Research Article

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Population Structure and Distribution of Asian Elephants in Dandeli-Anshi Tiger Reserve, India

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Abstract. The northern-most population of Asian elephants (*Elephas maximus*) in the Western Ghats resides in the North Kanara district of Karnataka state. I conducted a study on the major part of this elephant population which occurs in the Dandeli-Anshi Tiger Reserve, assessing their distribution, numbers and population structure, based on secondary information and field surveys. Elephant presence was confirmed in the Kulgi, Phansoli and Gund ranges of the Reserve. A total of 23 individual elephants were identified, providing a minimum estimate. The identified individuals consisted of 39.1% adults, 26.1% sub-adults, 30.4% juveniles and 4.4% calves. The sex ratio showed a gradual skew towards females from juvenile to adult.

Introduction

India holds 50-60% of free ranging Asian elephants (Vidya *et al.* 2005; Riddle *et al.* 2010), with four distinct populations in north-east, central, north-west and southern India (Sukumar 1986, 2003; Sukumar & Santiapillai 1996; Bist 2002). South India harbours approximately 22% of the global Asian elephant population (Vidya *et al.* 2005). This southern population can be divided into North Kanara, Brahmagiri–Nilgiri–Eastern Ghats, Anamalais–Nelliampathi–High Range and Periyar–Agasthyamalai subpopulations (Baskaran 2013). North Kanara in Karnataka represents the northernmost distribution of the southern population.

The North Kanara subpopulation consists of a few elephant herds scattered at low density, numbering perhaps less than 100 (Prasad *et al.* 1979; Sukumar 1986; Vidya *et al.* 2005; Baskaran 2013). The major part of this subpopulation is known to reside in the Dandeli-Anshi Tiger Reserve (Baskaran 2013). It is believed that this subpopulation was connected to the Mysore subpopulation, which is part of Brahmagiri-Nilgiri-Eastern Ghats (Nair & Gadgil 1980). The two subpopulations were also found to share the same mitochondrial haplotype (Vidya *et al.* 2005). Habitat loss and fragmentation in their traditional migratory routes confined the elephants to North Kanara making them vulnerable (Sarma & Easa 2006; Riddle *et al.* 2010). Since 1999, they have been extending their range towards Belgaum, Maharashtra and Goa (Sarma & Easa 2006; Kulkarni *et al.* 2008; Baskaran 2013). Information on the distribution, habitat conditions, size and structure of this population is required for conservation planning (Sukumar & Easa 2006; Baskaran 2013). This study provides preliminary information on the population structure of elephants and their distribution in Dandeli-Anshi Tiger Reserve.

Methods

Study area

The Dandeli-Anshi Tiger Reserve (recently renamed as the Kali Tiger Reserve through a gazette notification dated 11th December 2015) is located in the North Kanara district of Karnataka State between 14° 57' – 15° 9' N and 74° 15' – 74° 43' E and is part of the biologically rich Western Ghats. It is composed of two contiguous protected areas, the Dandeli Wildlife

Sanctuary and the Anshi National Park (Fig. 1). The reserve is spread over an area of 1074 km^2 and consists of five forest ranges (Kulgi, Phansoli, Gund, Anshi and Kumbarwada). Temperature varies from 16°C to 36°C with the coldest temperatures during January and highest in April-May. Rainfall occurs mainly from the South West monsoon (June to September) and varies from 1250 mm in the eastern part to 4000 mm in the west. Corresponding to the rainfall gradient, moist deciduous forest in the east transits to semi-evergreen forest in the west. Major vegetation types in the area include South Indian Moist Deciduous Teak Forest, Southern Moist Mixed Deciduous Forest and West Coastal Semi-evergreen Forest with Bamboo and riparian stands (Champion & Seth 1968). River Kali and river Kaneri are two major perennial natural sources of water in the reserve along with several undulating streams and springs flowing inside the reserve.

Elephant distribution

Information about elephant presence was obtained from the Forest Department staff and villagers, which indicated that elephants were absent from the Anshi and Kumbarwada Forest Ranges and the southern and western part of Gund Range. Based on this information, a field survey was conducted in the Kulgi and Phansoli Ranges and part of Gund Range. In the field survey, existing paths or trails in forest areas were traversed on foot, at an average of 3-4 km per day. The trail survey was carried out from 6:00–9:00 h and 16:00–18:00 h. The total distance covered was 48 km. Fieldwork for data collection was carried out from February to April 2011.

