A SURVEY OF BURNT AREAS IN BWINDI IMPENETRABLE AND MGAHINGA GORILLA NATIONAL PARKS, S. W. UGANDA

THE FIRES OF 2000

By

Aventino Kasangaki

Dennis Babaasa

Robert Bitariho

Ghad Mugiri*

Institute of Tropical Forest Conservation-Ecological Monitoring Programme

***Uganda Wildlife Authority-Mgahinga Gorilla National Park**

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II. EXECUTIVE SUMMARY

Fire has been one of the main management challenges and is considered one of the major long-term threats to forest biodiversity in Bwindi Impenetrable and Mgahinga Gorilla National Parks.

In June, July and August 2000 fire outbreaks occurred the two parks. During September 2000 we carried out a survey of the burnt areas, which aimed at documenting the burnt sites and extent of damage caused by the fires. This was done as part of a long term monitoring programme to advise park managers about what could be done to prevent, halt or decrease incidences of fire outbreaks.

The results show that approximately 0.2 square kilometers constituting 0.05% of the total park area was affected by fire in Bwindi Impenetrable National Park. The area affected was significantly smaller than that burnt in 1999 (2.64 square kilometers, 0.8% of park area); there has been a significant reduction in fire incidences in Bwindi in 2000 that we have attributed to the difference in the number of 'rainy days' in the 'North sector' and Buhoma and Ruhija, improved park boundary maintenance and increased sensitization of communities surrounding the park. However, the total numbers of 'rainy days' during the months of May to September were not significantly different between 1999 (139 'rainy days') and 2000 (127 'rainy days').

In Mgahinga Gorilla National Park, 0.1 square kilometers constituting 0.3% of the Park area was affected by fire. However, we have no previous with which to compare

these estimates. In both parks illegal honey collectors caused most fires with a few spreading from community agricultural fields. On a positive note, the communities' response to putting out fires was almost 100%. This shows an improved attitude of the communities towards protected areas.

Given the fact that fire has become a regular component of the disturbance regime in the two parks, we recommend preventive measures such as public education and good public relations between parks and local communities, instituting and enforcing legislation on regulations for lighting fire in the park, establishment of early warning systems and the establishment and maintenance of a clear park boundary. We further advocate for the provision and maintenance of appropriate equipment and training of park staff in fire suppression measures. Lastly, since illegal honey collectors caused most fires, we recommend that park staff and all stakeholders in the management of the two Parks intensify sensitization of the communities on the dangers of fire in protected areas.

1. INTRODUCTION

Fire has been one of the main management challenges and is considered one of the major long-term threats to forest biodiversity in Bwindi Impenetrable and Mgahinga Gorilla National Parks. During the 1999 drought, Bwindi experienced the most devastating fires in about eight years when 37 fires burned 2.64 square km. of the Park (Babaasa *et al.* 1999). The relatively large extent of these fires was attributed to a record drought, poor park boundary maintenance and to a small extent, reluctance of some communities to participate in extinguishing the fires. Peasant farmers who prepare their fields for planting by burning the previous years' stubble or by slashing and burning new fields began most fires. Exacerbated by drought and high temperatures, these 'agricultural fires' burned out of control and swept across the park boundary. Unlike the fires of 1999, the 2000 fires never attracted intensive media attention and much public concern.

In Mgahinga, Werikhe (1991) reports that in 1989 signs of fire were found in over 30 percent of the then Game and Forest Reserve and had been particularly prevalent on Mt Muhabura for many years. In 1985, a particularly bad fire reached the heath and afro-alpine vegetation of Mt. Muhabura. It is reported in the current management plan (1996 - 2000) for Mgahinga, that fires are started in the park for a variety of reasons, but are typically set by humans to improve pasturage for grazing livestock, to smoke out bees in the process of collecting honey, and to clear areas of brush around beehives. Also uncontrolled fires from neighboring farms may move into the forest

and others may be started by camping soldiers, as a result of military skirmishes, by poachers, trespassers and in some cases set deliberately as acts of arson or sabotage. The impact of fire on the ecology of the park is undocumented, but Kalina (1993) noted that grazing of some large mammals was encouraged. For example, bushbuck and black-fronted duikers are common in burned areas on Mt Muhabura while other species like the mountain gorillas made no use of the burnt areas. Hedberg (1964) reports that slow growing flora with little resistance to fire, such as the giant senecios, are particularly susceptible to fire.

