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SHORT COMMUNICATION

ESTIMATING THE DENSITY OF RED JUNGLEFOWL *GALLUS GALLUS* (GALLIFORMES: PHASIANIDAE) IN THE TROPICAL FOREST OF SIMILIPAL TIGER RESERVE, EASTERN INDIA

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Estimating the density of Red Junglefowl *Gallus gallus* (Galliformes: Phasianidae) in the tropical forest of Similipal Tiger Reserve, eastern India

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Abstract: To determine population status of wild animal using reliable sampling techniques forms an important component of conservation effort and effective wildlife management. We estimated the density of Red Junglefowl *Gallus gallus* using distance sampling, a quantitatively robust technique, in Similipal Tiger Reserve, Odisha, eastern India during September 2012 to May 2013. We laid 27 transects and walked seven to eight times for a total of 390km to obtain the distance sampling data. We used DISTANCE software for analysis. We estimated per km^2 Red Junglefowl group density as 4.99 and density as 7.64 birds in the intensive study area. Mean group size of Red Junglefowl was 1.48. Our results may prove helpful in planning better management needs and strategies for the survival and conservation of Red Junglefowl in different protected areas.

Keywords: Density, Distance sampling, *Gallus gallus*, line transect, Similipal Tiger Reserve.

Monitoring the population status of wild animals forms an important component of conservation effort and effective wildlife management. It provides information on the status of wildlife populations and can help evaluate effective conservation actions, thereby allowing for adaptive management (Williams et al. 2002). Additionally, it can give an insight into the biology of species, especially the fundamental process of survival and reproduction and vulnerability to immediate or long-term threats (Rockwood 2006). Large or medium-sized ground dwelling birds like the Red Junglefowl *Gallus gallus* play an important functional role in ecosystems, including dispersing seeds and controlling insect pests (Arshad et al. 2000), and serving as prey for large or small carnivores (Borah et al. 2009; Hayward et al. 2012). Furthermore the Red Junglefowl (hereafter RJF) species is very sensitive to forest fires as its ground nesting period coincides with forest fires in the tropical forests of India (Javed & Rahmani 2000). Therefore, monitoring the population of RJF is crucial for conservation and for forest management through conserving its habitat.

The RJF is distributed along the foothills of Himalaya from Myanmar to northwestern India extending southward into the hills of peninsular India (Ali & Ripley 1983). It also occurs in tropical and subtropical habitats in Myanmar, southern China and Indonesia to Java (Sullivan 1991; Ferrnandes et al. 2009). The RJF is listed as Least Concern in status because of its large range and population size (Birdlife International 2012). In many of the ranges the species is thought to be facing threats from habitat destruction and genetic contamination due to interbreeding with domestic chicken (Peterson & Brisbin 1998). Out of the five sub-species of RJF, two

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sub-species are found in India, *Gallus gallus murghi* and *Gallus gallus spadiceus* (Ali & Ripley 1983). *Gallus gallus murghi* is spread across in the northern and central parts of India, extending eastwards to Odisha and West Bengal and the *Gallus gallus spadiceus* is distributed in the northeastern parts (Collias & Collias 1967; Ferrnandes et al. 2009).

Despite its wide distribution in India, very few studies have been conducted on the RJF and these mainly relate to abundance and conservation status (Ferrnandes et al. 2009; Subhani et al. 2010; Harihar & Fernandes 2011), and habitat use (Javed & Rahmani 2000). Similipal is both a tiger reserve and a biosphere reserve that was established to conserve an integral assemblage of biodiversity with diverse habitat. Similipal forms a crucial link between the foothills of the Himalaya and the Eastern Ghats, as indicated by the presence of flora and fauna belonging to both these areas (Saxena & Brahmam 1989; Nair 2007, 2009, 2011, Sahoo et al. 2012; Mohapatra et al. 2014). This study comprehensively documents the population density, abundance and group size of RJF in the tropical forest of Similipal Tiger Reserve, eastern India.