GPS points were taken for each sighting of elephants and elephant sign such as dung, footprints, feeding signs, mud marks on tree trunks, and places of mud bathing. The number of dung piles clustered together was also noted. Secondary information about elephant encounters was collected from local villagers and GPS points of the locations were taken.

A map of elephant distribution was generated from location data using ArcGIS version 9.2.

To evaluate the pattern of elephant distribution in different ranges, dung encounter rates (number of dung piles/km surveyed) were used as an index of relative abundance (Sundaram *et al.* 2003). Encounter rates were categorized as high (>4 dung piles/km), medium (1-4 dung piles/km) or low (<1 dung pile/km).

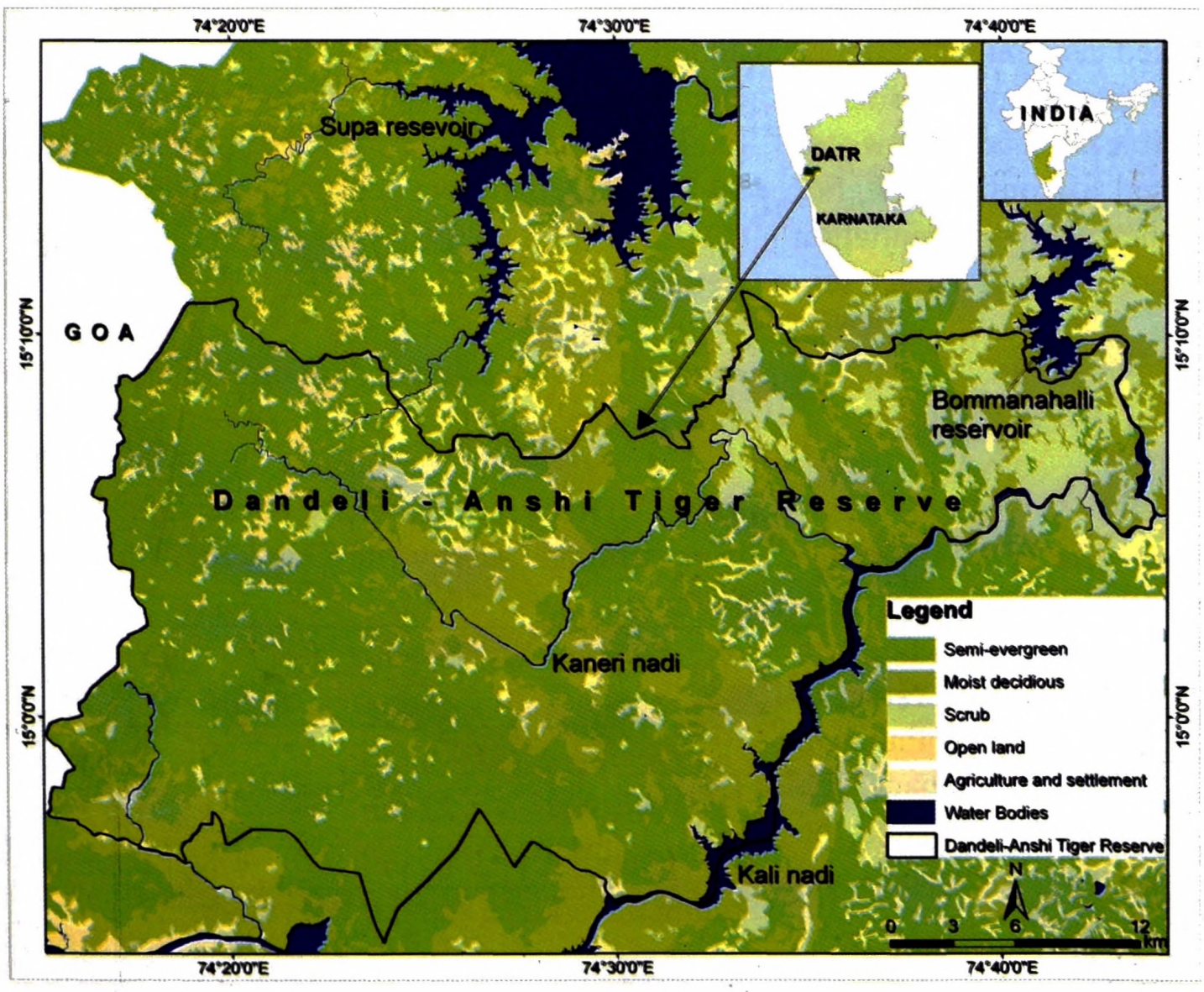

Figure 1. Map of the study area, Dandeli-Anshi Tiger Reserve. Source: Asian Nature Conservation Foundation, Bangalore, India.

