Short Communication

Estimating the seasonal densities of Indian peafowl *Pavo cristatus* and red junglefowl *Gallus gallus* in the northern Indian deciduous forests of Chilla Range, Rajaji National Park

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The development of reliable methods for estimating abundance is a prerequisite for assessing a species' conservation status (Conroy & Caroll, 2001). Galliformes species are useful indicators of environmental quality and the assessment of their status is essential for management purposes (Fuller & Garson, 2000). Most studies of pheasants estimate indices of abundance using encounter rates from visual or aural detections (Gaston, 1980; Khan & Shah, 1982; Young et al*.,* 1987; Duke, 1990; Khaling et al*.,* 1998; Datta, 2000; Ghose et al*.,* 2003), but more recently, methods incorporating the probability of detection are gaining popularity (O'Brien et al*.,* 2003; Azhar et al*.,* 2008).

In this study, we estimate the densities of two pheasant species, Indian peafowl *Pavo cristatus* (hereafter peafowl) and red junglefowl *Gallus gallus* (hereafter RJF) in the dry and wet seasons in the deciduous forests of Chilla Range (Rajaji National Park; hereafter RNP). The two species are widely distributed, occupying a variety of habitats across the Indian subcontinent (Ali & Ripley, 1987; Madge & McGowan, 2002). Despite concerns regarding the absence of reliable population estimate for peafowl (Ramesh & McGowan, 2009) and few incomparable abundance estimates of RJF (Collias & Collias, 1967; Javed & Rahmani, 2000) the current global conservation status for both these species is 'Least Concern' (IUCN, 2009), hence making it imperative to assess their status using reliable methods.

As species life histories are concomitant with seasonal changes, this study looks at seasonal variations in abundance and grouping for peafowl and RJF in the Chilla Range. In this study we employ standard distance-based density estimation procedures (Anderson et al*.,* 1979; Burnham et al*.,* 1980; Buckland et al*.,* 1993, 2001) and investigate the seasonal patterns in grouping (median group size, GS_m) and individual densities (D_i) among the two species. Though the two species differ by a factor of three in body size, they are predominantly ground dwelling and dependent on the under-storey vegetation (Collias & Collias, 1967; Johnsgard, 1986). They have similar life histories with breeding occurring during the dry season and the emergence of chicks coinciding with the onset of the monsoon and the dispersal of juveniles before winter.

The Chilla Range (148 km^2) of RNP lies to the east of the Ganges River and is characterized by rugged Shivalik Hills ranging from 400 to 1000 m in altitude with steep southern slopes, drained by seasonal rivers and streams running north to south. The forests of this region are categorized as Northern Indian Moist Deciduous Forest (Champion & Seth, 1968). With the valleys supporting extensive grasslands, the major associations are mixed forests on the south-facing slopes comprising *Terminalia alata, Anogeissus latifolia, Lagerstroemia parviflora, Holoptelia integrifolia, Ehretia laevis, Aegle marmelos,* and Sal *Shorea robusta* mixed and Sal-dominated forests on the gentle north-facing slopes. The study area experiences a 'dry' season from November to May with daily maximum temperatures ranging from ~16^o C to ~40^o C and only ~25% of the annual rainfall being received during this period. During the wet season (June to October), the daily maximum temperatures range from ~25^o C to ~35^o C and on average 1500 mm of rainfall.

Field sampling was carried out during winter (December 2006 to February 2007), summer

