

Estimating Elephant Populations In Dry Evergreen Forest of Thailand¹

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Abstract

To estimate elephant populations in tropical rain forest, we performed direct (in 2001) and indirect (in 2002) methods of counting elephants in Khao Ang Rue Nai Wildlife Sanctuary (1079 km²), Thailand. By total count, 136 elephants (0.126 elephant.km⁻²) were found in this sanctuary. Five herds and 13 lactating females were detected. Dung count was estimated to density of 0.623 elephant.km⁻² and was 4.95 times higher than total count. Ecological density increased 9.83 per annum between 1994-2001. We concluded that dung count seem to be over-estimated but a good indicator of elephant population changes over along period of times.

Introductions

An Asiatic elephant (*Elaphas maximus*) is a species of very high conservation value. The animals are regarded as key stone species (Western, 1989; Shoshani *et. al.*, 2004), flagship species (Phanthavong and Santiapillai, 1993; Santiapillai and Jackson, 1992) and heritage species (Anon, 1992). The ecological importance of elephants described by Whyte (2004) meet the criteria of umbrella species defined by Miller *et. al.* (1999). Therefore, areas containing some elephant populations are of local and international importance.

Compared with their cousin in African, Asiatic elephants are less studied on behavior, numbers and population. Scientific and intensive studies have been carried out in only some range countries such as India and Sri Lanka. However, anecdotal information has long been recorded. In ancient times, people realized the importance and benefits of elephants as a beast of burden and as an animal used in battle. As a result, knowledge on natural history of elephants has been accumulated. In addition, during colonial period, hunting of elephants for trophy added up information on biology and ecology of elephants. The mosaic data have been compiled and published in both English and native languages. The classic examples, to mention a few, are those written by Morris

Keyword : Dung count, Total count, Line transect, Khao Ang Rue Nai Wildlife Sanctuary

(1926) in India, by Thom (1933) and Peacock (1933) in Burma and by Rachanubhap (1966) in Thailand.

13 Countries have been reported to maintain some elephant populations (Lair, 1999:239). The total numbers of 38,000-48,000 were estimated. However, these numbers are so ambiguous, since systematic and long-term studies have been conducted in only some countries. The total numbers, therefore, need clarification.

It is estimated in Thailand, for example, that 2,384 elephants live in 63 protected areas ranging from 2 in Doi Pha Chang Wildlife Sanctuary (WS) to 300 in Thung Yai Naresuan WS (Langka, 2000). Most of these figures were gathered by questionnaire, which was less scientifically and statistically supported. These end up with population numbers fluctuated between 2,600-4,350 and 1,975 during 14 years of record since Lekagul and McNeely first reported in 1977 (Lekagul and McNeely, 1977). A lack of systematic and long-term monitoring has prohibited obtaining real numbers of elephant populations.

Morphologically, elephants are distinct mega-herbivores not difficult to identify. Usually, two methods have been used to secure their number. Direct methods, the method of counting animals from airplanes and at waterholes, have long been conventionally used in African's Savannah ecosystem. However, limits and constraints of these methods have been found in tropical rain forests of both sides of Indian Ocean, where visibility is limited. The syntheses of dung count widely used in deer population studies in North America having been applied to study elephant population is an alternative method used in dense tropical ecosystem. This method extrapolates three parameters known as dung density, dung decay rate and defecation rate of the elephant. This method seems to be most applicable and recommended in areas $<3,000 \text{ km}^2$ (Jachmann and Bell, 1979). Since the advent of this method, elephant numbers have been widely obtained on both continents. However, few studies have compared numbers of elephants gathered from direct counts and dung counts. Available data are the work in Africa by Jachmann and Bell (1984) who compared dung and aerial count. They found that numbers of elephant obtained by dung count is 2.6 time higher than aerial count.

To estimate numbers of elephant in tropical rain forest, we performed and compared direct and indirect counts of the elephant population living in Khao Ang Rue Nai Wildlife Sanctuary.