Individual identification and age-sex structure

In areas with low elephant densities, methods such as line transects with direct sightings or dung counts are ineffective in population size estimation and instead, individual identification is preferred (Varma *et al.* 2008). Hence, all elephants encountered were photographed and individually identified based on morphological features (Vidya *et al.* 2014) and their body condition scored (Fernando *et al.* 2009). Photographs were taken using a Canon D1000 digital camera with a Sigma DG 70-300 mm lens.

At each sighting of elephants, group size and sex of individuals were recorded. Photographs of the lateral view were taken so that the foot and shoulder were clearly visible. Any trees close to the elephants that could be used for height reference were noted and measured after the elephant moved away or a calibrated vertical pole was held by an assistant at the exact spot where the elephant was and a picture taken to estimate the shoulder height (Arivazhagan & Sukumar 2008). Ages of individuals were calculated from their shoulder height following Sukumar *et al.* (1988) and were categorised into calf (<1 year old), juvenile (1-5 years old), sub-adult (5-15 years old) and adult (>15 years old) classes (Arivazhagan & Sukumar 2008). Individuals with tusks were identified as male and those without tusks or with tushes were considered females. Wherever possible, the appearance of external genitalia was used to confirm sex. For calves and juveniles, when sex differentiation was not possible, 50% were assigned to each sex.

Results and discussion

Elephant distribution

All sightings of elephants were in Kulgi Range around Bommanahalli reservoir except for three elephants sighted once at night in crop fields in the Phansoli Range. Elephant sign was found in the sampled forest areas of Kulgi and Phansoli Ranges while in the Gund Range elephant sign was restricted to the Kaneri river basin. Thus, the presence of elephants in the Kulgi, Phansoli and Gund ranges of the Dandeli-Anshi Tiger Reserve indicated by the secondary information was confirmed by the field survey.

A high density of elephant sign was found around the Bommanahalli Reservoir in Kulgi range (Fig. 2). This may have been due to greater detection in the dry open habitat and frequent crossing of roads by elephants moving to and fro from the reservoir, as the surveyed trails were within 5 km of the reservoir.

Dung encounter rates (Table 1) were high in Kulgi Range which has dry deciduous habitat with flatter terrain, medium in Phansoli and low in Gund Ranges which have moist deciduous and semi-evergreen forest patches with undulating terrain. Dung piles were more commonly found in clusters and contained boli of various sizes, suggesting the presence of larger groups (>5) in Kulgi and smaller groups (<4) in Phansoli and Gund Ranges.

Elephant numbers

Elephants were encountered 8 times and the number of elephants sighted was 57. Of these, 31 were individually identifiable from photographs, which found 23 individuals and 8 re-sightings. Thus, the minimum population size estimate for the reserve is 23, although it is likely to be an underestimate. Therefore, the total number of elephants in the Dandeli-Anshi Tiger Reserve is likely to be at the upper end of the 15-50 estimated by Forest Department census or greater.

Age-sex structure

Analysis of the age structure of identified individuals found 9 adults, 6 sub-adults, 7

Table 1. Relative abundance of elephants drawn from ground survey in Dandeli-Anshi Tiger Reserve.

#	Range	Distance walked	# Signs	Encounter rate*
1	Kulgi	16 km	69	4.3 ± 3.3
2	Phansoli	22 km	31	1.4 ± 0.6
3	Gund	10 km	8	0.8 ± 0.7

*dung piles/km ± standard deviation

juveniles and 1 calf. The assessed population structure showed a lower proportion of sub-adults (26%) compared to juveniles (30%). As the sub-adult segment represents a wider age range (10 years) than the juvenile segment (4 years), the number of sub-adults is expected to be higher than juveniles in any population (Sukumar 2003). The discrepancy observed could be due to misclassification or small sample size in the present study, non-correspondence of the size and age classes, or a real decline in sub-adult category or increase in the juvenile category.

