An elephant dung survey of the Shimba Hills ecosystem, Kenya, and implications for management

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Abstract

During September 2002, the Shimba Hills ecosystem was surveyed for elephants (*Loxodonta africana*) using the elephant dung count technique. An elephant density of 2.6/km^2 was obtained in an area of about 250 km^2. A dung decay rate of 0.008 per day was obtained from data collected in 1994 using the reciprocal of the median duration time. From this study, an estimate of 649 ± 77 elephants (95% CL 501–842) was obtained. Compared with previous elephant estimates, the current results indicate that elephant numbers have increased by about 43% over a period of seven years. This represents a 6% annual increase. These results are important in making decisions on managing elephants. Various management options are discussed.

Résumé

En septembre 2002, on a étudié les éléphants (*Loxodonta africana*) de l'écosystème des Shimba Hills en utilisant la technique du comptage des crottes. On a obtenu une densité d'éléphants de 2,6/km^2 sur une superficie d'environ 250 km^2. On a déduit, à partir des données récoltées en 1994, un taux de décomposition des crottes de 0,008 par jour, en utilisant la réciproque de la durée moyenne. À partir de là, on obtient une estimation de 649 ± 77 éléphants (95 % CL 501–842). Comparés aux estimations antérieures, les résultats actuels montrent que le nombre d'éléphants a augmenté d'environ 43 % sur une période de sept ans. Ceci représente un accroissement annuel de 6%. Ces résultats sont importants pour la prise de décisions dans la gestion des éléphants. On discute de différentes options possibles.

Introduction

The African elephant (*Loxodonta africana)* in the Shimba Hills ecosystem survived the poaching that affected Kenya in the mid-1970s (Poole et al. 1992). This was due to thick forest cover coupled with an elephant-tolerant attitude of the local people (Poole et al. 1992). Surveying this elephant population in the 1970s and 1980s using aerial techniques was difficult due to forest cover. However, in the late 1980s dung count became increasingly popular as the most practical method for calculating elephant numbers in the forest. Thus in 1992 an elephant dung survey was conducted for the first time in the Shimba Hills ecosystem (Reuling et al. 1992). Litoroh (2002) has documented the historical account of the Shimba elephant population and how it has been monitored since early 1990s. This elephant population appears to have increased in numbers over the past decade, and by the late 1990s destruction of the habitat by elephants at Shimba had reached crisis levels. As a result, 30 elephants were removed from the Shimba ecosystem in 1999. Since then no formal dung surveys have been done. This report provides an update of elephant estimates and their distribution in the Shimba Hills ecosystem and examines the implications for their management.

Study area

The Shimba Hills ecosystem (fig. 1) is situated in the south-eastern part of Kenya, stretching from 39°17' to 39°30' E and from 4°09' to 4°21' S. It has a total area of about 250 km^2 for wildlife use. The climatic condition has been described by FAO/UNESCO (1977) as humid semi-hot equatorial with a mean annual temperature of 24.2°C (Braun 1977). The ecosystem experiences 'long rains' from mid-March to the end of June and 'short rains' in October and November. Annual rainfall averages 1150 mm (Jatzold and Schmidt 1983). Mist and fog contributed considerably to the total precipitation.

Vegetation of the Shimba Hills ecosystem consists of a mosaic of tropical seasonal evergreen rain forest, woodland (eight forest types) and fire-induced grassland. About 15% of the rare plants in Shimba Hills are coastal endemic (Schmidt 1991), and over 50% of the 159 rare plant species known to occur in Kenya are found in Shimba Hills (Beentje 1988). It is the habitat for globally threatened avian species and for endangered mammals with restricted range; it has an abundance of lepidopteran species (Blackett 1994; Bennun and Njoroge 1999). It is an important water catchment area (Blackett 1994). The forest holds spiritual significance for local people.

