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An Assessment of the Effectiveness of Nkuringo Buffer Zone in Mitigating Crop Raiding Incidences around Bwindi Impenetrable National Park, S.W. Uganda.

A technical report for the International Gorilla Conservation Programme (IGCP)



By

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March 2015

Table of Contents

I. Acknowledgement 1

II. List of acronyms used 2

III. Executive Summary 3

1. Introduction 4

1.1 Causes of human- wildlife conflict 4

1.2 Consequences of human- wildlife conflict 5

1.3 Classification of human- wildlife conflict interventions 5

1.4 Human- wildlife conflict in Nkuringo area 6

1.5 Human- wildlife conflict management in Nkuringo area 7

2. Problem Statement 8

3. Objectives of the study 8

4. Methods 9

4.1Study site 9

4.2 Data collection 10

4.2.1 Establishing the current spatial and seasonal patterns of crop raiding 11

4.2.2 Documenting and analyzing cases of wildlife crop raiding events 12

4.2.3 Geo-referencing the locations of all interventions in the buffer zone 13

4.2.3 Assessing community perceptions on effectiveness of buffer zone interventions 13

4.3 Data analysis 14

5. RESULTS 15

General result summary 15

5.1 Variation of crop raiding incidences across plots 15

5.2 Seasonal patterns of crop raiding 16

5.3 Extent of crop damage and vulnerability stages of the crops 20
5.4 Crop raiding distances moved by wild animals from the park boundary 24
5.8 Geo-referencing the buffer zone and locations of the interventions 26
5.3 Community perceptions on effectiveness of buffer zone interventions 27
5.2 Perceptions on benefits and challenges associated with interventions 29
6. Discussion 32
6.1 Spatial distribution of crop raiding incidences 32
6.2 Seasonal patterns of crop raiding incidences 33
6.3 Differences in crops raided and the extent of crop damage 33
6.4 Differences in crop raiding by wild animals 34
7. Conclusion 36
8. Recommendations 37
11. References 40
Appendix 1: Crop raiding data collection sheet 43
Appendix 2: Perceptions Questionnaire 45

I. Acknowledgement

This study was originated and funded by the International Gorilla Conservation Programme (IGCP) and carried out by the Institute of Tropical Forest Conservation (ITFC). We are greatly indebted to ITFC staffs that were involved in the study, more especially during the field data collections, these were: Michael Byamukama, Sliver Ntirenganya, Chistopher Byaruhanga and Emmanuel Tibenda. We would also like to thank Peter Kabano for producing the GIS maps that were used in this report. Special thanks go to the Uganda Wildlife Authority (UWA) and Nkuringo Community Conservation Foundation (NCCDF) staff that helped in data collection. We are particularly thankful to the local people who allowed us to interview them, provided views and allowed us access their gardens in the field for data collection.

II. List of acronyms used

ASCA	Accumulated Savings and Credit Associations
BINP	Bwindi Impenetrable National Park
BMCA	Bwindi Mgahinga Conservation Area
BMCT	Bwindi Mgahinga Conservation Trust
DRC	Democratic Republic of Congo
FAO	Food and Agriculture Organization
HUGO	Human-Gorilla Conflict Resolution Program
HWC	Human Wildlife Conflict
IGCP	International Gorilla Conservation Program
ITFC	Institute of Tropical Forest Conservation
IUCN	World Conservation Union
MBIFCT	Mgahinga Bwindi Impenetrable Forest Conservation Trust (now BMCT)
MGNP	Mgahinga Gorilla National Park
MUST	Mbarara University of Science and Technology
NCCDF	Nkuringo Community Conservation Foundation
PAs	Protected Areas
PAC	Problem Animal Control
PAM	Problem Animal Management
PCLG	Poverty Conservation Learning Group
UWA	Uganda Wildlife Authority
WCS	Wildlife Conservation Society
WWF	World Wide Fund for Nature

III. Executive Summary

In Bwindi Impenetrable National Park (BINP), a buffer zone strategy was introduced in Nkuringo (southern BINP) in 2005 to counter wild animal crop raiding incidences and to generate income for adjacent local people. This included introducing different strategies aimed at reducing the crop raiding incidences that were so prevalent then. Ten years after, we undertook an assessment of the effectiveness of the different interventions introduced in reducing the crop raiding incidences and the perceptions of the local people on the effectiveness of the strategies.

To achieve this we interviewed 81 local people on the effectiveness of available problem-animal management interventions using semi-structured questionnaires. Data on 117 and 5 crop raiding and poultry incidences respectively was collected on standardized plots that were originally set up by Andama (2009).

Results revealed that: there were significant differences in the spatial distribution of crop raiding incidences. There were also significant differences in the seasonal patterns of crop raiding incidences and this was also true for the different planted crops and across different conditions of the Mauritius thorn hedge. In comparison to a previous study by Andama (2009), we recorded fewer crop-raiding incidences; perhaps an indication of reduced crop raiding in Bwindi like in the past. Majority of the local indicated that the planting of the Mauritius thorn hedge and tea was the most effective in mitigating crop-raiding incidences while planting of lemon grass was the least effective.

We recommend a bottom-up approach of community based human-wildlife monitoring tool for a continuous collection of crop raiding data by local people. This involves the affected local people that will own the crop raiding mitigation approaches and will ascertain and track the effectiveness of interventions. This in turn will help the improvement of old interventions and development of better interventions for the future.

1. Introduction

The importance of human-wildlife conflict (HWC) management has been articulated in the Uganda National Policy on Conservation and Sustainable Development of Wildlife Resources, (2011). The policy prioritizes the mitigation of human wildlife conflicts in order to enhance a positive attitude towards conservation of wildlife resources in Uganda. The Uganda National Development Plan (2009) also prioritizes the implementation of lasting solutions to human–wildlife conflict. This report is a product of a 12 months (December 2013 to December 2014) study undertaken to assess and evaluate the effectiveness of Nkuringo Buffer Zone in addressing the human-wildlife conflict in Bwindi Impenetrable National Park, Uganda.

Human-wildlife conflict (HWC) is a crucial but challenging issue in the conservation of wildlife by protected area managers most especially in areas of high human population densities that coexist with wildlife**.** In 2003, the International Union of Conservation of Nature at the World Parks Congress defined Human Wildlife Conflicts (HWC) as "conflicts which occur when the needs and behavior of wildlife impact negatively on the goals of humans or when the goals of humans negatively impact the needs of wildlife." Such conflicts may result in animosity between wildlife and humans. HWC can take many forms, including the destruction of crops and property, and competition for natural resources. The people most affected by this conflict are rural farmers who live close to protected areas. Particularly in Africa, conflict between people and wildlife ranks amongst the main threats to conservation. (Kangwana, 1993; Conover 2002; Treves & Karanth, 2003).

1.1 Causes of human- wildlife conflict

The main cause of human-wildlife conflict is the competition between the growing human population and wildlife for the same declining living spaces and resources (Muruthi, 2005). The transformation of forests, savannah and other ecosystems into agrarian areas or urban agglomerates as a consequence of the increasing demand for land, food production, energy and raw materials, has led to a dramatic decrease in wildlife habitats (FAO, 2009). In Africa, the human population has been increasing rapidly since 1960 and thus the demand for more land for agriculture that is the main

source of economic activity. Agriculture has spread to more marginal range lands leading to encroachment into wildlife habitat. Under these conditions, the conflict between wildlife and local communities has inevitably increased (FAO, 2009, HWC in Africa). Other causes of human-wildlife conflict in Africa include: land use transformation, species habitat loss, degradation and fragmentation, growing interest in ecotourism and increasing access to nature reserves, increasing livestock populations and competitive exclusion of wild herbivores, abundance and distribution of wild prey, increasing wildlife population as a result of conservation programmes, climatic factors and stochastic factors (Di Stefano, 2004). In general, as human populations increase, development expands, the global climate changes and other human and environmental factors put people and wildlife in greater direct competition for a shrinking resource base (FAO, 2009; IGCP, 2013).

1.2 Consequences of human- wildlife conflict

HWC creates negative attitudes among the community, especially when they perceive little is being done to solve it. Efforts by conservationists to protect problematic wildlife have turned affected communities against associated conservation efforts (reviewed in Treves 2009). Under current conditions, most farmers would eliminate problem animals from their environment if given the choice. In Rwanda, crop damage was mentioned as one of the reasons as to why park-edge households do not plant trees, “because they believe trees create a habitat for problem animals” (Bush etal.,2010). In Uganda, Nampindo and Plumptre, 2005) found that failure by government to prevent the problem animals led to high school dropout since children stayed at home to guard crops in order to prevent heavy crop losses which often lead to lower incomes from agriculture. Further, some communities around Queen Elizabeth Conservation Area (QECA) that have regularly suffered impacts of crop and livestock raiding, consider efforts of protected area management to address HWC inadequate and use this as an excuse to engage in poaching (CARE, 2003).

1.3 Classification of human- wildlife conflict interventions

Human-wildlife conflict interventions have been classified into two major categories; the **direct and indirect interventions** (Treves et al., 2009). Direct interventions aim at

reducing the severity or frequency of encounters between wildlife and property or people while indirect interventions aim at raising people's tolerance for wildlife encounters (Treves et al., 2009). Direct interventions can further be classified into **preventive** and **mitigation** strategies. **Preventive strategies** inhibit and reduce the risk of conflicts between people and animals. They include complete removal of either the people or the animals, physically separating the two by the use of a barrier such as planting unpalatable crops, and employing a variety of scare and repulsion tactics, as is the case of Nkuringo buffer zone (Muruthi, 2005; FAO, 2009). Individual farmers can pursue some of these activities on individual plots of land (e.g. alternative crops), while others generally require larger scale collaboration (barriers along protected area boundaries). **Mitigation strategies** attempt to minimize impacts and lessen the problem. This includes all methods to eliminate or reduce the conflict that has already occurred. Examples are scare techniques such as drumming, firing bullets, shouting or other forms of noise-making, whips (made of tree bark or leather), fire crackers, use of dogs and spraying pressurized chilli-based pepper (Osborn and Parker, 2003; FAO, 2009). Some methods, like using dogs as a scare tactic are both mitigation and preventive strategies. **Indirect interventions** involve changing the attitude of affected communities through education, consolation payments and broader sharing of benefits associated with the presence of wildlife (Muruthi, 2005; Andama, 2009).

