Elephant census in the Ankasa Conservation Area in south-western Ghana

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Abstract

A dry-season dung count was carried out in January 2001 at the Ankasa Conservation Area in south-western Ghana to estimate the elephant population. After a reconnaissance, the study area was stratified into three strata of density: high, medium and low. But a better design was to arrange a high-density stratum along the Suhien River, on which 43 dung piles were spotted on the 16 transects that constituted the stratum. No dung piles were seen on the four transects that fell outside the Suhien River band. The elephant population was estimated to be 21 with 95% confidence limits of ± 15. This is probably the smallest elephant population in Ghana's forest zone.

Résumé

En janvier 2001, on a fait un recensement des crottes d'éléphants en saison sèche, pour estimer la population d'éléphants dans l'Aire de Conservation d'Ankasa, au sud-ouest du Ghana. Après une reconnaissance sur le terrain, la zone d'étude a été partagée en trois strates de densité dense, moyenne et faible. Mais on a trouvé préférable d'arranger une strate de forte densité le long de la Suhien, où l'on a aperçu 43 tas de crottes sur 20 transects. On a estimé que la population d'éléphants s'élevait à 21 individus, avec une limite de confiance à 95% de ±15. C'est probablement la plus petite population d'éléphants de la zone forestière du Ghana.

Introduction

In West Africa, the number of elephants has decreased dramatically as a consequence of hunting and habitat loss (Roth and Douglas-Hamilton 1991). Today, West African elephants account for less than 5% of the continental total (Barnes et al. 1999). They are found in small, isolated populations scattered throughout the region. This situation has necessitated the development of a subregional elephant management strategy (AfESG 1999) and Ghana has prepared a national strategy (Wildlife Division 2000).

As part of the implementation of the strategy, the Ghana Wildlife Division is required to survey all the elephant populations in the country. This report describes the first elephant survey of the Ankasa Conservation Area (ACA).

Study area

The census zone covered the Ankasa Conservation Area, which comprises the Ankasa Resource Reserve and the Nini-Suhien National Park (fig. 1). These two adjacent forests cover a total area of 509 km^2. The area lies in the wet evergreen zone (Hall and Swaine 1981) and falls within the western block of the Guinea–Congolian zone (Hawthorne and Musah 1993). The terrain is hilly. Parts of the Ankasa Resource Reserve have been lightly logged. The Nini-Suhien National Park has been less disturbed by logging because access to it is difficult (Hawthorne and Musah 1993). Hawthorne and Musah (1993) have described the condition of the Ankasa Resource Reserve as 'good' and the Nini-Suhien National Park as 'excellent'. The Ankasa Conservation Area is the most