(April to June 2007), monsoon (July to August 2007) and post-monsoon (October to November 2007). During each of these sampling periods, 12 permanently marked transects of varying lengths (0.91 to 2.49 km), through different parts of the study area and covering all vegetation associations, were surveyed three times (48.02 km of survey per sampling period). The surveys were carried out by two observers between 0615 and 0915 in post-monsoon and winter and between 0530 and 0830 in summer and monsoon. When the study species were encountered we recorded group size, detection (sighting or aural) angle, and detection (sighting or aural) distance measured by a laser range finder or an approximation to the nearest 5 m. In order to estimate seasonal densities we divided the year into two primary seasons (dry and wet). We pooled data from the winter and summer field sampling period to represent the 'dry' season and pooled data from the monsoon and post-monsoon sampling period to represent the 'wet' season. We estimated density using DISTANCE 5.0 Release 2 (Thomas et al., 2006). To model detection functions, we examined the data for signs of evasive movement and peaking at great distance from the line transect for each species separately. Following this, the data were either truncated at great distances or reclassed to ensure a reliable fit of key functions and adjustment terms to the data. Akaike Information Criterion (AIC) and goodness-of-fit (GOF-*p*) tests were used to judge the fit of the model. Using the selected model, estimates of half strip width (μ) expressed in metres, encounter rate (n/L) expressed as the number of groups/km, mean group size (GS) and individual density (D_i) expressed as number of individuals/km^2 were derived.

In total 205 km of transects were surveyed across the four sampling periods; a total of 129 individuals of peafowl were recorded on 68 separate occasions and 78 individual RJF were encountered on 41 occasions. As we had modelled detection functions specific to each species within each season, we derived estimates of n/L, GS and D_i specific to each dataset (Table 1). Results from the best selected models to fit the peafowl data for each season (Fig. 1a, b) indicated that μ did not vary significantly across the season. The estimated μ ranged from 47.35 ± 6.5 m in the dry season to 32.81 ± 5.8 m in the wet season. However, the estimated μ differed across species, with the best selected models to fit the RJF data for each season (Fig. 2a, b) estimated μ ranging from 18.5 ± 4.5 m in the dry season to 17.8 ± 3.8 m in the wet season.

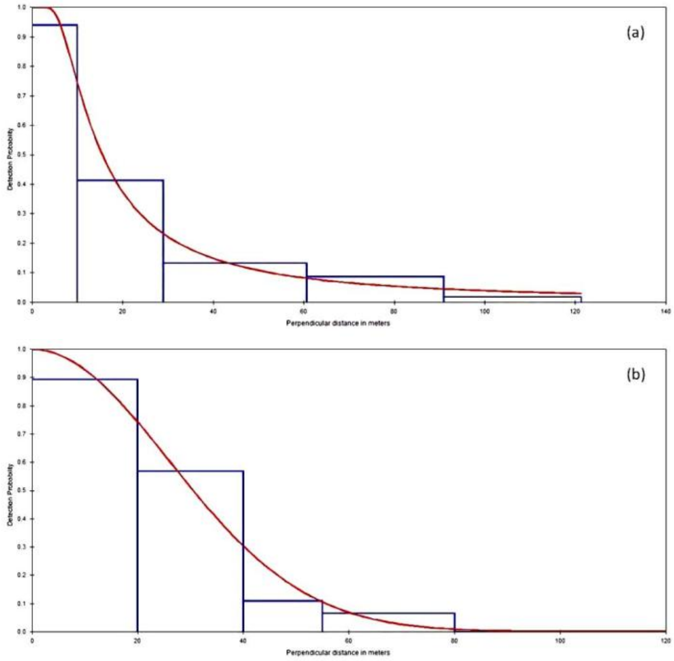

FIG. 1 The best-fit detection function model for the Indian peafowl during the (a) dry season and (b) wet season in the Chilla Range of Rajaji National Park, India, from December 2006 to November 2007.

