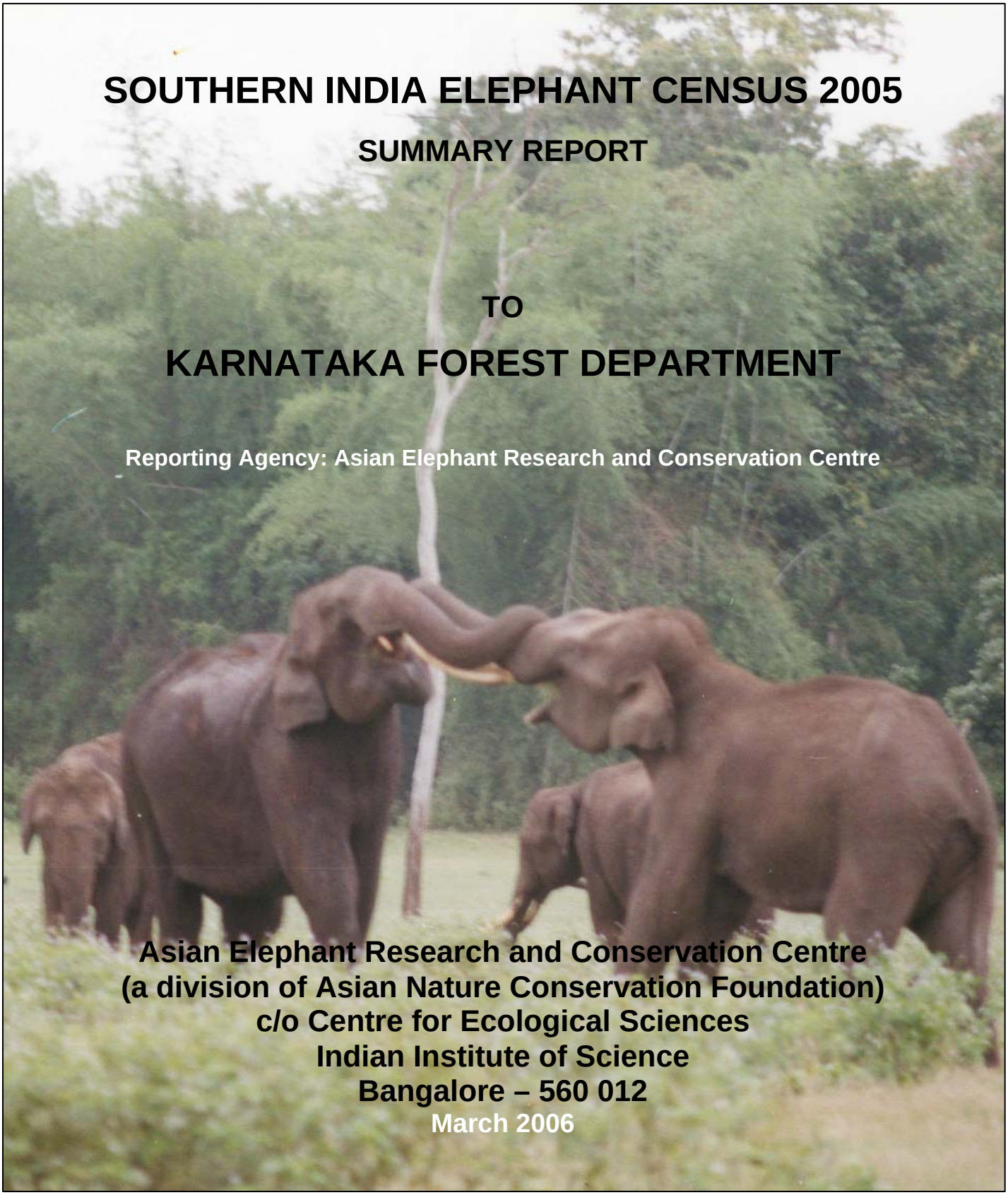
SOUTHERN INDIA ELEPHANT CENSUS 2005

SUMMARY REPORT

TO

KARNATAKA FOREST DEPARTMENT

Reporting Agency: Asian Elephant Research and Conservation Centre



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March 2006

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I. INTRODUCTION

A synchronized Elephant Census was carried out in May 2005 by the southern states with the coordination of Project Elephant, Government of India. Field data were collected between 5th and 7th May 2005 in all the four southern states - Karnataka, Tamil Nadu, Kerala and Andhra Pradesh. At the request of the Chief Wildlife Warden, Karnataka, the Asian Elephant Research and Conservation Centre took on the task of analyzing the data for various forest divisions in the state and producing this report.