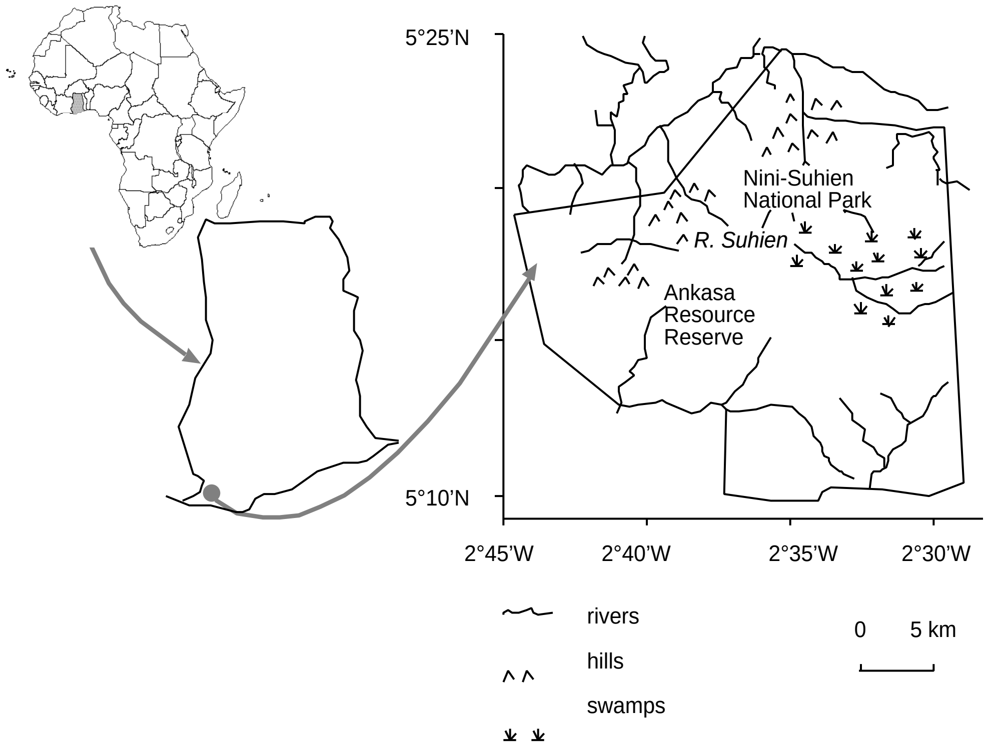

Figure 1. Ankasa Conservation Area (modified from PADP 1998). The River Suhien forms the boundary between the Nini-Suhien National Park and the Ankasa Resource Reserve. The insert maps show the location of Ankasa.

important forest block in Ghana in plant biodiversity.

The annual rainfall is between 1800 and 2000 mm (EDG 1992), falling mainly in two wet seasons: May–July and October–November. The driest months are January and February.

Methods

A reconnaissance was conducted in December 2000 to obtain a general impression about the terrain, types of vegetation and approximate dung-pile abundance, among other factors. The study area was then divided into three strata: the whole of the national park constituted the high-density stratum; the medium-density stratum covered the northern fringes of the resource reserve and extended to about 4 km south of the Suhien River (fig. 2); the entire southern part of the resource reserve constituted the low-density stratum. No dung piles were seen in the low-density stratum during the reconnaissance; the elephant density was therefore assumed to be zero and no transects were placed there (fig. 2).

A similar survey had been conducted in February and October 2000 in the Kakum Conservation Area, with an area of 366 km^2 and lying in the moist evergreen zone (Hall and Swaine 1981) of southern Ghana. It showed that 13–15 transects is the optimum sample size for dung counts in the Kakum area. This sample size was considered and increased to 20 transects for our survey at Ankasa. According to the reconnaissance, dung density in the high- and medium-density strata was in the proportion of 65:35. The 20 transects were thus allocated to the two strata in that proportion: 13 transects to the high-density and 7 transects to the medium-density stratum. The standard line transect method (Buckland et al. 1993; Barnes 1996) was employed for the dung counts (Barnes and Jensen 1987). The transects, each one minute of latitude or longitude long (1.84 km), were randomly distributed in the two strata and aligned perpendicular to major streams and water courses in north–south or east–west directions.

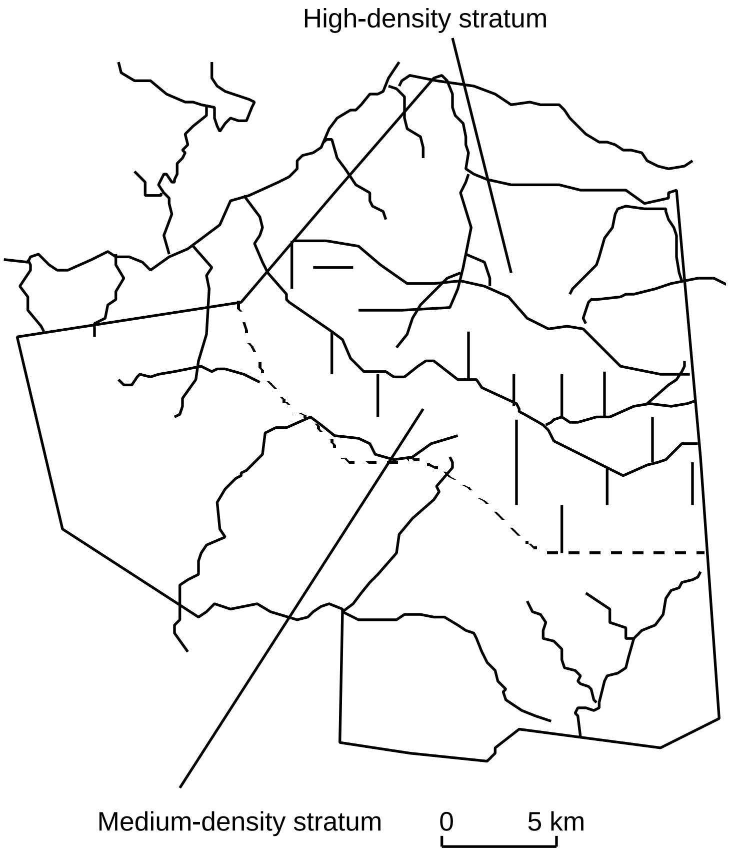

Figure 2. Ankasa Conservation Area showing the distribution of transects in the high- and medium-density strata.

