KARNATAKA ELEPHANT CENSUS 2010

Summary Report to

The Karnataka Forest Department

Reporting Agency:

Centre for Ecological Sciences, Indian Institute of Science, Bangalore

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Introduction

A synchronized elephant census was carried out in May 2010 by the southern Indian states under the auspices of Project Elephant, Government of India. At the request of the Chief Wildlife Warden, Karnataka, the Centre for Ecological Sciences with the technical expertise from Asian Nature Conservation Foundation (ANCF) compiled this summary report. A detailed Technical Report is in preparation, will be submitted to the Forest Department Karnataka with a month's time. The report briefly summarizes the results of population size and structure obtained using both direct and indirect methods during the 2010 Synchronized Elephant Census.

I. Population size

1a. Population estimate by sample block count method:

In total, 2843 elephants were counted over an area of 4924 km^2 by sample block count method across 18 forest divisions (Table 1). The estimated overall population for the 18-forest divisions (by summing up the total number of elephants estimated for the 18-forest divisions) came up with a mean of 5549 elephants with 95% Confidence Intervals of 4014–7119 elephants. However, the estimated overall population through analysis using pooled data from 18 forest divisions yielded a mean figure of 5630 elephants than the population size arrived by summation of figures for the various divisions, with a much lower 95% CI (5195–6065 elephants).

Table 1: Elephant population estimated by sample block count method in different forest divisions of Karnataka during Synchronized Elephant Census 2010

Forest division	Elephant habitat (km^2)	Sample size		Density / km^2	Estimated elephants population		
		Block area (number)	Elephant counted		Mean	LCL (min.)	UCL (max.)
Bandipur TR	906	529 (108)	1244	2.4	2130	1727	2534
Bannarhatta NP	104	89 (15)	65	0.7	76	36	117
Bhadra WLS	492	171 (27)	112	0.7	325	198	497
Cauvery WLS	519	190 (38)	195	1.0	535	361	704
C.Nagar WL (BRT WLS)	540	197 (52)	161	0.8	443	320	563
Chikamagalur	139	139 (15)	11	0.1	11	5	17
Hunsur	71	61 (12)	27	0.4	31	13	50
Hunsur WL (Nagarahole)	643	425 (49)	408	1.0	617	443	792
Kollegal	1222	592 (78)	285	0.5	589	457	720
Koppa	1151	110 (12)	0	0.0	0	0	0
Kudremukh NP	600	524 (32)	0	0.0	0	0	0
Madikeri *	892	892 (50)	50	0.1	50	36	64
Madikeri WL	379	160 (30)	76	0.5	180	114	245
Mandya	97	41 (8)	6	0.2	15	3	26
Mangalore	1128	484 (67)	24	0.1	56	42	69
Mysore	177	81 (10)	30	0.4	66	21	110
Ramanagara	353	129 (25)	92	0.7	251	150	351
Virajpet	337	110 (17)	57	0.5	175	88	260
Overall (Sum of divisions)	**9751**		**2843**		**5549**	**4014**	**7119**
Overall (Analysis of pooled data)	**9751**	**4924 (645)**	**2843**	**0.6**	**5630**	**5195**	**6065**

* Area sampled by sample block count method is exceeding the elephant habitat available within the division, used the total area sampling by block count method as elephant habitat.

1b. Population size estimate by dung count method:

The indirect, dung count method was also carried out in all the 18-forest divisions where sample block method was adopted (Table 2). The overall population for the 18-forest divisions (by summing up the total number of elephants estimated for each of these divisions) works out to 5113 elephants with 95% CI of 2737–7909 elephants. However, the overall population arrived through analysis using pooled data from 18 forest divisions yielded a mean figure of 6132 elephants with 95% CI of 3569–8969 elephants.

Overall, the population size estimated by sample block count method (mean about 5500) elephants is comparable with that of line transect dung count method (mean of 5100 or 6000). The two estimates are not directly comparable as the block count reflects the elephant population on the day of the census, while the dung count is an average estimate of the population in the approximately three months prior to the census in May 2010.