1.4 Human- wildlife conflict in Nkuringo area

In Bwindi and the Virunga Massif, gorillas and other wild animals come into human settlements and farms resulting into negative impacts on both the conservation of gorillas and the livelihoods of the people living in the area. The Nkuringo area immediately adjacent to Bwindi Impenetrable National Park (BINP) is a typical example of this (IGCP, 2009). A study by (Andama, 2009) that assessed the HWC situation in Nkuringo and the effectiveness of interventions piloted in buffer zone at that time identified the major wildlife species responsible for crop loss in the area, in the order of severity as: baboons, bush pigs, birds, gorillas, carnivores, and monkeys. The crops most affected were bananas, potatoes, beans, cassava and millet. Such conflicts pose a serious threat to wildlife survival and human livelihood. The Nkuringo area is also one of two areas in BMCA where mountain gorillas come out of the park and raid local

peoples' crops. These interactions with local people are a source of stress, can result in transmission of diseases, direct physical attacks, disabilities such as loss of limbs from snares and even death (Kalpers et al., 2010), see Plate 1.

1.5 Human- wildlife conflict management in Nkuringo area

Because of the threat posed by the HWC in Nkuringo, in 1998, the International Gorilla Conservation Programme (IGCP), Uganda Wildlife Authority (UWA) together with other partners sort out ways of mitigating the conflict. (Madden, 1998). These included using direct and indirect mitigation methods pointed out above. These were; formation of the Human Gorillas Response Team (HUGO) Programme. HUGO takes an immediate and coordinated effort to drive/chase gorillas whenever they leave the park and enter into community crop farms (Andama, 2009). In 2005, a buffer zone was established at Nkuringo, the only example of a buffer zone as an intervention measure for crop raiding animals in BMCA (Kalpers *eta*l., 2010). Several interventions and strategies were later tried in the buffer zone to reduce incidences of crop raiding and also generate incomes for the local people. The interventions included establishing a Mauritius thorn hedge and non-palatable crops like Artemisia, lemon grass, pasture and tea. The indirect methods were revenue sharing and the Clouds lodge owned by the local communities but run by a private investor for income to the local people.



Plate 1: A rodent and a bird snared and killed in Nkuringo because of crop raiding

2. Problem Statement

When the buffer zone and other interventions were first introduced in Nkuringo in 2005, there was a lot of optimism from the local people who anticipated the end of crop raiding (Maasiga *et al*. 2013; Andama, 2009). At the time of the introduction in 2009, most of interventions were conducted as experiments on a small scale (Andama, 2009). By then, various mitigation measures appeared successful at micro level (Andama, 2009). Over time, the different strategies to mitigate problem animals in Nkuringo have registered variable success and challenges (Babaasa *et al*., 2013; Masiga *et al*., 2011 and Kalpers *et al*., 2010). For example, Kalpers *et al*., 2010 found that Mauritius thorn hedges had helped reduce crop raiding in some areas of the buffer zone because the local people had helped maintain the hedge. However, in other parts of Nkuringo, local people continue to raise complaints about problem animals even after fifteen years from the time first measures were introduced (Luseesa, 2008, Akampulira, 2010). The reasons as to why the entire buffer zone and related HWC interventions are not as effective as expected are poorly understood and merit investigation. Kalpers *et al*. (2010) showed that it was difficult to objectively assess what has been done over the years in terms of human-wildlife conflict and buffer zone management, due to the absence of consistent and long-term datasets. It was recommended that basic ecological answers regarding the main problem animal species, intensity and distribution of crop-raiding incidents, impact of conflict resolution strategies, should continuously be collected (Kaplers *et al*., 2010). This study was thus conceived with the aim of furthering our understanding of what influences the degree of effectiveness of the different interventions introduced in Nkuringo to mitigate crop raiding. Importantly, this study also serves a monitoring purpose of continuing to identify the potential tensions to which the programme should flexibly respond to as well as reveal the degree of commitment of the local population in terms resolving the HWC problem.

3. Objectives of the study

The overall aim of the study was to assess the effectiveness of the problem animal management interventions in the buffer zone in reducing crop-raiding incidences.

Specifically, the study focused on the following objectives**:**

- Establishing the current spatial and seasonal patterns of crop raiding by various problem animal species across the buffer zone.
- Documenting and geo-referencing cases of wildlife crop raiding events near the buffer zone from December 2013 to December 2014
- Geo-referencing the buffer zone boundaries (inner and outer zones) and locations of all interventions in the buffer zone
- Assessing community perceptions on effectiveness of buffer zone interventions.
- Proposing mechanisms for continuous monitoring of human-wildlife conflict in the area.

4. Methods

4.1Study site

Nkuringo buffer zone is adjacent to Bwindi Impenetrable National Park (BINP) located in the extreme south-western part of Uganda, between latitudes 0^0, 53‟ to 1^0, 08‟ S and longitudes 29^0 35‟ to 29^0 50‟ E. BINP is also a UNESCO World Heritage site. It is most well known for harboring half of the world population of mountain gorillas (*Gorilla beringei beringei*) and has many endemic and restricted range species of birds, mammals and amphibians. BINP has a diverse natural forest area with a continuum of habitats ranging from 1,190 meters to 2,607 meters above sea level. The most problematic animals to crops are baboons, bush pigs, and elephants. Gorillas and L'hoesti monkeys are also a problem to crops. The buffer zone is 12 x 0.35 km covering the Nteko and Rubuguri Parishes of Kisoro District. It lies along the southern part of the park boundary of BINP that is delineated by River Kashasha. The area has rugged terrain, characterized by very steep slopes from the Rubuguri-Nteko main road towards Kashasha River. Gullies and streams frequently bisect the steep slopes, making the soils susceptible to agents of erosion (Andama, 2009).

The Nkuringo buffer zone is divided into a "community exclusive use sub-zone", which is the outermost 12km by 0.15km and an "actively managed sub-zone‟ which borders the park (12km by 0.2km). The outer buffer zone was supposed to have activities like,

problem animal control interventions, research and monitoring, community conservation education, and livelihood improvement initiatives (crop and animal husbandry and community tourism) were supposed to be practiced there. Unfortunately most of the above mentioned activities started but due to neglect and other factors, success has been limited. For example, management of the Mauritius thorn hedge in the outer buffer zone was expected to be continuous but due to neglect has been on hold since 2011. Currently, the major activity going on is tea cultivation that is supposed to act as both a tool for problem animal management and a livelihood approach for the local communities.

In the inner buffer zone, activities that were supposed to take place include gorilla tracking, research and monitoring, and manipulation of the ecosystem to prevent it from developing into mature forest. Unfortunately, manipulation of the ecosystem has not taken place and the inner zone has developed into a thick secondary forest where the Nkuringo gorilla group spends most of its time.

4.2 Data collection

The sampling procedure used was similar to that previously used by (Andama, 2009) for temporal comparison of data on HWC. Andama's study assessed the HWC situation in the same area Nkuringo and the effectiveness of the interventions piloted in buffer zone at that time. This study aimed at assessing what has changed since than especially that more and new interventions were introduced after Andama's study. The data collection was carried out over 12 months period from December 2013 to December 2014. Two field assistants were recruited from Nkuringo area to help with data collection. The field assistants made a total of 220 visits each (440 visits), each sampling plot was visited once every week to record details of crop raiding events with emphasis on date of occurrence of event, wildlife species responsible, type and stage of growth of crops damaged, extent of crop damage in terms of area. The data collected was crosschecked for accuracy and consistency with owners of gardens where animal raids occurred. In addition, structured interviews were held with personnel involved in human-wildlife conflict management within the study area. These personnel included staff of Uganda Wildlife Authority and HUGO.

In order to fulfill the specific objectives of the study, the following data collection protocols were used.

4.2.1 Establishing the current spatial and seasonal patterns of crop raiding

Information on 117 crops and 6 poultry raiding incidences caused by wild animals was collected from 220 visits by each field assistant, (2 of them making a total of 440 visits) to the community farmlands adjacent to the 12 km section of Nkuringo buffer zone (Figure 1). The sampling grids that were used by Andama, (2009) were also adopted for this study. Sampling grids consisting of two parallel belt transects with dimensions of 50 m (width) by 1,000 m (length), separated from the next by 500 meters were laid. Grids were established at 2 km intervals resulting in four sampling blocks along the buffer zone. The four sampling grids were labeled according to the villages where they were located. The first belt transect was located close to the boundary outer buffer zone (plate 2). The second belt transect was located 500m from the first transect away from the outer boundary in the community farmlands. Within each sampling grid, all land use practices were mapped for the 12 data collection months together with respective area coverage. Simultaneously, two transect walks parallel to each other were done and each sampling grid was examined for evidence of crop raiding. The walks were done four times in a week. As a result, each sampling grid was visited once a week. Over the 12 months of data collection, each filed assistant made 220 visits in total. Each crop-raiding event was recorded and geo-referenced. If two or more crop raiding events occurred during the course of the week, they were assigned the respective dates on which they occurred as reported by the affected farmers.



