SOUTHERN INDIA ELEPHANT CENSUS 2002

SUMMARY REPORT TO THE

KARNAKATA FOREST DEPARTMENT

Reporting Agency: Asian Elephant Research and Conservation Centre

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I. INTRODUCTION

Population estimation of Asian elephant (*Elephas maximus*) has been carried out using block total count method since the late 70's by State Forest Departments in India. However till recently, this method has not been recommended due to several shortcomings like intense labour requirements, fatigue of enumerators, double counting etc. However given that this method requires less specialized training it may be more broadly applicable than other statistically robust methods. The line transect method developed by (Burnham *et al*., 1980) has been used successfully for estimating elephant densities in Asia and Africa through direct counting (Varman & Sukumar 1995; Karanth & Sunquist, 1992; Baskaran & Desai 2000) in areas with high elephant density. The line transect method has also been used to estimate densities through enumeration of indirect evidence e.g. dung (Barnes & Jensen, 1987; Dawson, 1990) in areas with low elephant density and poor visibility. These methods have not been cross-validated against each other and given the directions from Project Elephant, Government of India for reliably estimating the elephant numbers in southern India during the year 2002, we felt that this was an excellent opportunity to validate results obtained from the dung count method with the random block total count method

The present census was conducted from 7th to 9th May 2002 in all the four southern states; Karnataka, Tamil Nadu, Kerala and Andhra Pradesh. Here we report the census results for Karnataka.

II. METHODS

1.Preparation, training and designing census strategy

For the current synchronized elephant census in southern India, it was decided to use a random block total count, waterhole count and line transect indirect (dung) count method. The block count and line transect dung count methods were used for estimating elephant densities and the waterhole count was used to ascertain population structure. The Asian Elephant Research and Conservation Centre, Indian Institute of Science conducted a two days workshop on elephant census techniques during April 2002 at Theppakadu, Mudumalai Sanctuary and Bandipur Project Tiger Reserve for officers from Karnataka, Tamil Nadu and Andhra Pradesh. During the workshop detailed discussions occurred about the relevance of different methods existing, the rationale and relevance of the methods chosen, design for sampling divisions where census was to be carried out and proposed data analysis. Data sheets for block, water hole and dung counts were designed and distributed to all officers. The actual census was conducted for three days from 7th to 9th May 2002. Block counts and waterhole counts were conducted respectively on 7th and 8th May 2002 and dung count was carried out on 9th May 2002 over all the elephant range in Karnataka.

2. Block count

Elephants were counted from sample blocks selected uniformly across the entire division. A compartment map of the division was obtained and approximately 30 % of the beats demarcated on the map were randomly chosen and designated census blocks. The sample blocks were systematically surveyed by a team of two to three people 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 below

3. Water hole count

Approximately 30 % of perennial waterholes within each division were observed on 8th May 2002 between 0800 to 1800 hrs by a team located on a *Machaan* or hide.

During this period all elephants visiting the waterhole were age and sexed. Elephant were classified into four major age classes 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). Animals were sexed based on presence or absence of tusks in the case of adults, sub-adults and juveniles. Care was taken to differentiate *Makhnas* from females using body characteristics and shape of genitalia. From this data the sex ratio was calculated for adults in each division.

4. Line transect dung count method

In all divisions, line transects were laid in l blocks where the block count was undertaken. In each sample block, a transect of 2 km length was laid across altitudinal gradients and perambulated once to enumerate dung piles. On sighting dung piles from the transect, information such perpendicular distance, dung pile status etc., were recorded. Elephant density was obtained using a Monte Carlo simulation method (*GAJAHA* Ver. 1.0) developed by Santosh and Sukumar (1995) by incorporating three variables - dung density obtained from line-transect data, defecation rates and dung decay rate. The defecation rate (16.33) calculated by (Watve, 1992) and decay rate (0.0097) calculated by (Varman *et al*., 1995) in Mudumalai Wildlife Sanctuary were used in the present analysis as this data does not exist for each division in Karnataka.

Data analysis

Data on block count was analysed by computing the number of elephants counted in each block using the sampled area and the total division area in the formula of Lahiri Choudhury (1991) given in next page.

Data on dung count was analysed using GAJAH (Ver. 1.0) by using the dung perpendicular distances, the total transect lengths, dung decay and defecation rates.

Sex ratio of adult male to female was estimated with pooled data of waterhole count and block count and separately for each division

III. RESULTS AND DISCUSSION

1. Elephant population estimated using block count method

The census was carried out in 22 forest divisions in Karnataka (Table 1). The elephant numbers were estimated for 18 divisions. In four divisions no estimate could be obtained due to lack of sightings of elephants or lack of information on total or block areas.

