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Research Article

Analysis of human-driven extinction of elephants in Nyungwe National Park, Rwanda

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Abstract

Nyungwe National Park (NNP) is one of Rwanda's largest remaining tropical forests. Due to the increasing threats from human activities, the park's biodiversity has been severely affected. In 1999, elephants were removed from the park due to these threats. This study, therefore, intends to analyze the human-driven extinction of elephants in Nyungwe National Park, Rwanda from 1965 to 1999. The results revealed that the human activities that lead to the extinction of elephants in Nyungwe include: Poaching for ivory trade at 75%, poaching for bushmeat at 20,6%, poaching for traditional medicine at 2,7% and poaching for decoration at the late 0,8%. The illegal human-driven activities that led to elephant extinction were Poaching, Gold Mining and Logging/tree harvesting. These activities were promoted by Poaching for Ivory Trading, Poaching for Bushmeat, Poverty and Human-elephants conflicts. All of these degraded elephant habitats in various locations such as Kamiranzovu, Gasare, Bigugu and eventually resulted in the extinction of elephants in NNP. Conservation efforts that exist today in Nyungwe National Park need to be reinforced mainly for threatened species so that they may not become extinct from Nyungwe as well and reintroduction of elephants in Nyungwe is needed for sustainable conservation of Nyungwe's biodiversity and tourism product development. In addition to this, an assessment of habitat quality in areas formerly occupied by elephants in Nyungwe is also needed as a prerequisite for elephant re-introduction planning and implementation.

Keywords: Elephant, Extinction, Nyungwe National Park, Re-introduction

Introduction

According to Matthew et al. (2015), population growth and economic development are two of the biggest factors that threaten the survival of wildlife and Human-wildlife conflict is also inevitable (Matthew et al, 2015). The various actions to protect and manage African elephants are needed in a comprehensive framework that aims to prevent their extinction. In the case of Nelleman et al (2012), these actions include training and support for law enforcers in border regions to address the illegal ivory trade chain and launching awareness campaigns and increasing the number of officers in targeted areas (Nelleman et al. 2012). Without the effective implementation of various conservation measures, the illegal trade of ivory will continue. In the case of Okello et al. (2011), this is why the government and private sector must work together to improve the enforcement of the law along the entire supply chain (Okello et al. 2011). Despite the progress that has been made, more research and funding are needed to address the human-elephant conflict in Africa.

According to Plumptre et al. (2002), Nyungwe National Park in Rwanda was created in 1933 as a forest reserve, to prevent different human activities which are harmful to biodiversity (Plumptre et al., 2002). These activities led to the extinction of some animal species, especially elephants in 1999 (Julian, 2009). According to IUCN (2008), elephants are categorized as vulnerable animals on the Red List of the International Union for the Conservation of Nature (IUCN). To date, there is no research on the contribution of anthropogenic activities to the vulnerability of elephants, especially in Rwanda.

Therefore, this research identified different reasons which caused the elephants' extinction from Nyungwe National Park. Illegal human activities and root causes that led to the extinction of elephants in NNP were identified, and even the impacts of human activities on elephants in NNP are analyzed. This will help park managers to assess if there is a relationship or similarity with current threats to NNP's remaining biodiversity, then after, appropriate measures will be taken for the protection and conservation of the NNP's biodiversity, particularly threatened species.

Materials and methods

This study on human-Driven activities that caused the extinction of elephants in Nyungwe National Park (NNP), was carried out in Nyungwe National Park. According to Plumptre et al.

(2002), Nyungwe National Park is located in the southwest of Rwanda between 2°15' and 2°55' South, and between 29°00' and 29°30' East at an altitude of between 1600 m and 2950 m (Plumptre et al. 2002). It covered thirty years, between 1970 and 2000 when the last elephant was killed in 1999 by the NNP. According to Weber (1989) and Dowset (1990), the Nyungwe forest is one of Africa's largest remaining blocks of lower mountain forests. (Weber, 1989; Dowsett, 1990).