Figure 1. Intensive study area and location map of Similipal Tiger Reserve

Study area

The study was carried out in Similipal Tiger Reserve, eastern India. The area is the 3rd largest tiger reserve in India, covering over 2,750km^2, and is characterized by an undulating hilly terrain. The altitude ranges between 300m and 1,200m. It lies between 20^{0}17'–22^{0}34'N & 85^{0}40'–87^{0}10'E. Some consider Similipal as part of the Eastern Ghats (Sinha 1971), while others treat it as the south-eastern extension of the Chhota Nagpur Plateau (Ray 2005). The area falls under the province of Chhotanagpur in the Deccan Peninsula bio-geographic zone (Rodgers & Panwar 1988). The survey was conducted within the "intensive study area" (ISA) of 421km^2, representing all major terrain and vegetation structure found in the tiger reserve (Fig. 1). The climate is seasonal, with a rainy season between July and October and an average annual precipitation of 1850mm (Srivastava & Singh 1997). The winter and summer seasons occur between November and February and March to June, respectively. Temperatures range from 3^{0}C in December and January to 38^{0}C in June. Champion & Seth (1968) classified the reserve as a tropical moist deciduous forest, dominated by *Shorea robusta, Syzygium cumuni*, *Mangifera indica, Terminalia tomentosa* and *Anogeissus latifolia*. Similipal is home to 1076 species of plants, 55 species of mammals, 304 species of birds, 60 species of reptiles, 21 species of amphibians and 38 species of fishes (Dutta et al. 2009).

Methods

Field sampling was carried out from the months of September 2012 to May 2013. The distance sampling by the line transect method was used to estimate densities of RJFs in the intensive study area (Buckland et al. 2001). A total of 27 line transects (each 2km long) were placed in the study area, totaling 54km. We made six to seven repeated walks on the transects, totaling a distance covered of 390km. The surveys were carried out between 06:00–10:00 hr and 16:00–18:30 hr. When the species were encountered we recorded the following information: the number of individuals; sex; sighting distance: distance to the species from the point of observation by using a range finder; and sighting angle: the angle between the transect line and the species from the point of observation was calculated using a hand-held compass.

We analyzed the data using the DISTANCE version-6 (Thomas et al. 2010) software and computed the estimate of density. We pooled the data from temporal replicates of each transect and treated the mean as a single sample (sample size = 27). We truncated the farthest sightings on transects to achieve a reliable density estimate. We estimated variance in encounter rates of animals between transects empirically (Buckland et al. 1993). We judged the fit of possible alternative models to each

specific dataset using Akaike's information criterion (AIC) value and goodness of fit tests generated by the program DISTANCE, and selected the best possible model. We generated encounter rate, average probability of detection and density using the selected model in the program DISTANCE.

Results

We recorded a total of 126 individuals of RJF on 85 occasions. The estimated cluster was 4.99 per km^2 with a mean group size of 1.48±0.13 (SE) and the encounter rate was 0.21 per km. The density of individuals was estimated to be 7.64 RJF per km^2 (95% confidence interval of 5.74–11.31 RJF per km^2) and the percent of coefficient of variation was 18.03 (Table 1; Image 1). The minimum population density of 5.74 RJF per km^2 account for 2417 RJF (lower CI) in the intensive study area of Similipal Tiger Reserve. The sightings ranged between 1 and 4 RJF with a mean of 1.48±0.79 (SD) RJF. Most of the sightings were single RJF (44.1%), although groups of two (28.3%), three (21.3%) or four (6.3%) were also sighted (Fig. 2).

We attempted to estimate seasonal density of RJF in the study area. Seasonal sightings were too low to estimate reliable density. Thomas et al. (2010) recommended that 45–60 sightings were essential to estimate reliable density.

