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## NOTE FROM THE FIELD

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### Population estimate of elephants in Arabuko-Sokoke Forest

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#### Abstract

Elephant numbers in Arabuko-Sokoke Forest were in 1991 estimated to be between 78 and 90. With dung as an index of elephant abundance, an estimate was done in 1996 to determine present numbers and if the population had increased. Dung decay rate was estimated using two methods: reciprocal of the mean survival time and two points on the exponential curve. Density was estimated to be 0.34 km<sup>2</sup> by the former method and 0.46 km<sup>2</sup> by the latter. These densities projected an elephant population of 126 and 172, respectively.

#### Résumé

En 1991, on estimait que le nombre d'éléphants de la Forêt d'Arabuko-Sokoke était compris entre 78 et 90. En se servant des crottes comme d'un index de l'abondance des éléphants, on a réalisé en 1996 une estimation pour déterminer leur nombre et voir si la population avait augmenté. On a estimé le taux de décomposition des crottes par deux méthodes : la réciproque du temps de survie moyen et deux points sur la courbe exponentielle. La première méthode donnait une estimation de 0,34/km<sup>2</sup>, et la seconde, une estimation de 0,46/km<sup>2</sup>. Ces densités correspondent respectivement à des populations de 126 et de 172 individus.

**Mots clés supplémentaires:** *Loxodonta africana*, taux de désintégration des croffins, population densité

#### Introduction

Elephants have a major impact on the species richness of their habitat (Western 1989, Waithaka 1994, Kamanga 1997). At high densities, their feeding activities lead to habitat degradation (Glover 1963, Höft and Höft 1992, Kamanga 1997). Data on elephant numbers and their feeding activities are therefore essential for proper management of elephant

populations, particularly in the increasingly fragmented and isolated habitats in which they occur. Gesicho (1991) estimated elephant numbers in Arabuko-Sokoke Forest to be between 78 and 90. Since there were no reports of elephant poaching in the forest from 1991 to 1996, the population was expected to increase. The aim of this study was to estimate the present elephant population size in the forest.

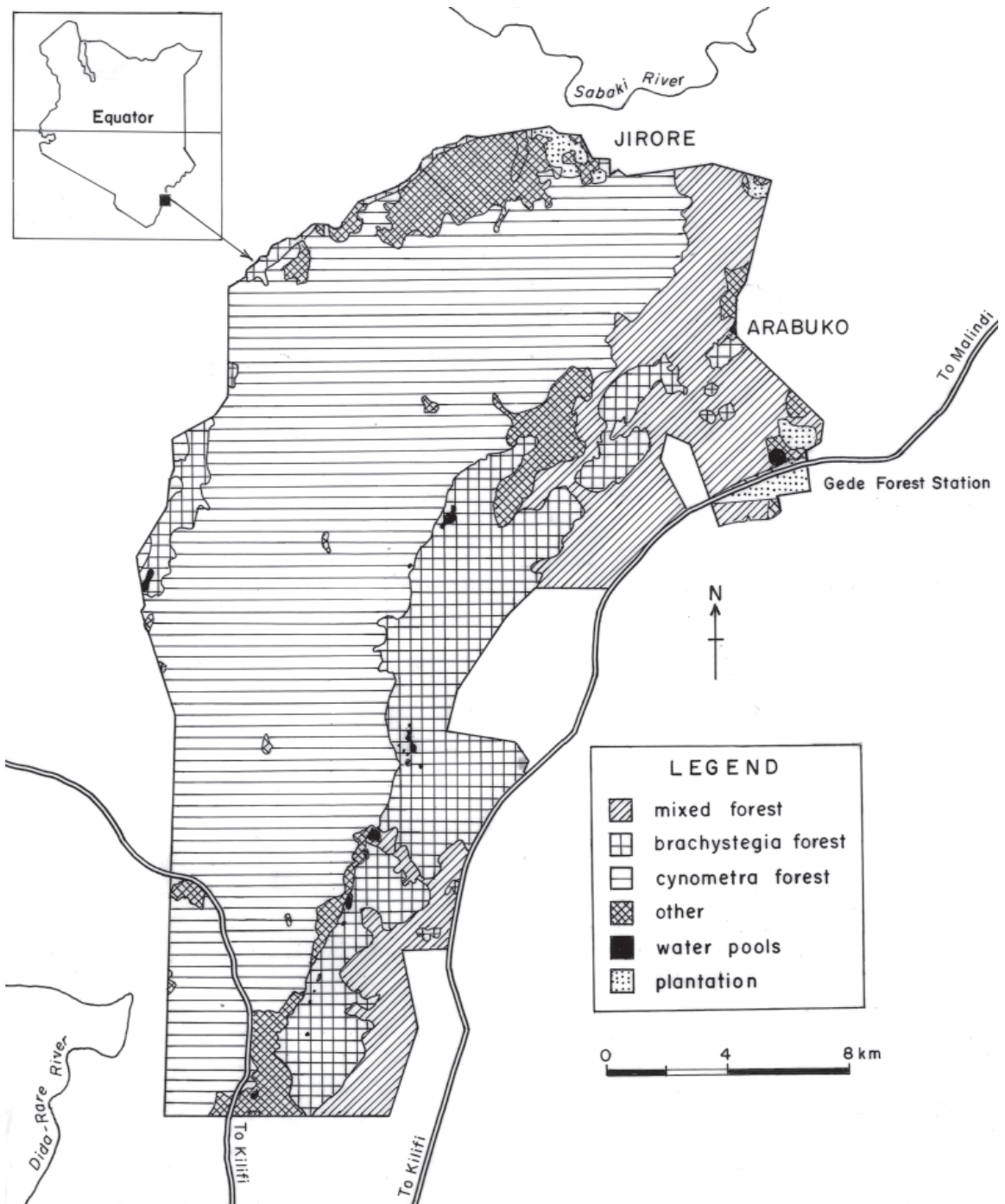


Figure 1. A map of Arabuko-Sokoke Forest showing the vegetation types and water sources. Inset shows where in Kenya the forest is located.