Plate 2: Crop damage estimation and assessment by field assistants

Figure 1: Plot set up for monitoring crop raiding by wild animals



Source: (Andama, 2009)

4.2.2 Documenting and analyzing cases of wildlife crop raiding events

Specific details pertaining to the 117 crop and 6 poultry events for the 12 months period were recorded on a form (see Appendix 1). These details refer to identity of the wildlife species involved in raids, the types of crops or livestock damaged and intensity of crop damage. More specifically, the number of crop raids by each wild animal was recorded on a weekly basis. In addition, for crops such as sorghum, millet, peas and beans, damage was quantified by measuring the area of the undamaged and damaged crops

(Plate 2). In contrast, for crops with large stems like bananas, maize and cassava, the number of stems in a garden that were damaged and undamaged was counted. The intensity of crop damage was assessed by laying quadrants at varying distances within the affected area in the garden using the dimensions shown for different crop types in Table 1.The number of damaged and intact fruits in each quadrant was counted to provide the relative intensity of crop damage. For livestock incidents the type, number of livestock attacked (Injured or killed) and predator involved was recorded.

Table1. Quadrat size classes used to assess intensity of crop damage.

Crop species	Size of quadrat
Banana, maize and coffee, cassava	10m x 10m or count the total number of the crops destroyed.
Sorghum, sweet and Irish potatoes,	1m x 1m
Millet, peas, beans	0.5m x 0.5m

Source: (Andama, 2009)

4.2.3 Geo-referencing the locations of all interventions in the buffer zone

The buffer zone boundaries for both the inner and outer zones were measured and geo-referenced using a tape measure and a hand held GPS unit (Garmin model 60CSx). To determine the size of the buffer zone the distances measured by the tape measure on ground were added to the distance generated by GPS and an average distance was generated. The locations of the different interventions were also geo-referenced. To measure sizes of large interventions that cover a large areas such as the Mauritius thorn hedge and tea plantations, a GPS unit and tape measure were used. For small localized interventions, only tape measures were used. The information collected under this objective was geo-referenced and mapped using the ArcGIS software.

4.2.3 Assessing community perceptions on effectiveness of buffer zone interventions

Eighty one household interviews of farmers around the buffer zone were carried out using semi-structured questionnaires. We used purposive sampling to choose 41 farmers who had suffered crop raids during the first 8 months of data collection. We then used random sampling to choose the other 40 respondents that had gardens in our sampling plots but were not crop raided during the data collection period.

We compiled a list a list of all garden owners along the entire buffer zone and extracted a list of all those farmers who had not been raided in the first 8 months of our data collection. The list of farmers not raided in the first 8 months formed the sampling pool for our control population. Then 40 farmers were randomly selected by picking numbers from a hat; the numbers corresponded to the farmers' list we had compiled for gardens not raided. If any of chosen 40 farmers experienced crop raiding between the 8th month and 12th month of data collection we chose another un-raided farmer to replace them. The issues and questions we focused on during the interviews are highlighted in Appendix 2 (attached).

4.3 Data analysis

Descriptive statistics were used to summarize the interview response data. The Kruskal-Wallis test was used to compare respondents' perceptions on the degree of effectiveness for each of the four plant-based interventions (Artemisia, Lemon grass, Mauritius thorn and Tea) across the four plots where respondents' gardens were located. Analyses on perceptions were conducted using the Statistical Package for Social Sciences (SPSS version 19, Chicago USA).

We used the non-parametric Wilcoxon test to compare crop-raiding incidences: across data collection plots and gardens, months of the year, between seasons (dry and wet), across crop raiding species and across different conditions of Mauritius thorn (gap, thin and thick). The non-parametric test was deemed appropriate due to insufficient sample sizes and lack of spatial independence among the plots and gardens. We performed the analysis in computer program R (version 3.1.1; R Core Team, 2014). We performed all statistical tests at 5% level of significance.

5. RESULTS

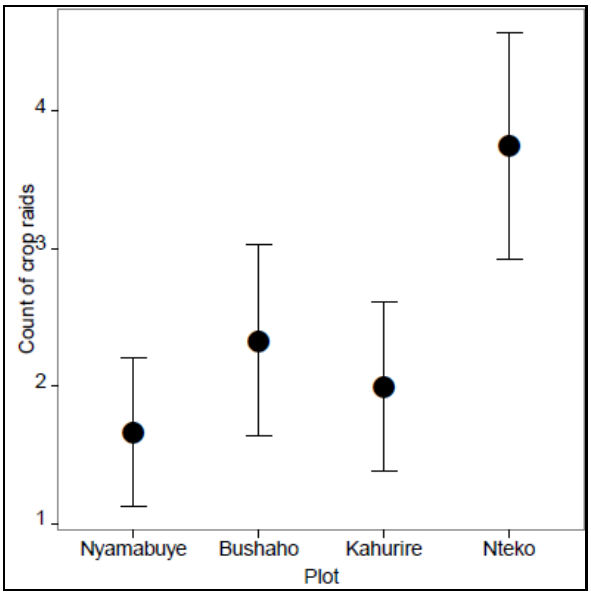
General result summary

A total of 117 crop-raiding incidences from 440 field visits by both field assistants were recorded from January to December 2014. Overall, crop-raiding incidences varied across plots, gardens, seasons, months of the year, planted crops, distance of garden from the park boundary and across different conditions of the Mauritius thorn hedge during the twelve months study period.

5.1 Variation of crop raiding incidences across plots

There was significant difference in crop raiding incidences across the plots established in different areas ($V = 1176$, $P < 0.05$, Wilcoxon's test) as also shown in Figure 2. Crop raiding incidences were highest in Nteko area (3.75 ±0.83SE) and lowest in Nyamabuye area (1.67±0.54SE). In the Figure 2, the panel bars show the variation of crop raiding incidences across the four plots. The black dots are the mean count of crop raiding incidences for each plot. Error bars represent standard error (SE). Rodents were observed only in Nyamabuye. Nteko also had the only recording of monkey crop raids. The crop raiding incidences in Nteko, Bushaho, Kahurire and Nyamabuye were 45, 28, 25 and 20 respectively out of the total 117 crop raiding incidents.

Figure 2: Spatial distribution of crop raiding incidences in Nkuringo Buffer Zone



Nteko plot is part of Nteko parish with villages of Kikobero, Mulore, Kankoko and Nteko being the most affected by the problem animals. While Nyamabuye plot is part of Rubuguri parish at the southern end of the buffer zone and the most affected village was Nombe.

5.2 Seasonal patterns of crop raiding

There was significant difference in crop raiding incidences during the dry and wet seasons ($V = 1176$, $P < 0.05$,Wilcoxon's test) as also shown in Figure 3. The panel bars in figure 3 show the variation in crop raiding incidences across the two seasons. The black dots are the mean counts of crop raiding incidences for each season. The mean count of crop raiding incidences was higher in the dry season (2.86±0.50SE) than in the wet season (1.85±0.42SE). The variation in crop raiding per season is related to the time when crops are planted and when they reach maturity and therefore available for the crop raiding animals (see also table 3). For most seasonal crops (maize, beans and sorghum) the dry season corresponds to the time they mature and are being harvested and thus available for the wild animals. During this period there is great competition for food between the wild animals and people harvesting their crops.

Figure 3: Crop raiding incidences across seasons in the Nkuringo Buffer Zone

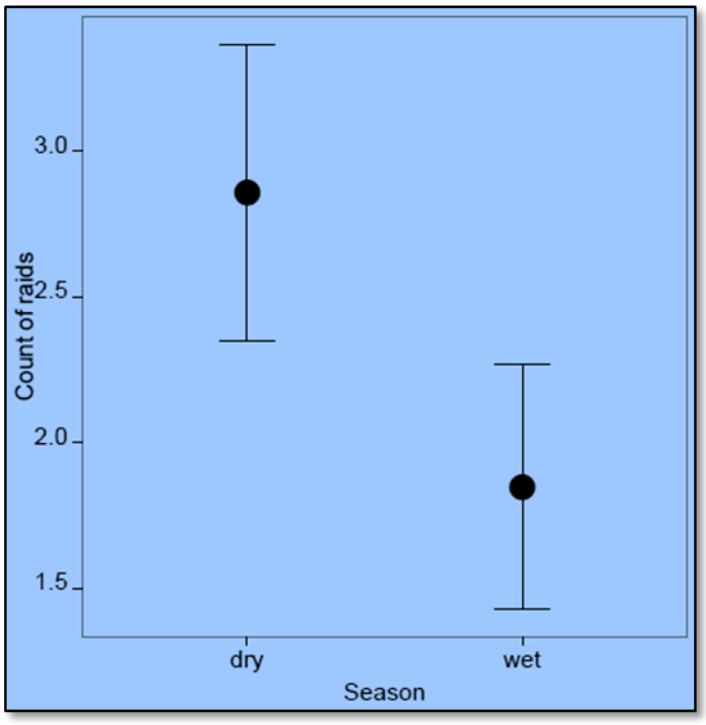
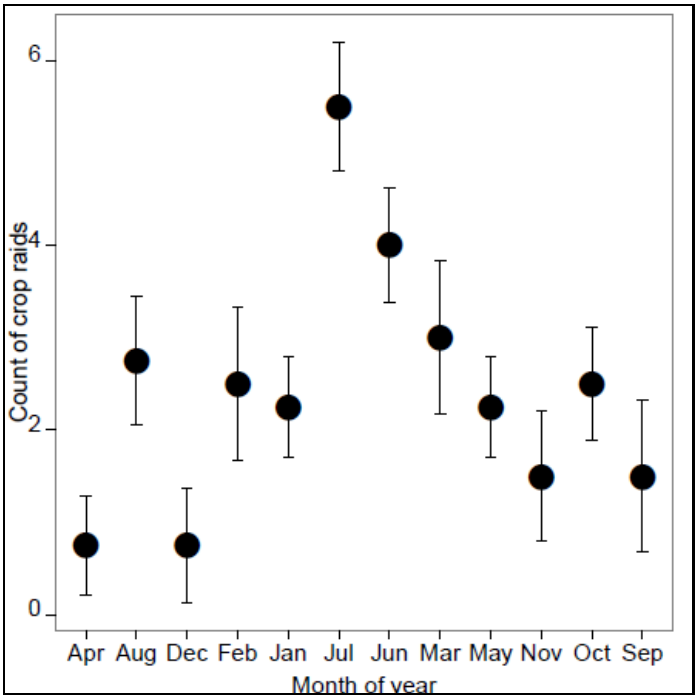


Figure 4 shows the variation of crop raiding incidences across the different months of the year. The panel bars show the variation of crop raiding incidences across the twelve months. The black dots are the mean counts of crop raiding incidences for each month. Crop raiding incidences were highest in July (5.5±0.9SE) and lowest in April (0.75±0.47SE) and December (0.75±0.47SE). There was a significant difference in crop raiding incidences across the twelve months ($V = 1176$, $P < 0.05$, Wilcoxon's test). July recorded 23 crop-raiding incidences followed by March, August, February and Jan with 12, 11, 11, and 10 incidences respectively. The least crop raiding incidents were recorded in April, December and September with crop raiding incidences of 3, 3 and 6 respectively (Figure 4).