The male : female ratio showed a gradual skew towards females from juvenile (1 : 0.8) to sub-adult (1 : 2) and adult (1 : 8). Such female biased sex ratios have also been reported from Mudumalai and Bandipur National Parks (Varma 2000). In a polygynous species like elephants, moderately female-biased sex ratios do not affect population growth (Sukumar 2003).

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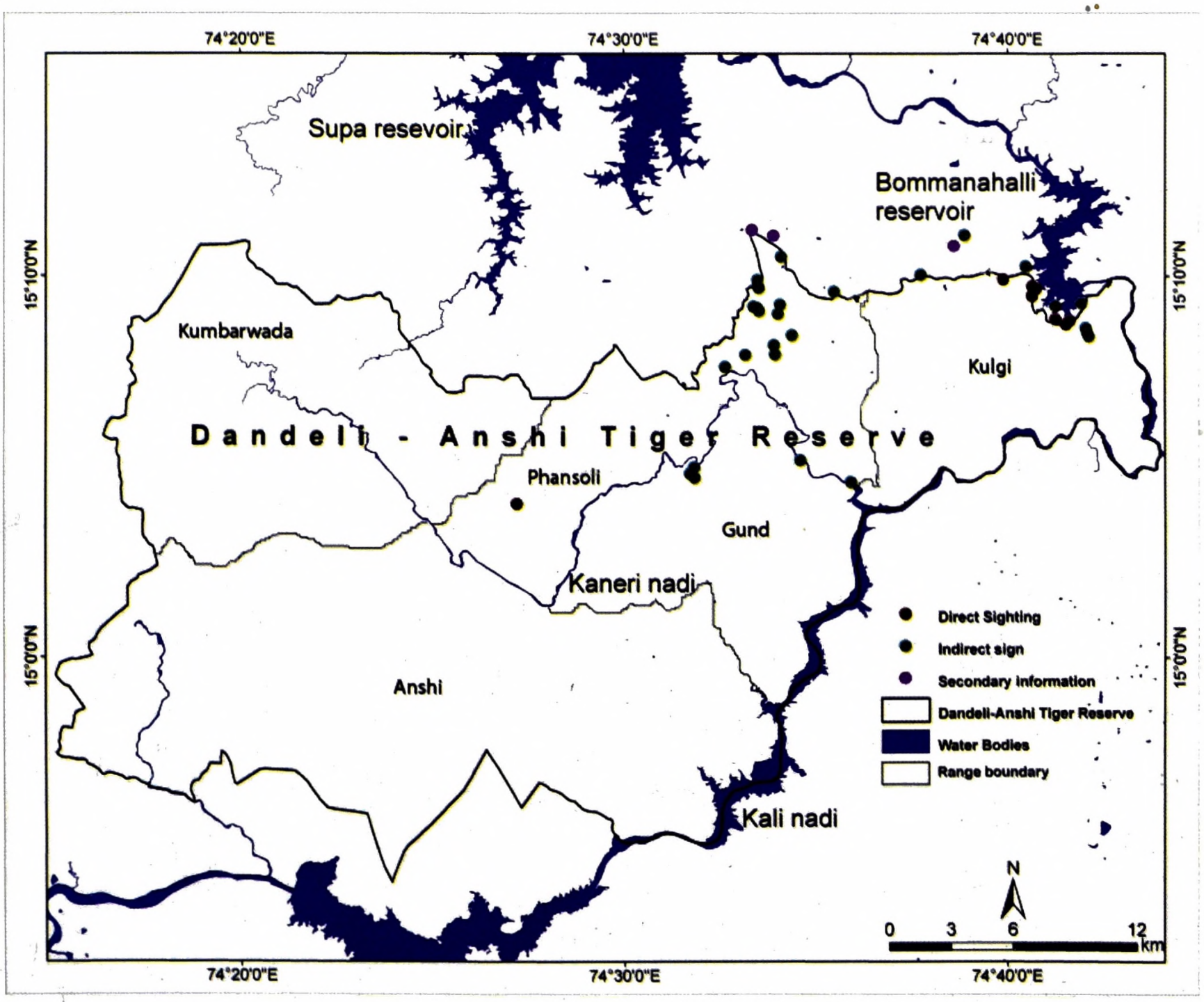

Figure 2. Map showing the distribution of elephants drawn from direct sighting, indirect signs and secondary information in Dandeli-Anshi Tiger Reserve. Source: Asian Nature Conservation Foundation, Bangalore, India.

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