Project Elephant Directorate recommended that two methods, a direct method (random block count) and an indirect method (dung count through line transects – Barnes & Jenson, 1987) be used for elephant density and population estimation, and a waterhole count for population structure as was done during the census of 2002. A one-day workshop on elephant census techniques was organized during December 2004 at Bandipur Tiger Reserve, for officers from all the Elephant Ranges of India by the Project Elephant Directorate with the help of CITES/MIKE South Asia and the Asian Elephant Research and Conservation Centre. During the workshop, detailed discussions took place on the relevance of various existing census methods, the rationale behind them and the relevance of the methods chosen. Sampling design for different forest divisions and the proposed data analysis were also discussed. As per decisions taken, block counts were conducted on 5th May, waterhole counts on 6th May and dung counts were carried out on 7th May 2005 across all the elephant divisions in Karnataka.

Asian Elephant Research and Conservation Centre was approached by the Karnataka Forest Department after the field operations were over, with a request to assist in data analysis. The field data from various divisions were provided to us for this task. Initially, it was seen that the data from some of the divisions were in non-standard formats and, hence, field visits by the staff of AERCC were necessary in order to collect the original raw data from these divisions. This task was completed only in February 2006. This report thus may still have some limitations in the analysis and results for some of the forest divisions.

II. METHODS

1. Sample block count

Elephants were counted from sample blocks selected randomly across the entire division. Between 30% and 50% of the beats were randomly chosen and designated as census blocks on the compartment map of the division. A team of two to three people perambulated the sample blocks and all elephant sightings were recorded in the block count data sheet. In addition, when possible, the age and sex of all animals seen were recorded. Age and sex classification was carried out using a key described in another section (see Population structure from sample block counts and waterhole counts). Where sample sizes were adequate, the statistical analysis of data were carried out for blocks of unequal sizes using the method described in Lahiri-Choudhury (1991). Due to non-availability of required variables such as block size, the block count data were not analyzed in as much detail for some divisions.

2. Line transect dung count method

In all divisions, line transects were laid in those blocks where the block count was undertaken. In each sample block a transect of length 2 km was laid across the altitudinal gradients and walked once to enumerate dung piles. On sighting dung piles from the transect line, information such as perpendicular distance and degradation stage of the dung pile were recorded. The line transect dung count data were used to estimate dung density using computer programme ***Distance Version 5*** and this dung density was converted into elephant density using ***Monte Carlo simulations*** (***GAJAHA Ver. 2.0***) by incorporating elephant defecation rate and elephant dung decay rate. The defecation rate (16.33) calculated by Watve (1992) in Mudumalai Wildlife Sanctuary was used in the present analysis. A decay rate of 0.0097 as calculated by Varman *et al.* (1995) for Mudumalai Wildlife Sanctuary for the analysis.

3. Population structure from block counts and waterhole counts

Waterhole count:

Water sources like streams, rivers and water holes were chosen within or close to the randomly chosen compartment or block in each division to understand population structure of elephants. Observations were made on the elephants visiting these points by teams sitting on a tree, *machaan* or hide. These data were collected on 7th May 2005. During this period all elephants visiting the waterhole were sexed as being male or female. From these data the sex ratio was calculated for adults in each division.

In order to understand age structure of the population, elephants were also classified into four major age classes based on their heights - i.e., calf (<1 year old), juvenile (>1 year to 5 years old), sub-adults (>5 year to 15 years old) and adults (>15 years) based on shoulder height as suggested by Sukumar *et al*. (1988). Individuals were recorded as 'Unidentified' if they could not be categorized into a specific age and sex.

Block count:

During the sample block count, apart from recording the number of elephants within the sample block, the age and sex of all animals seen were recorded when possible. Age and sex classification was done as described in the waterhole count. Age and sexing elephants is easier at waterholes than while carrying out block counts where visibility is often poor due to dense undergrowth. However, this was carried out in order to have a larger sample size in some of the divisions, which have low elephant densities.