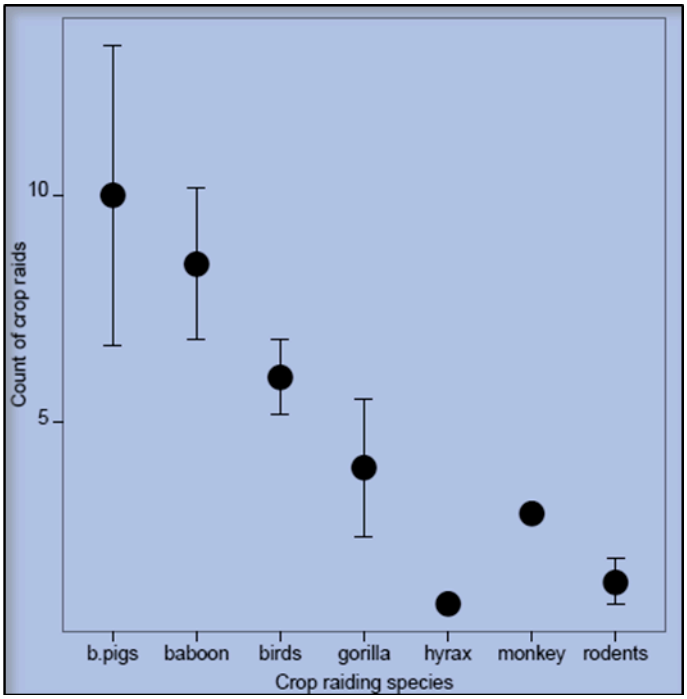
Figure 4: Monthly crop raiding incidences in Nkuringo Buffer Zone



5.3 Variation of crop raiding species

There was a significant difference in the types wild animals that raided crops (V = 190, P<0.05,Wilcoxon's test) also shown by Figure 5.The panel bars show differences in crop raiding incidences for the different types of animals. The black dots are the mean counts of crop raiding incidences for each animal. Bush pigs had the highest mean crop raiding incidence (10.0±3.29SE), Baboons, birds and gorillas followed with 8.5±1.66SE, 6.0±0.81SE and 4.0±1.53SE respectively. The least raids were by the tree hyrax with only 1 raid recorded. Bush pigs raid at night and in areas with no live fence intervention (Mauritius thorn), there are no people to chase them unlike during the day when people's presence would deter crop raiding of other species.

Figure 5: Variation of crop raiding incidences by the different animals in Nkuringo Buffer



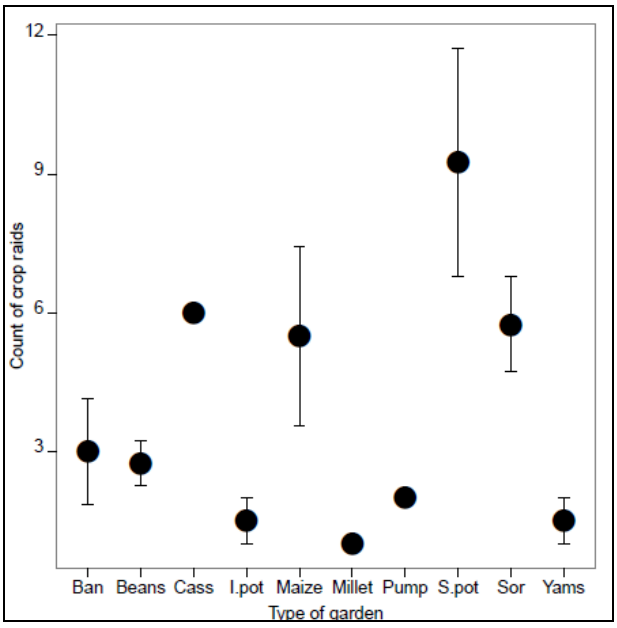
The highest incidence of crop raiding by gorillas was recorded during January, March, November and December when they ranged in the outer buffer zone and community land for periods longer than 5 days.

5.4 Variation of crop raiding on the different types of crops

There was a significant difference in crop raiding incidences on the different types of crops planted ($V = 351$, $P<0.05$, Wilcoxon's test) as also shown in Figure 6. The panel bars show the variation of crop raiding incidences for the different types of crops. The black dots are the mean counts of crop raiding incidences on each crop. Crop raiding on sweet potatoes was the highest with a mean count of 9.25±2.46SE followed by sorghum, maize and bananas with mean counts of 5.75±1.03SE, 5.05±1.94SE and 3.0±1.154SE) respectively. Millet was the least crop raided with a mean count of 1.00± 0.50SE. Bush pigs raided sweet potatoes mostly and birds raided sorghum majorly as table 2 shows. Baboons and bush pigs mainly raid maize crops. The crop raiding on the

different crops corresponds to the time of the year (month) when the crops are either mature or approaching maturity (see table 3).

Figure 6: Crop raiding incidences on the different crops in Nkuringo Buffer Zone



5.3 Extent of crop damage and vulnerability stages of the crops

The contributions of the major wild animals that damage crops as determined in Figure 5 above (Baboons, Bushpigs, Birds and Gorillas) on the different crops are shown in Table 2. Comparative results from Andama, (2009) are also shown. Baboons, birds and bush pigs respectively caused the most damage. During this study baboons were recorded eaten 6 chickens. Baboons caused the most damage on crops because they fed on almost all types of crops with exception of bananas. Baboons ate crops at all stages of development. The biggest damage they caused over the 12 months period was on maize they destroyed 2,880 maize cobs. Birds equally caused significant damage to sorghum and beans. The extensiveness of damage by birds on beans can be attributed to the fact that birds ate bean leaves at almost every stage of development. Some birds even dug out bean seeds from soil immediately after being sown by the farmers. Of the five most raided crops (Bananas, Maize, Potatoes, Beans and Sorghum) the maize crop was the most damaged followed by Beans, potatoes, sorghum and Bananas. The maize crop was eaten by all wild animals the reason it

showed the most damage (Plate 3). On the contrary, bananas were eaten by only mountain gorillas as shown in table 2.

When this study's damage rate results are compared with those of Andama, (2009) (also carried for one year between September 2008 to August 2008). The extent of damage by wild animal has generally decreased as shown in table 2. For example Andama, (2009) recorded 43 stems of bananas raided by baboons while we recorded only crop raiding on bananas by gorillas. Furthermore, whereas Andama, (2009) recorded Potatoes, Millet, Beans, Maize and Cassava as the five most damaged crops. We recorded Maize, Beans, Potatoes, Sorghum and Bananas as the five most damaged crops (table 2).

Table2: Estimated damage by different problems animals on different crops

Problem animal species	Sep(07)-Feb(08)	Mar-Aug (2008)	Total (2008)	Jan-June (2014)	July-Dec 2014)	Total 2014
Bananas(Number of plants)						
Gorillas	302	95	***397***	146	64	***210***
Baboons	21	12	***43***	0	0	***0***
Maize(Number of plants)						
Baboons	570	36	***606***	2602	278	***2880***
Gorillas	176	0	***176***	110	0	**110**
Birds	190	98	***288***	14	0	***14***
Bush pigs	443	976	**1419**	0	89	***89***
Potatoes(Sweet and Irish)(Area in square meters)						
Baboons	239	191	***430***	8	51	***59***
Bush pigs	5582	2106	***7688***	242	500	**742**
Beans(Area in square meters)						

Baboons	54	162	***216***	532	70	***602***
Birds	615	0	***615***	2028	12	***2040***
Sorghum(Area in square meters)						
Baboons	NA	NA	NA	84	26	***110***
Habituated gorillas	NA	NA	NA	15	0	***15***
Birds	NA	NA	NA	20	457	***477***
Bush Pigs	NA	NA	NA	0	93	***93***
Chicken						
Baboons	1	7	***8***	1	5	***6***



Plate 3: Maize and bananas damaged by baboons and gorillas respectively

Short seasonal crops such as beans, maize, sorghum, millet and pumpkins, before and after reaching maturity, were the most vulnerable to damage by animals (Table 3). The annual crops like bananas, cassava, sweet potatoes and yams were most vulnerable to damage at the fruiting stage though bananas and yams were also damaged throughout the year (Table 3). Fruits and leaves were the plant parts most damaged by problem animals (Table 3) however, baboons ate whole plant parts as well. Baboons ate whole germinating beans; bean leaves during growth as well as ripened beans. Most crops

experienced damage right from the flowering stage to the harvesting stage when fruits were mature.