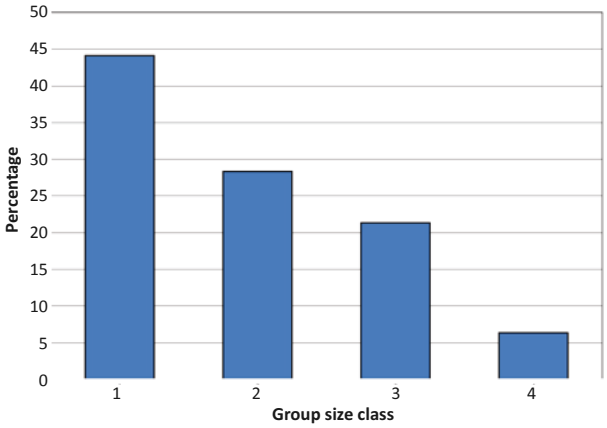

Figure 2. Group size classes of Red Junglefowl *Gallus gallus* in the Similipal Tiger Reserve (Total number of Red Junglefowl 126 in 85 sightings).

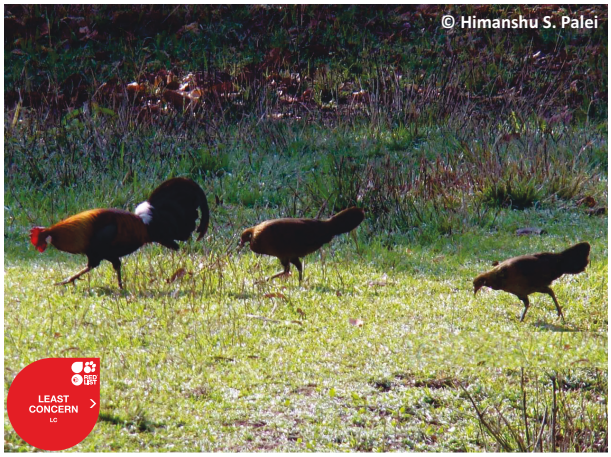

Image 1. Red Junglefowls *Gallus gallus* in Similipal Tiger Reserve

Discussion

Although distance sampling methodology has been used to estimate the density of Grey Junglefowl in many protected areas in India (Ramesh et al. 2011; Selvan & Sridharan 2012; Narasimmarajan et al. 2012), similar density estimates of RJFs are available only from Rajaji National Park (Harihar & Fernandes 2011). Our estimated density is lower than the density estimated from the Rajaji National Park (13.54 RJFs/km^2). The variation of density in different studies could be influenced by many factors such as season, annual variations and observer differences. However, in the absence of comparable density estimates from across representative habitats within India, it is difficult to identify the regulators of density of RJFs. The distance sampling technique based on line transect sightings of RJF provided a statistically robust estimate in estimating the population. By adopting this technique, comparable density estimates of the RJF can be generated from protected areas across the country which can serve as critical baseline data for future monitoring.

Table 1. Density estimate of Red Junglefowl *Gallus gallus* in the Similipal Tiger Reserve

Sightings	Group density (Dg/ km^2)		CV (%)	95% Confidence interval		Group size		Individual density (D/ km^2)		CV (%)	95% Confidence interval	
N	Dg	SE		Lower	Upper	GS	SE	D	SE		Lower	Upper
85	4.99	0.84	16.53	3.77	7.13	1.48	0.13	7.64	1.43	18.03	5.74	11.31

N - Total number of sightings; Dg - Group density; D - Density; SE - Standard error; CV - Coefficient of variance; GS - Group size.

Although our results for RJF population density in the Similipal are important, we still need a better understanding of ecological dynamics in RJF abundance. To fill this gap and to provide specific forest management recommendations to local institutions, we suggest that future research should focus on: (i) long term population monitoring of RJF to know population/ demographic parameters such as population trend and survivorship, (ii) investigating the ecological drivers that may explain population abundance among different habitats more broadly, (iii) the impact of forest fire and other anthropogenic disturbances on the RJF population. Along with population density, these issues are important for filling in the gap in information on status and ecology of this wide-ranging but less-studied species, which is important for both management and scientific reasons.

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