The survey team worked in two groups of three plus a line cutter. Each group walked once down the transects, which were temporary, led by a compass man and a line cutter. Stages of dung piles were recorded and their perpendicular distances from the centre-line of transects measured with tapes. Distance along transects was measured using a Keson Roadrunner (a long-distance measuring wheel with a five-digit counter fitted with an adjustable handle and used for measuring straight or curvilinear surfaces).

The program DISTANCE (Laake et al. 1993) was used to analyse the data to obtain the dung-pile density estimations.

Elephant numbers

Assuming that ACA was in a steady state (McClanahan 1986) at the time of the dung count, we estimated the density of elephants (E) using estimates of three variables: $E = Yr/D$, where Y = dung-pile density, r = decay rate, D = defecation rate; r = 0.0209 for the Ankasa dry season (Barnes et al. 1994). Since there was no estimate of the defecation rate for ACA, the one from Tchamba (1992) was used: D = 19.8.

The densities were then converted into elephant numbers by multiplying the respective densities by the corresponding area of each stratum. The analysis was done separately for each stratum, after which the separate estimates were combined (Norton-Griffiths 1978) to obtain the overall estimate of elephant numbers for ACA. The confidence limit calculations for the estimation of elephant numbers are given in Barnes (1993).

The rainfall model is probably the most accurate method for analysing dung-count data because it takes into account the rainfall preceding the count and makes no assumptions concerning either steady states or normality (Barnes et al. 1997; Barnes and Dunn forthcoming). However, it requires rainfall data for the two months preceding the survey. These data were not available for ACA; the only available data were those for 1993 and 1994. Rainfall data for the rainfall model were therefore collected from the nearest meteorological station, which is Axim, 40 km from the study area.

Results

Dung-pile density in each stratum

In all, 43 dung piles were spotted: 20 in the high-density stratum and 23 in the medium-density. The number of dung piles per transect ranged from 0 to 12 for the high-density stratum with an average of 1.54 per transect. In the medium-density stratum the number ranged from 0 to 8 with an average of 3.29 dung piles per transect. The dung-pile density per transect was significantly higher in the medium-density stratum (U = 45, $p < 0.01$). Table 1 shows the density of dung piles in each stratum and their variances.

Table 1. Estimates of dung-pile density per stratum in Ankasa Conservation Area

Stratum	Area (km^2)	Dung-pile density (Y)	Variance	Number of transects
High-density stratum (1)	166.00	HZ 63.74	HZ 1603.60	13
Medium-density stratum (2)	75.84	HN 196.88	HN 6696.80	7
High-density stratum after the post-facto stratification	142.81	FS 142.69	FS 2336.18	16

The mathematical models used for the dung-pile density estimations: HZ = hazard rate, HN = half normal, FS = Fourier series

The line transect model gave a better fit to the perpendicular distances in the new stratum (fig. 5) compared with the poor fit to the data in the previous arrangement of strata (figs. 6 and 7).

Elephant numbers

The scatter of points in figure 8 gives the regression poor predictive power; therefore, any estimates of Ankasa rainfall made from this regression would be unreliable. The Axim data for two months preceding the survey thus could not be used to predict ACA rainfall, and the rainfall model could not be used in this case to estimate elephant numbers.

Elephant numbers were derived by using the steady-state assumption model of elephant densities: dung pile density as given in table 1, dung rates from Barnes et al. (1994) and

Post-facto stratification

Observations on the ground during the main survey showed that elephants were active along the Suhien River. We therefore made a post-facto stratification (White and Edwards 2000) of the study area to improve the precision of the estimates.