Study Area

Gazetted in 1977, Khao Ang Rue Nai Wildlife Sanctuary (KARNWS) is the 5th protected area in Thailand set aside for conservation of wildlife under the Wildlife Preservation and Conservation Act B.E. 2503, amended in B.E. 2535. The sanctuary previously covered approximately 100 km^2 of lowland forests surrounded by concessioned-cum-encoached forests in the East of the country. Thanks to the nationwide-abandonment of logging concessions in 1991, Logging licenses in

the area were lifted in 1991 and 964 encroached families were translocated. People-free forests of about 900 km² were annexed to KARNWS in 1992. Presently, KARNWS covers 1,079 km² of the last remaining lowland rainforests in Thailand.

Situated in valleys of two mountainous ranges, KARNWS harbors a variety animal of lowland morphs. The areas characterized by more than 80% plain below 300 m.sl. interspersed with undulating mountains. Vegetation is mostly dominated by secondary forests of dry evergreen ones due to past encroachment and logging. 15-50 elephants were reported to wander during logging times (Storer, 1981). The area is relatively plain in the North and hilly in the South. Water dries out during the dry season between December and May. Precipitation averaged between 1995-2003 was 1220mm per year.

Methods

Dung Count

Ten transects, length totally 80.35 km. were transversed in the northern part of the sanctuary. Of these, 38.15 km passed through the area assigned as elephant's optimal habitat by the Forest Research Center (1999). Between August and September 2001, we carried out dung surveys following conventional methods described by Dawson and Dekker (1992). Dung density was computed by employing a practical computerized ELEPHANT program (Dawson and Dekker, 1992)

We used the number of 13.5 dung piles produced per day from Wanghongsa (2004a). The deterioration rate of elephant's dung in KARNWS was 0.0059 and 0.0126 dung per day in dry and rainy season respectively (Wanghongsa, 2004b). Thus, elephant density was calculated in the formula of

$$E = \frac{D \times R}{Y}$$

E= Ecological density

D = Dung density

R = Dung deterioration rate (0.0126 piles.day⁻¹)

Y = Defecation rate (13.5 piles.day⁻¹)

Direct Count

Between 5-8 March 2002, we sent, the counting units (28 teams of 3-4 skilled-persons) to well-marked permanent water sources greater than 1.0 m³ all over the sanctuary. We also asked officials in 22 forest-ranger stations situated in and around KARNWS to keep a vigil on their wells and ponds. In total, there were 50 elephant counting teams (Figure 1). All teams were assigned to count all elephants visiting defined water sources from 18.00h of the 5th March to 12.00h of the 8th March 2002. Teams were asked to report numbers of elephants seen and estimated total population

every day. The first was considered to be a minimum number and the latter was a maximum one. In addition, to avoid re-count of elephants, time of visiting water, movement and direction of elephants coming-in and going-out from water sources was noted. Data were pooled every day and numbers of elephants estimated. We used Bound Count Method (Choudhary, 1987) to estimate total population at 95% level of significance.

Historically, man-made water sources and farmlands inside the sanctuary were abandoned since 1993 when local people had been trans-located. We considered these areas optimal habitats for elephants. We assumed that 50% of elephants born between 1994-1996 leave the mother herds as they reached sub-adults at the time of study. We used 15% to correct estimated population. We derived this figure from ecological density in the area increase 68.83% between 1994-2001. Thus, there may have been a 15% error factor of those adult and sub-adult male elephants that had not joint the herds at the time of counting. These elephants may have subsisted on water sources less than 1.0 m³ that we had not seen or found. To gain a conservative number, we added 15% to the population that had been estimated.

