

# Population status of black and white colobus monkeys (*Colobus guereza*) in Kakamega Forest, Kenya: are they really on the decline?

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Eastern black and white colobus monkeys, or guerezas (*Colobus guereza*), are among the few primate species that have traditionally been regarded as not being adversely affected by habitat degradation. This view was recently challenged by von Hippel *et al.* (2000) who, using data from short-term censuses in 1992 and 1998, reported a striking decline in guereza density over a six-year period of light to moderate habitat degradation at Isecheno study site in the Kakamega Forest, Kenya. In this paper, I present evidence from my own more intensive study during the same period that suggests that the guereza population at Isecheno is actually quite robust and may in fact be increasing. I provide evidence to suggest that the census methods adopted by von Hippel and his colleagues are prone to overestimating density and that the decline in guereza density that they reported probably did not occur. My study suggests that brief censuses based on group counts over a given area, even when conducted by multiple observers, are not sufficient for accurately determining primate distributions and densities in rainforest environments. Data on animal distribution and density play a critical role in the development of conservation strategies and it is therefore important that these data be relatively accurate if biologists are to make informed conservation decisions.

**Key words:** population density, census, block method, group count method, birth rate, interbirth interval, forest degradation, conservation.

## INTRODUCTION

Most primate populations today face ongoing habitat disturbance, yet not all species respond to disturbance the same way. While many primate species experience declines in population density when their habitats are disturbed, there are several that do not and these flexible species will generally require less conservation attention (Johns & Skorupa 1987; Cowlshaw & Dunbar 2000). Conservation planners must therefore consider variation among species in the ability to withstand disturbance if they are to make optimal use of the limited funds and personnel available for conservation efforts.

Eastern black and white colobus monkeys, or guerezas (*Colobus guereza*), have traditionally been regarded as one of the few species whose population density is not adversely affected by habitat degradation. In fact, studies in both Kibale Forest, Uganda and Budongo Forest, Uganda, have demonstrated that guerezas exist at higher densities in selectively logged areas than in unlogged areas (Skorupa 1986; Plumptre & Reynolds 1994; Struhsaker 1997). Guerezas have also often been

reported to reach extraordinarily high densities in small East African forest fragments where few other primate species exist or are absent (Schenkel & Schenkel-Hulliger 1967; Leskes & Acheson 1971; Rose 1978; Dunbar 1987). These studies suggest that guerezas are particularly well adapted to life in disturbed forests, though the ecological factors that allow guerezas to flourish in these forests are not entirely clear (Oates 1977, 1994; Johns & Skorupa 1986).

The traditional view that guerezas thrive in disturbed areas has recently been challenged by von Hippel *et al.* (2000) who provide evidence that a guereza population in the Kakamega Forest, Kenya, experienced a striking decline in density over a six-year period during which the forest was degraded by human activity. Over a two-month period in 1992, von Hippel (1996) counted 18 guereza groups in the Isecheno study area at Kakamega, and calculated the population density to be 20.8 groups/km<sup>2</sup>. After returning to Isecheno for a one-day sweep census of the guereza population in 1998, von Hippel *et al.* (2000) reported that the original population of 18 groups had been

reduced to 12 groups (14.6 groups/km<sup>2</sup>) and that most of these losses had occurred in the eastern half of the study site where the number of groups had dropped from seven to two. Von Hippel *et al.* (2000) attributed this apparent reduction in guereza density to the degradation of their habitat by humans exploiting the forest for a variety of resources.

