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CENSUSING ASIAN ELEPHANTS BY DUNG DENSITY COUNT IN MAYURBHANJ ELEPHANT RESERVE OF ODISHA, INDIA

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ABSTRACT

The Mayurbhanj Elephant Reserve is located between 21°10' to 22°35' North latitude and 85°45'to 87°05' East longitude, spreading over 7043.74 km^2 in Mayurbhanj, Balasore, Bhadrak and Keonjhar districts of Odisha state (India). It comprises of a continuous tract covering Similipal Tiger Reserve, Kuldiha Sanctuary, Hadgarh Sanctuary and other Reserved Forest, Protected Forest, Village Forest, Revenue and homestead land. As part of the MIKE/CITES programme, elephant census based on dung density count was taken up in the Reserve during January to May, 2005. The paper presents the methodology adopted and findings of this census. The Reserve was divided into high, medium, low, and no elephant usage strata based on elephant census of 2002 (total count method). Based on dung-pile abundance on the ground, defecation rate, and dung decay rate, the final estimate of elephant numbers was made for each stratum. The dung density count of elephants shows that there are at least 788 elephants in the Reserve.

Keywords: Asian elephant, Dung density count, Elephant census, Mayurbhanj Elephant Reserve.

Introduction

The Asian elephant, *Elephas maximus* Linnaeus, once roamed over a vast area of Asia extending from the Tigris-Euphrates in West Asia to China in South East Asia through Iraq, Iran, Afghanistan, Pakistan, Nepal, India, Bangladesh, Sri Lanka, Myanmar, Thailand, Indo-China, Malay Peninsula, Java, Borneo and Sumatra. It has since disappeared from Mesopotamia, Syria (East Mediterranean), Iraq, Iran, Afghanistan, Pakistan, Java and most of China. In India elephants were distributed over a very large area extending from the Himalayan foot hills (1524m MSL) down South through Western Ghats, Karnataka, Kerala; on the East to Assam through Madhya Pradesh, Bihar, Bengal and Odisha. During recent years they have become much depleted in numbers due to destruction of their habitats because of uncontrolled growth of human population, excessive demand for cultivable land to raise crops, unplanned industrialisation, mining and lust for ivory (Behura, 2004).

At the turn of the 19th century there were five to ten million elephants both Asian and African put together. By 1979 they had been reduced to only about a million. By 2001 their numbers became further reduced to 400,000 African and 40,000 Asian elephants. In the last 100 years we have lost more than five million elephants due to hunting and habitat destruction (Swain, 2004). The process of annihilation is continuing unabated and the future of elephants remains bleak. Several measures were initiated both globally and locally for the conservation of this magnificent animal of our time. Ivory imports were banned; the elephant was placed as an Appendix-I animal in CITES' (Convention on International Trade in Endangered Species) regulation; African and Asian elephant specialist groups were formed to suggest conservation measures; Elephant Projects were initiated in elephant holding countries; and national and international funds have been setup for funding conservation activities.

In India, Project Elephant was launched in February, 1992 and Elephant Reserves (ERs) were named to protect elephants with specific action plans. There are 26 Reserves across India extending over 60,000 km^2. Mandated by Conference of Parties' (COP) resolution of CITES, Monitoring of Illegal Killing of Elephants (MIKE) program started in South Asia in 2003 to measure levels and trends in the illegal hunting of elephants, to determine changes in these trends over time and to determine the factors causing or associated with such changes, and to try and asses in particular to what extent observed trends are a result of any decision taken by the COP to CITES. MIKE is being implemented in 10 ERs in India and they are Chirang Ripu (Assam), Dhang Patki (Assam), Eastern Doars (West Bengal), Deomali (Arunachal Pradesh), Garo Hills (Meghalaya), Mayurbhanj (Orissa), Mysore (Karnataka), Nilgiri (Tamil

Dung density count of elephants shows that there are atleast 788 elephants present in Mayurbhanj Elephant reserve of Odisha.

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Nadu), Shivalik (Uttarakhand) and Wayanad (Kerala). As part of the MIKE/CITES programme elephant census based on dung density count was taken up in the above 10 ERs. The paper presents the methodology adopted and findings of such a census in Mayurbhanj ER.