This study is a descriptive survey that is both quantitative and qualitative. The targeted population in this research was 11684 and they were composed of the local community (n=11362), NNP staff (n=192), local leaders (n=10), and ex-poachers (n=120). The local communities were from areas surrounding NNP, namely Bweyeye and Nyakabuye in Rusizi District; Ruharambuga, Karambi, and Rangiro in Nyamasheke District; Nkomane, Buruhukiro, and Kitabi in Nyamagabe District; Twumba, Muganza, and Nyabimata in Nyaruguru District. Additionally, the Staff of the NNP and the members of former poachers' cooperatives in the NNP were also included in the population targeted in this study. From the above target population, a sample of 386 people was selected to represent the total population. The sample was calculated using the Yamane Taro, as follows: $n = \frac{N}{1+Ne^2}$

Where: n = sample N= Population e = level of precision (error)

The level of precision used here is 0.05.

The process of sampling is used to select a specific population for a study. According to the 1992 book by Kendall, sampling is a systematic process that involves selecting elements to be analyzed in order to obtain useful information. A sample is a portion of a statistical population that is being examined to gain a deeper understanding of the population or question under study.

Local people located in NNP surroundings were selected using stratified random sampling whereby the sectors of origin (Bweyeye, Nyakabuye, Ruharambuga, Rangiro, Karambi, Buruhukiro, Kitabi, Nkomane, Nyabimata, and Muganza) were considered as strata, and they were selected randomly from those sectors. On the other hand, simple random sampling was to select 130 as a sample size out of 192 Nyungwe National Park staff. In addition, purposive sampling was used to select people from various sectors around Nyungwe National Park who know about the elephants in the park.

This research used both a questionnaire and an interview guide, as tools, and the questionnaire was tested by administering it to a population of the same characteristics before the real data collection. Inconsistencies and mistakes on the questionnaire were identified and addressed. After data collection, the researcher took time to put together and analyze them using different techniques and tools. Producing and analyzing quantitative information statistical packages for social studies (SPSS version 16) was used.

Results

The results from the analysis of human-driven extinction of elephants in Nyungwe national park, Rwanda. This analysis was made by the researcher on the Human-driven extinction of elephants in Nyungwe national park (NNP), one of the largest remaining tropical montane forests left in the Albertine Rift, an important biodiversity hotspot in Africa. This study considered the population of sectors in the districts surrounding NNP, namely Bweyeye and Nyakabuye in Rusizi District; Ruharambuga, Karambi, and Rangiro in Nyamasheke District; Nkomane, Buruhukiro, and Kitabi in Nyamagabe District, Muganza and Nyabimata in Nyaruguru District.
In addition, the Staff of the NNP and the members of cooperatives of former poachers in the NNP are also included in the population. From the total population, the researchers observed that the population in those sectors is 11362, the NNP staff are 130, local leaders while poachers are 120. The interpretation and analysis of the data that were collected from the field were done based on the research objectives, where data were collected by using questionnaires administered to people from 10 sectors surrounding NNP namely Bweyeye and Nyakabuye in Rusizi district; Ruharambuga, Karambi and Rangiro in Nyamasheke district; Nkomane, Buruhukiro, and Kitabi in Nyamagabe district; Muganza and Nyabimata in Nyaruguru district. While the interview was given to the leaders of NNP, Poachers cooperatives, as well as local leaders.

Respondents per categories and percentage

During this research, respondents were chosen based on different categories which include: the local community, local leaders, ex-poachers other people who carry out different activities within NNP such as park staff and researchers. Local leaders have been chosen because they have enough information about the community which they represent. According to the current

administrative structure, Nyungwe is surrounded by five districts such as Rusizi, Nyamasheke, Karongi, Nyamagabe and Nyaruguru. Some local leaders from sectors adjacent to Nyungwe in the above-cited districts have been consulted and have provided information related to human activities that caused the extinction of elephants from Nyungwe National Park.

