Himalayan monal and koklass was highest during spring and lowest in summer (TABLE 4 & 5).

TABLE 4 Abundance (± s.e.) of Himalayan monal in different seasons.

Seasons	Sightings	Density± s.e.	E.R. ± s.e.
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 5 Abundance of koklass (± s.e.) in different seasons.

Season	Sightings	Density± s.e	E.R. ± s.e
Summer	2	3.24±2.53	0.10±0.07
Autumn	20	31.69±4.57	0.69±0.029
Winter	19	36.09±4.21	0.65±0.011
Spring	12	38.27±5.6	0.68±0.02
Overall	53	28.54±2.44	0.67±0.01

The call count for koklass estimated 1.96 ± 0.22 males per location in spring (n = 26) (TABLE 6).

TABLE 6 Call count estimates for koklass at each calling station

Calling Stations	N	Males per Station ± s.e.
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

Response of Himalayan monal and koklass
The density of Himalayan monal varied significantly in relation to disturbance (F_1 = 7.7, *P* = 0.01) and season (F_3 = 6.7, *P* = 0.002). Monal density decreased along an increasing gradient of disturbance (β = -10.6 ± 3.8, *t* = -2.8, *P* = 0.01). The density of monal was less in winter (β = -17.8 ± 7.5, *t* = -2.4, *P* = 0.03) and summer (β = -24.5 ± 6.9, *t* = -3.6, *P* = 0.002) than other seasons.

The density of koklass varied significantly with season (F_3 = 3.9, *P* = 0.02) but not with overall disturbance (F_1=0.02, *P* = 0.87) although grazing alone has been shown to have some influence on abundance of both the pheasants (Bhattacharya et al., 2007). Density of koklass was significantly high in spring (β = -11.7 ± 6.9, *t* = 1.8, *P* = 0.09) than other seasons.

Habitat use by Himalayan monal and koklass
The analysis of habitat use by the pheasants considered 13 variables for both autumn (χ^2_{16} = 80.55, *P* < 0.001, -2 loglikelihood = 72.97 and Nagelkerke R^2= 0.69) and spring (χ^2_{16} = 97.9, *P* < 0.001, -2 loglikelihood = 53.62 and Nagelkerke R^2= 0.79). The variables edge habitat, sub alpine habitat, North Western & Western aspect, shrub cover and litter depth showed positive influence in the occurrence of pheasants whereas grass cover, livestock presence and herb height showed negative influences (FIG. 2 and FIG. 3).

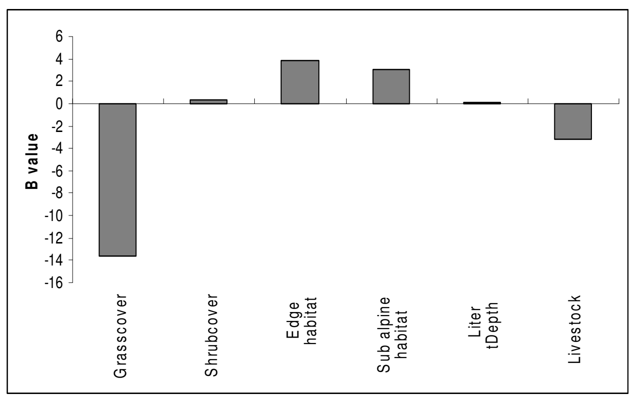

FIG. 2 Effects of habitat variables on the occurrence of pheasants in Bedini-Ali during autumn, 2005-06.

Discussion

Himalayan monal occupies upper temperate oak-conifer forests, subalpine oak forests interspersed with open grassy slopes, cliffs and alpine meadows between 2400 – 4500 m, mostly concentrating in a narrow belt of 2700 – 3700 m (Grimmet et al., 1998). They exhibit clear altitudinal migration reaching as low as 2000 m in winter (Ramesh, 2003).

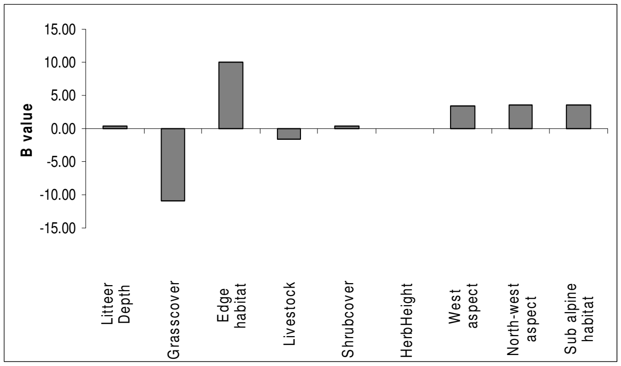

FIG. 3 Effects of habitat variables on the occurrence of pheasants in Bedini-Ali during spring, 2005-06.

