Socio-economic and ecological baseline impact study of the reclaimed part of Sarambwe Nature Reserve after border reaffirmation

A technical report by:
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II. Executive Summary

Sarambwe Nature Reserve (SNR) located in the Democratic Republic of Congo (DRC) is contiguous with Bwindi Impenetrable National Park (BINP) partly forming a corridor for wildlife such as mountain gorillas. As a result a recent border reaffirmation by GVTC, the border reaffirmation process coincidentally caught up over 36 households as encroachers in SNR. We sort to assess the socioeconomic impacts of the encroachers on the ecological functions of the SNR through carrying out household surveys and forest surveys in the SNR. This was done within the SNR using household surveys, transects and plots respectively. A total of 40 households all located in the SNR were interviewed and of these, 23 were located in Democratic Republic of Congo (DRC) while 17 were located in Uganda.

Household survey results have shown that 80% of the respondents were born outside the SNR and these were between the ages of 20 to 40 years indication of the encroachment being a recent activity. The major source of income for respondents living in the SNR is subsistence farming (contributing to over 60%). All the interviewed respondents had no formal employment as a source of income. The subsistence farming was carried averagely in small acreage of land of up to 5 acres per household.

Indigenous tree species' stem density was significantly different between forested and the "cleared forested" areas of SNR. Tree species stem density were highest in the forested areas than in the cleared forested areas. Tree species with high stem densities included the *Psychotria mahonii, Myrianthus holstii* and *Milletia dura* while those with low stem densities were in the cleared forested areas and included the *Carapa procera*, *Leplaea mayombesis* and *Shirakiopsis ellaptca.* Furthermore, the size class distribution of the different tree species was significantly different between the forested and the "cleared forested" areas. Large sized tree individuals (adults) were more abundant in the forested areas than in than in "cleared forestd" areas and vice versa for small sized individuals. Tree species diversity was highest in the forested areas than in the cleared forested areas.

Four types of large mammals were encountered (either directly or by signs) in the study area. These were the Black and White Colobus monkeys, Black Fronted Duikers, Bush pigs and the Red tailed monkeys. Eighty seven (87) species of birds were recorded in both forested and “cleared forested” areas of SNR recorded and of these, 15 were Albertine Rift Endemics.

In conclusion, past and present anthropogenic perturbations in Bwindi and SNR have largely played a role in the distributions of tree species and fauna in the forest. Almost all the recorded tree species in SNR are majorly secondary forest types that prefer disturbance and more light conditions since they responded by increased regeneration in highly disturbed areas. We therefore recommend the eviction of the encroachers from SNR and the active management by planting of indigenous trees and removal of exotics from the nature reserve to restore the ecological integrity of SNR.

III. List of Abbreviations

BINP: Bwindi Impenetrable National Park

DRC: Democratic Republic of Congo

GVTC: Greater Virunga Transboundary Core Secretariat

GVL: Greater Virunga Landscape

ICCN: Institut Congolais pour la Conservation de la Nature

ITFC: Institute of Tropical Forest Conservation

JTC: Joint Border Commission

PAAs: Protected Area Authorities

SNR: Sarambwe Nature Reserve

TSC: Timed Species-counts

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1. Introduction

Sarambwe Nature Reserve (SNR) located in the Democratic Republic of Congo (DRC) is contiguous with Bwindi Impenetrable National Park (BINP) partly forming a corridor for wildlife such as mountain gorillas that move across the international border of Uganda and the DRC. The Nature Reserve is one of the 8 protected areas that constitute the Greater Virunga Landscape (GVL) as laid out in appendix 1 of the Greater Virunga Transboundary Collaboration (GVTC) Treaty. The transboundary nature of BINP and SNR calls for a trans-boundary natural resource management approach to better manage wildlife in the two protected areas. Accordingly, Protected area managers between the two countries have held meetings, coordinated patrols, and sharing information in their efforts to manage movement of wildlife across borders and cross-border illegal activities. With the Greater Virunga Trans-boundary Core secretariat establishment and signing of a treaty as a legal requirement, the operationalization of these transboundary wildlife conservation activities between the two PAs has been strengthened. The GVTC treaty was established as a transboundary collaboration framework for programmes and activities on wildlife conservation and tourism development amongst partner states of DRC, Rwanda and Uganda without ceding and or affecting the respective sovereign rights over the protected areas under their respective territorial jurisdiction (article 3 of the GVTC Treaty).