III. RESULTS AND DISCUSSION

1. Elephant population estimated using block count method

The census was carried out in 26 forest divisions in Karnataka (Table 1). Due to the non-availability of raw data and data of sample block size in many instances, elephant numbers with statistical confidence limits were estimated only for 9 Forest Divisions. For divisions where all the required variables were not available or sample sizes were too small for statistical analysis, densities were calculated from the number of elephants sighted within the sampled area and extrapolated to the total division area. In such divisions, the number of elephants counted during sample block count was shown as LCL, as otherwise the estimated LCL in these divisions was less than the number of elephants counted and in some cases was towards the minus side.

A total of 1640 elephants were recorded by sampling teams during block counts within the 26 forest divisions. Using densities calculated by dividing the number of elephants sighted by the sampling area, elephant population size was estimated as 4,347 for all the divisions together. The present estimate is lower compared to 5800 elephants estimated during census of May 2002. Such differences in the estimate of elephants for Karnataka do not reflect any significant population reduction but could be due to changes in habitat use of elephants between May 2002 and May 2005; thus one would have to look at estimates for adjoining forest divisions in Tamil Nadu and Kerala. At the same time, we cannot rule out the possibility of undercounts of elephants in many blocks that were larger in size. In fact, this is a distinct possibility because the sample block size in some cases were as high as 25 km^2 where it would be impossible for a small team to effectively perambulate and count elephants.

Table 1: Elephant population estimated using sample block count for the forest divisions of Karnataka

S. No.	Division	Elephants Sighted	No. of Blocks [area sampled, km^2]	Mean elephant density/ km^2	Division Area Km^2	Estimated Population	95% CL	
							LCL	UCL
1	Bandipur	459	38 [459]	1.34	906.32	1217	825	1610
2	Nagarahole	328	21 [262]	1.25	643.36	804	459	1149
3	Bhadra WLS	135	10 [124.4]	1.09	492.3	534	178	891
4	BRT WLS *	173	NA [207.7]	0.83	583.67	486	173	1052
5	Virajpet	60	28 [60]	0.88	337	297	142	332
6	Cauvery WLS	202	36 [236.6]	0.85	510.5	445	255	636
7	Kollegal	49	66 [398.5]	0.12	1145	151	114	188
8	Madikeri [T]	26	12 [131]	0.2	373.22	75	32	116
9	Bannerghatta *	52	4 [73.5]	0.71	104	74	52	160
10	Hunsur [T] *	16	4 [22.2]	0.72	142.7	16	16	114
11	Madikeri - WL	26	8 [82]	0.32	197.66	63	16	110
12	Hassan *	42	13 [140.22]	0.3	249.6	75	42	222
13	Bangalore Rural*	29	8 [84.12]	0.34	84.12	29	29	51
14	Mysore [T] *	11	4 [67.42]	0.16	131.52	17	11	47
15	Brahmagiri	7	5 [53.69]	0.07	181	13	6	21
16	Chikkamagalur **	8	16 [NA]	NC	??	8	8	8
17	Mandya *	7	4 [85.4]	0.08	96.9	8	7	18
18	Dandeli *	5	59[346.09]	0.02	894.53	26	5	37
19	Belgaum	2	84 [NA]	-	1448.82	2	2	2
20	Karwar *	2	62 [455.5]	0.004	1421.78	6	2	19
21	Shimoga	1	NA		826.6	1	1	1
22	Haliyal	0	147 [359]	-	1421.78	0	0	0
23	Yellapur	0	100[??]	-	548.8	0	0	0
24	Koppa	0	46 [NA]	-	??	0	0	0
25	Bangalore Urban	0	1 [11.8]	-	??	0	0	0
26	Sirsi	0	60 [NA]	-	??	0	0	0
	Total	1640			12741.2	4347	2375	6784

* Divisions where LCL figure was towards minus side due to poor sample size or non-availability of block sizes, number of elephants sighted during the block count is shown as LCL.

** Block sizes and total area of the division of the division not available

2. Elephant population estimated based on dung count method

Population estimation of elephants using dung count method was carried out for 18 divisions out of the 26 divisions of Karnataka. The numbers of elephants estimated for these divisions are given in Table 2. The dung count data from 18 forest divisions show that the mean population was over 6100 elephants (average of estimates with 5% & 10% outlier data cutoff). In Kollegal division the dung count method yielded exceptionally high numbers (996 elephants) compared to block count (151 elephants), such unusual estimates need to be dealt with caution.