All the dung piles were spotted within 4 km on either side of the river (fig. 3). This band was thus treated as one stratum (the high-density stratum), with 16 transects in which 43 dung piles were recorded, an average of 2.69 dung piles per transect. The rest of the study area where no dung piles were spotted constituted the low-density stratum (fig. 4).

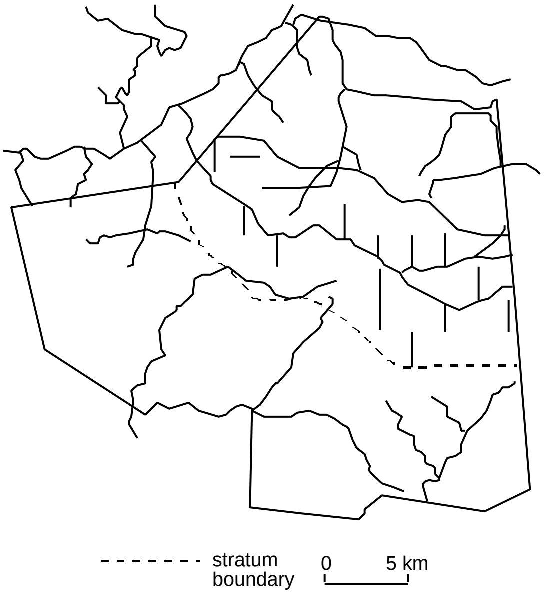

Figure 4. Ankasa Conservation Area showing the distribution of transects after the post-facto stratification.

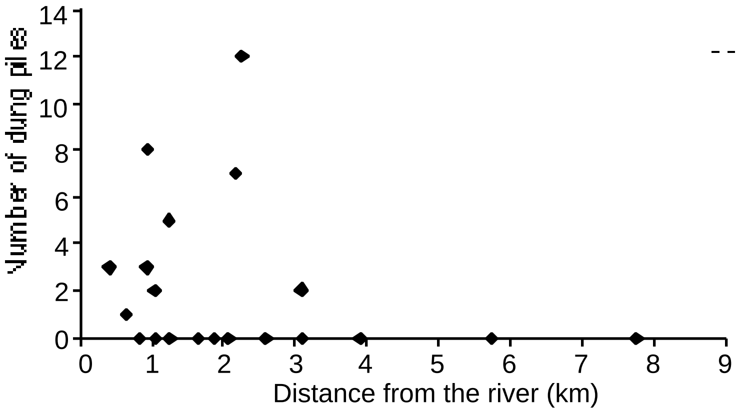

Figure 3. Scatter diagram of the number of dung piles seen on transects and the nearest distance from the midpoint of the transect to the Suhien River.

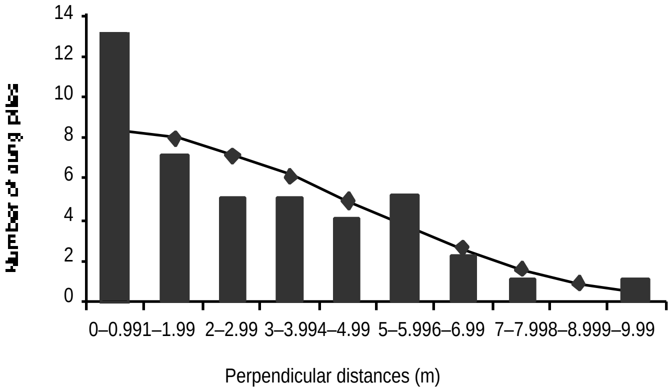

Figure 5. Frequency distribution of the perpendicular distances of dung piles after post-facto stratification (*n* = 43, *f*(0) = 0.20).

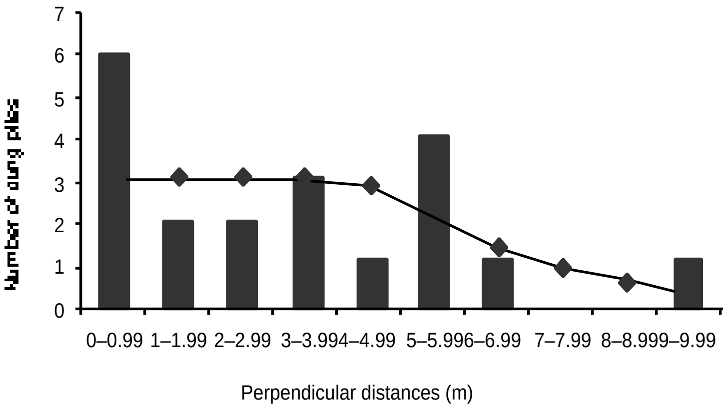

Figure 6. Frequency distribution of the perpendicular distances of dung piles in the high-density stratum (*n* = 20, *f*(0) = 0.15).