As the neighbours of the NNP, the local community gave us information about the activities that caused the extinction of elephants from the Nyungwe National Park because many of them used to live and pass through the forest whenever they wanted to go to another side of the park for different activities including visiting their relatives. Due to the geographical location of Nyungwe National Park, travellers from both southern and western provinces used the load that links the east and western parts of Nyungwe. The movement of the community from both sides, allowed them to access information related to activities that were occurring in Nyungwe National Park.

Therefore, we hope that the information gathered from them is accurate and useful to this study. Nyungwe National Park harbours different species of plants and animal species as well as natural resources which include gold. Due to the availability of these natural resources within Nyungwe National, poachers used to enter this rich forest to exploit these natural resources including fauna and flora species. At that time, poaching activities were widespread in the Nyungwe forest. Logging and hunting animals were regarded as important sources of daily life. After being sensitized by NNP staff about the importance of the conservation of biodiversity, some community members started and decided to stop their poaching activities which contributed a lot to the animal decline and extinction of some animals including elephants. Nowadays, they are grouped in cooperatives so that they may be able to work together for improving their welfare through different alternative income-generating activities.

These ex-poachers have contributed to this research and they are now participating in anti-poaching patrols organized by NNP rangers within the park.

Respondents per gender

According to Figure 1, both males and females participated in this research as the respondents. Even if the role of females is disregarded in the field of biodiversity conservation, the level of their involvement contributes and has both great negative and positive impacts on biodiversity and different natural resources.

Once females are fully involved in various natural resources management activities, they can bring about positive changes in conservation as they also contribute to the consumption of forest resources such as fuel wood as well as preparing food for their families and their partners when they are going to hunt animals. Additionally, when females are well prepared and educated about biodiversity conservation and natural resource management, they can discourage and reduce many illegal activities done in different protected areas which are harmful to fauna and flora species. During this research, they provided constructive information which we hope will contribute positively to biodiversity conservation.

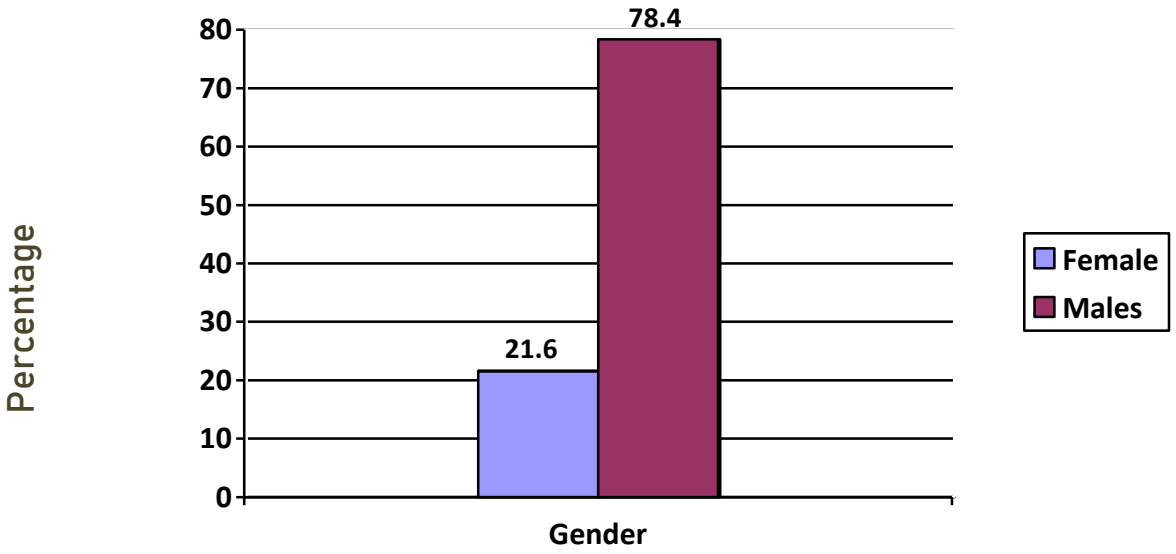

Figure 1. Percentages of respondents per gender (Source: Primary data, March 2022)

Respondents per age class

In this research, we interviewed people who were above 18 years old in 1999, when the last elephants were observed in Nyungwe, to get accurate and reliable information. This age has been chosen because it is when people are considered as mature and responsible according to the laws of many countries including Rwanda (Table 1).