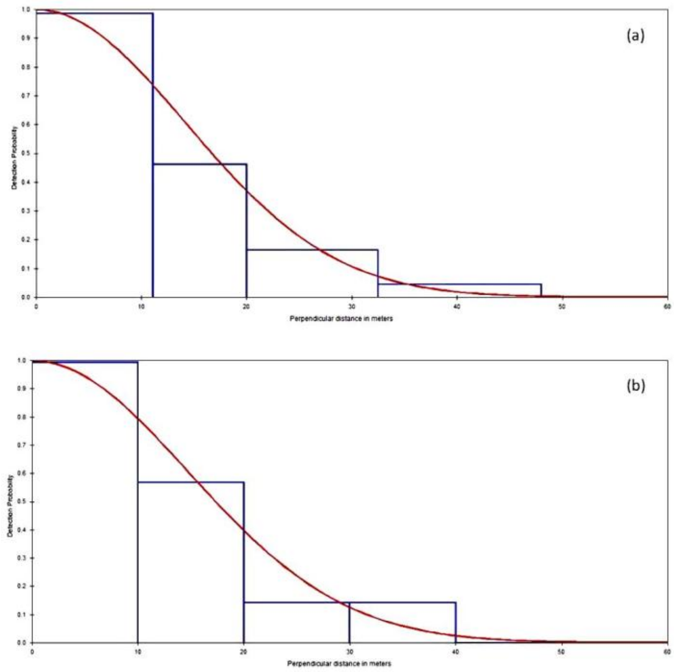

FIG. 2 The best-fit detection function model for the red junglefowl during the (a) dry season and (b) wet season in the Chilla Range of Rajaji National Park, India, from December 2006 to November 2007.

TABLE 1 Densities of Indian peafowl (PF) and red junglefowl (RJF) across the dry and wet seasons in the Chilla Range of Rajaji National Park, India, from December 2006 to November 2007.

	Season	n	n/L±SE	p	GS±SE	D_i	95% CI D_i	CV%	GOF-p	df
PF	Dry	48	0.50±0.09	0.2591	1.91±0.20	10.11	6.20 - 16.43	24.94	0.7412	4
	Wet	20	0.24±0.07	0.2706	1.65±0.22	6.08	3.12 - 11.82	34.47	0.8827	4
RJF	Dry	28	0.27±0.09	0.2964	1.76±0.21	13.54	7.55 - 24.26	30.12	0.8578	4
	Wet	13	0.16±0.06	0.3071	1.01±0.11	4.30	1.81 - 10.25	45.69	0.8969	4

Note: Number of groups (n), encounter rate of groups (*n/L*) and associated standard error (SE), detection probability (*p*), mean group sizes (GS) and associated standard error (SE), individual densities (D_i), 95% confidence intervals on D_i (95% CI D_i), Percent Coefficient of variation on D_i, the probability of chi-square goodness of fit (GOF-p) and degrees of freedom [df]. Total effort of 205 km.

Studies of RJF (Collias & Collias, 1967) and other information on peafowl (Ali & Ripley, 1987) have indicated that the dry season is the courtship and breeding period for both species in the Lower Himalayas and Gangetic plains. During this period both species are territorial and there is an enhanced presence of the species at display arenas, which could have an influence on the encounter rates (Johnsgard, 1986). Though the results of the Mann-Whitney *U* test indicate that the estimates of encounter rates (*n*/*L*) of peafowl (Z = 1.29, *P* = 0.096) and RJF (Z = 1.12, *P* = 0.13) were not significantly different, we feel that they may in part account for the high encounter rates of both species during the dry season.

The test for differences in grouping indicated that GS did not differ significantly across seasons between species. However, previous studies (Ramesh, 2003; Kumar et al*.,* 2006) of pheasant species from higher altitudes of the Himalayas have shown that aggregations occur during the winter season possibly in response to sparse distribution of food resource and protection from predators. Studies of RJF have reported larger groups during the pre-breeding and post-breeding period in the Terai area (Javed & Rahmani, 2000). Though our results provide less support to this observation, dry season GS were higher than in the wet season in both species. We believe that with the progression from post-monsoon to winter, mean maximum temperatures drop from 29.0 ± 1.0^{o} C to 19.0 ± 0.5^{o} C in this region with a potential decrease in food resource. However, these observations need further validation with additional information on resource availability. These two species have similar life histories that are concomitant to seasons and the availability of resources (Johnsgard, 1986), thereby making it critical to undertake measured effort to understand factors that govern their distribution and abundance and even monitor them while utilizing them as indicator species.