Among the 18 divisions where the elephant numbers were estimated, Bandipur Tiger Reserve, Nagarahole National Park, Cauvery and BRT Wildlife Sanctuaries were found to have more than 500 elephants (Table 1) with high densities (~2 elephants/km ^{2}). Kollegal and Bhadra Wildlife Sanctuary were found to have moderate numbers with a low density (0.61 elephants per sq. km - Bhadra Wildlife Sanctuary and 0.31 elephants per sq. km - Kollegal) in a large area. Other areas in the state such as Madikeri Territorial Division, Hunsur, Brahmmagiri Wildlife Sanctuary, Virajpet, Madikeri Wildlife, Nugu Wildlife Sanctuary, Belgaum, Dandeli and Karwar Divisions had numbers varying from <10 to <100 elephants (Table 1). Though elephants were not sighted in Haliyal and Yellapur Divisions during the block count, the waterhole count and dung count methods revealed that there are elephants in these areas and numbers may be very few.

From these results it can be inferred that Bandipur Tiger Reserve and Nagarahole National aid in supporting a viable population of >500 breeding individuals (Sukumar, 1992) and thus these areas are the prime elephant habitats in the state. Similarly some other divisions like Cauvery, and BRT Wildlife Sanctuaries and Kollegal division should also be treated as important elephant areas as these help in supporting a viable population through being contiguous with other divisions within the state and in Tamil Nadu.

Table 1. Elephant population estimated using block count method for various divisions in Karnataka

S. No	Division	No. of blocks sampled	No. elephants Counted	Total area	Mean density and range of elephant numbers			Mean number
					Mean	LCL	UCL	
1	Bandipur TR	59	843	874	2.26	1469	2487	1975
2	Nagarahole NP	57	555	642	1.78	842	1439	1143
3	Cauvery WLS	29	369	510.5	1.58	509	1109	807
4	BRT WLS	42	240	560.35	1.06	411	774	594
5	Kollegal	19	29	1145	0.31	190	518	355
6	Bhadra WLS	37	106	492.46	0.61	204	401	300
7	Brahmagiri WLS	13	32	181	0.65	50	184	118
8	Madikeri TT	36	42	373.32	0.23	64	105	86
9	Hunsur TT	8	33	104	0.7	18	126	73
10	Mysore	12	72	104	0.65	49	87	68
11	Bannergatta NP	9	53	104	0.68	21	121	71
12	Hassan	2	27	384.8	0.22	27	85	56
13	Virajpet	34	25	336.96	0.15	33	68	51
14	Madikeri WL	11	24	197.66	0.25	18	81	49
15	Nugu WLS	3	25	32.32	0.82	12	41	27
16	Dandeli	34	3	834.74	0.02	11	23	17
17	Karwar	11	3	338.22	0.05	6	28	17
18	Belgaum	61	10	1448.82	0.015	21	22	22
19	Mandya	5	14	??		14	14	14
20	Chikamagalur	58	5	??		5	5	5
21	Haliyal	27	Nil	1165.9	NS	-	-	-
22	Yellapur	4	Nil	548.48	NS	-	-	-
	Karnataka	**571**	**2510**	**10378.5**	**0.67**	**3974**	**7718**	**5848**

NIL – No sighting of elephant
?? – Block sizes and Total area of the Division not mentioned
TT – Territorial, WLS – Wildlife Sanctuary
WL – Wildlife Division, NP – National Park, TR – Tiger Reserve

Elephant population estimated based on dung count method

Population estimation of elephant using dung count method was carried out for sixteen divisions of twenty-two divisions where the block count method was conducted. The numbers of elephants estimated for the sixteen divisions are given in Table 2.

Densities estimated through dung count method are substantially different from that of block count for some divisions when data was analyzed using dung piles recorded up to 10m or 15m (perpendicular distance) from the transect line and excluding outliers. Density estimates with different cutoff points of perpendicular distances are given in Table 2. Among these, the Bandipur Tiger Reserve, Nugu, Cauvery and BRT Wildlife Sanctuaries showed very low densities from the dung count method with a cutoff of 10 – 15m when compared to the block count method. On the other hand, in divisions where very few or no elephants were recorded during the block count (Dandeli, Haliyal and Yellapur), the dung count method yielded much higher elephant numbers.

The densities estimated for Bandipur Tiger Reserve, Cauvery and BRT Wildlife Sanctuaries were similar to the densities obtained from the block count only at cutoff points of 1m or 2m. These figures should be treated cautiously as it is usually prescribed to exclude 15 to 20% of the sample that fall significantly away from the transect line (as the visibility of such piles is highly variable along the transect). However, in the above divisions we excluded >60% of the data to get density estimates similar to block count method.