During this research, a big number of respondents were between 40 and 60 years old. People in this age category have participated in various activities related to the harvest and use of natural resources that are available at a high level in Nyungwe National Park, mainly fauna and flora

species. As Nyungwe is located in a remote area, its resources were utilized by local people through direct consumption or harvesting to sell them. Therefore, the human pressure on natural resource harvest was high and a big number of adult people were fully involved and depended much on these natural resources for living with their families. Based on this situation we hope that the information provided by them will be used for setting relevant conservation strategies.

Table 1. Respondents per age classes

Age class/years	Frequency	%
18 – 30	26	4
31-40	90	14
41-50	226	35
51-60	284	44
61 -------	20	3
Total	646	100

Illegal human activities contributed to the extinction of elephants in the NNP

To understand different illegal human activities that contributed to the extinction of elephants, respondents were asked about illegal human activities that contributed to the extinction of elephants in NNP. According to Table 2, a big number of respondents said that poaching activities contributed a lot to the extinction of elephants in NNP at the rate of 85% and gold mining at the rate of 12%.

Table 2. Illegal human activities contributed to the extinction of elephants in the NNP

Illegal Activity	Frequency	Percentage
Poaching	550	85
Logging	12	2
Honey collection	6	1
Gold mining	78	12
Total	646	100

Impacts of Illegal human activities on Elephants in NNP

The below table summarizes the information that we got from respondents about the impacts of illegal human activities on elephants in NNP, where the extinction of elephants is the greatest

impact caused by human activities on elephants at the rate of 78%, while 13% is habitat degradation and habitat loss at 9% (Table 3).

Table 3. Impacts of illegal human activities on Elephants in NNP

Impact	Frequency	%
Habitat degradation	84	13
Habit loss	58	9
Extinction of elephants	504	78
Total	646	100

The main root causes of elephants' extinction in NNP

As it is indicated in the table 4, the respondents highlighted different root causes of the extinction of elephants in Nyungwe National Park where Ivory trading scored highest at 81% while poverty occupies 11% and 5% is human-wildlife conflicts (Table 5).

Table 4. Root causes of the elephant's extinction in NNP

Root causes	Frequency	%
Poverty	72	11
Poaching for Bush meat	12	2
Human-Wildlife conflicts	32	5
Poaching for Ivory trading	524	81
Traditional medicine	6	1
Total	646	100

Table 5. Percentage of respondents who have seen or heard existence of elephants in NNP

Response	Frequency	%
Seen	168	26
Heard	478	74
Total	646	100

Last period when elephants were seen in Nyungwe National Park

The table below provides information about the last period when elephants were seen or heard in Nyungwe National Park. According to results from this research, 48 % of respondents have seen elephants in Nyungwe between 1970 -1980, while 29 % of respondents have seen elephants up to 1999. After this year, no more elephants have been seen again in Nyungwe National Park. According to the results of this research, elephants were distributed in different locations, but some areas had been mentioned more compared to others. Those areas are Gasare, Vubiro, Bweyeye, Kavumande, Gashwi, Yahayi, and Kamiranzovu which rank the highest in having a big number of elephants living in NNP (Table 6).

Table 6. Periodical percentage of elephants' presence in NNP

Period	**Frequency**	**%**
1970 – 1980	310	48
1981 – 1990	187	29
1991 – 1999	149	23
2000 – 2010	0	0
Total	646	100

Distribution of elephants in Nyungwe before 1999

According to the results of this research, elephants were distributed in different locations, but some areas had been mentioned more compared to others. Those areas are Gasarethe Vubiro, Bweyeye, Kavumande, Kugashwi, Yahayi, and Kamiranzovu which rank the highest according to these numbers.