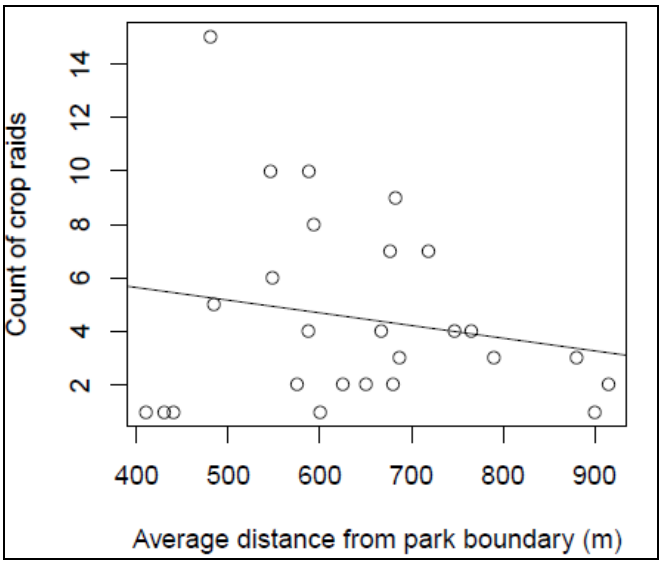
Table3: Crop species and months when they are most vulnerable to raiding.

Crop species	Months when most vulnerable	Planting months	Harvest months	Stage when most vulnerable	Parts eaten
Bananas	Every month			Fruiting Flowering	Pith, fruits,leaves
Beans	May-July	March and Sept	Jan and June	Flowering Fruiting	Fruit, leaves, seedlings
Cassava	4 months from time of planting	All year	4 months from time of planting	Fruiting Flowering	Root
Pumpkins	3 months from time of planting	All year	3 months from time of planting	Fruiting	Fruit
Maize	Jan, July and Nov, Dec	Feb, March and Sept	Jan and Dec	Flowering Fruiting	Fruit, stem
Millet	May –July and Dec	Feb	June and July	Flowering. Fruiting	Fruit, leaves
Sorghum	August –– September	Feb and March	August- Sept	Flowering	Stem, fruit
Sweet potatoes	Depending on when they are planted. Normally from 3 months	All year	Depending on when planted	Flowering	Leaves, root
Yams	Depending on when they are planted. Normally from 3 months	All year	Depending on when planted	Flowering Fruiting	Leaves, fruit

5.4 Crop raiding distances moved by wild animals from the park boundary

There was significant difference in the average distances moved by wild animals while raiding crops from the park boundary (V = 351, P<0.05, Wilcoxon's test) also shown in figure 7. Generally there was high crop raiding incidences between 400 and 700 meters from the park boundary. The crop raiding counts decreased with increasing distance from the park boundary (Figure 7).

Figure 7: Average crop raiding distances from the park boundary



5.7 Differences in crop raiding incidences along mauritius thorn hedge categories

We defined the status of the Mauritius thorn hedge based on three categories. The first represented sections of the hedge that were well managed since they looked healthy and thick and could actually block wild animal movements (Plate 4). The second category represented areas of the hedge that were poorly maintained since they were thin and a wild animal could pass through the hedge (Plate 5). Lastly, the third category defined open areas of the hedge that were not continuous either as result of failure of thorn seeds to germinate and grow into an intact hedge or actively opened by people for paths (Plate 5). The first, second and third categories of the Mauritius thorn hedge measured 2.6km, 3.1km and 4.4km in length respectively.



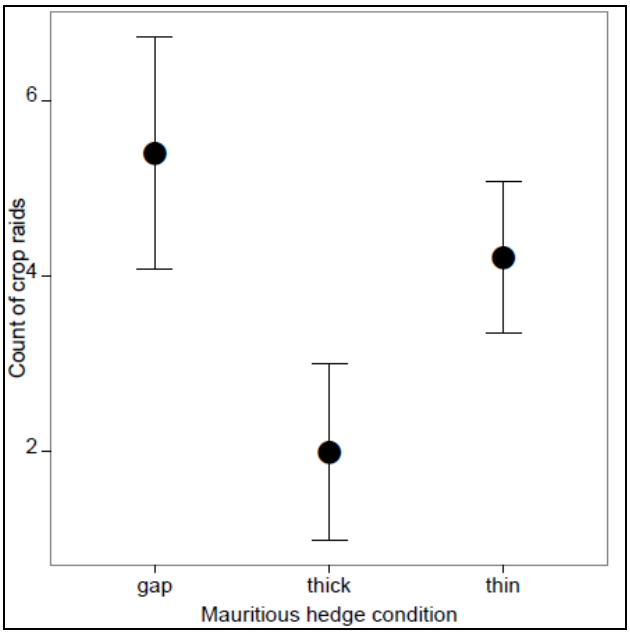
Plate 4: A typical thick Maurithius thorn hedge in Nkuringo



Plate 5: Maurithius thorn hedge with a gap (right) and a thin hedge (left).

We compared crop-raiding counts of gardens adjacent to the different Mauritius thorn hedge categories (Gap, thick and thin). We found a significant difference in crop raiding patterns along the different categories of the hedge ($V = 351$, $P<0.05$, Wilcoxon's test) as also shown in Figure 8.The panel bars in figure 11 show the variation of crop raiding incidences across the twelve months. The black circles are the mean count of crop raiding incidences for each category of Mauritius thorn. The mean counts of raids on gardens adjacent to gap category were highest (5.4±1.33SE), followed by gardens adjacent to thin category (4.21±0.86SE) and the least raids were on gardens adjacent to thick hedge (2.0±1.0SE).

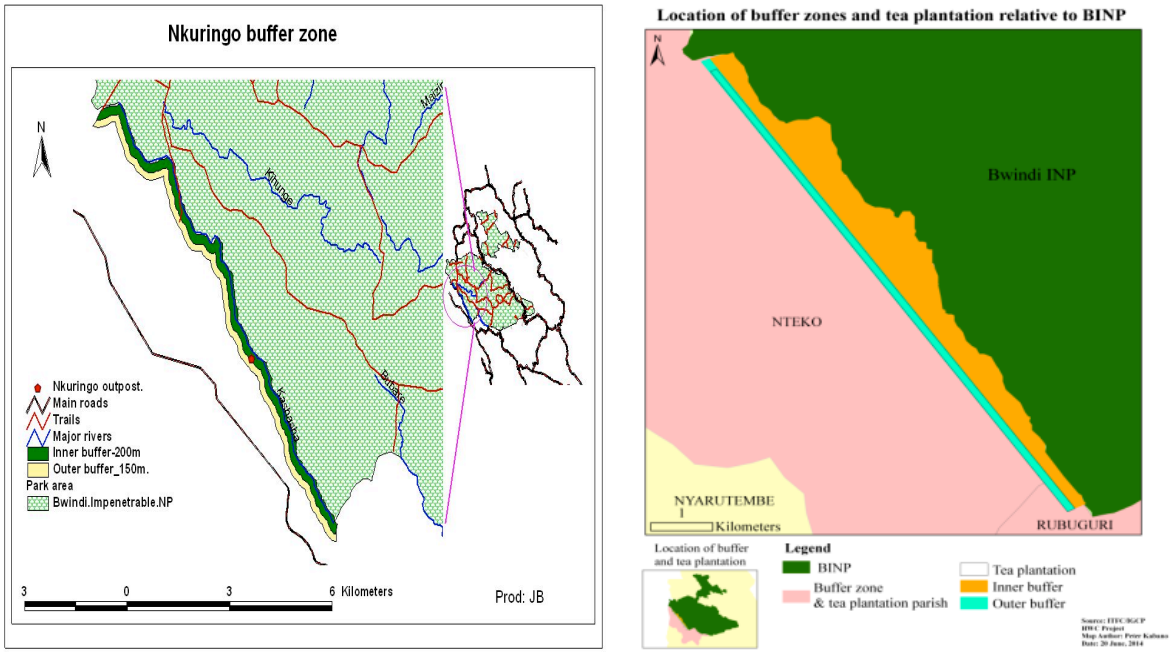
Figure 8: Crop raiding incidents for gardens adjacent to different categories of Mauritius thorn (gap, thin and thick)



5.8 Geo-referencing the buffer zone and locations of the interventions

The ground truthing distance of the buffer zone length was 11.7km and width was 350m (150m outer buffer zone and 200m outer buffer zone). The area of inner and outer buffer zones was calculated to be 4.7km^2 and 1.5km^2 respectively (Figure 9). The length and width of the planted tea plantation in Nkuringo were 11.1km and 144m respectively. The area covered by the tea was estimated thus to be 1.3km^2. The Mauritius thorn hedge measured a length of 10.1km in total. The status of the hedge was defined based on the three categories mentioned above. The first, second and third categories of the Mauritius thorn hedge measured 2.6km, 3.1km and 4.4km in length respectively.

Figure 9: Location of the buffer zone and tea plantation relative to BINP



(Source: Andama, 2009)

5.3 Community perceptions on effectiveness of buffer zone interventions

Local people perceptions on the effectiveness of the different interventions that have been tried in the Nkuringo buffer zone since it was initiated are presented in table 4. Respondents rated the degree of effectiveness per intervention on a scale of three (1-3): very effective (1), fairly effective (2) and not effective (3). In total, seven interventions were mentioned by respondents. Five of them were based on cultivation of specific plants, one involved use of a mechanical device and the other was defined by human presence at the site of conflict (HUGO). Although some of these interventions (lemon grass, Artemisia, baboon traps and pasture grass) are no longer in use today, respondents were freely allowed to mention them. The most commonly mentioned strategies were: Tea growing (96.3%), establishing and maintenance of Mauritius thorn hedge (85.2%), planting lemon grass (43.3%), and growing Artemisia (38.3%) Cultivation of pasture grass was the strategy mentioned by least respondents1.2% (see table 4).

Table 4: Different interventions and their effectiveness as mentioned by respondents. (N=81).