Method

Mayurbhanj Er

The Mayurbhanj ER (Fig.1) was constituted in September, 2001 and located between 21°10' to 22°35' North latitude and 85°45'to 87°05' East longitude, spreading over 7043.74 km^2 in Mayurbhanj, Balasore, Bhadrak and Keonjhar districts of Odisha state. It comprises of a continuous tract covering Similipal Tiger Reserve (2750 km^2), Kuldiha Sanctuary (272.75 km^2), Hadgarh Sanctuary (191.06 km^2) and other Reserved Forest, Protected Forest, Village Forest, Revenue and homestead land (3213.81 km^2).

Census Design

Since the early 1980s biologists have used dung counts for surveying elephants in the forests of both West and Central Africa (e.g. Short, 1983; Merz, 1986; Barnes *et al.*, 1995). The same techniques have also been used for Asian elephants (Dawson, 1990; Santosh and Sukumar, 1995; Varman, Ramakrishnan and Sukumar, 1995). An estimate based on dung counts usually requires estimates of three variables – dung-pile abundance on the ground (i.e. dung-piles per km^2), defecation rate, and dung decay rate – which are later combined to give the final estimate of elephant numbers (Barnes, 2001). For this following steps were followed in Mayurbhanj ER.

A. Stratification of Elephant Zone

1. Each Forest Division (FD)/ Protected Area (PA) constituting the Reserve was stratified as follows on the basis of the elephant densities known from the previous (viz. 2002) census:
   a. High density/High usage strata (H): > 1 elephant/ km^2
   b. Medium density / Medium usage strata (M): 0.5- 1 elephant/ km^2
   c. Low density /Low usage strata (L): Below 0.5 elephants/ km^2
   d. No usage-elephant free zone (not included in the calculation of 'effective elephant habitat' while extrapolating sample data).
2. For quick stratification, a 'forest beat' was taken as the unit of stratification and it was allotted to H, M or L on the basis of the majority of its area falling under a particular stratum. A stratified map of the FD / PA was prepared on the scale 1: 50,000.

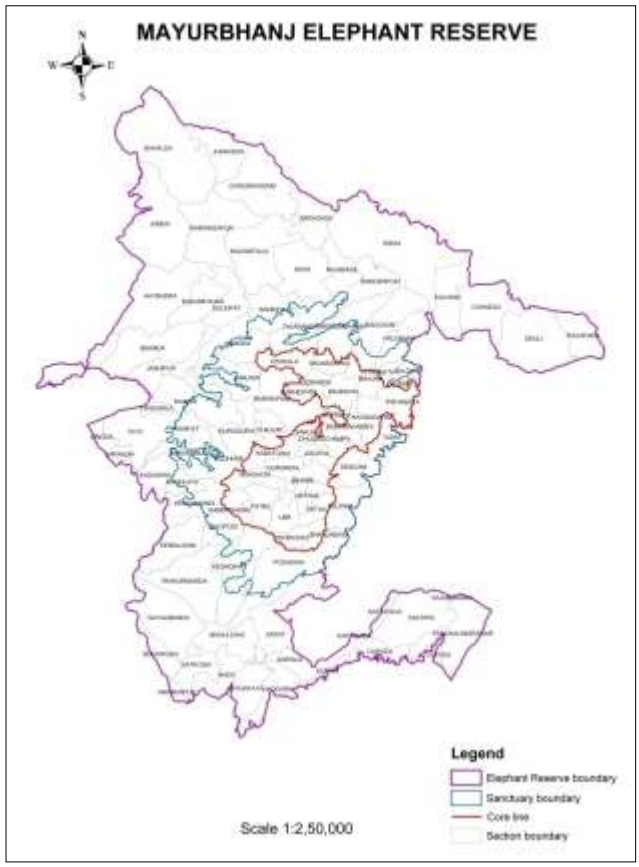

Fig. 1: Mayurbhanj Elephant Reserve, Odisha, India.

B. Measuring Dung Decay Rate (also called Dung Disappearance Rate) or DDR

1. Calculation of DDR needed an experiment on a sample of dung piles scattered over various strata. A number of visits to the field were made, adding fresh dung piles to the sample and recording the state of the previously marked dung piles.
   - A fresh dung pile was one which was 0-24 hours old.
   - State of a dung pile was recorded as Present (=1) or Absent (=0).