The densities estimated using 5% and 10% data cutoff were more or less similar in all the divisions except Bandipur and Virajpet. Densities estimated through dung count method are substantially different from that of block count for some divisions when data was analyzed with a 5% and 10% cutoff of the sample size (Table 2). Among these, the Bandipur Tiger Reserve and Kollegal Division showed much lower densities from the block count method compared to the dung count method. On the other hand, in divisions such as BRT, Bhadra WLS, Virajpet and Hunsur (Territorial), the elephant density estimated using dung count was lower than that of block count and in the rest of the divisions, both dung count and sample block count yielded similar density.

Some differences in densities estimated from two different methods are expected not only due to differences in methodology but also the time differences in the estimates. The direct count method provides an estimate of the elephant population on that particular day. The indirect dung count, however, provides an estimate of the average elephant density over the previous few months.

Substantial difference in densities obtained with the two methods could also be due to sampling errors. Sampling errors could arise due to inaccurate estimation, rounding off of perpendicular distances and moving away from the transect line in search of dung piles in the line transect method. Improper estimation of block sizes and the survey team not restricting itself to the sampling block during the surveys are the source of errors in

the block count method. It is to be noted that for the best results block sizes have to be of more or less the same size).

Table 2: Elephant population estimated using dung count method for various divisions in Karnataka with 5% and 10% cutoff

S. No	Division	5% cutoff			10% cutoff			Total Population		
		Mean	LCL	UCL	Mean	LCL	UCL	5% cutoff	10% cutoff	Average
1	Bandipur	1.64	0.95	2.48	2.02	1.17	3.06	1486	1831	1659
2	Nagarahole*	1.74	0.84	2.79	1.77	0.91	2.80	1119	1139	1129
3	Bannerghatta	0.84	0.48	1.38	0.90	0.49	1.48	87	94	90
4	Brahmagiri	0.46	0.07	0.97	0.40	0.09	0.82	83	72	78
5	Madikeri WL**	0.67	0.32	1.09	-	-	-	132	132	132
6	Cauvery[@]	1.12	0.62	1.73	1.12	0.64	1.74	572	572	572
7	BRT WLS[$]	0.39	0.22	0.60	0.42	0.23	0.67	228	245	236
8	Bhadra	0.21	0.12	0.34	0.21	0.11	0.34	103	103	103
9	Hassan	0.80	0.41	1.35	1.14	0.54	1.93	200	285	242
10	Hunsur T	0.37	0.20	0.59	0.38	0.22	0.58	53	54	54
11	Kollegal	0.88	0.48	1.38	0.86	0.45	1.36	1008	985	996
12	Madikeri T	0.74	0.41	1.16	0.86	0.50	1.33	276	321	299
13	Mandya	1.26	0.66	0.83	1.23	0.65	1.99	122	119	121
14	Mysore T	1.10	0.49	1.85	1.24	0.47	2.27	145	163	154
15	Virajpet	0.13	0.07	0.20	0.34	0.11	0.65	44	115	79
16	Chikkamagalur	0.05	0.02	0.07	0.05	0.02	0.08	-	-	
17	Dandeli	0.06	0.03	0.09	0.06	0.03	0.10	52	54	53
18	Belgaum**	0.10	0.02	0.20				142	142	142
	Total							5852	6425	6139

*Cutoff 20 & 25%; ** Without cutoff as sample size was very small; [@] Cutoff 10 & 15%; [$] Cutoff 5 & 8%

3. Elephant population structure based on classification during sample block count and waterhole counts

The data from water hole count as well as sample block count were pooled for each division in order to get larger sample size for estimating age structure and sex ratios. In total both during sample block and water hole counts 2080 elephants were counted (Table 3) and age/sex details were collected for 2030 elephants [excluding 50 individuals unidentified] in sixteen forest divisions of Karnataka during the 2005 synchronized elephant census (Table 4).