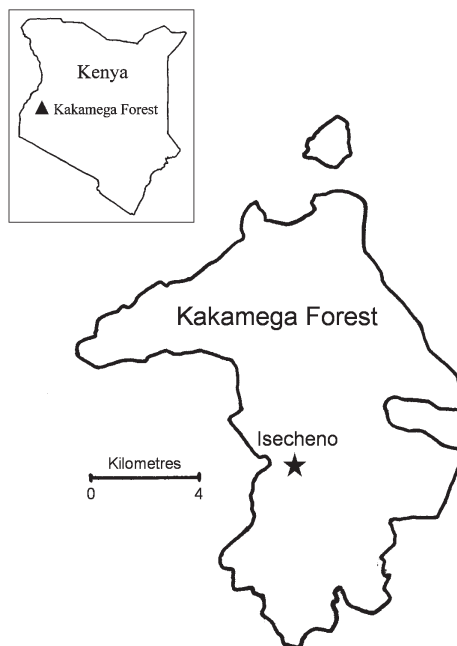
While von Hippel *et al.* (2000) provide a timely description of the conservation threats facing the Kakamega Forest, their conclusion that habitat degradation has taken its toll on the guereza population at Isecheno appears to be unfounded. In this paper, I provide long-term data from my own more extensive study that suggest that despite ongoing habitat degradation, the guereza population at Isecheno is quite robust. Guerezas at Isecheno exist at a high population density and have high birth rates, short interbirth intervals, and apparently high infant survival rates relative to other well-studied African colobine populations for which similar data are available.

My results suggest that brief censuses, even when conducted by multiple observers, are not sufficient to determine primate distributions or densities in forested areas. Given the importance of distribution and density data in devising conservation initiatives (Ganzhorn *et al.* 1996/97; Plumptre *et al.* 2002), it is critical that such data are reliable if the limited budgets and personnel available to conservation initiatives are to be used wisely.

## METHODS

### *Study site and duration*

I conducted my research on guerezas at Isecheno study site in the Kakamega Forest, western Kenya (Fig. 1). The most recent estimate based on satellite imagery shows that indigenous forest at Kakamega covers 101 km<sup>2</sup>, 86 km<sup>2</sup> of which lies in the block that contains Isecheno (Brooks *et al.* 1999). My study area at Isecheno covered the central ~64 % of von Hippel *et al.*'s (2000) 0.82 ha study area. Light to moderate habitat degradation has occurred in much of the study area, with the most intensive disturbance occurring in the western half (von Hippel *et al.* 2000). An irregular grid system of trails passes through much of the study area at intervals of 50–150 m for the north–south trails (M-6 to M+5) and 200–350 m for the east–west trails (A,B,C) (Fig. 2). This trail system facilitates observational research on primates at the



**Fig. 1.** Isecheno study site in the Kakamega Forest, western Kenya.

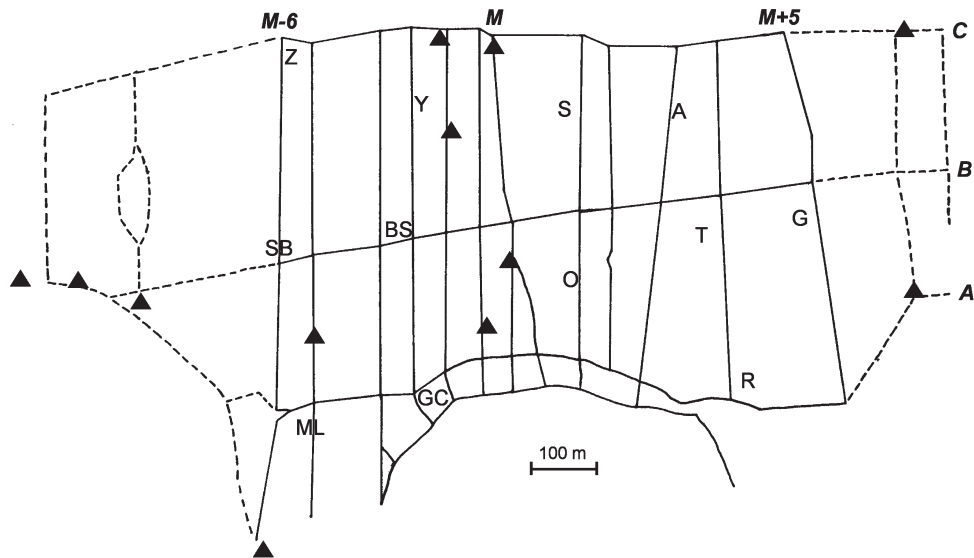
study site. Three diurnal primate species, *Colobus guereza*, *Cercopithecus ascanius*, and *C. mitis*, are regularly found at Isecheno, while *Papio anubis* are occasional visitors.