   Present was any stage where some dung material was left.

   Absent was a stage where only traces (e.g. plant fibre remains, termite moulds, mud, etc.) were left and no dung material was present. Absent also included 'total disappearance' of dung pile (e.g. washing away in heavy rains).
2. Number of Dung piles to be marked for calculating DDR :

   An ideal target was to have about 120 dung piles for each stratum within the ER. As there were three strata, the total target for the ER = 360 (Table-1).

3. Initiating the Experiment :

It takes about 105 days to complete the experiment. The experiment began about 14 weeks (98 days) before the proposed date of census by dung count method.

4. Selecting dung piles:

It required to visit the field every fortnight as per the schedule in Table 1, searching for fresh elephant dung (less than 24 hours old) in each stratum and marking the same for future reference.

5. Marking dung piles :

Each dung pile was marked and numbered uniquely using wooden pegs with number written on top with indelible paint and also written on an aluminum foil tagged to the peg or nearby tree. GPS reading of the location was recorded.

6. Observations :

During each visit, the previously marked dung piles were visited and their state (Presence / Absence) noted. During the last visit (i.e. 6.5.2005), the state (Presence / Absence) of all previously marked dung piles were noted. No fresh dung pile was marked on this visit.

7. Recording Observations :

A specially designed DDR observation form was filled up for each Range/ Division. However, a consolidated form was prepared for the entire ER based on the observations made on the last day (i.e. 6.5.2005).

C. Estimating dung densities

Dung densities were estimated using the line transect method where the perpendicular distance from the center of each dung pile to the transect line (Fig.2) was measured as per distance sampling (e.g., Buckland *et al.,* 2002; Thomas and Karanth, 2002).

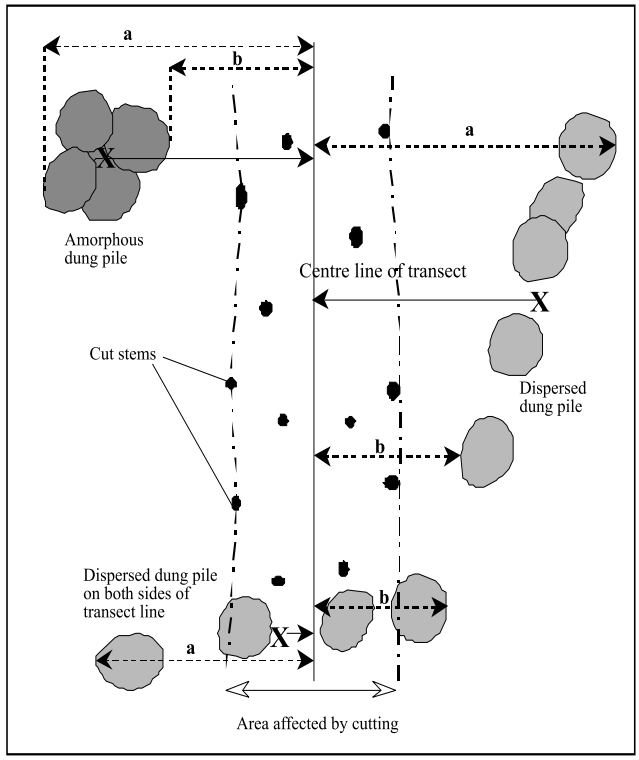

Fig. 2 : Measuring perpendicular distances from line transects (White and Edwards,2000). The perpendicular distance of the dispersed dung pile (X) is calculated by measuring the distance to the furthest edge of the furthest bolus (a), and the nearest edge (b) of the nearest bolus to the centreline, adding the two measurements and dividing by 2. Where a dung pile traverses the centreline, the perpendicular distance (X) is found by subtracting the smaller distance (b) from the larger (a), and dividing by 2.

Table 1: Marking of dung piles for calculation of dung decay rate in Mayurbhanj elephant reserve.