Results

Ecological Density

338 dung piles were detected along 80.35 km transects. Mean dung piles was 4.65 boli. Average perpendicular distance was 220.9 cm. Stage of detected dung was significantly different (Chi-square test for homogeneity, $\chi^2_4=91.23$, $p<0.05$) on the descending order of C1, D, C2, B and A respectively. 33.73% of dung was in decomposition stage of C1. Dung density was estimated at 667.08 (369.945-965.070) dung.km⁻². Elephant density, thus, was 0.623 elephant.km⁻² (Table 1)

Table 1. Statistic figures of dung survey in KARNWS between August and September 2001

Numbers of dung piles detected	338 piles
Distance survey	80.35 km
Dung density	667.508 piles.km ⁻²
95% Confidence Limits	297.563
95% Confidence Interval	369.945-965.070 piles.km ⁻²
Covariance of dung density estimate (CV)	19.71%
Defecation rate	13.5 piles.day ⁻¹ (Wanghongsa, 2004a)
Deterioration rate	0.0126 piles.day ⁻¹ (Wanghongsa, 2004b)
Ecological density	0.623 elephant.km ⁻²
95% Confidence Interval	0.345-0.901 elephant.km ⁻²

Crude Density

Elephants were detected in 18 out of 50 counting points. In 84 hours, elephants were seen visiting water sources 32 times. 78.12% of the events occurred between 18.00-06.00h. Pool data came up with a population range between 93-158 elephants. Calculated population was 118 (73-928). When a 15% correction factor was applied, total population was estimated to number 136 (84-1067) animals. Crude density was, thus, 0.126 elephants.km⁻². Five herds of elephants were mapped (Figure 1). 13 calves <1 year old, determined from the height lower than the mid point between mother's belly and anus (Wanghongsa, 2004c; 2004d; 2004e) were recorded. Four lone big bulls were detected roaming not far from herds. Locations of herds were reported elsewhere (Wanghongsa, 2004e; 2004f)

Discussions

As flat land and past-logging operations, KARNWS seems to be the most suitable elephant habitat in Thailand. Ideally, optimal habitats for elephants were considered to be 60% forest and 40% grassland (McKay, 1973; Buss, 1992) with plenty of surface water. 11% of land in KARNWS were cultivated during logging periods and 80% of forest had been selectively logged. Unfortunately, water has not plentiful. Approximately 5 km of perennial creek are present during dry season relative to a total of 668 km. creek's length in the whole sanctuary. This land was abandoned when government moved people out of the sanctuary. Movements of elephants were free. Thanks to the first elephant survey (unpublished data) by means of dung count in 1994 in KARNWS, which was 0.247 elephants.km⁻², ecological density increased 68.83% between 1994 and 2001 or 9.83 per annum. Population growth of 9.83% per annum is possible in this sanctuary. The finding of 13 mother-calve bonds could support this figure.

Only one live elephant was sighted during the survey. The encounter rate was 0.012 time.km⁻¹. In other areas such as Huai Kha Khaeng Wildlife (HKKWS), the encounter rate was 0.005 (Sukmasuang, 2001), and 0.099 in India (Karanth, 1991) and 0.015 in Congo (Fay and Agnagna, 1991). The ecological densities in these areas were respectively 0.36, 0.7 and 0.92 elephant.km⁻². Our ecological density was 0.623 comparatively similar to that of India but encounter rate was that of Congo. Covariance of dung density estimate was 19.71%, which was lower than critical thresholds of 20%. We are confident that our ecological density and encounter rates were scientifically sound. In our study, density of transect was 74.47 m.km⁻² seems to be long enough to run dung survey with more reliable results, indicated by CV <20%.

Dung count seems to be the most logical method in estimating elephants especially in dense vegetation. In Africa, elephant population estimated from dung count was 2.6 times higher than aerial count (Jachmann and Bell, 1984). The difference between ecological density and crude density in this study was calculated at 4.95. The figure was so high that it seemed to be less reliable when interpreted ecological density to the total population. Care and attention must be taken when converting dung density to total number of elephants.