Even if the elephants were observed in different locations in Nyungwe National Park before 1999, there are some places preferred more by elephants than others. These locations include Kamiranzovu swamp, Uwinka, Bigugu surroundings and Gasare. Kamiranzovu swamp is the biggest swamp found in Nyungwe National Park because it covers an area of 13km^2, and has a variety of plant species including water which is available year-round. The results from this research indicated that elephants preferred this swamp mainly in the dry season because it was easy to get fresh glasses for eating, water to drink as well as bathing in muddy surroundings.

According to the results from this research, the above information is true and is supported by other sources which include a small portion of a video shot by one traveller from this swamp and the eyewitness said that the last elephant in Nyungwe died in 1999 lived and killed in this area.

Uwinka is another location, mentioned in this research, preferred by elephants. According to the findings of this research, Uwinka served as a transit corridor for elephants during their local migration between Kamiranzovu swamp –Bigugu and Gasare. During this research, we observed some pitfall traps created by poachers still existing along this corridor. As this corridor is used regularly by elephants, creating these pitfall traps along this corridor increased the chance of the poachers of getting elephants in these traps.

Bigugu is the highest mountain in Nyungwe; it lies at an elevation of 2950 m above sea level. Due to its elevation, It has diverse vegetation from the bottom to the top. On the bottom of this huge mountain of Nyungwe, there are big trees that include bamboos which were attracting the elephants and spent some days there before moving forward to Gasare.

Gasare is another location cherished by elephants. When you have an overlook around, it is semi-savannah because it is characterized by grassland and short open forest. This vegetation was the favorite food for elephants and is the main reason that pushed elephants to select this place as their favourite as there are some water bodies that are available a year around. During the rainy season, they preferred living in high elevation locations like Gasare and Bigugu, while in the dry season, they preferred living in Kamiranzovu swamp where it is easy to get fresh grass and water to drink.

Figure 2. Illustrates the Historical map of elephant distribution in Nyungwe National Park before 1999 (Source: Primary data, 2022)

Discussion

The outcome of this research was analyzed, discussed, and interpreted according to the objectives of this study. As it was documented by different researchers (Francisco, 2014), and (IUCN, 2008) our findings indicated that despite the creation of protected areas, threats from human activities still persist and are causing the decline and extinction of wildlife species and conservation efforts in many protected areas are weak.

Illegal human activities contributed to the extinction of elephants in Nyungwe National Park

In this research, we documented different human activities (Table 2) that contributed to the extinction of elephants in Nyungwe National Park which include logging, gold mining, honey collection, poaching for bushmeat, and ivory trading. In the case of Kaiwen et al. (2020), the elephants' range has reportedly shrunk by over 90% during the 20th century in West Africa due to the threat of commercial logging and slash-and-burn agriculture where large areas of habitat for elephants were threatened by these activities (Kaiwen et al., 2020). According to Nelleman et al.(2012), less than 20% of the region's elephant range is protected (Nelleman et al. 2012).

As the Nyungwe forest is very wide, people lived in the forest to facilitate their activities of harvesting natural resources. Therefore, there were a big number of people inside the park for different reasons which include business activities such as supplying food to those who lived in the park while buying some items from the park like timbers, gold, and bush meat.

Poaching activities were common because there was a gap in the conservation of the Nyungwe forest. Nyungwe was created in 1933 as a forest reserve to prevent different human activities that are harmful to biodiversity, but this status of Nyungwe as a forest reserve was not sufficient to prevent complete human activities within. As the case of ORTPN (2006) , Nyungwe's status was upgraded from Nyungwe forest reserve to Nyungwe National Park in 2005 to further restrict human pressure on biodiversity and its conservation (ORTPN, 2006). It was late for survival of elephants because the last elephant in Nyungwe was already killed in 1999. In addition to this gap in conservation, poaching activities were influenced by gold mining activities that were carried out in Nyungwe National Park. There were different mining sites and each mining site would have up to five thousand people. They were depending much on forest resources for survival mainly bush meats, fuel wood and honey.