Both peafowl and RJF are icons within the Indian context considering that the peafowl is accredited as the national bird and the RJF a progenitor of modern day domestic chickens (Liu et al*.,* 2006). Although estimates for peafowl have been obtained using questionnaire surveys (Choudhury et al*.,* 2007), they cannot be validated unless empirical data can be substituted, while earlier studies on RJF (Collias & Collias, 1967; Javed & Rahmani, 2000), which were conducted in similar habitats, do provide information on habitat requirements and selection (Kalsi, 1992; Javed & Rahmani, 2000); our study only details the patterns in abundance across seasons. Our study is the first study that has estimated abundance of peafowl and one of the few studies estimating abundance of RJF, while accounting for probability of detection across seasons in India. However, comparisons of abundance estimates were not possible as the methods employed did not correct for the probability of detection. It is in this regard that we urge further studies on these species to adopt methods incorporating detection probabilities to estimate population sizes reliably.

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References

ALI, S. & RIPLEY, S.D. (1987) *Compact Handbook of the birds of India and Pakistan.* Oxford University Press, New Delhi.

ANDERSON, D.R., LAAKE, J.L., CRAIN, B.R. & BURNHAM, K.P. (1979) Guidelines for line transect sampling of biological populations. *Journal of Wildlife Management*, 43, 70-78.

AZHAR, B., ZAKARIA, M., YUSOF, E. & LEONG, P.C. (2008) Efficiency of Fixed-Width Transect and Line-Transect-based Distance Sampling to Survey Red Junglefowl (*Gallus gallus spadiceus*) in Peninsular Malaysia. *Journal of Sustainable Development*, 1, 63-73.

BUCKLAND, S.T., ANDERSON, D.R., BURNHAM, K.P. & LAAKE, J.L. (1993) *Distance sampling: Estimating abundance of biological populations.* Chapman and Hall, London.

BUCKLAND, S.T., ANDERSON, D.R., BURNHAM, K.P., LAAKE, J.L., BORCHERS, D.L. & THOMAS, L. (2001) *Introduction to distance sampling: Estimating abundance of biological populations.* Oxford University Press, Oxford.

BURNHAM, K. P., ANDERSON, D. R., & LAAKE, J. L. (1980) Estimating density from line transect sampling of biological populations. *Wildlife Monograph*, 72, 1-202.

CHAMPION, H.G. & SETH, S.K. (1968) *The Forest Types of India.* Government of India Press, Nasik, India.

CHOUDHURY, B.C., SATHYAKUMAR, S. & CHRISTI SYLVIA. (2007) An assessment of the current status of the Indian Peafowl (*Pavo cristatus*) in India based on questionnaire survey. In *Galliformes of India, ENVIS Bulletin, Wildlife and Protected Areas*, Vol 10 (eds S. Sathyakumar, and K. Sivakumar), Wildlife Institute of India, Dehradun, India.

COLLIAS, N.E. & COLLIAS, E.C. (1967) A field study of the Red Junglefowl in North-Central India. *The Condor*, 69, 360-386.

CONROY, M.J. & CARROLL, J.P. (2001) Estimating abundance of Galliformes: tools and application. In *Proceedings of the 7th International Galliformes Symposium* (eds M. Woodburn, P. McGowan, J. Carroll, A. Masavi, & D. Z. Zang), pp 204-215. Kathmandu, Nepal, World Pheasant Association, UK.

DATTA, A. (2000) Pheasant abundance in selectively logged and unlogged forests of western Arunachal Pradesh, Northeast India. *Journal of Bombay Natural History Society*, 97, 177-183.

DUKE, G. (1990) Using call counts to compare Western Tragopan populations in Pakistan's Himalaya. In *Pheasants in Asia 1989* (eds D. A. Hill, P. J. Garson, & D. Jenkins), pp. 193-199. World Pheasant Association, Reading, U.K.

FULLER, R. A. & GARSON, P. J. (2000) *Pheasants: Status Survey and Conservation Action Plan 2000–2004.* WPA/Birdlife/SSC Pheasant Specialist Group, IUCN, Gland, Switzerland, and Cambridge, UK, and the World Pheasant Association, Reading, UK.

GASTON, A. J. (1980) Census techniques for Himalayan pheasants including notes on individual species. *Journal of World Pheasant Association*, 5, 40-53.