I conducted my research over a five-year period: in July 1993, November/December 1995, November 1996 – March 1998, and August 1998. My study therefore almost completely overlaps and fills in the spaces between von Hippel's two-month study in 1992 and his team's one-day census in 1998. Over the course of the study, I amassed more than 3000 hours of observation on guerezas.

### *Group distribution and density estimation*

#### Data collection

I used data from long-term research on home range size and overlap (Struhsaker 1981) to compute guereza densities at Isecheno. These data were collected on five study groups (O, T, GC, ML, BS) over a one-year period towards the end of the study (March 1997 – February 1998). During this period, all-day dawn-to-dusk follows were conducted on 60 days for O Group, 59 days for T Group, 23 days for GC Group, 22 days for BS group, and 21 days for ML group (Fashing 2001a). Additional data on the ranges of other groups, which overlapped those of the five main study groups, were collected opportunistically during



**Fig. 2.** Guereza group distribution at Isecheno during my one-year study of ranging patterns in 1997/98 and in von Hippel *et al.*'s (2000) one-day sweep census in 1998. Groups in my study are indicated with letters, while groups sighted by von Hippel *et al.* are indicated with solid triangles. Trails are labelled with bold and italic lettering. Dashed lines represent regions outside my study area that were surveyed by von Hippel *et al.*

this period, most often during encounters with one of the main study groups.

Movements by members of each study group and the locations of groups they encountered were plotted on a modified version of a map of the study site created by M. Cords in 1989 (Fashing 2001a). Group 'center of mass' (Cords 1987; Butynski 1990) and the pattern of movement between consecutive centres of mass were plotted at half-hourly intervals (Fashing 2001a). Individual movements within the study groups were generally easy to monitor since group spread within guereza groups is usually quite small (Fashing & Cords 2000).

#### Data analysis

Ranging data were analysed using the 'block method' (Struhsaker 1981; Chapman *et al.* 1988; Whitesides *et al.* 1988; Fashing & Cords 2000). A grid of 0.25 ha quadrats was superimposed over a map of the home ranges of the five study groups. Quadrats of range overlap with non-study groups were identified and divided into categories based on the number of non-study groups which shared each quadrat with at least one study group. The total number of quadrats used only by study groups was divided by one, the total number of quadrats used by study groups and only one non-study group was divided by two, the total

number of quadrats used by study groups and only two non-study groups was divided by three, and so forth. The values for each category of quadrat were then summed to produce an adjusted home range size for the five study groups combined. I then divided the adjusted home range size by 5 to produce an average adjusted home range size. Finally, I divided 1 by the average adjusted home range size (in km<sup>2</sup>) to produce a density value of groups/km<sup>2</sup>.

The description of the block method provided above can be condensed into the mathematical formula:

$$D = \frac{1}{(E + VA/2 + VB/3 + VC/4 + \dots) / 5}$$

where  $D$  = density of groups;  $E$  = area used only by study groups (in km<sup>2</sup>);  $VA$  = area used only by study groups and one other group (in km<sup>2</sup>);  $VB$  = area used only by study groups and two other groups (in km<sup>2</sup>);  $VC$  = area used only by study groups and three other groups (in km<sup>2</sup>).

Because the block method uses data on the ranging patterns of individually recognized groups, it is the method that most closely approximates the 'true' density of animals in a given area (Struhsaker 1981; Fashing & Cords 2000). It yields particularly accurate results when applied to long-term data on the ranging patterns of multiple

**Table 1.** Infant birth dates and infant survival data for the 11 females in the three groups for which group composition was intensively monitored throughout the study.

Female	Group	Date gave birth <sup>1</sup>	Infant still alive at end of study?
D'arcy	O	3 November 1997	Yes
Saffron	O	29 December 1996	Yes
Veruca Salt	O	13 March 1997	Yes
TF1	T	10 July 1997	Yes
TF2	T	3 June 1997 and 17 March 1998	No Yes
TF3	T	10 July 1997	Yes
TF4	T	10 August 1997	Yes
TF5	T	2 November 1997	Yes
Dolores	GC <sup>2</sup>	6 January 1997	Yes
Harriet	GC	Did not give birth	Yes
Kelley	GC	16 March 1998	Yes

<sup>1</sup>Birth dates listed here are accurate to within seven days or less of when an infant was actually born.

