Notes and records

Golden monkey populations decline despite improved protection in Mgahinga Gorilla National Park, Uganda

Dennis Twinomugisha[1] and Colin A. Chapman[2*]

[1]*Institute of Environment and Natural Resources, Makerere University, PO Box 7298, Kampala, Uganda and* [2]*Anthropology Department and McGill School of Environment, 855 Sherbrooke St West, McGill University, Montreal, Canada, H3A 2T7 and Wildlife Conservation Society, 2300 Southern Boulevard, Bronx, NY 10460, U.S.A.*

Introduction

Human modification of ecosystems is threatening biodiversity on a global scale (Laurance, 1999). With respect to primates, this issue is critical because the tropical forests they occupy are undergoing rapid anthropogenic transformation and populations are also being affected by forest degradation and hunting (Chapman & Peres, 2001; Chapman, Lawes & Eeley, 2006). Setting up a system of protected areas is the primary conservation strategy for the vast majority of species. Yet, little is known about long-term ecosystem dynamics in protected areas and thus we cannot predict what will happen to species in parks over the long-term.

In this study we start to address this gap in our understanding of the long-term value of protected areas by providing a case study of the endangered golden monkey (*Cercopithecus mitis kandti*) inhabiting Mgahinga Gorilla National Park (MGNP), Uganda. We built on censuses conducted in 1989 by Werikhe (1991) and in 1998 by Twinomugisha, Basuta & Chapman (2003) and conducted a census in 2003. We used the same methods, during similar times of the year and where possible the same census routes as those used previously and thus we consider we provide an accurate picture of population change over 14 years.

The area of MGNP was first gazetted in 1930 as a Gorilla Game sanctuary and covered 33.7 km^2, but in 1939, 15.5 km^2 of this was reclassified as un-demarcated crown forest allowing bamboo extraction (Kingston, 1967; Malpas & Infield, 1981). Because of an increasing shortage of land for cultivation, the forest reserve was reduced by 10.4 km^2 in 1951 [Uganda National Parks (UNP), 1996]. The Gorilla Game Sanctuary was renamed the Gorilla Game Reserve in 1964 and was enlarged to 47.5 km^2; however, this boundary was never demarcated and people remained settled on 13.8 km^2 (Malpas & Infield, 1981; UNP, 1996). Encroachment on this conservation area was compounded by illegal activities including poaching of wildlife and bamboo harvesting. By the latter half of 1980s, the Gorilla Game Reserve had attracted international attention and a number of conservation projects were initiated. This attention culminated in upgrading the Reserve to a National Park in 1991, which offers the highest level of protection under the Ugandan constitution (UNP, 1996). During the same year, the World Bank Global Environmental Facility established a trust fund to contribute to conservation efforts in and around the park (UNP, 1996). In June 1992, the Ugandan government reached an understanding with the local people illegally settled in the park and they were re-located.

With this more or less steadily increasing level of protection and the potential for regeneration of the degraded areas, one would predict that the size of the golden monkey population would increase. This prediction was addressed here by conducting a detailed census in 2003 and comparing the density estimates and distribution of animals from this census to similar surveys conducted in 1989 and 1998. While the increased level of protection leads one to be optimistic about the fate of golden monkeys in MGNP, there are still reasons to be concerned about. Tilman *et al.* (1994) presented a multispecies model in which a number of competing species could persist in an environment where there were many habitat patches and habitat destruction and patch removal. This model concluded that there would be delayed extinction of competitively superior species, or what has been coined an extinction debt (Loehle & Li, 1996). Cowlishaw (1999) applied these ideas when he used species–area extinction models to predict extinctions of primates for a range of African forests based on forest deforestation. While his findings predicted

*Correspondence: Tel.: +514 398 1242; Fax: +514 398 1643; E-mail: colin.chapman@mcgill.ca

extinctions, no extinctions had occurred. He suggested that there is a time lag between habitat loss and actual extinctions, such that the current state of threatened species translates into an extinction debt that may eventually be paid. Therefore monitoring of golden monkey populations is warranted so that timely remedies can be applied if declines are detected.

Methods

To obtain an estimate of golden monkey abundance, line transect censuses were conducted twice a month for seven months (January 2003 to July 2003). To be able to compare these census results to those of the 1998 survey by Twinomugisha *et al.* (2003), census walks were carried out in the exact manner as in the past study, which had been conducted at a similar time of the year (March to August 1998). Censuses were conducted by walking at 1 km h^{-1} along three 4-km and one 5.7-km transects along the exact routes used in 1998. One of the 4-km transects was laid in the previously encroached and degraded part of the park that has been recovering for 13 years. Upon sighting a social group the following variables were recorded: location, sighting angle, sighting distance from observer, height above ground, vegetation type and the number of individuals in a group. Sighting distance was visually estimated and to aid in visually estimating the transect was marked off at 100 m intervals. The majority of the censuses began between 06.40 and 08.30 hours and lasted to 10.40 and 11.40 hours for all 4 km transects and till 14.00 hours for the 5.7 km transect.