GHOSE, D., KAUL, R. & SAHA, G.K. (2003) Status survey of the Blyth's tragopan in Blue Mountain National Park, Mizoram, India, using call-count technique. *Current Science*, 84, 95-97.

IUCN. (2009) IUCN Red List of Threatened Species. Version 2009.1. <http://www.iucnredlist.org/> Accessed on 5 September 2009.

JAVED, S. & RAHMANI, A.R. (2000) Flocking and habitat use pattern of the Red Junglefowl *Gallus gallus* in Dudwa National Park, India. *Tropical Ecology*, 41, 11-16.

JOHNSGARD, P.A. (1986) *The Pheasants of the World*. Oxford University Press, New York.

KALSI, R.S. (1992) Habitat selection of Red Junglefowl at Kalesar Reserve Forest, Haryana, India. In *Proceedings of the 5th International Symposium on Pheasants in Asia* (eds D. Jenkins and others), pp 80-82. Lahore. Pakistan, World Pheasant Association, UK.

KHALING, S., KAUL, R. & SAHA, G.K. (1998) Survey of the Satyr Tragopan *Tragopan satyra* in the Singhalila National Park, Darjeeling, India using spring call counts. *Bird Conservation International*, 9, 361-371.

KHAN, W.M. & SHAH, I.H. (1982) Population dynamics of the Koklass Pheasant (*Pucrasia macrolopha*) in Malkandi forest, Pakistan. *In Pheasants in Asia 1982* (eds C. D. W. Savage & M. W. Ridley), pp 40-43. World Pheasant Association, Reading, UK.

KUMAR, S.R., RAWAT, G.S. & SATHYAKUMAR, S. (2006) Winter Ecology of Impeyan Monal *Lophophorus impejanus* (Latham) in Kedarnath Wildlife Sanctuary, India. *Journal of Bombay Natural History Society*, 103, 49-56.

LIU, YI-PING., WU, GUI-SHENG., YAO, YONG-GANG., MIAO, YONG-WANG., LUIKART, G., BAIG, M., BEJA-PEREIRA, A., DING, ZHAO-LI., PALANICHAMY, M.G. & ZHANG, YA-PING. (2006) Multiple maternal origins of chickens: Out of the Asian jungles. *Molecular Phylogenetics and Evolution*, 38, 12-19.

MADGE, S. & MCGOWAN, P. (2002) *Pheasants, partridges and grouse. Including* *buttonquails, sandgrouse and allies.* Helm Identification Guides, A & C Black Publishers Ltd., London.

O'BRIEN, T.G., WIBISONO, H.T. & KINNAIRD, M.F. (2003) Crouching Tigers, Hidden Prey: Sumatran Tiger and Prey Populations in a Tropical Forest Landscape. *Animal Conservation*, 6, 131-139.

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

RAMESH, K. & MCGOWAN, P. (2009) On the current status of Indian Peafowl *Pavo cristatus* Aves: Galliformes: Phasianidae): keeping the common species common. *Journal of Threatened Taxa*, 1, 106-108.

REICZIGEL, J. & RÓZSA, L. (2007) Flocker 1.1. Budapest, Hungary. <http://www.behav.org/flocker/.>

REICZIGEL, J., LANG, Z., RÓZSA, L. & TÓTHMÉRÉSZ, B. (2008) Measures of sociality: two different views of group size. *Animal Behaviour*, 75, 715-721.

THOMAS, L., LAAKE, J. L., STRINDBERG, S., MARQUES, F. F.C., BUCKLAND, S.T. & BORCHERS, D.L. (2006) Distance 5. Release 2. Research Unit for Wildlife Population Assessment, University of St. Andrews. <HTTP://WWW.RUWPA.ST-ND.AC.UK/DISTANCE/>.

YOUNG, L., GARSON, P. J. & KAUL, R. (1987) Calling behaviour and social organisation in the Cheer Pheasant: implications for survey technique. *Journal of World Pheasant Association*, 12, 30-43.

Biographical sketches

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