	No of Responses	Very effective	Fairly effective	Not effective
Tea Plantation	78(96.3)	2(3)	73(93)	3(4)
Mauritius Thorn	69(85.2)	0(0)	43(62)	26(38)
Artemisia	31(38.3)	0(0)	11(26)	31(74)
Lemon grass	35(43.2)	0(0)	0(0)	35(100)
HUGO	3(3.7)	0(0)	3(100)	0(0)
Traps	2(2.5)	0(0)	2(100)	0(0)
Pasture grass	**1(1.2)**	**0(0)**	**0(0)**	**1(100)**

Percentages are shown in brackets above

We tested whether the respondents' perceptions on the degree of effectiveness for each of the four plant-based interventions (Artemisia, Lemon grass, Mauritius thorn and Tea) were significantly different across the four plots where respondents' gardens were located. We found that for Artemisia, the degree of effectiveness was not significantly different across the four plots of Bushaho, Kahurire, Nteko and Nyamabuye (X^2 = 0.224, df = 3, P = 0.974, Kruskal-Wallis test). Similarly, the degree of effectiveness was not significantly different across four plots for Lemon grass intervention (X^2 = 0.00, df = 3, P= 1.0, Kruskal-Wallis test). Further, the degree of effectiveness was not significantly different across four plots in the case of Mauritius thorn (X^2= 1.885, df =3, P= 0.597, Kruskal-Wallis test). However, in the case of the tea intervention, the perceptions of degree of effectiveness were marginally significant (X^2 = 7.416, df = 3, P =0.060, Kruskal-Wallis test) across the four plots.

Significant differences in degree of effectiveness among the four plant-based interventions were noted for each of the four plots (Nteko: X^2 = 46.11, df = 3, P = 0.00; Bushaho: X^2 = 28.16, df = 3, P = 0.00; Kahurire: X^2 = 25.35, df = 3, P = 0.00; Nyamabuye : X^2 = 15.54, df = 3, P = 0.001,Kruskal-Wallis test,).

Tea was considered the most effective intervention with 93% of our respondents mentioning it was effective (table 4). The effectiveness of tea was associated with financial benefits accrued from being employed at the tea plantations and also the reduction of diurnal crop raiding by baboons afraid of crossing tea plantations with workers present most of the day (table 5). With Mauritius thorn 62% of our respondents that participated in its management and use considered it fairly effective while the 38% thought it was not an effective intervention. The effectiveness of Mauritius thorn was associated with reduced crop raiding, financial benefits that were given to people participating in the management of the hedge through ASCAS by NCCDF and also from equipments like hoes and gumboots provided to people managing the hedge. The ineffectiveness of Mauritius thorn was linked to injuries people sustained in its management and lack of financial support after NCCDF stopped financial assistance towards Mauritius thorn management (table 5). All respondents that had tried lemon grass considered it not effective at all. It was mentioned that lemon grass intervention did not attract any kind of benefit to the local people both in terms of reducing crop raiding and economic incentives. Respondents associated lemon grass with wastage of their resources and time after they experienced complications with storage and lack of markets (table 5).

5.2 Perceptions on benefits and challenges associated with interventions

Respondents identified the benefits and challenges associated with interventions (table 5). Respondents also correlated benefits with successful or effective interventions and linked some challenges with unsuccessful interventions.

37.6%responses associated with benefits were linked to financial benefits that included: employment in the tea plantation, money provided by NCCDF through ASCAS for the management of the Mauritius thorn and money from selling the Artemisia crop. Reduction in crop raiding accounted for 14.5% of the total responses on benefits associated with interventions. Respondents related this reduction in crop raiding to interventions like tea and Mauritius thorn. Interestingly, 33.8% of responses did not identify with any benefits from interventions. Benefits in form of equipments (hoes, gum

boots and machetes) distributed to people working in the buffer zone accounted for 12.8% of the responses on benefits. Interventions that contributed high percentages for not being effective: Lemon grass, Artemisia and Mauritius thorn (see table 5) were associated with wastage of people's time, resources and energy by 9.0% of total responses on challenges.

The analysis on challenges showed that injuries sustained during work on various interventions like Mauritius thorn, tea, Artemisia, lemon grass and HUGO accounted for 34.2% of responses on challenges (table 5). Responses in connection with delayed payments for people working in the tea plantations and lack of payments (financial incentives) for interventions like Mauritius thorn, Artemisia, Lemon grass and HUGO contributed 16.0% and 10.0% of total responses respectively. 15.0% of the responses on challenges were associated with failure to find market for Artemisia and lemon grass. Whereas tea was highlighted as the most effective intervention (table 4) 6.0% of the responses on challenges of interventions were attributed to rising increase in scarcity of food crop to tea as it tends to draw away a substantial part of the labour force that would be engaged in crop agriculture (Table 5). Unfavorable physical conditions (rocky and water logged soils for Mauritius thorn to grow contributed 4.0% of the responses on challenges associated with interventions

Table 5 Benefits and challenges associated with interventions in general

Benefits associated with interventions	% responses for benefits mentioned (n=234)	Challenges associated with interventions	% Responses for challenges associated with (n=234)
Financial benefits	37.6	Injuries from thorns, snake bites	34.2
No benefits Incurred	33.8	Delayed payments (Mostly with tea)	16.0
Reducing crop raiding	14.5	Lack of market for Artemisia and lemon grass	15.0
Equipment(gum boots, hoes, machetes)	12.8	No payments involved	10.0
Medicine for malaria	1.3	Waste of time, energy and resources	9.0
		Tea causing famine(people have no time to cultivate food crops)	6.0
		Unfavourable physical conditions for Mauritius thorn (soils, shed from trees)	4.0
		Complicated storage leading to losses(Lemon grass)	3.4
		**Other	2.4

****other include(Herbicides from tea being toxic to the soil and bees, Mauritius thorn being cut down for tea, baboons habituation to traps and limited land for tea cultivation)(Number of responses 234 because all the 81 respondents gave more than one response)***

6. Discussion

6.1 Spatial distribution of crop raiding incidences

Crop raiding incidences varied significantly across the four data collection plots. High incidences of raids were noted in the north of the buffer zone specifically in Kikobero and Kankoko villages in Nteko plot and this was also noted by Andama, (2009). Majority of the baboon, bush pigs, gorilla and bird raids occurred in this area. The high concentration of crop raiding incidents in the north of the buffer zone around Kikobero village and Kankoko villages could perhaps be explained in two ways.

The first is based on the observation that these areas are not only less populated but have also more uncultivated land patches with tall and thick natural vegetation characteristic of early succession stages of forest communities. Further, the local people who have land in these villages, especially in Kankoko village, have allowed the trees to grow because they want to harvest them for timber, charcoal and firewood. Such landowners are in not in hurry to cut down the trees since they possess alternative land for cultivation far from the park boundary. Such vegetation environments offer attractive habitats for problem animals responsible for regular crop raids in the area as also noted by Andama, (2009). Wild animals use such forests patches for cover while crop raiding. Similarly, (Nepal and Weber, 1995) agree that the presence of such forests increased the cases of crop raiding because the forest acts as an extension for animals to prepare for intrusion into the agricultural land.

The second reason is based on the observation that cultivated areas in Nkuringo are scattered and this makes it difficult for the farmers to benefit from group vigilance during crop guarding. In other places along the buffer zone like Kahurire village, most gardens are cultivated close to each other in an open area. Guarding happens at almost the same time and animals are easily repulsed in unison even though each farmer attends to his/her own garden. The end result is group guarding since the gardens of different farmers are very close to each other and the area is open. Neighboring farmers are able to alert each other in case of approaching problem animals. Guarding has been

reported by several authors such as (Naugton-Treves *et al*.,*1998;* Akampulira, 2011; Hill and Wallace, 2012) as a preferred intervention against animals especially primates and birds by most farmers. Nteko farmers have made an attempt to solve this problem by synchronizing cultivation of crops like beans, maize, millet and sorghum. This helps them achieve combined guarding efforts. However, this practice has some short falls of non-uniformity in desired crops for cultivation and unwillingness to engage in cultivation at the same time in some seasons. As result, around Kikobero and Kankoko villages instead of two cropping seasons for seasonal crops, they sometimes have one.

6.2 Seasonal patterns of crop raiding incidences

Several studies on HWC have indicated that patterns of crop raiding depend on seasons among other factors (Thapa, 2010;Schley *et al*., 2008; Gottfried *et al.,* 2006). The significant difference in crop raiding incidences between the wet and dry season is due to the fact that during the dry season crops are mature and very attractive to the wild animals (Thapa, 2010). The variation in season is related to the time when crops are planted and when they reach maturity. For most seasonal crops (maize, beans and sorghum) the dry season corresponds to the time they mature and are being harvested. During this period there is great competition for food between the wild animals and people harvesting their crop (Gottfried *et al.,* 2006). For example during the month of July we recorded the highest crop raiding incidences and the crop most affected was sorghum and maize as they approached harvesting time. The crop raiding incidences during the wet season were associated with annual crops like sweet potatoes, bananas and cassava during the month of March.

6.3 Differences in crops raided and the extent of crop damage

The degree of crop damage by problem animals has been reported to vary depending on the crops, stage of growth and crop raiding animals involved (Thapa, 2008). Most animals are known to eat the ripening or fruiting stage of the crops whereas a few others are able to feed on all stages of development of a crop. In this study, sweet potatoes sorghum and maize had the most crop raiding incidents. The maize crop was the most damaged and was eaten by all the animals except rodents. This observation is similar to what was observed in Kibale by (Naughton-Treves *et al.,* 1998). The

attractiveness of maize crop to many animals is attributed to the high nutritional content those animals obtain in shorter period of time (Naughton-Treves et al*,* 1998).

Bush pigs showed preferences for sweet potatoes regardless of their location from the park boundary. Indeed, farmers clearly observed that on many occasions, bush pigs would ignore other types of crops and head straight to sweet potato gardens that were farther away from the park boundary. Andama, (2009) also showed a similar result for sweet potatoes and bush pigs. For birds, the sorghum crop was fed on right from early to late stages of development significantly increasing at its maturity stage. In the case of mountain gorillas, the banana plantations were the most preferred.

