Genetic census reveals increased but uneven growth of a critically endangered mountain gorilla population

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ABSTRACT

Monitoring changes in the population dynamics of endangered species is crucial to effective conservation strategies. The mountain gorilla population of the Virunga Massif has been the subject of intensive conservation efforts, research and several censuses over the last 40 years, but the region has also been affected by political instability and war. Here we present results from the 2010 census, which was the first to utilize genetic analyses of fecal samples for the entire population. The genetic analyses improved the accuracy of the population estimate by identifying several instances in which gorillas otherwise would have been undercounted or double-counted. The population was estimated to be 480 individuals; including 349 individuals found in 24 groups that were habituated for research and tourism, 101 individuals found in 12 unhabituated groups, fourteen solitary males, and a correction factor of sixteen for undetected infants. The population has increased by 26% since 2003 (an annual rate of 3.7%) and it has almost doubled since 1981. Nearly all of the increase can be attributed to a relatively higher growth rate in the habituated groups from 2003 to 2010, and in all five of the previous intervals between consecutive censuses. Nonetheless, it would be imprudent to habituate additional groups due to the concomitant risks of disease transmission from humans, behavioral disturbance and potential vulnerability to poaching. The results show that it is possible for conservation efforts to succeed even under difficult conditions, while highlighting the continuing challenges of managing a wild population of both habituated and unhabituated gorillas.

1. Introduction

Routine monitoring of population size for endangered species is a key element to conservation strategies (Nichols and Williams, 2006). Such monitoring can serve as a measure of both the intensity of threats to the population and the effectiveness of various conservation strategies being implemented (Ferraro and Pattanayak, 2006). Population dynamics are unlikely to be static over time due to variation in environmental conditions and the animals' responses to such changes. Furthermore, growth rates may not be the same for all portions of a population, particularly in cases where threats vary spatially and/or certain management strategies target specific individuals or groups of the population (Rachlow and Berger, 1998). However, in practice, conducting routine monitoring is difficult because of the time, effort and expense involved in obtaining accurate estimates of population size especially when using indirect signs or targeting wary or cryptic animals.

Mountain gorillas (*Gorilla beringei beringei*) are critically endangered and found in only two small island populations: the Virunga Massif and the Bwindi Impenetrable National Park. The Virunga mountain gorilla population is found in the Virunga Massif, which spans the borders of north western Rwanda, south west Uganda and eastern Democratic Republic of Congo (Fig. 1). The population has been the subject of intensive conservation efforts, research and several censuses over the last 40 years, however during the past 20 years the region has also been frequently affected by political instability and war (Robbins et al., 2011). The last census of the
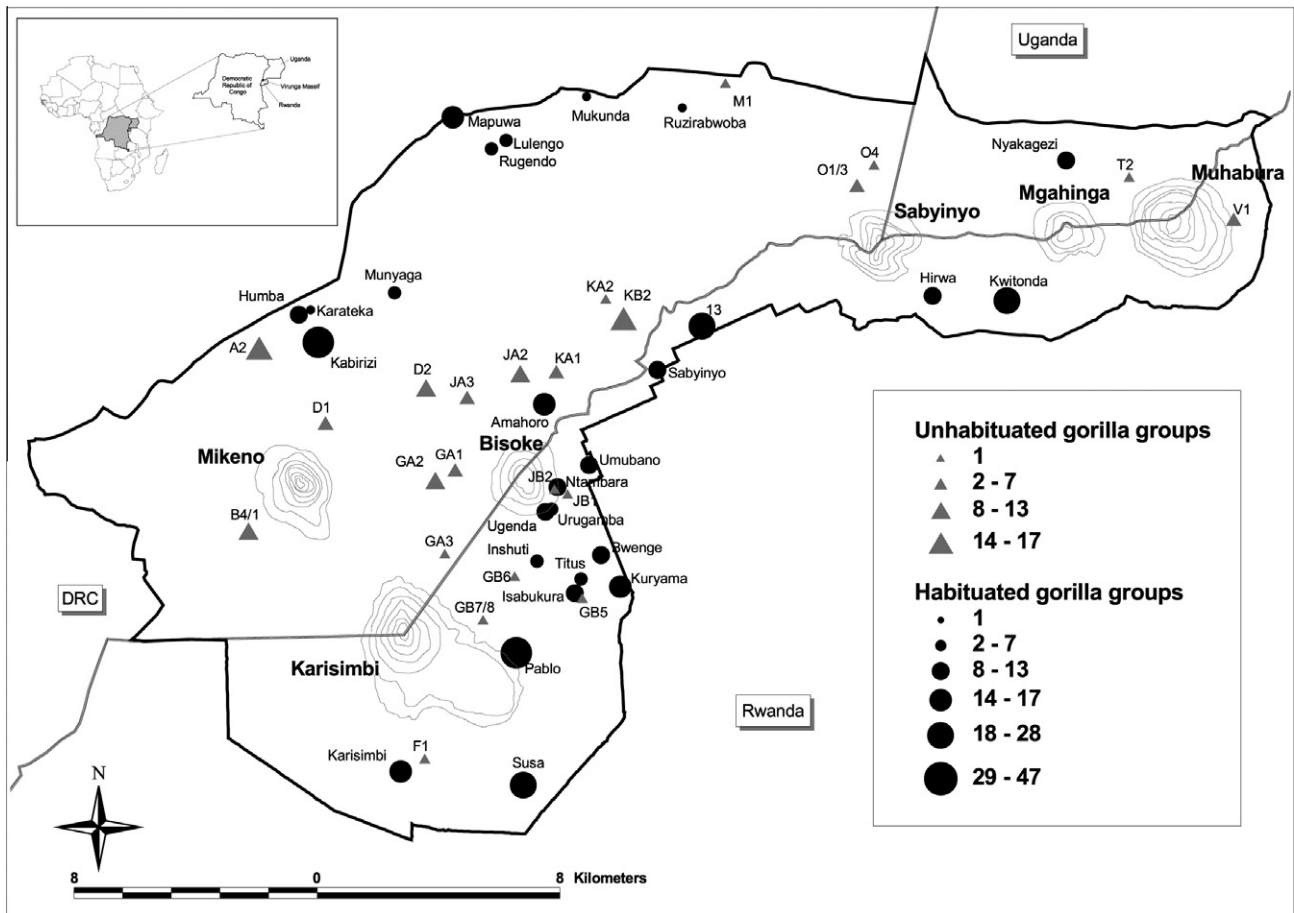
Fig. 1. Distribution of gorilla groups during the 2010 census. Triangles represent unhabituated groups, circles represent habituated groups. The size of the symbol reflects group size. Unhabituated groups were named based on the sector in which they were located. Group names correspond to those found in Table 3.