During spring, in their breeding season they are found in pairs between 3000 - 3500 m (April-May) (*pers. obs.)* and in summer between 3500 – 4000 m. A comparatively low density estimate of Himalayan monal along the least disturbed transects and an absence from highly disturbed transects of the study area (mean elevation 3500 m) in summer (June - September) are indicative of high altitudinal migration. Himalayan monal are threatened in most of their range due to poaching and other anthropogenic factors (Ramesh, 2003). Male Himalayan monal had been heavily hunted for their crest feathers in Himachal Pradesh (Ramesh, 2003) until 1982 and interactions with locals of the study area also confirmed the hunting pressure during the recent past. Avoidance of seasonally disturbed areas by Himalayan monal might be an consequence of such historical persecution of the species.

Unlike Himalayan monal, koklass does not extend beyond the tree line. It occupies temperate broadleaf, conifer and subalpine oak forests with dense undergrowth (2100 – 3300 m) (Grimmet et al*.,* 1998). One of the drab pheasants, the koklass skulk under bushes to camouflage, reducing their detection which probably imparts less hunting pressure on the species (*pers. obs.*). They also give loud pre-dawn calls during the breeding season, revealing their presence (Ramesh, 2003). Such range restrictions coupled with compensatory behavioural adaptation causes koklass to occupy disturbed areas, but at times it exhibits negative response to livestock and the shepherd dogs (Bhattacharya et al*.*, 2007).

During autumn and spring, pheasant occurrence had a positive relationship with decreasing grass cover and increasing shrub cover. During both autumn and spring, pheasants used the edge habitat and sub-alpine habitat with more leaf litter than the open alpine region with more grass cover. This may be due to more food availability in the form of insects in sub-alpine and edge habitat litter cover or may be due to avoidance of herded livestock. A significant negative relationship of pheasant occurrence with livestock presence may be indicative of the avoidance of alpine habitat with more grass cover and high livestock use. A comparison of abundance of Himalayan monal and koklass pheasants between Bedini-Ali and other Protected Areas revealed that Himalayan monal occurs in higher abundance inside the Nanda Devi National Park (Sathyakumar, 2004) but similar to Tunganath region in Kedarnath Wildlife Sanctuary (Sathyakumar et al., 1992) which is also subjected to anthropogenic pressures. However, the koklass abundance estimate in Bedini is similar to Nanda Devi NP, but lower than Kedarnath WLS.

Conservation Implications

Galliformes in Bedini Ali meadows are using habitats which are subjected to different forms of anthropogenic pressures such as livestock grazing, non-timber forest product (NTFP) collection and tourism. NTFP collection includes fodder grasses, bamboo, nuts, fruits and medicinal and aromatic herbs. Fodder collection is practised throughout the whole area 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 cause adverse impacts on the wildlife and their habitat. During May 2006, 13 camps of the fungi collectors and more than 500 people including local villagers and outsiders were observed during collection of that fungus in the habitat used by Himalayan snowcock and snow partridge. Along with this, lichen collection (Jhulla, used for colour production) and montane bamboo *Arundineria spathiflora* collection by local people from the subalpine forests also causes removal of tree and shrub cover. These uncontrolled NTFP extractions particularly during April-May (spring), may cause adverse impacts on Galliformes and their habitats as it is their breeding period. These activities should be regularly monitored and restricted to reduce their impact on Galliformes and their habitats.

Large numbers of tourists visit the study area from April to December. One hundred and twenty nine tourist groups along with 383 pack animals were recorded from August 2005 to

June 2006 visiting 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. This needs to be strictly controlled.

The presence of people, livestock and shepherd dogs has a negative impact on Galliformes that use predominantly the same pastures and forest, and further increases in livestock will negatively affect the rangelands and Galliformes in the Bedini Ali Region. Management authorities need to address all the constituents i.e., the local residents (villagers of Wan, Ballan, Kuling and other villages situated in Dewal block), their livestock, and the conservation values. As this area is very important from an ecological perspective it should be managed with concern for the development of resident communities. Therefore, careful and participatory planning is essential to rationalize realistic goals of both pastoral production and wildlife conservation in the area.