Table 3: Number of elephants recorded during sample block and waterhole count in different divisions of Karnataka (n = 2080)

Division	Overall male	Overall female	Unidentified	Total
Bangalore Rural	8	11	0	19
Bandipur	232	571	0	803
Bannerghatta	26.5	65.5	1	92
Bhadra	79	100	3	179
Brahmagiri	11	17	0	28
Chikamagalur	6	6	4	12
Hassan	49	55	6	104
Hunsur territorial	13	16	0	29
Karwar	2	0	0	2
Kollegal	14.5	41.5	2	56
Madikeri Territorial	28.5	17.5	6	46
Madikeri WL	3	4	7	7
Mandya	3.5	10.5	1	14
Mysore Territorial	18	21	0	39
Nagarahole	188.5	384.5	9	573
Virajpet	33	44	11	77
Grand Total	**716**	**1365**	**50**	**2080**

Overall sex ratio:

Overall (irrespective of age classes) sex ratio of male to female estimated for the state was 1:1.9. However, when we look at sex ratio of various age classes like adult, sub-adult, etc there are only marginal differences that may not reflect the real situation. For example, among adults the male to female ratio was 1:1.8, while the skew increases to 1 male for every 2 female at the sub-adult stage and again drops to 1:1.4 at juvenile level. It is unlikely that elephant populations would have such sex ratios considering the fact that elephant is a polygynous species whereby sex ratio at birth is expected to be equal and begin skewing naturally towards females gradually as the age increases. Therefore, skew is expected to be higher in the adult level than in the sub-adult segment. Apart from this natural process, in Asian elephants we also have to consider the human factor (ivory poaching) selectively removing subadult and adult males (tuskers) from the population, and thus the skew is expected to be even higher than the natural condition in the adult class as compared to sub-adult or juvenile classes. In a population where poaching pressure is relatively low as in northeastern India, the sex ratio at adult level is about 1:2.5 to 1:3 (male to female). As southern India experiences higher poaching pressure than northeastern India, it is unlikely to have sex ratio of 1:1.8 at adult stage in Karnataka as the census figures show.

There appear to be problems in the classification of various age classes. For example, in the census data the adult male numbers (290) outweigh the sub-adult numbers (66) by

almost five times. Similarly, the number of calves (161) that represent individuals less than a year old was reported to be much higher than the number of juveniles (114) that represent individuals from >1 year up to 5 years old in the population. Therefore, it is evident from the results that some of sub-adults have been misidentified as adults in the case of males, while juveniles have been wrongly classified as calves. Such misclassification resulted in age class distribution biased towards adults forming 63% (Fig. 1) and the rest of the classes less than 40% (with calf proportion more than the juveniles class). It is possible to misclassify a sub-adult male as an adult male when a sub-adult male is sighted alone, as there are no adult animals for comparing them while aging. Such misclassifications generally increase the number of adult males and decrease the number of adult females thus biasing the sex ratio towards males in the population. Thus the overall sex ratio in the state may still be more towards females than what was estimated here.

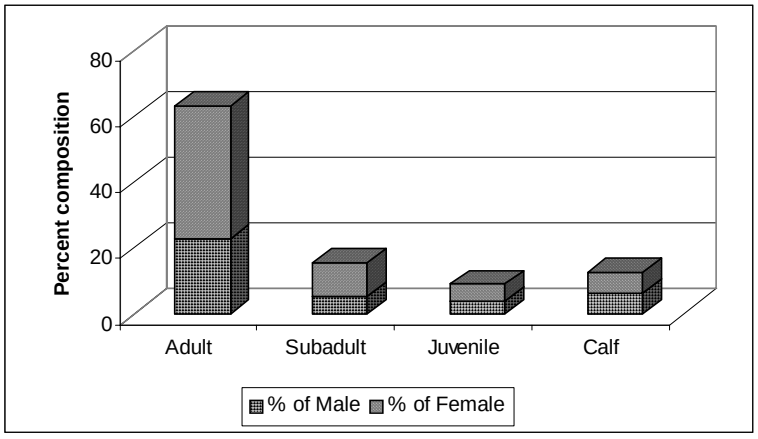
Table 4: Sex ratio of various age classes of elephant recorded during sample block and waterhole count in different divisions (n = 2030)