<sup>2</sup>A fourth female was present in GC group at the beginning of the study but disappeared soon thereafter.

groups at a given study site (Struhsaker 1981; Fashing & Cords 2000). However, for comparative purposes, I also estimated density using the 'group count method' (i.e. divided the number of groups regularly sighted in the study area by the size of the study area), as in von Hippel (1996) and von Hippel *et al.* (2000). Unlike the block method, the group count method does not take into account home range size or the amount of home range overlap between groups when computing density.

#### *Reproductive patterns*

##### Data collection

Data on group composition were collected opportunistically over a 17-month period from November 1996 to March 1998. In the three most intensively monitored groups (O, T, GC), data on infant births and deaths were collected for each female throughout this study period.

##### Data analysis

I calculated annual birth rate ( $B$ ) with the formula:

$$B = \frac{i(12)}{(d)(f)}$$

where  $i$  is the number of infants born over the course of the study,  $d$  is the duration (in months) of the study, and  $f$  is the number of females studied. Interbirth interval ( $I$ ) was calculated as the total adult female months divided by the total number of infants born during the study period (Siex & Struhsaker 1999).

## RESULTS

### Distribution of groups and population density

The approximate epicentres of the home ranges of the five main study groups and the locations where seven non-study groups were regularly sighted are depicted on a map of the Isecheno trail system (Fig. 2). Several other groups were sighted once or twice in the study area as well but are not included on this map since they may have been temporary visitors entering the study area to gain access to eucalyptus bark or soil, food sources that groups occasionally travelled long distances to exploit (Fashing 2001a,b). The approximate locations of the 12 groups von Hippel and his colleagues detected in their 1998 census (of a larger area) are plotted in Fig. 2 as well for comparative purposes. Of the 12 groups that I regularly observed between trails M-6 and M+5, six were found west of M and six were found east of M. Clearly, von Hippel *et al.* (2000) failed to detect most, or even all, of the groups living between M and M+5. This oversight during a one-day census is not surprising considering the greater distance between census trails and lower level of habituation of guerezas in the eastern half of the study site.

The quadrats entered by each of the five study groups and the patterns of range overlap between these groups and non-study groups are pictured in Fig. 3. Based on these ranging data, the block method yields a 'true' density of 11.5 groups/km<sup>2</sup>. By way of comparison, the group count method,



counts over a short period and without regard to patterns of home range size and overlap. Using data collected during a one-day sweep census in 1998, von Hippel *et al.* (2000) overestimated guereza density by 27 % despite failing to detect most of the groups in the eastern half of Isecheno. This paradox of overestimating density despite undercounting groups can be explained by the fact that von Hippel *et al.* did not consider the ranging patterns of the groups they detected. Without adequate ranging data, von Hippel *et al.* greatly underestimated the area actually used by guereza groups at Isecheno.

The degree of von Hippel *et al.*'s overestimate would have been much greater had they detected all of the groups in their study area. This point is made particularly clear by the fact that when I used the group count method to estimate density for the 12 groups regularly sighted in the study area during my long-term research, the density estimate I obtained (23.1 groups/km<sup>2</sup>) was two times greater than the 'true' density (11.5 groups/km<sup>2</sup>) calculated via the block method. Thus, using complete group counts to estimate primate density in the absence of ranging data can result in massive overestimates.

This point might explain why von Hippel (1996) produced a much higher density estimate in 1992 than in 1998. Because he was at Isecheno for nearly two months in 1992, von Hippel was far less likely to have missed groups than during his team's one-day census in 1998. Since the group count method yielded a 101 % overestimate when applied to my long-term data on group distribution, it seems reasonable to infer that von Hippel's 1992 estimate of 20.8 groups/km<sup>2</sup> may represent a large overestimate as well. Assuming the group count method produced a similar level of error for von Hippel in 1992 as for me in 1997/98, the actual density in 1992 was probably closer to 10–11 groups/km<sup>2</sup>. If this inference is correct, then the population increased, not decreased, over the six-year period between von Hippel's censuses. This conclusion would be consistent with the fact that neither guenon researcher M. Cords nor I saw physical evidence of a guereza population crash despite the fact that Cords spent 2–3 months each year and I spent more than 19 months at Isecheno between 1992 and 1998 (Fashing & Cords 2000).