Marginal differences between densities estimated from two different methods are expected due to differences in methodology. But a substantial difference in densities obtained with the two methods could be due to sampling errors. Sampling errors could arise in situations like inaccurate estimation and rounding up 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 survey team not restricting to the sampling block during surveys are sources of errors for the block count

method. The field staff in Karnataka were rather new to the dung count method unlike the block count, which has been used by staff for a long time.

Table 2. Elephant population estimated using dung count method for various divisions in Karnataka

S. No	Division	Sample Size	Total Area	Density of elephants			Total Population	% data used	Cut off Point
				Mean	LCL	UCL			
1	Bandipur TR	1521	874.0	2.5	2.15	2.91	2185	39	2
				1.51	1.29	1.74	1320	47	3
				1.0	0.85	1.14	874	65	5
2	Nagarahole NP	2854	642.0	1.6	1.33	1.78	1027	81	8
				1.4	1.2	1.59	899	90	10
3	Cauvery WLS	206	510.5	1.2	0.98	1.4	613	16	1
				0.15	0.12	0.17	77	89	10
4	BRT WLS	399	560.6	1.0	0.8	1.08	560	32	2
				0.24	0.21	0.28	134	76	10
5	Kollegal	305	1145.0	0.33	0.28	0.38	378	91	15
6	Haliyal	31	1165.9	0.2	0.16	0.24	233	100	6
7	Bhadra WLS	719	492.5	0.52	0.44	0.60	256	60	5
				0.4	0.33	0.45	197	85	10
8	Dandeli	320	834.7	***0.22***	0.19	0.25	184	83	15
9	Belgaum	246	674.0	***0.13***	0.11	0.14	88	83	15
10	Hunsur TT	399	104.0	0.84	0.7	97	87	95	15
11	Yellapur	34	548.5	0.09	0.06	0.1	49	82	15
12	Brahmagiri WLS	86	181	0.19	0.16	0.23	64	78	5
13	Karwar	14	338.2	0.03	0.02	0.04	10	100	10
				0.7	0.50	0.84	23	26	3
14	Nugu WLS	53	32.3	0.25	0.19	0.3	8	74	10
15	Mandya	45	?	0.19	0.16	0.22		96	10
16	Mysore	63	?	0.05	0.04	0.07		83	15
17	Madikeri TT	ND	373.3						
19	Madikeri WL	ND	197.7						
20	Virajpet	ND	337.0						
21	Bannergatta NP	DNS	104.0						
22	Chikamagalur	DNS	?						
23	Hassan	DNS	?						

Density figures underlined match with block count density, ND – No dung count data received, DNS – Dung count data not suitable for analysis, ? Total area is not available, TT – Territorial, WLS – Wildlife Sanctuary, WL – Wildlife Division, NP – National Park, TR – Tiger Reserve

The density estimation carried out using dung count method in Mudumalai Wildlife Sanctuary (2.3 elephant/km^2 with a cutoff point of 15m), which is contiguous to Bandipur Tiger Reserve, also showed a density close to the block count density of Bandipur Tiger Reserve (2.3 elephant/km^2). Thus, it is possible that the inexperience of the field staff with this new technique could have resulted in under or over estimation of elephant numbers in most of the areas. Hence, it is inappropriate to discuss or compare the dung count results with the block count method in the present census at this. Therefore, the present dung count exercise could only be treated as an experience for the field staff of Karnataka and an experiment to assess its relevance as a future census technique.

Sex ratio

Water hole count data were used for estimating the adult sex ratio, as age and sexing elephants is easier in water holes than while carrying out block counts where visibility is often poor due to dense undergrowth. The sample size obtained in water hole count was very small for some divisions. The sex ratio estimated for water-hole counts (Table 3) was more or less similar to that of block count (Table 4) and thus both data were pooled together to obtain the sex ratios with larger sample size.

Overall adult sex ratios estimated for entire Karnataka was 1:3.7 (Table 5). However male to female ratio was found to vary across different divisions. For example ratio was skewed towards females (>1:7) in divisions like Cauvery, and BRT Wildlife Sanctuaries and Kollegal in eastern Karnataka, while it was almost equal in Bhadra Wildlife Sanctuary and Madikeri Division. The two prime elephant habitats such as Bandipur Tiger Reserve and Nagarahole National Park had a sex ratio 1:4.5 and 1:2.7 respectively. Adult males were more than females in areas like Dandeli, Karwar etc where very few or no elephants were counted during block counts.