Division	Adult Male to Female	Sub - Adult Male to Female	Juvenile Male to Female	Calf (Male to Female)	Overall (Male to Female)
Bangalore Rural	1 : 2.7	Nil	2 : 0.0	1 :1	1 : 1.4
Bandipur *	Nil	Nil	Nil	Nil	1 : 2.5
Bannerghatta	1 : 2.6	1 : 2.7	0 : 6.0	1 :1	1 : 2.5
Bhadra	1 : 0.7	1 : 3.1	1 : 1.4	1 :1	1 : 1.3
Brahmagiri	1 : 2.0	1 : 1	1 : 0.5	Nil	1 : 1.5
Chikamagalur	1 : 1	Nil	Nil	Nil	1 : 1.0
Hassan	1 : 1.1	1 : 1.8	1 : 0.4	1 :1	1 : 1.1
Hunsur territorial	1 : 3.5	1 : 0.2	3 : 0	1 :1	1 : 1.2
Karwar	2 : 0	Nil	Nil	Nil	2 : 0
Kollegal	1 : 5.0	1 : 0	Nil	1 :1	1 : 2.9
Madikeri Territorial	1 : 0.5	1 : 2	Nil	1 :1	1 : 0.6
Madikeri WL	1 : 1.5	Nil	Nil	1 :1	1 : 1.3
Mandya	1 : 2.3	0 : 3.0	Nil	1 :1	1 : 3.0
Mysore Territorial	1 : 1.2	Nil	Nil	1 :1	1 : 1.2
Nagarahole	1 : 2.4	1 : 2.2	1 : 1.9	1 :1	1 : 2.0
Virajpet	1 : 1.6	1 : 0.7	1 : 1.0	1 :1	1 : 1.3
Grand Total	1 : 1.8	1 : 2.0	1 : 1.4	1 :1	1 : 1.9

•Sex ratio was computed only for the overall population (irrespective of age classes) as data were not collected in detailed

Division-wise figures of sex ratio reveals that among the major elephant bearing divisions, elephant classification data collected in Nagarahole seem to be more reasonable as sex ratio skews gradually from juveniles (1:1.9) to sub-adults (1:2.2) and further to adults (1:2.4). Even here, longer term research data show the adult sex ratio to be about 1:5. Bandipur an important elephant division in Karnataka, has classified the elephants into male, female and calves, and thus detailed analysis of sex ratio could not be carried out. The results of Bhadra another important elephant division, show that the ratio of male to female is biased towards females in sub-adult class (1:3.1) and in the case of adult it is male biased (1: 0.7).

Figure 1. Age Structure of elephants recorded during sample block and waterhole count (n = 2030)



The very high % of adult class compared to other classes indicates that there could be wrong classification of sub-adult class into adult class and also juveniles into calves.

4. Division wise details

Bandipur Tiger Reserve

Block Count: Bandipur National Park provided raw data of sample block count, water-hole count and dung count with all the necessary details. Detailed analyses [including density/km^2, lower and upper population sizes at 95% confidence limit] were done using the sample block count data. In total 38 blocks / beats were sampled during the sample block direct count. The block sizes varied from 4 km^2 to 20 km^2 with a mean of about 9 km^2 and in total 459 elephants were sighted over the 342 km^2 sampled across various strata of the division. However, the confidence limits at lower (825 elephants) and upper level (1610 elephants) seem to be very wide, and this could be due to the wide variation in the sample block sizes and number of elephants sighted in each block (0 to 61 elephants).

Dung count: With reference to dung count there were some flaws in the data collection; for instance, perpendicular distances have been recorded with different units of measurement (records are in centimeters, meters as well as in inches, and for some only the value is mentioned without the unit). Therefore, in the dung count analysis we have discarded some of the data where units of measurement have not been recorded.

Nagarahole National Park

Block Count: Only the range wise summary of sample block count data was received. Since the statistical application requires the raw data, we are not able to carry out detailed analysis for the Nagarahole block count data. With the existing details of total number of elephants recorded and total area sampled, we were able to estimate the mean density of elephants / km^2, and from this the mean population size for the park has been calculated.

Dung count: The raw data of dung count was obtained and analysis of the dung data was carried out.

Bhadra Wildlife Sanctuary

Block Count: Initially, raw data of sample block counts were sent for 27 blocks of which, block size was mentioned only for seven blocks (with 82.5 km^2 total area sampled and total sightings of 135 elephants). However, in the second set of data, sample block details have been sent only for 10 compartments / blocks (with 124.4 km^2 total area sampled and total sightings of 135 elephants). From the sample block data it appears that some of the blocks have been divided further into smaller units and surveyed by many teams. Although elephant sighting details have been given for individual sampled areas, block sizes have been given collectively for a given block rather than for individual sampling units. However, with the available data (10 block sizes and sighting details) we have done detailed analysis of density / km^2 and population size (upper and lower limit).