## Materials and methods

### Study area

Arabuko-Sokoke Forest (fig. 1) is in Kilifi and Malindi Districts, Coast Province, Kenya at 3°50' to 3°10' S and 39°50' to 40° E. It lies along the Mombasa–Malindi highway between Kilifi and Malindi towns and has an area of 372 km<sup>2</sup>. Rainfall is bimodal with mean annual rainfall ranging from 900 mm to 1100 mm. Monthly average temperatures range from 27 to 30°C. The forest supports a diversity of fauna (Britton and Zimmerman 1979, Dreves 1992, Chira 1993, Fairclough *et al.* 1995).

### Methods

The elephant population in Arabuko-Sokoke Forest was estimated using dung as the index of elephant abundance (McClanahan 1986, Barnes and Jensen 1987). This method requires three parameters: elephant dung decay rate ( $R$ ), defecation rate ( $D$ ) and dung density ( $Y$ ).

To determine elephant dung decay rate ( $R$ ) in the forest, 94 fresh elephant dung piles were marked and monitored regularly from November 1995 to December 1996 until they all decayed (Barnes and Barnes 1992). Dung decay rate was calculated using two methods: 1) the reciprocal of the mean survival time and 2) two points on the exponential curve (Barnes and Barnes 1992). The widely used figure of 17 dung piles per day (Wing and Buss 1970, Barnes and Jensen 1987) was used for the defecation rate. Litoroh and Mwathe (1996) estimated elephant dung density ( $Y$ ) in Arabuko-Sokoke Forest in 1996 to be

869 dung piles per square kilometre. This figure was used to estimate elephant density ( $E$ ) in the forest using the ratio  $E = RY/D$ .

Elephant population estimate was the product of elephant density and the forest area.

## Results

The mean survival time for elephant dung piles in Arabuko-Sokoke Forest was 151.5 days ( $\pm 98.5$  SD). Dung decay rate was 0.0066 per day, using the reciprocal of the mean survival time method (Barnes and Barnes 1992). Elephant density was 0.337/km<sup>2</sup> (table 1). As the area is 372 km<sup>2</sup>, calculations would indicate that there were 126 elephants in the forest. However, the method using two points on the exponential curve (Barnes and Barnes 1992) yielded an elephant dung decay rate of 0.0091, indicating an elephant density of 0.463/km<sup>2</sup> and an elephant population of 172 elephants (table 1).

## Discussion

Gesicho (1991) estimated the population to be between 78 and 90 elephants in 1991 using the method of two points on the exponential curve. Although estimating elephant numbers in forests by the three parameters of elephant dung decay rate, defecation rate and density (Barnes and Jensen 1987) is prone to error, the 1996 count was greater than the 1991 count made by the same method. These findings therefore indicate that the elephant population in the forest has been increasing. Dung decay rate is influenced by many factors including humidity, rainfall, exposure to sunshine, activity of organisms like dung beetles

Table 1. Elephant dung decay rate, density and population estimates at Arabuko-Sokoke Forest in 1996/97

Method	Dung decay rate (dung piles per day)		Elephant density (elephants/km <sup>2</sup> )		Elephants (no.)	
	no.	range	no.	range	no.	range
Reciprocal of mean survival time	0.007	0.006–0.008	0.337	0.299–0.387	126	111–114
Two points on the exponential curve	0.009	0.005–0.012	0.463	0.278–0.633	172	104–235

Range was estimated using the standard error of the mean of the dung decay rate. Method according to Barnes and Barnes (1992).

and termites, and diet (Barnes 1993; White 1995). At Arabuko-Sokoke Forest dung beetles were very active during wet season (personal observation). Some of the dung piles monitored were marked at the beginning of November 1995 before the commencement of the wet period while others were marked in late November and December 1995 (a wet period). Therefore, the calculated dung decay rate is representative of climatic variations.

In my study, elephant density in Arabuko-Sokoke Forest was between 0.34 and 0.46/km<sup>2</sup>, calculated on the method of estimating dung decay rate. In 1995, Shimba Hills, another Kenyan coastal forest, had an elephant population density of 2 elephants/km<sup>2</sup> (Kamanga 1997). This population density was higher than could be supported by that forest. Thus elephants were destroying the forest at an alarming rate by pulling down trees (Kamanga 1997 and personal observation). In that study, the elephant carrying capacity of Shimba Hills was estimated to be 1.4/km<sup>2</sup>. Although Arabuko-Sokoke Forest has a relatively low elephant population density during my study, there is need to monitor the elephant population to safeguard the forest's biodiversity from increased elephant density. In addition, elephants in the forest raid crops on farms adjacent to the forest (Muoria, unpublished data). Thus further increase in elephant numbers might translate into higher crop-raiding intensities.

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