The main root causes of elephant extinction in NNP.

According to Table 4, the main root causes of poaching activities include poverty, bushmeat and ivory trading (Table 4). According to Rushton et al. (2005), the meat of wild animals has previously been and is still an essential source of income for millions of indigenous people and local communities. Killing elephants in NNP was encouraged by the high demand for elephant tasks which was also attracting elephant tusks business doers from neighbouring countries.

Therefore, poverty among local people and ambition of becoming rich were pushing many people to be involved and participate in these poaching activities which caused the extinction of elephants in Nyungwe National Park in 1999.

According to Richard (2000), conflict between elephants and farmers is already widespread and can lead to the displacement or elimination of elephants while causing a decline in their range and numbers (Richard, 2000). In this research, the respondents said that conflicts between communities and elephants in Nyungwe National Park were there even though these conflicts were at a minimal level. According to Ngcobo et al. (2018), when human elephant conflicts occur, not only is there a risk of property loss, but human safety may also be jeopardized (Ngcobo et al., 2018). According to the outcome of this research, these conflicts contributed to the extinction of elephants in Nyungwe National Park. In response to this case, most of the people affected demanded that the elephant should be killed.

Impacts of human activities on Elephants in NNP

According to Francisco (2014), human population growth and economic development have resulted in the rapid increase of habitat loss and poaching, two of the major threats to wildlife (M.Francisco, 2014). According to the outcome of this research carried out in Nyungwe National Park (Table 4) and the case of Tshimangadzo et al. (2018), poaching is a major and growing threat to elephant populations and the increase in the illegal trade of wildlife products is contributing a lot in biodiversity loss and rapid decline among elephants (Tshimangadzo et al., 2018). According to Plumptre et al. (2002), Nyungwe was created as a forest reserve in 1933 to prevent different human activities which were harmful to the biodiversity of Nyungwe National Park such as animal poaching, logging, gold mining, honey collection, bush fires for agricultural activities (Plumptre et al., 2002). In the case of Julian (2009), different animals were hunted in Nyungwe National Park but elephants were targeted due to the high demand for ivory and bush meat in and outside of Nyungwe National Park (Julian, 2009, Wahab et al. 2021). According to the outcome of this research, these illegal human activities led to the extinction of elephants from Nyungwe National Park in 1999 (Table 6).

According to Figure 1, elephants were distributed all over In Nyungwe National Park. The top five sites occupied by elephants in Nyungwe include Kamiranzovu, Gasumo, Gasare, Gashwi and Kavumande. Even if the habitat qualities of these areas occupied by elephants are not yet

documented, we think that they were providing suitable ecological conditions for the survival of elephants like shelter, food and safety. Currently, some remnants of elephant skeletons can be seen in some places in Nyungwe National Park where they are scattered. These skeletons are indicators of the former elephant's home range and can also facilitate a study on the habitat quality of areas occupied by elephants and their distribution in Nyungwe National Park (Fig. 2).

Figure 2. The Skeleton of last elephants killed in Nyungwe National Park

Conclusion

In this research, different illegal human activities that contributed to the extinction of elephants had been documented such as poaching, logging, gold mining, and honey collection. The main root causes of poaching elephants in Nyungwe National Park include poverty, poaching for bush meat, poaching for ivory trading, and human-wildlife conflicts which resulted in the extinction of elephants in NNP. Therefore, the conservation efforts that exist today in Nyungwe National Park need to be maintained and reinforced where it is necessary mainly for threatened species so that

they may not become extinct from Nyungwe as elephants did. The issue of the extinction of elephants from Nyungwe National Park and the need of reintroducing them in Nyungwe National Park need to be discussed by different conservation organizations and stakeholders for the improvement of biodiversity conservation in Nyungwe National Park as well as assessing habitat quality and ecological requirements for elephants need, a prerequisite for elephants.

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