The question of interest in this survey is how much of each park area was burnt and causes of the fire in each case. This question has many applications depending on the definition of the burned area and the purposes for which the information will be used. Managers concerned with wild fires need to know how many fire fighters they need to put on the fire line and what equipment they need to order. In addition, the managers want to know the causes of fires in order to put in place measures that can halt or decrease further outbreaks. The public has a natural curiosity about what is happening, and media people need to know how many square kilometers have burned in order to satisfy that curiosity. The scientists trying to understand the process of fire and the effects of the fire on the forest ecosystem need to know how much of their study areas have burned as well as the intensity and the distribution of the burns, and wildlife managers need to know how much habitat has been modified. Against this background, the annual pattern of fire incidences is documented in Bwindi and

Mgahinga. Such information will assist in understanding the causes and effects of fire and in developing appropriate management responses to them.

2. METHODS

In September 2000, we surveyed burnt sites in Bwindi and Mgahinga National Parks with the help of park rangers and local people. All the areas affected by fire between June and August were surveyed. The burnt sites could be recognised by charred remains of trees, charring on barks of live trees, and ash on the ground. We distinguished between newly burnt sites and older sites by degree of growth of bracken fern and herbaceous vegetation. We recorded Global Positioning System (GPS) receiver coordinates of the burnt sites and then entered them into a Geographic Information System (GIS) database of the two parks. The relative locations of the sites were then displayed on the maps of Bwindi and Mgahinga using ArcView programme.

On sites where the extent of the fire was small and had more or less regular shape, (e.g., triangular, rectangular or square) we determined the area by measuring the dimensions of the burnt patch using a 50m tape measure. The area was then calculated using appropriate formulae based on the shape of the burnt area. Where a burnt area was large and of irregular shape, a number of points at the edge were geo-referenced using a GPS receiver and entered into ArcView programme. After drawing polygons on the edge points, we then calculated the areas of the individual polygons.

Determination of whether or not a fire originated from outside the park depended on evidence at the park boundary. If the fire was observed to have started at the park boundary, it was deemed to have crossed over from the neighbouring community land. This would be confirmed by interviewing the local people and park rangers. If the fire did not originate outside the park, there was no evidence of burning from the boundary. For such fires, causes were determined by looking out for signs such as tree trunks from which honey was harvested evidenced by ladders leaning against the trunks and enlarged holes on the tree trunks from where honey was being removed. Fires caused accidentally by honey harvesters in the Multiple-Use Zones were determined from information provided by the local people and park rangers who participated in extinguishing of the fires. This would be corroborated on the site by looking for presence of a beehive. Community participation in putting out fires was assessed from the parks' records, interviews with wardens, park rangers and local people living adjacent to the burnt areas.

Fire behaviour was investigated in this survey so as to get an insight into the amount of ecological damage done. Fire behaviour classification follows that of Brown and Davis (1973). By observing the degree to which fuels from mineral soil upwards to the treetops were involved in combustion, it was possible to tell the behaviour exhibited by a fire at a particular site.

3. RESULTS

Figure 1 is a map of burned areas within Bwindi in 2000. Seven fire sites were recorded. It is evident from the map that the distribution of fire sites was concentrated in the 'Southern Sector' and none was recorded in the 'Northern Sector'. Comparison of the number of year 2000 burnt areas with those of 1999 (Fig. 2) shows that there were significantly fewer fires during the year 2000 than in 1999 (7 as opposed to 37; $\chi^2_{1df} = 19.12$, $P < 0.01$). Figure 2 further depicts a recurrence of fire in the Rushaaga area. Table 1 shows the locations of the burnt sites and area affected by fires, cause of the fire, the behaviour it exhibited, and community participation. Approximately 0.2 square kilometers of the Park was burnt. This constitutes 0.05% of the total Park area (Table 2). In comparison, 2.6 square kilometers (0.8%) of the Park were burnt in 1999 (Table 2). However the difference in the area burnt between 1999 and 2000 was not statistically significant ($\chi^2_{1df} = 0.8$, $P > 0.05$). One fire site that burned in March 2000 near the Congo border is not included in this survey. However, according to the Law Enforcement Warden Bwindi, the fire crossed from the community land and burnt an area of approximately 0.003 square kilometers.

In an attempt to find an explanation for the reduced fire incidences between Buhoma and the 'North Sector' and the extreme end of the 'South Sector' in year 2000, we analysed 'dry season' (May - September) 'rainy days' data for Rushamba outpost in the 'Northern Sector' and Buhoma in the 'Southern Sector' and compared it with data from Ruhija. The 'Northern Sector' and the Buhoma areas of the 'Southern Sector'

Figure 1

Figure 2

Figure 3

receive approximately the same amount of rainfall. Both areas were not burnt during the year 2000. On the other hand, Ruhija and Rushaaga being at similar altitude (about 2300m), may receive similar amounts of rainfall, and data from Ruhija can be taken as representative of rainfall at Rushaaga. A 'rainy day' is defined as one on which 1 mm or more of rain was recorded. The difference in the mean number of 'rain days' of the three stations was highly statistically significant ($F_{2,12} = 7.622$, $P<0.01$). The Tukey multiple comparisons test proved a significant difference in 'rainy days' between Buhoma and Ruhija, and Rushamba and Ruhija to be significant at P = 0.01 and 0.05 respectively. However, comparison of the 'rainy days' for the same months between 1999 and 2000 did not show any significant difference ($t_{14} = 0.18$, P.0.05).

