**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\(^\circ\)C to ~40\(^\circ\)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\(^\circ\)C to ~35\(^\circ\)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 ($\mu$) 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 $\mu$ did not vary significantly across the season. The estimated $\mu$ ranged from 47.35 ± 6.5 m in the dry season to 32.81 ± 5.8 m in the wet season. However, the estimated $\mu$ differed across species, with the best selected models to fit the RJF data for each season (Fig. 2a, b) estimated $\mu$ ranging from 18.5 ± 4.5 m in the dry season to 17.8 ± 3.8 m in the wet season.
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 tosparse 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°C to 19.0 ± 0.5°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


Biographical sketches

ABISHEK HARIHAR has a particular interest in the population dynamics of mammals. For the past 6 years he has been monitoring large mammalian prey and predator populations in the Rajaji National Park. MERWYN FERNANDES has a Masters in Wildlife Biology, currently working as a Research Fellow with the Wildlife Institute of India. His areas of interest include wildlife law and policies, urban biodiversity and bird behaviour.