Dung count: Although the dung count raw data was received and analysis carried out, the data seems to have the problem of rounding off of the perpendicular distances or approximate estimation of the perpendicular distance without using a measuring tape. In some transects, instead of recording perpendicular distance to the transect line, records of distance from the beginning of the transect line have been entered. Therefore the density arrived using dung count data may be prone to some error.

Kollegal Forest Division

Block Count: Raw data of sample block counts were received for 66 blocks covering 4 different ranges (49 elephants sighted). The results seem satisfactory as the statistical confidence limits were small (due to large number of sampling blocks, 66 blocks) unlike the other divisions.

Dung count: The dung count data seems to be adequate for analysis but yielded exceptionally high density. Results of dung count need to be treated with caution.

BRT Wildlife Sanctuary

Block Count: The range wise summary of sample block count data was obtained initially for 4 ranges (73 elephants in 207.7 km^2 sampled area). With the existing range wise details of total number of elephants recorded and total area sampled, we were able to estimate the mean density of elephants / km^2 as well as the mean population size. Block sizes for the sample blocks were not available and thus statistical confidence limits could not be reliably obtained.

Dung count: Dung count raw data were obtained and analysis was carried out, but the results showed an elephant density only half that of sample block count density.

Cauvery Wildlife Sanctuary

Block Count: The raw data was received raw data for sample block count of 22 blocks (202 elephants sighted) and analysis was performed.

Dung count: The dung count raw data were obtained and results of dung count was comparable with that of sample block count although dung count showed higher density by about 0.2 elephants/ km^2.

Madikeri Wildlife Sanctuary

Block Count: Raw data of sample block count for 8 compartments / blocks covering 82 km^2 with a mean block size of 10.3 km^2 was received. Detailed analysis of mean elephant density and population size (lower and upper limit) has been carried out.

Dung count: The dung count data seems to be in order and the data have been analyzed.

Madikeri Territorial

Block Count: The raw data of sample block count have been sent only for 12 compartments / blocks, in which compartment / block sizes have been mentioned only for nine compartments (totaling an area of 131.0 km^2 and the total number of elephants sighted is 26) while the remaining three block sizes were not provided. With these data we were able to estimate the mean density of elephants / km^2 as well as the confidence intervals.

Dung count: The dung count data seemed adequate and has been analyzed

Bannerghatta National Park

Block Count: The sample block count raw data were sent for 4 beats / blocks (mean block size of 18 km^2 and sampled area of 73.36 km^2). Detailed analyses including mean elephant density and the upper and lower confidence limit of population size have been carried out.

Dung count: Raw data for the dung count was received for 4 transects (each with 2 km length) and was analyzed. The density result obtained through dung count data is comparable with that of density calculated using block count data.

Mysore Territorial

Block Count: The raw data for sample block count was sent for 4 beats / blocks (67.42 km^2 sampled area with mean beat/block size of 17 km^2). Detailed analyses of mean elephant density and the upper and lower confidence limit of population size have been carried out.

Dung count: Raw data for the dung count, received for 5 transects (2 km length), was analyzed.

Karwar

Block Count: The raw data of sample block count data were received for 62 blocks (2 elephants in an area of 455.5 km^2) and using this data, we were able to do detailed analysis.

Dung count: No dung count raw data was obtained.

Virajpet

Block Count: The raw data of sample block count was sent for 25 blocks (with total sightings of 60 elephants in an area of 42.5 km^2). Detailed analyses of mean elephant density and population size (lower and upper limit) have been carried out. However, just two blocks out of 25 blocks account for 35 of the 60 elephants sighted (60%) during block counts and this may have inflated the present density estimate (0.88 elephants/ km^2). If these two data points are removed as noise from the analysis, the densities are comparable to the results from the dung count.

Dung count: The dung count data seems to be in order and the results shows an elephant density of 0.34 elephant / km^2.

Chikamagalur

Block Count: The raw data of sample block count was sent for 16 blocks without details of the block size, and thus no calculation could be done. Eight elephants were sighted on the sample block counts.

Dung count: A dung density of 0.05-elephants/ km^2 has been calculated for this division where twenty-five 2-kilometer transects were laid. However, since total area of the division is also not available, we have not been able to calculate the total population size for the division.