In HKKWS ($2,780 \text{ km}^2$), Srikachang and Sukmasuang (1996) extrapolated ecological density of $0.61 \text{ elephant.km}^{-2}$ to a total number of 284 individuals or the crude density of $0.102 \text{ elephant.km}^{-2}$ in 1994. Therefore, the difference was 5.97 times. Eight years later in 2002, Sukmasuang (2004) estimated ecological density of elephant in this sanctuary being 0.14-0.53 and estimated, by multiplying total area to ecological density, a total number of 885 elephants. It is clear that between 1994 and 2002, elephants in HKKWS increased from 284 to 885 or 75.12 per annum. There is a problem with this figure. If 1994 Srikachang and Sukmasuang's and 2002 Sukmasuang's numbers were true, all elephant that they estimated in 1994 must have had been female and pregnant and some had given twin offspring. Or, all elephants in HKKWS and adjacent protected areas must have had migrated to the study area in 2002. This is scientifically impossible. However, if we divided 885 by 5.97, the result would be 148.74 elephants living in HKKWS in 2002. Population would have decreased 16.91 per annum, which was impossible as well.

In KARNWS, the total number by multiplying total area to ecological density, of elephants estimated by dung count in 1994 was 247 individuals. Our study estimated 136 individuals. Therefore, in 7 years, population would have decreased to 111 elephants or 15.8 elephants per year, which contradicted the fact finding 13 pairs of mother and young-of-the-year. However, when considering ecological density using the same defecation and decay rate, density increased from 0.247 to 0.417 between 1994-2001 or 9.83% per year, which is scientifically sound. We therefore concluded that converting dung density to total population without applying any correction factor is an over-estimation. Correction factor is an area-specific, since threats, topography, availability of surface water and vegetation are limiting factors for the elephants.

Many factors may contribute to an over-estimation of ecological density. Dung survey assumed that all elephants defecate at the same rate. In fact, the rate of defecation remains inconclusive. In studying the defecation rate of domesticated elephants, Wanghongsa (2004a) and Wanghongsa *et. al.* (2005) discovered the significant difference in defecation rate between age and sex of elephants. These differences can be attributed to physiology of elephants, which is different among age and sex (Gakuya *et. al.*, 2003). In addition, spatial and temporal variations have been found in elephant's defecation rate. In Africa, elephants defecated more in the rainy season than in the dry season (Ruggiero, 1992), which is in a factor of 1.5 (Jachmann and Bell, 1984). In Asia, elephants in humid zones investigated by Sivaganesan and Kumar (1994), defecation was >184%

higher than elephants in a dry zone examined by Srikachang (unpublished data), Wanghongsa (2004a) and Wanghongsa *et. al.* (2005). All of the elephant's defecation rates in Thailand were conducted with domesticated elephants. In practice, these animals were chained and allowed to feed natural fodder only in daytime within the radius of their confinement. In night-time, animals were tightly chained. This can not be compared with wild elephants that feed 17-19 hours a day (Vancuylenberg, 1977).

Deterioration rate is another parameter more severely variable. Between season variation was investigated by Wanghongsa (2004b) who found that the rate was 2.14 times faster in wet season. This is probable due to high activity of insects in the wet season. 29 families of insects have been retrieved from 100 dung piles (Wanghongsa *et. al.*, 2004). In addition, ground feeding birds such as jungle fowl, partridges, quails etc. usually ransack dung for insects they prey upon. These activities accelerate deterioration rate of elephant dung piles. Barn *et. al.* (1997) found that precipitation 2 preceding months governed the decay rate of elephant dung.

It is obvious that, although a number of factors may contribute to an over-estimate density by means of dung count, it seems to be good indicator of population change over a time, if the method is repeated. We recommended it be use for monitoring population dynamics of elephants in an insular habitat.

We would like to thank hundreds of forestry personals and army officers who participated in the counting elephants, and to a friend who burned his energy editing the manuscript.

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