Table 1: Location, extent, cause, nature of the fires and local community response in Bwindi Impenetrable National Park, 2000.

Location	*Area (sq. km)*	*Cause of fire*	*Nature of fire*	*Community response*
1.Murutooma	0.0182	Honey hunting	Surface	Voluntary
2.Kemihanga	0.0014	Honey hunting	Crown / surface	Voluntary
3.Nyakagongo	0.0012	Honey hunting	Surface	Voluntary
4.Kijuma Hill	0.0155	Honey hunting	Ground / surface	Voluntary
5.Rumbya Hill	0.0928	Unknown	Ground	Voluntary
6.Mukisirira	0.0096	Beehive construction	Surface	Voluntary
7.Rwamunyonyi	0.0318	Arson	Crown / surface	Voluntary
Total	0.1705			

Table 2: Comparison between the 1999 and 2000 fires in Bwindi Impenetrable National Park.

Year	No. of burnt sites	Total area burnt (sq. km)	% age of area	Total rainy days (May to Sept)
1999	37	2.64	0.8	139
2000	7	0.17	0.05	127
% Reduction	81 %	93.7 %		

In Mgahinga Gorilla National Park, two fire burns were recorded (Fig. 3), one on the slopes of Mt Muhabura and the other, more extensive one on Mt Sabinyo. An area of 0.11 square kilometers was burnt on Mt Sabinyo and 0.004 square kilometers on Mt Muhabura. The total area burnt constituted about 0.3% of the total park area. However the Sabinyo area could be an under estimate of actual acreage affected by fire given the fact that some areas were inaccessible to the survey team because of the rugged and difficult terrain. Although the Muhabura site in Mgahinga has experienced several fires previously, long-serving park staff informed us that this was the first time for fire to occur on Mt Sabinyo side of the park.

The causes of the fires were identical in the two parks. In Bwindi, 57.1% (i.e. 4 out 7) of the fires were caused by honey hunters. It is alleged that the Rwamunyonyi fire was due to arson 14.3% (i.e. 1 out of 7) by some locals who wanted to destroy other peoples' hives and for the remaining two fires one was caused by people constructing beehives illegally within the Kashasha Multiple-Use Zone, while for one fire, the cause could not be ascertained (Table 1). It is reported by Mgahinga Park staff that

illegal honey collectors caused the Mt Sabinyo fire, while the Muhabura fire crossed from the community land into the park. Table 1 above shows that in Bwindi, three fires were of surface type, two were ground fires and the remaining two showed a mixture of fire types. By interviewing rangers and some local people it was found out that communities participated willingly in putting out all the fires.

4. DISCUSSION

In Bwindi, there was a significant reduction in the number of fire burns in 2000 compared to those of 1999. The 2000 fires in Bwindi were concentrated in the 'Southern Sector' of the park. A moister microclimate caused by a high number of 'rainy days' in the 'Northern Sector' and Buhoma, which maintained fuel moisture content above the moisture of extinction, was possibly responsible for the reduced fire burns in those parts of the park. It is well known that fires can penetrate those forests that have lost portions of their canopies because of severe seasonal drought (Nepstad *et al*. 1995). In addition, the Warden Law Enforcement Bwindi and the area Community Conservation Ranger attribute the reduced fire incidences to the deterrent fines that were paid by those responsible for the 1999 fires and increased community sensitization. The Warden Law Enforcement further attributes the reduced extent of fires to an alert fire fighting team as opposed to the situation of 1999. There was a recurrence of fire in the Rushaaga and Rubuguri area although not in the exact sites that burned in 1999. This area has a history of fires and logging (McNeilage *et. al*. 1998, Babaasa *et. al*. 1999). The recurrence of fires in this area may be attributed to the communities' negative attitude towards the park. The Warden Law Enforcement

reports that this area has the highest number of illegal activities. Forest stands that have been selectively logged are particularly susceptible to burning because of extensive canopy openings that create a warmer, drier microclimate, which hastens fuel drying. We observed that Bwindi fires are restricted to the ground layer and appear to cause severe damage. Ground fires are insidious; although consuming only leaf litter, they kill many trees and increase canopy openings and woody debris, making the forest far more vulnerable to devastating wild fires in future (Cochrane *et. al*. 1999).