In conclusion, my results suggest that a one-day census, even by three observers working simultaneously, is simply too brief to accurately measure forest primate distributions and densities. These

results also suggest that a longer study not taking into account home range size and degree of home range overlap provides a more complete list of the groups entering a study area, but is even less accurate at estimating densities than brief sweep censuses. Thus, the group count method appears to be a poor means of estimating forest primate densities.

How can forest primate densities be more accurately estimated during short-term studies? In situations where only a short period is available for primate censusing, line transect censuses are generally considered to be the method of choice. However, it should be noted that even line-transect censuses must be undertaken repeatedly over a period of several months or more if reasonably accurate density estimates are to be achieved (Struhsaker 1981; Chapman *et al.* 1988; Whitesides *et al.* 1988; Brugiere & Fleury 2000; Fashing & Cords 2000).

#### **Is the guereza population increasing at Kakamega?**

My evidence that use of the group count method can result in large density overestimates suggests that von Hippel (1996) greatly overestimated guereza density in 1992 and that the Isecheno guereza population may be increasing rather than declining. Patterns of female reproduction during my long-term study also suggest that the Isecheno guereza population is robust and possibly increasing. The annual birth rate of 0.71 infants per female year at Isecheno is higher than the rates for all other African colobine populations for which the relevant data have been published, including guerezas at Kibale (0.6: Oates 1974) and red colobus monkeys at several sites (0.27–0.43: Jozani, Zanzibar, Siex & Struhsaker 1999; 0.49: Kibale, Uganda, Struhsaker & Pope 1991; 0.50–0.58: Tana River, Kenya, Marsh 1978; Decker 1989). The birth rate for guerezas at Isecheno is also higher than the rates for most well-studied cercopithecine populations (Andelman 1986). The fact that 10 of 11 infants survived through the end of the study period is another testament to the health of the Isecheno guereza population.

Interestingly, the reproductive patterns of guerezas at Isecheno bear a striking resemblance to those of the red howler monkey (*Alouatta seniculus*) population at Hato Masaguaral, Venezuela. The birth rates and interbirth intervals for these two populations are nearly identical (B = 0.73 infants per female year and I = 17 months at

Hato Masaguaral) and infant survival rates for both appear to be high as well (Crockett & Rudran 1987). Based on these reproductive parameters, Crockett & Rudran (1987) concluded that the howler population at Hato Masaguaral appeared to be increasing in size. The fact that the reproductive parameters of guerezas at Isecheno mirror those of howlers at Hato Masaguaral suggests that the guereza population at Isecheno may also be increasing. Also suggestive that the Isecheno population is increasing is the fact that the number of individuals in the three most intensively monitored groups increased by 18 % over the course of my study.

While von Hippel *et al.* (2000) provide a valuable warning about the ongoing habitat degradation at Kakamega, their conclusions about its effects on the guereza population at Isecheno are not supported by my long-term data on this population. Signs that habitat degradation is occurring are readily apparent at Isecheno, but this degradation does not appear to be having adverse effects on the guereza population, and in fact, the population may be increasing. My study suggests that guerezas at Isecheno, as elsewhere, are resilient in the face of light to moderate habitat degradation (Skorupa 1986; Plumptre & Reynolds 1994; Struhsaker 1997). Still, only a handful of primates are known to exhibit such resilience (Cowlshaw & Dunbar 2000) and the results of my study of guerezas at Isecheno should not be misused to argue that habitat degradation is not a threat to primates. In fact, the results of recent research in forest patches around Kibale suggest that even guereza populations suffer declines and sometimes disappear entirely from patches subjected to high levels of disturbance (Chapman *et al.*, in press). Thus, the resiliency of guerezas is not limitless and it is hoped that current local forest conservation initiatives at Kakamega will help minimize further degradation and the risk that guerezas and other animals in the forest will one day be extirpated (Fashing 1999; Cords 2000).

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