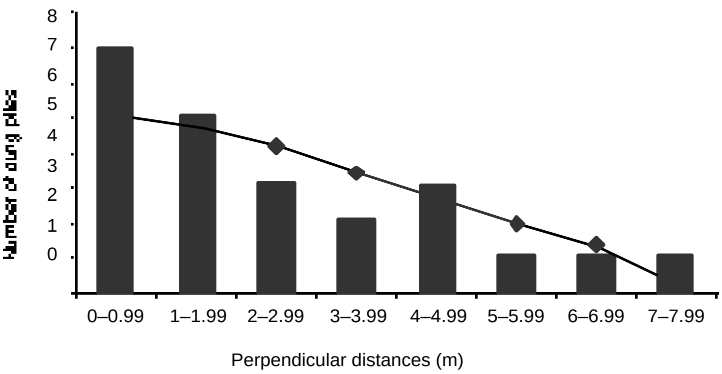

Figure 7. Frequency distribution of the perpendicular distances of dung piles in the medium-density stratum (*n* = 23, *f*(0) = 0.22).

defecation rates from Tchamba (1992). Values were multiplied by the area of each stratum (table 1). Elephant numbers thus derived were 11 ± 15 in the high-density stratum and 16 ± 16 in the medium-density stratum.

Discussion

The stratification was based on the reconnaissance conducted in December, but a month later the transects recorded a higher dung-pile density in the medium-density stratum (table 1). This could be due to the relatively short period of the reconnaissance coupled with the small, mobile and clumped nature of the elephant groups. Also, there was little literature on the distribution of elephants in ACA. Survey teams are likely to encounter this kind of problem in areas holding small populations. To avoid this, a reconnaissance should be done to identify the area with no dung piles and then the rest of the study area should be treated as one stratum.

The number of dung piles recorded was 20 in the high-density stratum and 23 in the medium-density stratum. These numbers are fewer than the minimum of 60 to 80 needed to achieve a satisfactory level of precision (Buckland et al. 1993). The post-facto stratification resulted in a better fit of the line transect model to the data and thus probably gives a better estimate of the elephant population than the original stratification.

The estimate of 21 elephants confirms the suspicion of the park management that ACA holds a very small population. It may currently be holding the smallest elephant population in the wildlife-

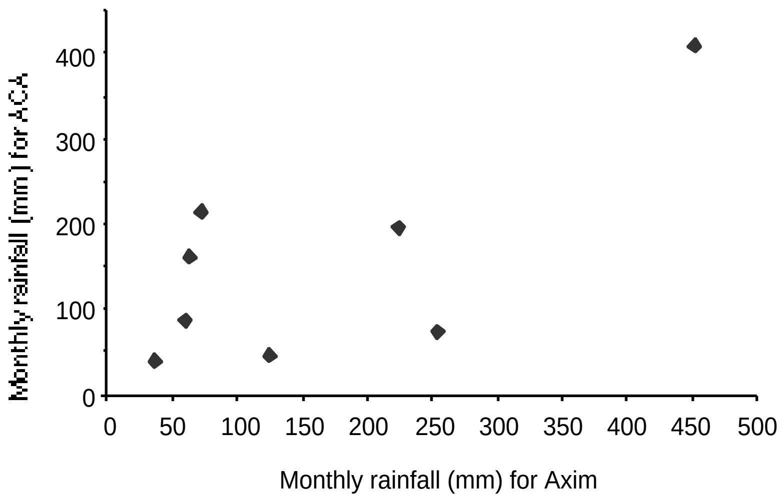

Figure 8. Regression between ACA and Axim 1993–1994 rainfall data ($r = 0.71$, $p < 0.05$).

protected areas of the forest zones of Ghana. According to Sukumar (1993), it is unlikely to be a viable population size. Such a population, if isolated, runs the risks of demographic and environmental stochasticity (Sukumar 1993; Barnes 1999). We have established that the Ankasa elephant population is small. However, it has not been proven whether this population is an isolated one. It is thus recommended that further work be carried out to determine whether the elephants move between Ankasa and the adjacent Draw River Forest Reserve.