A graph of frequencies of sighting distances was used to determine the point where the curve sharply tapered off and this distance was regarded as the distance within which one could reliably sight groups. This point was at 25 m and was used as the Maximum Reliable Sighting Distance to determine the census strip area. Sightings beyond that distance were few and were dropped from the estimations.

A comparison was also made to findings from a census of golden monkeys conducted in January 1989 to January 1990 by Werikhe (1991) . Werikhe (1991) conducted censuses in a similar fashion along eight transects (ranging from 2.7 to 4.5 km) all laid in the part of MGNP that was not settled. Werikhe's transects followed existing trails that mostly ran along an altitudinal gradient and cut across vegetation types.

To provide an index of relative abundance that does not make some of the assumptions of the line transect methodology, we calculated changes in a relative abundance measure: the number of groups seen per km of census trail walked (Chapman *et al.*, 2000). This method does not take into account differences in visibility among periods or differences in the ability of the observers to detect animals; however, it is less likely to be biased by differences among observers in the ability to estimate distance. Both density and relative abundance were calculated because where both estimates agree we can have more confidence in the observed trend. For both of these indices we provided information for two 'sets' of transects. First we provided data for all transects and second we provided data for all areas excluding the area in the regeneration zone that was not used by golden monkeys in 2003. This allows an evaluation of densities in all areas and in just those areas that it appeared the golden monkeys viewed as suitable habitat in the last survey.

Results

In 2003, the density of golden monkeys (set 1, transect with degraded habitat included) was 3.31 groups km^{-2}, while in 1998 the density in the same area was 5.11 groups km^{-2} (Table 1; Twinomugisha *et al.*, 2003). The density of monkeys in 2003 excluding of the regenerating zone was 4.28 groups km^{-2} (set 2), while in 1998 the density for this area was 6.03 groups km^{-2}. In 1989, Werikhe (1991), found the density to be 3.24 groups km^{-2}. Werikhe conducted censuses at a time when encroachers were still using the regenerating zone, thus his results excluded this zone. Unlike the 1998 census, there were no monkeys encountered in the regenerating zone in 2003. These results suggest an increase in golden monkey density between 1989 and 1998, but a decline between 1998 and 2003.

In 2003, 56 census walks were made over a total distance of 247.8 km and 46 monkey social groups were encountered (set 1; Table 2). Excluding the regenerating zone, which did not contribute any sightings, 42 censuses were conducted over 191.8 km and 46 groups were sighted (set 2). This sighting rate (set 1: 0.19 groups km^{-1}; set 2: 0.24 groups km^{-1}) was lower than that obtained in the 1998 census (set 1: 0.44 groups km^{-1}; set 2: 0.52 groups km^{-1}). In 1998, 132 groups were encountered cumulatively after 67 census walks along an

Table 1 Sighting rates and density estimates of golden monkeys in Mgahinga Gorilla National Park, Uganda in 1989, 1998 and 2003. Set 1 includes the area regenerating after human encroachment, while set 2 does not

Park area	Total groups	Total censuses	Total census length	Census area (km2)	Groups km^{-2}	Sighting rates km^{-1}
Set 1 2003	46	56	247.8	12.39	3.31	0.19
Set 2 2003	46	42	191.8	9.59	4.28	0.24
Set 1 1998[a]	–	–	–	–	5.11	0.44
Set 2 1998[a]	–	–	–	–	6.03	0.52
Set 2 1989[b]	–	–	–	–	3.24	0.91

[a]From Twinomugisha (2000).
[b]From Werikhe (1991).

Table 2 Number of social groups sighted along the different transects during census walks in 2003 in Mgahinga Gorilla National Park, Uganda

Transect	No. of censuses	Total groups	Range	Mean ± SE
1	14	0	0	0.00
2	14	16	0–3	1.14 ± 0.25
3	14	17	0–3	1.21 ± 0.30
4	14	13	0–3	0.93 ± 0.25

accumulated distance of 298.6 km. Werikhe (1991) walked 241 km in 69 census walks and encountered 116 groups.

Similarly, encounter rates of monkey groups in different vegetation zones were lower in 2003 than in 1998 (Table 3). In some of the vegetation zones (i.e. *Hypericum* woodland, swamp-meadow) there were no social groups sighted in 2003, but groups were sighted in these habitats in 1998. Similarly, sighting rates in similar vegetation types were lower than during Werikhe's census (Table 4).

Discussion

Following the protection of endangered species in a national park, their numbers are expected to increase as has been previously documented. For example, Chapman & Balcomb (1998) documented that howler monkey (*Alouatta palliata*) density was higher in a sector of Guanacaste National Park, Costa Rica that had been protected for a longer period than in newly protected areas. Comparing the density estimates of golden monkeys in MGNP between 1989 and 1998 would suggest that they were following this pattern, while the decline in density between 1998 and 2003 suggests that something unexpected is occurring. In contrast, the sighting rates suggest a steady decline in golden monkey abundance between 1989 and 2003. Regardless of which method is used, evidence suggests that while they have received increased protection over the last 14 years, their population has declined.