Table 2: Elephant population estimated by dung count method in different forest divisions of Karnataka during Synchronized Elephant Census 2010

Forest Division	Elephant habitat (km^2)	Mean/ km^2				Estimated elephant population		
		Dung density (SE)	Elephant density	LCL (min)	UCL (max)	Mean	LCL (min)	UCL (max)
Bandipur TR	906	3010.3 ± 571.02	1.8	0.98	2.79	1622	888	2529
Bhadra WLS	492	460.2 ± 75.13	0.3	0.15	0.41	133	74	202
Bhannarhatta NP	104	1582.2 ± 137.98	0.9	0.57	1.32	97	59	137
Cauvery WLS	519	589.7± 29.11	0.4	0.22	0.48	182	114	249
Chamraj Nagar (BRT WLS)	540	2357.5 ± 285.94	1.4	0.82	2.02	756	443	1091
Chikmagalore	59	253.9 ± 35.40	0.2	0.08	0.23	9	5	14
Hunsur T	71	1935.4 ± 174.12	1.2	0.71	1.61	82	51	115
Hunsur WL (Nagarahole TR)	643	2608.0 ± 395.44	1.6	0.91	2.3	997	585	1480
Kollegal	1222	220.0 ± 8.72	0.1	0.08	0.17	159	98	208
Koppa	1151	640.14 ± 268.26	0.4	0.05	0.83	449	58	955
Kudremukh NP	600	Too small sample size to estimate elephant density						
Madikeri	373	670.5 ± 74.41	0.4	0.24	0.57	146	90	213
Madikeri WL	379	738.0 ± 60.30	0.4	0.24	0.67	163	91	254
Mandya	97	1336.4 ± 107.37	0.8	0.49	1.11	77	47	108
Mangalore	1128	56.4 ± 6.48	0.03	0.01	0.04	34	11	45
Mysore	177	769.1 ± 63.62	0.5	0.28	0.64	80	49	113
Ramnagara	353	179.3 ± 15.83	0.1	0.06	0.16	35	19	56
Virajpet	337	460.8 ± 27.53	0.28	0.16	0.42	94	54	142
Overall (by summation)	**9152**					**5113**	**2737**	**7909**
Overall (by analysis)	**9152**	**1134.6 ± 14.32**	**0.67**	**0.39**	**0.98**	**6132**	**3569**	**8969**

I. Population structure:

Overall, 4737 elephants were counted during the sample block and waterhole counts in 18 forest divisions. Of this, 4553 elephants (96%) were age-sexed, and the rest were either unidentified or not aged (*n* = 184 or 4%). Age-sex compositions of these 4553 elephants show that 52% of the population consisted of adults and the rest (48%) by younger classes of sub-adults, juveniles and calves (Table 3), with sub-adult female component taking a significant proportion of it (18%). Overall male to female ratio for all the divisions together was 1:2.2 (Table 2). However, when we look at the sex ratio of various age classes there are only marginal differences that may not reflect the real situation. For example, among adults the male to female ratio was 1:2.3, while the skew increases to 1 male for every 2.9 females at the sub-adult stage and drops to 1:2.3 for the juveniles.

It is unlikely that elephant populations would have such patterns in sex ratios considering that the elephant is a polygynous species where sex ratio at birth is expected to be equal and may begin skewing towards females gradually with increasing age. Therefore, skew is expected to be higher at the adult stage than in the sub-adult and juvenile segments. In Asian elephants we also have to consider the human factor (ivory poaching and conflict-related deaths), which can be expected to selectively remove adult and sub-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. Karnataka is unlikely to have a sex ratio of 1:2.3 among adults as the census figures show.