Since there were no fire incidences reported in Mgahinga in 1999, and only two in 2000, we cannot make quantitative comparisons between the years. However, Werikhe (1991) reported evidence of fire in 30% of the then Game and Forest Reserve, suggesting that fire incidences have reduced since the reserve was gazetted a National Park in 1991. Mapping of the 2000 fires is a first step in understanding future changes of fire regimes in Mgahinga. It should be noted that the rugged and difficult terrain especially on Mt. Sabinyo poses a big challenge to fire prevention and fighting. For example, this year's fire on Sabinyo burnt for a long time (one month) and died out at the onset of rain in spite of the efforts by the Mgahinga park staff and local communities to put it out.

The causes of fire in Bwindi and Mgahinga in 2000 were mainly due to illegal honey harvesting unlike the fires of 1999 in Bwindi, which originated mainly from the surrounding agricultural land. Community response in putting out the fires was

almost 100% voluntary in the two parks and we attribute this to improved relations of the park staff with the communities and sensitization of the communities about their roles in conserving natural resources. However, the community-park relations in Rushaaga area of Bwindi seem to be poor as fires continue to devastate the park every dry season.

The Bwindi and Mgahinga fires may seem innocuous considering the percentage of the total park area they affect (0.05 % in Bwindi and 0.34 % in Mgahinga for 2000) but in fact their effects can be severe. Most trees in forests are characterised by thin bark and therefore are highly susceptible to damage by fire. Uhl and Kauffman (1990) through examination of bark tissues and simulated fires in primary forest in east Amazon found that a small percentage of the standing vegetation would likely survive even a low intensity surface fire. They estimated that in the event of fire in a primary forest, 98% of all stems greater or equal to 1cm dbh would be killed. During this survey, we observed that the fire mostly affected small trees and saplings. Bark thickness is diameter dependent, which explains why smaller trees experience greater mortality from fires (Holdsworth & Uhl 1997).

Fire increases fuel loads as standing dead trees begin to fall or shed branches. Fuel loads increase with number of dead or partially dead trees of any size class. If the forest reburns within a few years of the initial fire, the fires will be much worse. In recurrent fires, flame length, depth, spread rate, residence time and fire line intensity will be successively higher (Cochrane & Schulze, 1999). Left unchecked, this fire

regime can quickly degrade the forest to a state similar to vegetation on recently abandoned agricultural land. Even if the fires can somehow be controlled, the future forest structure and composition will be dramatically changed, with many mature forest species extirpated. Already large swathes of the 'Northern Sector' of Bwindi, which are repeatedly burnt, weedy vines and grasses have formed dense mats above ground level, potentially suppressing recruitment of tree seedlings for years. In Mgahinga, scrub and shrub land are common on Mt Muhabura. As a result of the recurrent fires the area resembles more of woodland than a tropical montane moist forest. Fires create large gaps on ridge slopes of Bwindi (Lind & Morrison 1974) that show no sign of forest regeneration. The impact of fire differs from other natural or man-made gap forming processes in that most pre-existing seedlings and saplings are killed by fire (Woods 1989). If land management practices are not changed, recurrent forest fires will occur. The resultant fire regime, once established, will quickly and severely damage large areas, likely deflecting succession to savanna and scrub vegetation (Cochrane *et al.* 1999).

5. CONCLUSIONS AND RECOMMENDATIONS

In both parks, but more especially Bwindi, fire has become a regular component of the disturbance regime. If fires become more severe as a result of human-caused forest disturbances and climate changes, it is likely that forest regeneration will be slower and less predictable because severe fires will result in increased mortality of both seeds and sprouting species. As a recurrent disturbance phenomenon, fire shows unparalled potential to impoverish and alter these Afromontane forest ecosystems. If there is any reason for optimism, it is that local support for conservation seems to be improving in Bwindi and Mgahinga. This provides hope for the future, but there is no room for complacency. For without far greater international and domestic commitment vast expanses of these two parks will continue to burn each year.

Fire control and prevention measures based on repeated surveys of burnt areas have been proposed to park management (Babaasa *et al*. 2000). Fire control can be achieved by knowing the cause of the fire and fire behaviour. Preventive measures are necessary to check on fire outbreaks and prepare to meet situations that may arise as and when a fire breaks out. Preventive measures include public education and good public relations between parks and adjacent communities, legislation, regulations for lighting fire in the park, firebreak establishment, inclusion of fire-fighting funds in annual operation budgets, provision and maintenance of appropriate equipment, training of park staff in fire suppression measures, fire season declaration,

maintenance of forest trail system for quick movement of fire fighting team, and an alert fire fighting organization.

Since fire has become a recurrent phenomenon in the Rushaaga / Rubuguri area, it is recommended that a community conservation ranger be appointed and posted to that location for effective sensitization of the communities. We further recommend that a weather station be established at the Rushaaga ranger outpost so as to closely monitor the relationship between weather and fire.

We recommend that Mt Sabinyo in Mgahinga be closely watched for possible fire outbreaks during the dry season, as fire fighting on this terrain is almost impossible.

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