The distribution of golden monkeys has also changed since 1998. While there were sightings of monkeys in the seven vegetation types in 1998, there were no sightings in

Table 3 Sighting rates of golden monkeys in different habitats in Mgahinga Gorilla National Park, Uganda, in 1998 and 2003. Transect lengths are the same in both periods

		2003			1998		
Vegetation type	Transect length (km)	Group seen	km walked	Group km^{-1}	Group seen	km walked	Group km^{-1}
Bamboo mixed	1.9	7	26.6	0.26	33	35.6	0.93
Pure bamboo	6.25	36	87.5	0.41	60	105.5	0.57
Heath forest	1.9	2	26.6	0.08	7	33.4	0.21
Open forest	0.85	1	11.9	0.08	14	17.9	0.78
Swamp	0.4	0	5.6	0.00	1	7.0	0.14
Hypericum	2.4	0	33.6	0.00	10	43.2	0.23
Regenerating	4.0	0	56.0	0.00	2	56.0	0.13

Table 4 Sighting rates of golden monkeys in different habitats in Mgahinga Gorilla National Park, Uganda, in 1989 (Werikhe, 1991)

Vegetation type	Kilometre walked	Groups km^{-1}
Bamboo	107.8	0.91
Hagenia–Hypericum	35.7	0.22
Montane woodland	20.3	0.44
Swamp	13.9	0.07
Sub-alpine	38.7	0.00
Alpine	24.5	0.00

three of them in 2003. Similarly, small groups were seen at high elevations in 1989 and 1998, but not in 2003. One of the vegetation types in which there were no sightings in the 2003 census is the regenerating grassland and woody grassland, yet this area had improved protection and the vegetation was recovering. One possible explanation for this change in distribution is that as the population density of golden monkeys has declined, animals are able to restrict their ranging to only the most preferred habitats.

The golden monkey's preferred habitat appears to be bamboo and bamboo mixed with trees (Werikhe, 1991; Twinomugisha *et al.*, 2003). This type of habitat comprises about 40% or approximately 13.5 km^2 of the park. All sightings during this study were in this vegetation type. At a group density of 4.28 groups km^{-2}, this means that there are currently approximately 57.69 groups of golden monkeys in MGNP. Given an average group size of 17.1 individuals, this equals approximately to 989 ± 521.5 SD (range 467–1511) individuals, which is only 40.6% of the population estimated by Twinomugisha *et al.* (2003) for 1998 (81.3 groups making up 2438 ± 1463 SD, range 975–3901). Bamboo may be a critical resource given its prominence in the golden monkey diet and its year round availability and use (percentage of monthly feeding time mean 59.9, range 39.0–79.1; for information on which parts of bamboo are eaten in different months see D. Twinomugisha & C. A. Chapman, unpubl. data).

Presently, bamboo is the most sought after item by the local community bordering the national park. The local people claim that bamboo in specific locations is particularly suitable for crafts and other uses, thus the same areas tend to be repeatedly harvested year after year. This harvesting pattern may eventually negatively affect the growth of bamboo leading to poor yield or even a retreat in coverage. In similar bamboo stands on Mt Elgon, Uganda, Scott (1994) found that bamboo culm d.b.h. decreased with increasing harvest intensity. A recent trend that we have observed is that bamboo shoots are being harvested for human consumption (D. Twinomugisha, pers. obs.). This is a practice that has been brought to the local community by soldiers positioned in the national park to provide security. For some, bamboo shoots are a delicacy and there is a possibility that the local people, who have not traditionally fed on bamboo shoots, will take on the practice. The distribution of bamboo is strongly influenced by climatic and edaphic factors; however, evidence suggests that it can also be limited by harvesting and/or elephant numbers which are affected by human hunting in many areas (Hemp, 2006). Forest disturbance caused by elephants create conditions conducive for bamboo expansion and when elephant populations are removed from areas declines in bamboo have been documented (Banana & Tweheyo, 2001). Given that elephants are now rarely seen in MGNP and harvesting is occurring and it is often concentrated in a few specific locations, the extent of bamboo should be monitored. In addition, it would be valuable to experimentally determine how harvesting influences bamboo stands and to determine if there is a sustainable and perhaps beneficial level of harvest.

It is unclear what is causing the observed golden monkey population decline in MGNP despite improved protection. What is clear is that the golden monkeys are primarily using the vegetation zones with bamboo. This may be because other habitats are marginal and regeneration has not proceeded to levels at which it is able to sustain a resident population. Given the level of regeneration that is evident after 13 years, it seems unlikely that regeneration through a natural process will lead to the recovery of the bamboo community in the near future, thus, it may be appropriate to carry out a restoration programme in this area. This would add about 10.1 km^2 of preferred habitat, which will result in a 75% increase in bamboo vegetation. Given the prominent role bamboo plays in the habitat selection and diet of the golden monkey and trends of harvesting, illegal bamboo harvesting is the greatest threat to the golden monkey population. However, given the nutritional importance of some of the fruit and flowers provided by trees such as *Maesa lanceolata* and *Hypericum revolutum*, greater efforts should be invested in preventing all types of harvests.

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