The reason for this appears to be misclassification of age classes in the census data. For example, age structure estimated by a more scientific study (Arivazhagan and Sukumar 2005) in Nagarahole National Park has shown that the adult, sub-adult, juvenile and calves comprised 43.5%, 26.3%, 22.7% and 7.4% of the elephant population, respectively. In comparison, the 2010 census data of Nagarahole (Table 4) showed considerable variation in age structure (51.3% adult, 28.2% sub-adult, 11.2% juvenile and calf 9.3%) in age structure. Even the elephant population in Periyar Tiger Reserve, Kerala, with a significantly lower birth rate compared to Nagarahole has only 48.4% of individuals in the adult segment (Arivazhagan and Sukumar 2005). Therefore, it is very unlikely for either Nagarahole (with relatively high birth rate) or the entire Karnataka region to have an adult segment greater than 50% of the population.

Table 3: Overall age-sex composition and sex ratio of elephants obtained by sample block count and waterhole count methods from 18 forest divisions of Karnataka recorded during 2010 Synchronized Elephant Census

Age class	**Age structure (%)**			**Sex ratio**
	Male	**Female**	**Total**	**M : F**
Adult	16.1	36.2	52.3	1: 2.3
Sub-adult	6.1	17.7	23.8	1: 2.9
Juvenile	4.0	9.0	13.0	1: 2.3
Calf	5.5	5.5	11.0	1:1.0
Total	**31.7**	**68.4**	**100**	**1:2.2**

Table 4: Age-sex composition and sex ratio of elephants obtained by sample block count and waterhole count methods in different forest divisions of Karnataka recorded during 2010 Synchronized Elephant Census

Division (*n* = No. of ele. age-sexed)	**Female (%)**				**Male (%)**				**Calf**	**Male to Female Ratio**			**Calf/AF**
	Adult	**Sub-adult**	**Juvenile**	**Overall***	**Adult**	**Sub-adult**	**Juvenile**	**Overall***		**Adult**	**Sub-adult**	**Juvenile**	
Bandipur (2132)	34.7	20.5	11.8	**66.9**	12.9	5.9	5.1	23.8	9.3	1: 2.7	1: 3.5	1: 2.3	0.3
Bannerghatta (77)	41.6	13.0	5.2	**59.7**	15.6	3.9	3.9	23.4	16.9	1: 2.7	1: 3.3	1: 1.3	0.4
Bhadra (100)	34.0	4.0	3.0	41.0	24.0	11.0	2.0	**37.0**	22.0	1: 1.4	1: 0.4	1: 1.5	**0.6**
Cauvery (286)	42.5	19.0	7.8	**69.4**	11.2	1.9	1.9	14.9	15.7	**1: 3.8**	1: 10.2	1: 4.2	0.4
C. Nagar (BRT) (360)	43.3	14.2	6.1	**63.6**	12.2	3.1	3.3	18.6	17.8	**1: 3.5**	1: 4.6	1: 1.8	0.4
Chikkamagalur (11)	18.2	9.1	0.0	27.3	63.6	0.0	0.0	**63.6**	9.1	1: 0.3	0	0	0.5
Hunsur (25)	20.0	16.0	4.0	40.0	40.0	8.0	4.0	**52.0**	8.0	1: 0.5	1: 2.0	1: 1	0.4
Nagarahole (571)	34.5	18.4	8.4	**61.3**	16.8	9.8	2.8	29.4	9.3	1: 2.1	1: 1.9	1: 3	0.3
Kollegal (470)	42.3	14.5	3.6	**60.4**	20.4	3.4	3.0	26.8	12.8	1: 2.1	1: 4.3	1: 1.2	0.3
Koppa (0)	-	-	-	-	-	-	-	-	-	-	-	-	-
Kudremukh (0)	-	-	-	-	-	-	-	-	-	-	-	-	-
Madikere (53)	34.0	15.1	9.4	**58.5**	20.8	7.5	1.9	30.2	11.3	1: 1.6	1: 2.0	1:5	0.3
Madikeri WL (111)	25.2	12.6	12.6	50.5	24.3	14.4	3.6	**42.3**	7.2	1: 1.0	1: 0.9	1: 3.5	0.3
Mandya (7)	28.6	0.0	0.0	28.6	57.1	0.0	0.0	**57.1**	14.3	1: 0.5	0	0	0.5
Mangalore (62)	19.4	21.0	3.2	43.5	38.7	3.2	11.3	**53.2**	3.2	1: 0.5	1: 6.5	1: 0.3	0.2
Mysore (69)	23.2	20.3	0.0	43.5	37.7	10.1	0.0	**47.8**	8.7	1: 0.6	1: 2.0	0	0.4
Ramanagara (164)	41.5	13.4	12.8	**67.7**	15.2	7.3	1.8	24.4	7.9	1: 2.7	1: 1.8	1: 7	0.2
Virajpet (73)	37.0	5.5	1.4	43.8	28.8	9.6	8.2	46.6	9.6	1: 1.3	1: 0.6	1: 0.2	0.3
Grand Total (4533)	**36.2**	**17.7**	**9.0**	**62.9**	**16.1**	**6.1**	**4.0**	**26.1**	**10.9**	**1: 2.3**	**1: 2.9**	**1: 2.3**	**0.3**