No. of visit	Date of visit	No. of fresh dung piles to be selected and marked							Total
		Stratum H (Jenabil & UBK)	Stratum M (Chahala, Nawana(N), Nawana(S), Pithabata & National Park	Balasore(WL) Division (L1)	Anandpur (WL) Division (L2)	Karanjia Division (L3)	Rairangpur Division (L)	Baripada Division (L5)	
1	21.01.05	17	17	17	17	17	17	17	119
2	05.02.05	17	17	17	17	17	17	17	119
3	20.02.05	17	17	17	17	17	17	17	119
4	07.03.05	17	17	17	17	17	17	17	119
5	22.03.05	17	17	17	17	17	17	17	119
6	06.04.05	17	17	17	17	17	17	17	119
7	21.04.05	18	18	18	18	18	18	18	126
8	06.05.05	Final recording of observations (Present / Absent)							
		120	120	120	120	120	120	120	840

Results and Discussion

Dung decay rates of high (Upper Barakamuda and Jenabil Ranges of Similipal Tiger Reseve), medium (Nawana North, Nawana South, Pithabata, Chahala, and National Park Ranges of Similipal Tiger Reserve), and low (buffer of Similipal Tiger Reserve coming under Baripada, Karanjia and Rairangpur Divisions, and whole of Hadgarh and Kuldiha sanctuaries) strata are furnished in Table 2. Elephant density and elephant numbers based on dung density counts are set in Table 3. As per the present dung density count of elephants there are at least 788 elephants in Mayurbhanj Elephant Reserve (Table 3).

Table 2 : Dung decay rate calculation in Mayurbhanj Elephant Reserve.

Strata	No. dung piles monitored	Mean days for decay	CV (days)
Karanjia (L3)	38	72.60	0.0548
Rairangapura (L4)	67	77.02	0.0504
Baripada (L5)	67	77.02	0.0504
L (R,B,K Div.)	142	72.88	0.0642
M (Simlipal)	155	153.93	0.3443
H (Simipal)	125	89.54	0.0634

Notes: High density strata (H) comprises of Upper Barakamuda(UBK) and Jenabil Ranges of the core area Medium density strata (M) comprises Nawana North, Nawana South, Pithabata, Chahala and National Park ranges of the core area. Low density strata (L) comprises of Rairangapura (R), Baripada (B) and Karanjia (K) Divisions.

The various census methods used to estimate elephant numbers in India are total counts, sample counts, waterhole counts, sight and resight counts and dung counts. In total counts the entire elephant area is traversed and sighting of elephants is recorded. This method of counting elephants has been practised in different parts of India from late seventies (Krishnamurthy, 1991; Lahiri-Choudhury, 1991; Singh, 1978; Swain, 1996). A sample count is one where a predetermined portion of the entire elephant area is searched, usually in a number of small distinct sample areas. The details of the methods and analysis have been reported by Dawson and Dekker (1992); Karanth (1991); Rodgers (1991); Sagar and Singh (2001), and Sukumar *et al*. (1991). In the waterhole count technique elephants are counted as they visit waterholes. This technique was employed to count elephants of Orissa in 1999 (Swain, 2004; Swain and Patnaik, 2002). Sight and resight method (Rodgers, 1991) has been adopted to a sight, recognize and resight methodology which works on simple proportions in accordance to the Petersen or Lincoln Index (Overton, 1971). Sukumar (1985) has reported 'registration and sex ratio method' and has estimated the elephant population of Biligirirangan in South India using this methodology. Elephants in Mayurbhanj Elephant Reserve have always been counted as per total count method and the populations so arrived in 2005 and 2007 are 465 and 517 respectively.

Barnes (2001) opines that there are few more options for counting elephants in forests. One of them is the individual recognition of animals at saltlicks or water sources (Turkalo and Fay, 1995; Turkalo, 1996). But it is not possible to adopt as it requires particular conditions that are rare (Barnes, 2001). Another method is thermal imaging which has been successfully practised for deer (Gill *et.al.*, 1997) and the same is impractical for dense tropical forests (Barnes, 2001; Prinzivalli, 1992). Barnes (2001) emphasizes that the only method superior to dung density count is DNA sequencing of elephant dung identifying individual elephants in a forest and application of mark capture-recapture framework in calculation of elephant density. However, it requires advanced laboratory skills and expensive materials (Barnes, 2001). But this can be used to validate the dung count or new development introduced to dung count.