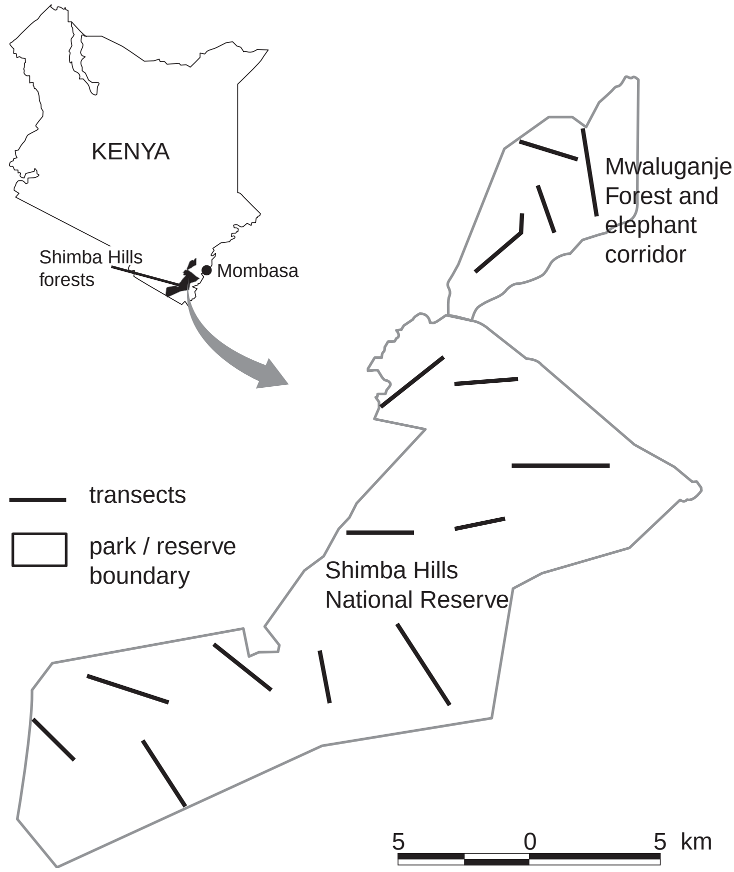

Figure 1. Map of the study of area showing distribution of transects.

Methods

Line transects (fig. 1) were randomly placed in the study area to sample for dung density as described by Barnes and Jensen (1987). Data on dung density have been analysed using the DISTANCE sampling program (Buckland et al. 1993). Dung density was converted into elephant density as described by Barnes (1993) using the following equation:

$$E = Y(r/D)$$

where E is the number of elephants per square kilometre, Y the number of droppings per square kilometre; r the rate of dung decay, and D the density of droppings produced per elephant per day. The 95% confidence limit was calculated using the Monte Carlo technique as described by Barnes and Barnes (1992). Data collected at Shimba Hills in 1994 (Mwathe 1995) were analysed using the reciprocal of the median duration time (Barnes et al.1994) to obtain the decay rate. The defecation rate of 19.0 droppings per elephant per day was used (Jachmann 2001). Although this introduces a potential source of error, it is not serious.

Results

A pooled dung density estimate for the entire area was 6172 dung piles per km^2. A mean dung decay rate of 0.008 was obtained for the entire ecosystem. The elephant-useable habitat is 250 km^2. Thus assuming a defecation rate of 19 droppings per elephant per day, we obtain an elephant density of 2.6. This translates into an estimate of 649 ± 77 elephants (95% CL 501–842). The estimated elephant numbers are 453 for 1995, 475 for 1997, 523 for 1998, 575 for

1999 and 649 for 2002. For the entire ecosystem, the general trend is a steady increase in elephant numbers from about 453 ± 181 in 1995 to 649 ± 77 elephants in 2002.

Elephant dung piles in all stages of decay were found in high concentrations on all transects. For example, a transect placed in Marere and another in Mwaluganje area recorded over 230 dung piles each within a distance of 2.4 km.

Discussion

The present results indicate that on a year-round basis there are definitely at least 501 elephants in the Shimba Hills ecosystem, possibly as many as 842, but the true population size is probably around 649. Compared with the 1995 analysis, the present result is probably more accurate because it has much narrower confidence limits.

Analysing dung count data and translating results of dung density, dung decay and defecation rates into elephant numbers should always be done with caution due to errors, as described by Barnes (1993) and Jachmann (2001). Defecation rate in the present study could be an important source of error because it is borrowed from another site. However, the amount of error is probably insignificant since the same rate has been applied in analysing all the data sets (except the 1994/95 data sets), and hence the error is probably constant.