*Overall excluding calves

Appendix 4. Details of line transect sampling, sample size obtained, density of dung piles estimated and other distance sampling parameters used versus obtained

Division name	Transect distance (*n*)	Sample size	Dung density			AIC (min)	% CV	Function key	Model
			Mean (SE)	LCL	UCL				
Bandipur TR	210 (105)	3396	3010.3 ± 571.02	2082	4352	6399	19.0	Hazard Rate	H. polynomial 15m CI
Bhannarhatta NP	22 (11)	492	1582.2 ± 137.98	1333	1877	1230	8.7	Hazard Rate	S. polynomial 15m CI
Bhadra WLS	26 (13)	121	460.2 ± 75.13	334	635	634	16.3	Hazard Rate	H. polynomial
BRT WLS	104 (52)	1787	2357.5 ± 285.94	535	650	1444	12.1	Uniform	S. polynomial 15m CI
Cauvery WLS	62 (31)	599	589.7± 29.11	1860	2988	4002	4.9	Hazard Rate	Cosine 20m CI
Chikmagalore	30 (15)	61	253.9 ± 35.40	192	335	144	13.9	Half-normal	Cosine 15m CI
Hunsur T	26 (13)	502	1935.4 ± 174.12	1622	2309	1199	9.0	Hazard Rate	S. polynomial 15m CI
Nagarhole TR	114 (57)	1176	2608.0 ± 395.44	3192	3917	7454	15.2	Hazard Rate	Cosine
Kollegal	124 (62)	582	220.0 ± 8.72	204	238	1594	4.0	Half-normal	Cosine 15m CI
Koppa	24 (12)	88	640.14 ± 268.26	288	1424	89	41.9	Hazard Rate	Cosine 20m CI
Kudremukh NP	22 (11)	2	10.62 ± 0.000	11	11	6	0.0	Uniform	Cosine
Madikeri	88 (44)	458	670.5 ± 74.41	539	833	883	11.1	Hazard Rate	S. polynomial 15m CI
Madikeri WL	54 (27)	338	738.0 ± 60.30	629	867	676	8.2	Hazard Rate	Cosine 15m CI
Mandya	16 (8)	201	1336.4 ± 107.37	1141	1566	377	8.0	Half-normal	Cosine 20m CI
Mangalore	118 (59)	67	56.4 ± 6.48	44	72	167	12.1	Uniform	Cosine 15m CI
Mysore	20 (10)	151	769.1 ± 63.62	653	905	322	8.3	Half-normal	Cosine 20m CI
Ramnagara	52 (26)	162	179.3 ± 15.83	151	213	923	8.8	Hazard rate	S. polynomial
Virajpet	58 (29)	226	460.8 ± 27.53	410	518	525	6.0	Hazard rate	Cosine 16m CI
Overall	**1170 (585)**	**10409**	**1134.6 ± 14.32**	**1107**	**1163**	**24099**	**1.3**	**Half-normal**	**Cosine 15m CI**