Mandya

Block Count: The sample block count raw data was received for only Malavalli Range for 4 blocks (mean block size of 21 km^2). Using this data we were able to estimate the mean density of elephants / km^2 and population size (lower and upper limits).

Dung count: The dung count raw data received have been analyzed but the estimate (1.23 elephants / km^2) appears to be higher compared to block count (0.08).

Hunsur Territorial

Block Count: The sample block count raw data was received for two ranges (Anechowkur & Periyapatna) that consisted of 4 blocks (totaling an area of 22 km^2 of the 143 km^2) and we have estimate the mean density as 0.72-elephants/ km^2 with a mean population size of 103 elephants. The confidence intervals are very large because there were only four samples.

Dung count: The dung count raw data received for 8 transects of 2 km each appears all right. The analysis gave a density (0.38 elephant/km^2) that is half of block count (0.72 elephant/km^2).

Hassan

Block Count: The sample block count raw data was received for 13 blocks / beats of four Ranges without block sizes. There was no detail of range wise area sampled. Therefore no analysis could be done.

Dung count: The dung count raw data received for 18 transects of 2 km each appears all right. The dung count data showed a density of 0.8 to 1.14 elephants / km^2.

Brahmagiri Wildlife Sanctuary

Block Count: The sample block count raw data was received for 5 blocks and detailed analysis was carried out.

Dung count: The dung count raw data was received and analysis was carried out.

Bangalore Rural

Block Count: The sample block count raw data was received for 8 blocks / beats belonging to two ranges (total area of 84.12 km^2 and total number of elephants sighted 29). Although density was worked out using the total area of sampling available and total number of elephants recorded, the density will reduce if we include area of those blocks for which size is not available.

Dung count: No dung count raw data was received. Total area is not known for extrapolation.

Dandeli

Block Count: No elephant was sighted in the sample block but 5 elephants were found outside the census blocks.

Dung count: The Dung count raw data was received and analysis was carried out.

Belgaum

Block Count: Only two elephants were sighted in the 84 sample blocks. No analysis was done due to lack of block size data.

Dung Count: In Belgaum of the 54 km of transects walked 49 dung piles were seen.

Koppa & Sirsi

Block Count: No elephant sighted in the 46 sample blocks at Koppa and 20 sample blocks at Sirsi.

Dung Count: No dung was seen in the 24 km of transects that were walked in Sirsi division either.

CAVEATS

Most problems seen in the data sets provided seem to arise from to the absence of uniform data sheets. A uniform datasheet provided to all the divisions to collect data for block, waterhole and dung counts could avoid these problems.

1. Block count

1. Some of the sample block sizes are larger than the prescribed size (I.e. they are too large to be surveyed by a single survey team). Ideally blocks should be less than 5 km^2 for the method to work well. This is because the method assumes a complete count within this sampled block.

2. Some large compartments have been divided into smaller sampling units (which is ideal), and elephant sightings have been given for each sampling block. However, the sizes of such sampling units have not been given.

3. The number of sampling units covered in 2005 was lesser compared to the 2002 Census in the major elephant bearing divisions.

2. Line transect dung count method

1. Ideally it is best to calculate dung decay rates for a given division as conditions for dung decay vary from one habitat to another. However, since *this exercise was not carried out by any of the forest divisions* we used the decay rate of 0.0097 as calculated by Varman et al. (1995) for Mudumalai Wildlife Sanctuary for the analysis.

2. Perpendicular distances from the transect line to the center of the dung piles need to be measured accurately with a tape and with the same units. This could have been communicated to the sampling teams during the briefing meeting on the different things that need to be carried out during the census. A mention on the data sheet of the need for accurate measurements in meters could have solved this problem. From the data it seems like many teams did not use tapes, which is a must for this method to give accurate results. There is no need to measure the distance of the dung piles from the starting point of the transect as has been noticed in some of the data sheets. Rounding off errors and lumping are very evident with a lot of the teams, which were estimating the perpendicular distances visually (see figure below). This needs to be avoided in order to get a robust estimate of densities.

3. Population structure from sample block counts and waterhole counts

1. Population structure data suggest that more training is essential for collecting reliable data and such training could be given initially for selected staff, which could be used in the waterhole count at least to get the reliable data for each division.

2. Use of experienced elephant mahouts capable of estimating age could also be experimented in collecting age-sex composition data.

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