The current observation agrees with an earlier one made by (Andama, 2009) who noted that majority of crop raiding in Nkuringo area happened when crops were due for harvest. Overall, the above observations suggests that cultivation and successful harvesting of high yields of the sweet potatoes, sorghum, maize and beans is rather difficult around Nkuringo buffer zone. It is therefore understandable that when communities plant sorghum, beans and maize, they usually invest heavily in terms of time and efforts to guard their crops from being raided by problem animals. Crop damage estimation ranked maize, potatoes, sorghum and sweet and beans as the most damaged crops respectively. This is slightly similar to the results obtained by (Andama, 2009). The tea plantation though still young has also helped on reducing baboon raids due to presence of local people planting and maintaining their gardens. .

6.4 Differences in crop raiding by wild animals

The ecological and social behavior of crop raiding animals influence the extent and variation of crop raiding (Thapa, 2008; Warren, 2003).For instance, gorillas were only recorded to crop raid when ranging in the local community gardens and outer buffer zone for more than 3 days. There was no incidence when gorillas were reported to come from the park, raid crops and return to the park. The association between ranging behavior and crop raiding has also been supported by observations from studies in Kibale National Park by (Naughton-Treves *et al.,* 1998). In contrast to any other crop

raiding species reported in this study; baboons raided all the crops with exception of bananas. This is not perhaps surprising since it has been reported elsewhere that baboons are frequent and expert raiders that live in large social groups and have ability to feed on a variety of crops (Warren, 2003). In this study the nocturnal nature of crop raiding by bush pigs was the reasons they caused more damage since no humans are present to chase them at night. During the night bush pigs are able to move in gardens freely as the owners of gardens are sleeping and unaware. Controlling nocturnal crop raiders is quite difficult and as such can cause a lot of damage compared to diurnal crop raiders. (Naughton-Treves *et al*., 1998; Akampulira, 2011, Babasa *et al.*, 2013).

6.5 Effects of crop raiding on the different conditions of Mauritius thorn hedge.

This study noted that there was a significant relationship between location of crop raiding incidents and presence of gaps along the Mauritius thorn hedge. Specifically, the spatial locations of crop raiding incidents corresponded to either the spatial locations of gaps or thin areas (non-continuous parts) of the Mauritius thorn hedge where the hedge was the major intervention. These observations suggest that most problem animals were unable to gain access to gardens in the proximity of intact sections of the hedge and that the intact sections of the hedge were most probably effective barriers against crop raiders along the Nkuringo buffer zone. This suggestion is supported by earlier studies where the barrier effectiveness of the intact hedge has been acknowledged (Andama 2009; Andama, 2007; Kaplers *et al.,* 2010; Akampulira, 2011;Masiga *etal*., 2012; Babaasa, *et al.,* 2013).

6.4 Crop raiding distances moved by the wild animals,

Like in most protected areas in Uganda, HWC increases with decreasing distance of communities from the park (Ilukol, 1999, Hill, 1997). A study by Ilukol, 1999 in Kibale, Uganda, showed that crop raiding by elephants was more rampant within a distance of 200 m from the park boundary. Strudsrod and Wegge, (1995) also noted that the seriousness of crop damage varied with distance from the park boundary. Furthermore, this study has observed that food preferences were a significant factor in influencing distances moved and hence intensity of crop damage by a particular problem animal.

For example, bush pigs move long distances from the park boundary to feed on their preferred crops like sweet potatoes. Nonetheless, in rare cases, distance appeared to have a great influence on the frequency and hence intensity of crop damage.

6.5 Community perceptions on effectiveness of buffer zone interventions

A range of interventions to deter crop raiding have been used by local communities around Nkuringo buffer zone. Local people were aware of all the interventions but differed on their effectiveness. Specifically planting lemon grass was not beneficial at all to most local communities and hence ineffective in reduction of crop raiding despite considerable time and effort originally invested in implementing the intervention. Tea was observed as the most effective since tea planting was not only beneficial monetarily, but also was a more effective intervention to reducing crop raiding.

7. Conclusion

The Nkuringo buffer zone has helped mitigate crop loss by wild animals and therefore reduced conflicts between local communities and park management as this study shows. Before the buffer zone was introduced, crop raiding was at its peak and more especially by mountain gorillas that if this was not curtailed would have led to a precarious situation between the local communities and park management. The introductions of Interventions in the buffer zone have had varying levels of successes; the Mauritius thorn has helped reduce wild animal crop raids in places where it has been well maintained. However, in places where the Mauritius thorn hedge is not well maintained, crop-raiding incidences are still prevalent. The recent introduction of tea planting in the buffer zone seems to have reduced crop raiding incidences and more particularly by baboons.

Crop raiding incidences are more concentrated in the north part of the buffer zone in Nteko parish than the South part of the buffer zone. There is a new threat emerging from crop raiding by bush pigs because they raid in the night and are therefore difficult to control using the other intervention (except the Mauritius thorn hedge) and in areas where the Mauritius thorn hedge has not been well maintained. Tea at its current stage cannot contain bush pigs raids.

8. Recommendations

The recommendations below are intended to improve monitoring of wild life crop loss and therefore human-wildlife conflict around Nkuringo buffer zone but may be applicable elsewhere in areas adjacent to Bwindi-Mgahinga Conservation Area and beyond.

1. There is need to continue the collection of crop raiding data in villages neighboring the buffer zone and generally for the rest of BMCA. Without continuous data collection on crop raiding incidences, it will be difficult to monitor the different interventions and therefore ascertain the effectiveness of the interventions that have been put in place.

2. The current protocols used by HUGO to monitor human-wildlife conflict in Nkuringo should add GPS location coordinates and an estimation of crop area damaged during each crop-raiding incident. This will in turn enable the HUGO staff to undertake trainings in the use of the GPS and data collection protocols

3. The issue of introducing incentives to the HUGO members has always come up prominently during interviews with the local communities. These incentives could be provided from other sources such as NCCDF and the gorilla levy funds.

4. Previously the Accumulated Savings and Credit Associations members (ASCA) a community association under NCCDF collected information on HWC. Unfortunately this information has not been collected the past 3 years. The local people that were collecting this information stopped doing so after funding from NCCDF was stopped. NCCDF should take a leadership role and encourage the ASCA groups and other local people to participate in the monitoring of crop raiding at individual household levels especially in those communities where crop raiding incidences are prevalent. The importance of the monitoring crop raiding by the local people should be made clear to the ASCA members. This recommendation has been made after we observed the relationship between

NCCDF, the community and UWA in the area have improved than was in the past.

5. Tea plantation workers should assimilated in the monitoring of crop raiding incidences by the NCCDF and this should be through training and provision of materials to enable them record key observations in the field essential on human-wildlife conflict monitoring. Tea plantation workers are given special emphasis since they spend most of their workdays in the year in the tea plantation that has been established and runs alongside the entire stretch of the Mauritius thorn hedge at the Nkuringo park boundary.

6. The management of NCCDF should be encouraged to integrate monitoring human-wildlife conflict among its core activities and allocate resources to the activity. The NCCDF management should use the data to track its own progress and also lobby support from development organizations to specifically address impediments to progress towards reducing human-wildlife conflict in Nkuringo area first and then scale-up efforts to other areas around BMCA.

7. The data monitoring protocols suggested in recommendation 2 to 5 are community based. These protocols should be supported by NCCDF and supervised by NCCDF, UWA and possibly ITFC. The data collected by the local people should then be transferred and included in the ranger based monitoring (RBM) described below and analyzed by UWA. This analysis should be done on a quarterly basis and should be participatory.

8. Conservation Through Public Health (CTPH) has Village Health and Conservation Teams (VHTC). The teams regularly visit households neighboring the buffer zone to collect information related conservation and health. They also collect information on gorilla movement into the community. The teams can be trained and empowered to collect more generalized data on other crop raiding species as well.

9. The ranger-based data collection protocol used by UWA should be modified to include crop raiding monitoring by the local communities. This could be through the introduction of the community monitoring protocols for monitoring crop raiding incidences and other community activities such as illegal activity monitoring, multiple use monitoring etc. Remarks from communities on wild animals and their actions at time of observation outside park boundaries and, in cases where crop damage is reported should be included in this community based monitoring tool. Participation of rangers in collecting human-wildlife conflict data would be an additional useful component of this community led monitoring tool.

10. The management of NCCDF and local governments should mobilize and commit resources for reinforcing and maintenance of the Mauritius thorn hedge since it is important in reducing the incidences of crop raiding when well maintained.

11. References

Akampulira E. (2011)Guidelines for improved uptake and management of Human WildlifeConflict Interventions by local communities. Unpublished report to the Institute of Tropical Forest

Andama E. (2009) Community Based Human Wildlife Conflict Management. The case of NkuringoBuffer Zone Bwindi Impenetrable National Park, Uganda.

Babaasa, D. Akampulira, E and Bitariho, R.(2013) Human-wildlife conflict management: Experiences and lessons learned from the greater Virunga Landscape. A report for the Greater Virunga Transboundary Collaboration Secretariat

FAO, (2009). Food and Agriculture Organisation of the United Nations; Human-Wildlife Conflict In Africa Causes, consequences and management strategies. FAO Forestry paper

Gottfried H., Robbins M. and Boesch C**.** (ed.) (2006).Feeding Ecology in Apes and Other Primates: Ecological, physical and behavioral aspects. Cambridge University Press, Cambridge.

Hill, C.M. (2000) Conflict of interest between people and baboons: crop raiding Uganda. International Journal of Primatology 21, 299–315.