At the time of our survey, elephant activities were common along the Suhien River, and we recommend that future surveys conducted in the dry season should follow the stratification shown in figure 4.

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References

[AfESG] African Elephant Specialist Group. 1999. Strategy for the conservation of West African elephants. Proceedings of a workshop held in Abidjan, 22–26 February 1999. African Elephant Specialist Group, Ouagadougu. Unpublished.

Barnes, R.F.W. 1993. Indirect method for counting elephants in forest. *Pachyderm* 16:24–30.

Barnes, R.F.W. 1996. Estimating forest elephant abundance by dung counts. In: Kangwana, K., ed. *Studying elephants*. AWF Handbook No.7. African Wildlife Foundation, Nairobi.

Barnes, R.F.W. 1999. Is there a future for elephant in West Africa? *Mammal Review* 29:175–199.

Barnes, R.F.W., Asamoah-Boateng, B., Naada Majam, J., and Agyei-Ohemeng, J. 1997. Rainfall and the population dynamics of elephant dung piles in the forests of southern Ghana. *African Journal of Ecology* 35:39–52.

Barnes, R.F.W., Asamoah-Boateng, B., Naada Majam, J., Agyei-Ohemeng, J., Tchamba, M.N., Ekobo, A., and Nchandji, A. 1994. Improving the accuracy of forest elephant census methods: study of dung decay rates in Ghana and Cameroon. Wildlife Conservation Society, New York , USA. Unpublished.

Barnes, R.F.W., Craig, G.C., Dublin, H.T., Overton, G., Simons, W., and Thouless, C.R. 1999. *African elephant database 1998.*IUCN/SSC African Elephant Specialist Group, Gland, Switzerland and Cambridge, UK. 249 p.

Barnes, R.F.W., and Dunn, A. Estimating forest elephant densities in Sapo National Park, Liberia, with a rainfall model. *African Journal of Ecology.* Forthcoming.

Barnes, R.F.W., and Jensen, K.L. 1987. How to count elephants in forests. IUCN African Elephant Specialist Group Technical Bulletin 1:1–6.

Buckland, S.T., Anderson, D.R., Burnham, K.P., and Laake, J.L. 1993. *Distance sampling: estimating abundance of biological populations.* Chapman & Hall, London and New York.

[EDG] Environment and Development Group. 1992. Protected area development in southwestern Ghana. EDG, Oxford. Unpublished.

Hall, J.B., and Swaine, M.D. 1981. *Distribution and ecology of vascular plants in tropical rainforest: forest vegetation in Ghana*. Junk, The Hague.

Hawthorne, W., and Musah, J. 1993. *Forest protection in Ghana*. ODA and Forest Inventory and Management Project Planning Branch, Forestry Department, Kumasi, Ghana.

Laake, J.L., Buckland, S.T., Anderson, D.R., and Burnham, K.P. 1993. DISTANCE User's Guide V2.0. Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Fort Collins, CO.

McClanahan, T.R. 1986. Quick population survey method using faecal droppings and a steady state assumption. *Africa Journal of Ecology* 24**:**37–39.

Norton-Griffiths, M. 1978. *Counting animals.* African Wildlife Foundation, Nairobi.

[PADP] Protected Area Development Project. 1998. *Small mammals survey of Bia and Ankasa.* Accra: Protected Area Development Project, Ghana Wildlife Division.

Roth, H.H., and Douglas-Hamilton, I. 1991. Distribution and status of elephants in West Africa. *Mammalia* 55:489–527.

Sukumar, R. 1993. Minimum viable populations for elephant conservation. *Gajah* 11:48–51.

Tchamba, M.N. 1992. Defecation by the African forest elephant (*Loxodonta africana cyclotis*) in the Santchou Reserve, Cameroon. *Mammalia* 56**:**155–158.

Wildlife Division. 2000. *Strategy for the conservation of elephants in Ghana.* Wildlife Division, Forestry Commission, Accra.

White, L., and Edwards, A. 2000. *Conservation research in the African rainforests: a technical handbook.* Wildlife Conservation Society, New York.