Results from the present study are comparable with the results obtained in 1995, 1997, 1998 and 1999 (Litoroh et al. 2001), since the same method has been used in data analysis. This represents a general increase in estimates of elephant numbers by nearly 44% in a period of over seven years (since 1995) and is a 6% annual increase.

Occurrence of dung piles in all stages of decay all over the reserve indicates that elephants were well distributed over the Shimba Hills ecosystem. High concentrations were found in Marere and Mwaluganje areas, a similar coastal forest about 100 km to the north of Shimba, where over 230 dung piles were recorded on a 2.4-km transect. This concentration is considerable compared with Shimba Hills, where only 251 dung piles were recorded within a total distance sampled of 42.4 km.

The high dung pile concentration at Marere and Mwaluganje concurs with previous surveys. For instance, in 1997 a first helicopter count was done in which 150 elephants were counted in Mwaluganje Elephant Sanctuary alone (Litoroh 2002). After translocating 30 elephants out of Mwaluganje in 1999, another helicopter count was conducted in 2000 (Litoroh 2000; Kahumbu 2002), in which 200 elephants were counted in the sanctuary, representing a 33% increase in about three years. Since Mwaluganje is basically a dispersal area for Shimba Hills National Reserve, this increase was probably due to elephant dynamics within the ecosystem. According to the present study, the Shimba Hills elephant population has increased considerably. An overall elephant density of 0.5 elephants/km^2 has been recommended for Shimba (Litoroh 2002).

Implications for management

The high density of elephants living within a confined area causes increasingly serious management problems.

First, although the area outwardly appears to be flourishing, the habitat is under intense pressure from elephants. Results from elephant–habitat interaction studies of Mwathe (1995) and Litoroh et al. (2001) have shown a negative correlation between elephant density and various vegetation parameters. Litoroh et al. (2001) has shown that the overall diversity of plant species for the Shimba Hills ecosystem has declined over the period from 1997 to 1999. As the elephant numbers go up the plant species disappear. Additionally, the habitat is degraded through changes in plant community structure. Earlier studies (Schmidt 1991, 1992; Davis and Bennun 1993; Robertson and Luke 1993; Hoft and Hoft 1995) have expressed the need to take urgent conservation measures to protect biodiversity in Shimba Hills. The concerns are:

- The confinement of an increasing elephant population within a small area has resulted in serious destruction of trees, opening up of forests and erosion of biodiversity resources. As a result, some endemic species in the area are critically threatened.
- The size of the highly diverse natural forest is at its lowest critical margin, a factor contributing to a high fragility of the ecosystem. The resilience potential of the forest disturbance resulting from previous anthropogenic activities is high but the insulation of the reserve coupled with a high density of mega-herbivores has interfered with natural regeneration and processes of succession.

- An unknown number of plant and animal species is gradually disappearing. For instance, there are many fewer sightings of colobus monkeys at the Mwaluganje Forest Reserve where the high-canopy trees that they depend upon have been destroyed by elephants. The high density of elephants may result in a large-scale cascade of extinction that cannot be predicted; neither can the economic loss be quantified.

Second, human–elephant conflict around Shimba Hills is escalating. Before an electric fence was constructed around Shimba Hills between 1980 and 1994, about 58% (*n* = 2171) of the cases of human–wildlife conflict were caused by elephants (Mwathe and Waithaka 1995). Within the same period, there were 43 cases of human death and injury, 85% caused by elephants. Initially, the fence was effective, with few incidents of elephants breaking the fence, and people were able to cultivate close to the fence. Human–elephant conflict cases reduced by 33% between 1995 and 2000 while elephant-induced human death and injury reduced by 70% during the same period (Litoroh 2003). However, over the past two years the 120-km perimeter fence has been rendered nearly 60% ineffective and cases of human–elephant conflict are again on the increase (Litoroh 2003).

The principal reason for malfunctioning of the fence is poor to no maintenance due to insufficient funding to engage labour and purchase fence materials. There are only two fence attendants and one technician responsible for maintaining the fence, although the standard requirement is to have one fence attendant for every 4 km and one technician for every 16 km. An additional problem is that the earthing design of Mwaluganje fence is poor, which means that the fence does not provide enough electric shock to deter elephants. Since there is no compensation for crop damage, most elephant cases go unreported unless someone has been injured or killed. However, according to the occurrence book at the warden's office, over 200 cases of human–wildlife conflict were reported between 2001 and 2002, elephants accounting for 84% of the incidents. During the same period elephants killed seven people. Additionally, between January and May 2002, elephants broke wire and poles and destroyed 37 km of the fence. In one incident they broke 115 poles.