Hill, C. Osborn, F. and Plumptre, A.J. (2002) Human-Wildlife Conflict: Identifying the problem and possible solutions. Albertine Rift Technical Report Series Vol. 1.Wildlife Conservation Society

IGCP, (2013. The International Gorilla Conservation Programme's Terms of Reference for Assessing and Evaluating the Effectiveness of Nkuringo Buffer Zone in addressing the Human-Wildlife Conflict

IUCN. (2003) World Parks Congress Recommendation 20:Preventing and Mitigating Human- Wildlife Conflicts. IUCN,Gland,Switzerland

Kalpers, J. Gray, M. Asuma,S. Rutagarama,E. Makambo, W and Rurangwa E. (2010) Buffer zonemanagement and Human Wildlife Conflict Management. IGCP Lessons Learned

Kleiman, D.G., Reading, R.P., Miller, B.J., Clark, T.W., Scott, J.M., Robinson, J., Wallace, R.L.,

Cabin, R.J. &Felleman, F. (2000) Improving the evaluation of conservation programs. Conservation Biology, 14, 356–365

Little, P.D. (1994) The link between local participation and improved conservation: a review of issues and experiences. In Natural Connections: Perspectives in Community-Based Conservation (eds D. Western, R.M. Wright & S.C. Strum), pp. 347–372. Island Press,Washington, DC, USA.

Luseesa, D. (2008) A study of the economic and ecological feasibility of various buffer crops and products in the Nkuringo buffer zone, Southern BINP, Kisoro District. International Gorilla Conservation Programme. Unpublished Report.

Madden, F. (1998) "The problem Gorilla". A report of the east and central African workshop on problem mountain gorillas using the situation in Bwindi Impenetrable National Parkas a basis for solution development. IGCP and CARE-DTC.

Masiga, M. Byamukama, B. Akampulira, E (2011) A review of sustainable financing and implementation of problem animal management interventions in Bwindi Mgahinga Conservation Area. A report for the Enterprise Environment and Equity in the Virunga Landscape of the Great lakes (EEEGL)

Muruthi, P (2005) Human wildlife Conflict: lessons learned from AWF's African Heartlands. AWF Working Papers. Nairobi, Kenya: African Wildlife Foundation. 59

Naughton-Trever, L., (1998). Predicting patterns of crop damage by wildlife around Kibale National Park, Uganda. Conservation Biology 12, 156e168.

Naughton-Treves L., Treves A., Chapman A. C. and Wrangham R. (1998). Temporal patterns of crop-raiding by primates: linking food availability in croplands and adjacent forest *J. appl. Ecol.* 35: 596–606.

Schley, L., Dufrene, M., Krier, A., Frantz, L., 2008. Patterns of crop damage by WildBoar (Sus scrofa) in Luxembourg over a 10 year period. European Journal of Wildlife Research 54,589e599.

Sheil, D., Akampulira E (2012) Interventions to reduce Human-Wildlife Conflict: Recommendationsbased on local experiences. Institute of Tropical Forest Conservation.

Sitati, N.W. Walpole, M.J. & Leader-Williams, N. (2005) Factors affecting susceptibility of farms to crop raiding by African elephants: using a predictive model to mitigate conflict. Journal of Applied Ecology, 42, 1175–1182.

Thapa, S.(2010) Effectiveness of crop protection methods against wildlife damage: A case Study of two villages at Bardia National Park, Nepal. Science and Technology

Policy Research, University of Sussex, Brighton BN1 9QE, UK. Elsevier, Crop protection series

Sutherland, W.J. Pullin, A.S. Dolman, P.M. & Knight, T.M. (2004). The need for evidence-based conservation. Trends in Ecology & Evolution, 19, 305–308.

Warren Y. (2003) Olive Baboons (*Papio cynocephalus anubis*): Behaviour, Ecology And Human Conflict in GashakaGumti National Park, Nigeria. In *Centre for Research into Evolutionary Anthropology*. Roehampton University of Surrey, London.

Weber, A.D. Hill, C.M and Reynolds, V. (2007) Assessing the failure of a community-based human- wildlife conflict mitigation project in Budongo Forest Reserve, Uganda. Oryx 41, 177–184.

Wildlife Conservation Society (WCS) African Programme (2009). Wildlife Conservation Society and the Great Virunga Landscape. A prospectus of the Great Virunga Landscape. Published by the Wildlife Conservation Society.

Appendix 1: Crop raiding data collection sheet

Nkuringo crop raiding monitoring data sheet

A. Site information

Village/Plot/Transect……Date……..Sheet No.……
Altitude…..……Enumeratorname…… …….Time (Start)……Time (end)……..Date of incident……GPS readings:
35M……UTM……..EPE…….....
Complainant's names……Distance of garden from park boundary……(meters)

B. Problem Animal species

Problem animal species (a) Gorillas (HG- habituated gorillas, WG-wild gorillas) (b) Baboons (c) Bush pigs
(d) Monkeys (L'hoesti/Blue) (e) Bird (Names)……..
(f) Any other animals (Names) …….. ……..
Method of identification (observed/spoors/reported/ foot marks tick one) any other…….
Time of damage……..

Problem Animal age	Number	Observed/ deduced from
Group size		
Adult		
Sub-adult		
Juveniles		

C. Mitigation measure None/yes (tick as appropriate)

If yes-state type of mitigation used

(a) Artemisia (b) Tea (c) HUGO group(d) Mauritius thorn (e)Lemon grass (f)Barley (g) wheat (h)Pasture grass(i) Guarding (j) traps Any other method (specify)……

D. Crop damage

Quality before damage and age of crop

1. Good/Medium/Poor Seedling/Intermediate/Mature
2. Good/Medium/Poor Seedling/Intermediate/Mature

1 Crop type (refer to 1 above) ……
2 Crop type (refer to 2 above)……..
3Crop type (refer to 1 above)

Dimensions (meters) of total field /number of crops where damage occurred

Damaged area

1. Length (mtrs) (millet, sorghum, beans etc)……No.(Banana, maize, cassava etc)……
2. Width (mtrs)……,Crop density (in 1m x 1m)……....

Undamaged area

1. Length (mtrs) (millet, sorghum, beans etc)……..No.(Banana, maize etc)……..
2. Width (mtrs)…… ……Crop density (in 1m x 1m.

Quadrant size classes to consider in assessing the intensity of crop damage.

Crop (s)	**Size of quadrant**
Banana, Maize and coffee, cassava	10m x 10m or count the total number of the crops destroyed.
Sorghum, sweet and Irish potatoes,	1m x 1m
Millet, peas, beans	0.5m x 0.5m

Crop damage level assessment(pods/heads)in specified quadrates		
Crops at boundary of garden		
No	damage	intact
1		
2		
3		
4		
Crop in middle of garden		
No	damage	intact
1		
2		
3		
4		

E. Other damage (tick and specify details)

Other damage	number	Details
Food store		
Livestock		
Human injury		
Threat		
Others		

Appendix 2: Perceptions Questionnaire

Survey questionnaire on relevance of Nkuringo Buffer zone in relation to status of Human- wildlife conflict in adjacent communities.

Introduction and Request for Consent to participate in the study

Greetings Sir/Madam, my name is……. We are conducting a study on problems you experience from wildlife in Bwindi Impenetrable National Park and issues focused on addressing these problems. We humbly seek your participation. The responses you give us will help us assess the impact of problems animals and also help us evaluate the interventions in place from your perspective. All that you share with us will be kept confidential and we will not write your name on this form if you wish us not to.

Your participation in this study is voluntary and you may decide not to respond to some or to all the questions. However, we hope that you will participate in this study because your ideas are important to us.

Are you willing to participate in this study? YES/NO

Date: _____

INTERVIEWER'S NAME: _____

Part 1 Demographic and Back ground assessment

1. Name.....Respondent ID……
2. Sex..... Age.....
3. Marital status.....
4. Parish..... Village..... Sub county..... GPS

   Points of Homestead…… Plot where farm land is

   Located……
5. Gender of house hold head (a) Female (b)Male
6. Size of house hold …….
7. What is your major source of livelihood/income? (A) Trading (b) Employment (c) Farming (d) Others mention

8. How much land do you own?(a)Less than one Acre (b)1 to 3 Acres (c) 3 to 6 Acres (d) More than 6 six Acres

9. How much of this is under cultivation usually (a) a quarter (b) half (c) Three quarters (d) all

10. How far are your gardens from the park boundary?

Part 2 Crop raiding assessment

11. Do you have any problems with animals from the Park? If yes, list them

12. Please rank the Problem animals from the most destructive to least destructive

13. During which months of the year do you cultivate and harvest specific crops? (complete table below)

14. At what stage of growth (early, flowering, fruiting, ripening) is each of the above mentioned crops most vulnerable to raiding and by which species in particular? (Complete table below).

Name of crop	Month (s) of cultivation	Month (s) of harvesting	Vulnerable stage of growth	Major crop raiders	Estimate damage normally done in Sq or No of stems

15. Have you ever lost livestock to wild animals? YES/NO

16. If Yes, list the types , number and unit cost of livestock lost due to specific wild animals in the past year(**April 2013 to April 2014**)

Type of livestock	Unit cost (UGX)	Quantity lost	Total cost (UGX)

Part 3 Intervention assessment

17. Are you aware of the presence of the Nkuringo Buffer zone? (a)Yes (b) No.

Do you consider the Nkuringo Buffer zone to be an effective barrier to crop raiding wildlife? Yes/no. Give reason (s) to support your answer.

18. What interventions have you used since the buffer zone was initiated?

19. For each of the above interventions, comment on their degree of effectiveness and give reason to support your response. Use the following key and table below (1=Very effective, 2=fairly effective, 3=marginally effective, 4=not effective at all)

Intervention	Degree of effectiveness	Perceived benefit	Perceived draw back

20. How do you maintain the buffer zone and other interventions associated with it?

21. Is the level of your investment in the buffer zone and other interventions worth the gain you get from them? (a) Yes (b) No. Please give reason to support your response

22. Do you have any further ideas or comments on how buffer zone and interventions can be made more effective?

23. Do you think the buffer zone and its interventions have reduced the intensity of crop raiding ever since they were introduced?

24. Are you aware of alternative interventions not associated with the buffer zone that could help reduce crop raiding by wildlife in your area (a) Yes (b) No. If yes please mention them

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