Table 3 : Elephant density and elephant numbers in Mayurbhanj Elephant Reserve

Strata	No of transects	Elephant density/ km^2	Strata area in km^2	Elephant numbers	CV of elephant density	UCL (ED)	LCL (ED)	UCL (EN)	LCL (EN)
Baripada	18	0.430	455.00	196	0.273	0.695	0.251	316	114
Karanjia	12	0.335	507.34	170	0.256	0.572	0.196	290	99
Rairangpur	09	0.401	342.17	137	0.300	0.779	0.207	267	70
L(R,B,K, Ku,H))	39	0.429	1766.49	758	0.165	0.584	0.302	1032	534
M (Similipal)	20	0.188	572.20	108	0.407	0.420	0.084	240	48
H (Similipal)	14	0.981	331.77	325	0.211	1.546	0.623	513	207
Total of all strata (HML)				1191				1785	788

Notes: High Density strata (H) comprises of Upper Barakamuda(UBK) and Jenabil Ranges of the core area Medium density strata (M) comprises the Nawana North, Nawana South, Pithabata, Chahala and National Park ranges of the core area Low density strata (L) comprises of Rairangapura (R), Baripada (B) and Karanjia (K) Divisions, Kuldiha(Ku) and Hadgarh(H) sanctuaries.

ED = Elephant density
EN = Elephant numbers
UCL = Upper limit of 95 % confidence interval
LCL = Lower limit of 95 % confidence interval

Dung counts therefore remains as the only practical and scientific method of counting elephants in tropical/subtropical forests of India. The methodology is also easy to learn by wildlife officers and researchers. Furthermore, dung counts have the advantage that they give data not only on numbers but also on distribution and deferential habitat use. Dung counts are likely to remain the most practical option for most wildlife managers in the forest zone, at least for the foreseeable future (Barnes, 2001).

Conclusion

This is the first time census of elephants was taken up in Mayurbhanj ER by dung density count. For this the Reserve was divided into high, medium, low, and no elephant usage strata based on elephant census of 2002 (total count method). Based on dung-pile abundance on the ground, defecation rate, and dung decay rate, the final estimate of elephant numbers was made for each stratum. The dung density count of elephants shows that there are at least 788 elephants in the Reserve. To arrive at a precise population figure of elephants in the Reserve, repeated counting of dung density is necessary in

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उड़ीसा (भारत) के मयूरभंज हाथी रिजर्व में लीद (डंग) घनत्व के आधार पर हाथियों की गणना

देवव्रत स्वेन तथा बसंत कुमार बेहुरा

सारांश

मयूरभंज हाथी रिजर्व, अक्षांश में $21^{0}10'$ से $22^{0}35'$ के बीच तथा पूर्वी देशान्तर में 7043.74 वर्ग कि0मी0 भू–भाग में मयूरभंज, बालासोर, भद्रक तथा क्योंझार जिलों में फैला हुआ है। इसमें सिमलीपाल बाघ रिजर्व, खुल्डिया अभ्यारण, हडगढ़ अभ्यारण तथा अन्य आरक्षित वन, रक्षित वन ग्राम वन, राजस्व तथा घरों के आसपास की भूमियां वन क्षेत्र की निरंतरता लिये हुये समाहित है। जनवरी के मई 2005 के बीच माईक/साइट्स कार्यक्रमों के तहत रिजर्व में लीद घनत्व के आधार पर हाथियों की गणना की गई। प्रलेख में अपनाई गई पद्धति और गणना के परिणाम प्रस्तुत किये गये है। 2002 में सम्पूर्ण गणना पद्धति के आधार पर की गई गणना के अनुसार रिजर्व का हाथियों की आबादी के उच्च, मधयम, निम्न और शून्य क्षेत्रों में विभाजित किया गया। भूमि पर लीद के अम्बार, मलत्याग करने की दर तथा लीद के अपक्षय होने की दर के आधार पर प्रत्येक स्तर पर हाथियों की संख्या का आकलन किया गया। लीद के घनत्व के आधाार पर की गई गणना के अनुसार रिजर्व में कम से कम 788 हाथी मौजूद हैं।

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