Thus the human–elephant conflict situation is again assuming alarming proportions. Some local people are retaliating by spearing elephants or shooting them with bow and arrows. Over the past seven months three elephants have been speared, two shot with arrows and one snared with a wire rope.

In view of the above, solutions urgently need to be found to stop the escalation of human–elephant conflict and diminish the high risk of losing biodiversity caused by elephant-induced destruction of habitat.

Elephant management interventions

Presently the Kenya Wildlife Service (KWS) is grappling to minimize these conflicts on a short-term basis by carrying out piecemeal fence repairs and shooting problem elephants as a control measure. For instance five elephants were shot on control between January and June 2003. However, this problem requires medium- and long-term interventions with varied approaches.

In March 1997, KWS convened a workshop at Tiwi near Shimba Hills in an effort to address the Shimba elephant problem. Although the workshop recommended culling as the immediate and short-term intervention management option to reduce the elephant density, the measure was not implemented because of controversy associated with it (Litoroh 2002).

Kenya does not subscribe to culling for ethical reasons. It is not a popular concept in Kenya as it is said to be inhumane and it disrupts the elephant social set-up. Additionally, the thinking in 1997, at the time of the workshop, was that only four years earlier Kenya had spearheaded the ban on ivory trade, and it would have been untenable for KWS to make an about-turn and resort to culling. Culling was therefore opposed but this thinking may have to change with time.

Elephant drives: We conducted two elephant drives in Narok, in south-western Kenya, in the recent past, but experience has shown that the elephants returned in a week's time. Thus an elephant drive is successful only on a very short term and therefore is not an efficient way of managing elephants.

Winning space: The Shimba Hills ecosystem is surrounded by a growing human population, which makes it an ecological island. Winning space would involve serious socio-political considerations, which appear insurmountable. Realistically, there is hardly any more space (as buffer zone) to be won for elephants after Mwaluganje Elephant Conservancy was created.

Fertility regulation: Immunocontraception has proven efficacious as a means of inducing sterility among African elephants. This method is more humane than culling; however, because immunocontraception has practical problems and takes a long time, it was not considered an immediate option, but the option may be revisited in future.

Elephant translocation: In a generally good terrain and open country, translocation has emerged as a common tool that KWS uses in managing wildlife populations. Shimba Hills and Mwaluganje present special difficulties due to rough terrain and relatively thick vegetation. Despite this, KWS took a bold step and successfully moved 29 elephants from Mwaluganje to Tsavo East National Park in November 1999. The decision to move elephants was based on the outcome of the Tiwi workshop and after taking into account socio-political considerations both at Shimba and at Tsavo. Since the above number is negligible, the Shimba Hills draft management plan (Litoroh et al. 2003) has proposed translocation of a further 200 over a period of five years to achieve the desired effect. However, translocation at Shimba is an expensive exercise (one elephant costs over USD 2500), which KWS cannot afford on its recurrent expenditure, and the agency would have to seek additional donor support. Translocation is expensive, but it is a short-term measure to reduce elephant density. However, on medium- and long-term bases, the elephant population needs to be stabilized through other means such as immunocontraception, if it is found acceptable.

Conclusion

- This survey shows that elephant numbers in the Shimba Hills have steadily increased since 1995 and monitoring of this population should be maintained.
- Construction of an electric fence coupled with human settlement around the reserve firmly curtailed elephant migration, resulting in localized destruction of the vegetation that is associated with compression.
- Elephant density in the Shimba Hills ecosystem needs to be reduced to acceptable levels. Translocation of 29 elephants from Shimba to Tsavo is thought to be an appropriate management intervention measure to address issues of habitat destruction on the short term, but more elephants need to be translocated to achieve the desired results.
- The remaining elephant population should then be stabilized through fertility regulation by immunocontraception, if it is found acceptable, or through further translocations on a recurrent basis.
- The electric fence at Shimba Hills should be properly maintained.

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