Overall there appeared to be some misclassification of adult females as sub-adults (thus we find records of female herds without adult females but with sub-adult females, juvenile females and calves e.g. Bandipur Tiger Reserve) and sub-adult males as adults (as the total number of sub-adult males counted were less than adult males –e.g. Bandipur Tiger Reserve). It is possible to misclassify a sub-adult male as

an adult male when a sub-adult male is alone, as there are no adult animals for comparing 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 3. Sex ratio estimated based on water hole count for various divisions in Karnataka

S. No.	Division	Number of elephants recorded			Sex Ratio
		Total	AF	AM	AM:AF
1	Cauvery WLS	150	64	9	1:7.1
2	BRT WLS	129	34	5	1:6.8
3	Bandipur TR	1076	398	86	1:4.6
4	Badhra WLS	18	4	2	1:4.5
5	Nugu WLS	28	10	7	1:4.3
7	Mandya	12	6	2	1:3
8	Nagarahole NP	686	240	84	1:2.9
6	Belgaum	8	4	2	1:2
9	Mysore	37	13	6	1:2.2
10	Hunsur TT	42	15	9	1:1.7
11	Bannergatta NP	47	16	13	1:1.2
12	Haliyal	2	1	1	1:1
13	Hassan	5	0	5	0:5
14	Kollegal	7	3	0	0:3
15	Yellapur	2	1	0	1:0
16	Dandeli	1	0	1	0:1
17	Brahmagiri WLS	0	0	-	-
18	Madikeri TT	0	0	-	-
19	Virajpet	0	0	-	-
20	Madikeri WL	0	0	-	-
21	Chikamagalur	0	0	-	-
22	Karwar	0	0	-	-
	Karnataka	**2249**	**808**	**233**	**1:3.5**

Table 4. Sex ratio estimated based on block count for various divisions in Karnataka

Sno	Division	Number of elephants recorded			Sex Ratio
		Total	AF	AM	AM:AF
1	BRT WLS	272	73	9	1:8.1
2	Mandya	14	8	1	1:8.0
3	Kollegal	29	15	2	1:7.5
4	Hassan	55	9	2	1:4.5
5	Bandipur TR	843	313	71	1:4.4
6	Mysore	72	42	11	1:3.8
7	Virajpet	25	10	3	1:3.3
8	Nagarahole NP	555	179	70	1:2.6
9	Bannergatta NP	59	24	9	1:2.6
10	Hunsur TT	33	18	9	1:2.0
11	Cauvery WLS	369	116	11	1:10.5
12	Nugu WLS	25	8	5	1:1.6
13	Madikeri WL	24	10	6	1:1.6
14	Belgaum	10	5	3	1:1.6
15	Badhra WLS	142	36	26	1:1.4
16	Madikeri TT	42	13	11	1:1.2
17	Chikamagalur	5	2	2	1:1.0
18	Brahmagiri WLS	32	5	7	1:0.7
19	Karwar	3	1	2	1:0.5
20	Dandeli	3	0	1	0:1.0
21	Yellapur	-	-	-	-
22	Haliyal	-	-	-	-
	Karnataka	2612	887	261	1:3.4

Table 5. Sex ratio estimated based on water hole and block counts for various divisions in Karnataka

S. No.	Division	Number of elephants recorded			Sex ratio
		Total	AF	AM	AM:AF
1	Cauvery WLS	519	180	20	1:9
2	Kollegal	36	18	2	1:9
3	BRT WLS	401	107	14	1:7.6
4	Mandya	26	14	3	1:4.7
5	Bandipur TR	1919	711	157	1:4.5
6	Virajpet	25	10	3	1:3.3
7	Mysore	109	55	17	1:3.2
8	Nagarahole NP	1241	419	154	1:2.7
9	Belgaum	18	9	5	1:1.8
10	Hunsur TT	75	33	18	1:1.8
11	Bannergatta NP	106	40	22	1:1.8
12	Madikeri WL	24	10	6	1:1.7
13	Nugu WLS	53	18	12	1:1.5
14	Badhra WL	160	40	28	1:1.4
15	Hassan	60	9	7	1:1.3
16	Madikeri TT	42	13	11	1:1.2
17	Haliyal	2	1	1	1:1
18	Chikamagalur	5	2	2	1:1
19	Brahmagiri WLS	32	5	7	1:0.7
20	Karwar	3	1	2	1:0.5
21	Yellapur	2	1	0	0:1
22	Dandeli	4	0	2	2:0
	Karnataka	4862	1696	493	1:3.7

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