entire Virunga mountain gorilla population was conducted in 2003 (Gray et al., 2009) when the population was estimated to contain 380 individuals, a 17% increase since the previous census in 1989. These results indicate a steady increase in the population size since the low point of 250 gorillas in 1981. However, an analysis of the population dynamics spanning four decades indicated that the growth occurred unevenly across the population (Robbins et al., 2011). In particular, groups habituated to human presence for either research or tourism apparently grew at a higher rate than unhabituated groups (4.1% annual growth versus a 0.7% annual decline from the 1970s to the mid-2000s). While the entire population has received intensive levels of conventional protection including ranger patrolling for illegal activities, this difference in growth rate was attributed to the benefits of routine, nearly daily protection and veterinary interventions that were possible only for the habituated gorillas. Because the most recent population-wide census was conducted in 2003, the full impact of the subsequent political instability that resulted in intermittent encroachment of armed combatants and civilian populations into the park, sometimes poor security situation limiting the amount of monitoring that could be done, and recent poaching events on the gorilla population (with respect to size, distribution, composition and rate of growth or decline of the population) is unknown. It is known that in 2007 at least ten habituated gorillas were killed in Parc National des Virunga, DRC, but the status of the unhabituated groups is only possible to assess through indirect censusing. In particular, it is important to analyse the population dynamics of the habituated and unhabituated groups separately in order to estimate the impact of differing conservation efforts.

Studies of many species of rare and cryptic animals have shown that censusing methods that rely solely on indirect methods often suffer from limitations that can lead to inaccurate estimates of population size (Norris et al., 2011; Kühl et al., 2008). Incorporating genetic analysis into survey designs can greatly improve the precision of population estimates (Arrendal et al., 2007; Zhan et al., 2006; Arandjelovic et al., 2010, 2011; Katzner et al., 2011). The previous censuses of the Virunga gorilla population have used what is referred to as the 'sweep' method to estimate the number of unhabituated gorillas (all individuals of the habituated groups are known, providing an accurate number for those groups), in which several teams systematically walk throughout the forest looking for fresh signs of gorillas and estimate the population size based upon the number of night nests found (Gray et al., 2009). Based on the high density of reconnaissance teams walking simultaneously through the forest, this method assumes that all, or nearly all, gorillas are found and also assumes that each individual is counted only once. However, the sweep method relies on a number of assumptions that, if not met, may lead to inaccuracies in the population size estimate (Guschanski et al., 2009). First, it is known that the number of nests found from the same group can vary, because gorillas may on occasion make more than one nest per night and that not all nests may be found, so the number of gorillas assigned to a group may in fact be more or less than estimated from the nest counts. Second, the sweep method is also susceptible to the possibility of counting a particular group twice (if they are found in different locations with differing number of nests) or considering two unique groups to be the same group (if they are found in the same area and have similar numbers of nests). Additionally,