Acknowledgements

We thank Dr. R.K. Rai, Director (CS), Ministry of Environment and Forests, Government of India for the funding support for this project and for his help and cooperation. We thank Shri S.K. Chandola, Chief Wildlife Warden, Uttaranchal and his predecessor Shri A.S. Negi, for granting us the permission to carry out this work at NDBR. We thank Shri. Samir Sinha, Director NDBR for providing us the necessary help and cooperation for the conduct of this study. We thank Shri P.R. Sinha, Director WII for providing us the necessary facilities, encouragement and support for the smooth conduct of this project. We thank Dr. K. Sankar, Research Coordinator and Faculty Incharge, WII Research Laboratory for his help and support for the study. We thank all the field staff of NDNP, NDBR & Badrinath FD and Shri Than Singh Bisht, field assistant for their help in the field work.

Reference

ALI, S. (1981) The Himalaya in Indian Ornithology. *The Himalaya-aspects of change* (eds Lall, J. S. and Moddie, A.D.). Oxford University, India International Center, New Delhi. 17- 31.

BHATTACHARYA, T., SATHYAKUMAR, S. & RAWAT, G.S. (2007) Impact of Anthropogenic Pressures on Abundance and Distribution of Galliformes at Bedini-Ali, Nanda Devi Biosphere Reserve, Uttarakhand *In:* S. SATHYAKUMAR & K. SIVAKUMAR (Eds.). Galliformes of India. *ENVIS Bulletin: Wildlife and Protected Areas*, 10(1), 155-162

GASTON, A.J. (1980) Census Techniques for Himalayan Pheasants including Notes on Individual Species. *Journal of the World Pheasant Association,* 5, 40 – 53.

GRIMMETT, R., INSKIPP, C. & INSKIPP, T. (1998) Birds of the Indian Subcontinent. Oxford University Press, Delhi. pp 888.

HINES, J.E. (2006) PRESENCE 2.0 USGS, Patuexent Wildlife Research Centre, Laurel, MD. USA.

NOUROUSIS, M.J. (1990) PSS/PC+ Advanced Statistics 4.0 for the IBM PC/XT/AT and PS2 Chicago, SPSS Inc

RAMESH, K. (2003) An ecological study on pheasants of the Great Himalayan National Park, Western Himalaya, *Phd thesis*, Forest Research Institute, Deemed University, Dehradun.

SANKARAN, R. (1993) An Ornithological Survey of Nanda Devi national Park. (IN) *Scientific and Ecological Expedition to nanda Devi*. A report. pp. 16-34.

SATHYAKUMAR, S. (2004) Conservation status of Mammals and Birds in Nanda Devi National Park: An assessment of changes over two decades (IN) *Biodiversity Monitoring Expedition nanda Devi 2003*. A report. pp. 1-14.

SATHYAKUMAR, S., PRASAD, S.N., RAWAT, G.S. & JOHNSINGH, A.J.T. (1992) Ecology of kalij & monal pheasants in Kedarnath Wildlife Sanctuary, Western Himalaya. *Pheasants in Asia 1992.* World Pheasant Association International.

THOMAS, L., LAAKE, J.L., STRINDBERG, S., MARQUES, F.F.C., BUCKLAND, S.T., BORCHERS, D.L., ANDERSON, D.R., BURNHAM, K.P., HEDLEY, S.L. & POLLARD, J.H. (2005) Distance 4.0. Release "x"1. Research Unit for Wildlife Population Assessment, University of St. Andrews, UK. http://www.ruwpa.stand. ac.uk/distance

Biographical sketches

TAPAJIT BHATTACHARYA is a senior Research Fellow of Wildlife Institute of India. His area of research interest is ungulates and Galliformes in high altitudes and socioeconomic and ecological aspects of medicinal plants. S. SATHYAKUMAR PhD is a scientist 'F' and Head of the Endangered Species Management

Department in Wildlife Institute of India. His field of interest is ecological research and conservation of high altitude fauna. G. S. RAWAT PhD is a Scientist 'G' of Wildlife Institute of India and his field of research interest is taxonomy, ecology and conservation of high altitude flora and fauna.