SNR gained transboundary prominence in conservation when the BINP's Rushegura habituated Mountain gorilla group crossed into Sarambwe in 2008 for the first time and latter on in 2010. The Rangers in Sarambwe did not have experience with regular monitoring of mountain gorillas and accounting for each member of the group, this required that the rangers know each gorilla by name using facial or nose prints signs. Through a transboundary arrangement, facilitated the GVTC framework, eight BINP rangers were hosted by ICCN at SNR ranger post to work with their counterparts and train them in gorilla daily monitoring and recording that included orienting them in identification of the individuals in the group by their names. This then began the transboundary collaboration by the different rangers from Uganda and DRC in mountain gorilla monitoring. While the GVTC Partner states agreed to corporate without

compromising the territorial sovereignty of the either states, there are several disputed interstate boundary conflicts that keep on re-occurring around Sarambwe sometimes resulting in the enhancement of transboundary illegal wildlife trade in GVL and challenges to peace and security in the region. During the 2018 recently held mountain gorilla census, a skirmish with the gorilla census team resulted in a conflict with law enforcement officers from Uganda along the Sarambwe border and this resulted in the suspension of the second sweep of the gorilla census in SNR.

GVTC, with financial support from the Kingdom of Netherlands through the Kigali Embassy, has over the recent years engaged the state parties from the community level to Ministerial level to have this conflict resolved. In the engagement, it was agreed that border reaffirmation be carried out by the two states as the optimal solution. In December 2018, GVTC engaged the DRC-Uganda Joint Border Commission, (JTC) the only body with mandate to demarcate and re-affirm borders and requested partnership for the border reaffirmation. The JTC agreed to partner with GVTC and also to give Sarambwe and Lake Edward border reaffirmation as priority boundary areas. GVTC further engaged the Office of the Special Envoy of the United Nations Secretary General (O/SESG) for the Great Lakes Region to raise supplementary funding to facilitate the Sarambwe-Bwindi border reaffirmation processs. The Border reaffirmation was done and completed in June 2019 and the international border was reaffirmed that month.

As a result of this border reaffirmation, the border reaffirmation process coincidentally caught up 36 households as encroachers in SNR. Other structures such as a Church, a trading center and commercial crops such as coffee and banana plantations came to be located within the Sarambwe game reserve. Furthermore, other households had gardens within the reserve but with homes in Uganda. It was later on established that most of these affected persons were migrants from other regions of Uganda and DRC. They had sold off their property and came to buy cheap fertile and large pieces of arable land without suspecting that this was a game reserve yet the sellers knew.

Therefore, most of those with households located in the reserve will become destitute at the end of this crop season (August 2019).

It is on this premise described above that a study was recommended to assess the ecological and socioeconomic impacts of encroachment in SNR. The situation described above presents both opportunities and risks that need to be studied and understood. The ICCN will have the opportunity to take full conservation measures while GVTC will have an opportunity to undertake the transboundary conservation measures within its mandate that include coordinated patrols, joint gorilla monitoring and census and restoration of degraded habitats. The conservation of mountain gorillas will have increased gorilla habitat as well. On the other hand, the affected households have lost their livelihoods and may become potential poachers both within BINP and SNR. This is a group that needs to be quickly identified and their source of livelihoods understood when plans for their reallocations are to be carried out.

To concretize the border reaffirmation results into the GVTC measure of improved conservation indicator “Trends of area under conservation” whose rationale is that “Effective conservation should result in the PAs being protected from encroachment and degradation”, this study is thus a baseline monitoring framework for the above interventions that was carried out in SNR with the purpose and objectives as specified below.

2. Study Justification

The Sarambwe- Bwindi border reaffirmation results of June 2018 showed that part of SNR had been encroached by over 36 resident homesteads and 66 other homesteads with cultivation gardens within the reserve. This situation puts in place conservation management, ecological and socio-economic challenges that are threats to improved conservation of the SNR. Therefore, this study was proposed as a baseline to measure the extent to which the encroachment in SNR by the local people has been impacted on and its forest recovery trends understood when the encroachers have been relocated elsewhere. This study will contributes to improved conservation of SNR and will contribute to the GVTC indicator of “Trends of area under conservation” whose rationale

is “Effective conservation should result in the PAAs being protected from encroachment and degradation.

Sites that have in the past supported natural forest vegetation but have been degraded by land use practices such as agriculture and logging are generally difficult to re-vegetate because degraded soils, fires and competition from herbs and shrubs arrest the successional process (Eilu *et al.* 2005). In some cases enrichment planting has been undertaken to enhance regeneration and encourage the development of the forest (Fimbel & Fimbel, 1994). Whereas regeneration can proceed naturally, studies in the Mbwa river tract of BINP have recorded introduced species such as Black Wattle (*Acacia mearnsii)* that could become invasive (Eilu *et al.* 2005). It is therefore important to understand the baseline flora and fauna compositions by carrying out biological inventories of key taxa in order to generate for a biodiversity database of the SNR. This was the basis of this study.

3. Study Objectives

The specific objectives of the study are:

i. Assess the socio-economic impacts of encroachment by the local people and possible threats to trans boundary conservation and management when households encroaching in the SNR are evicted from the reserve.
ii. Assess the ecological impacts of the SNR encroachments by the local communities
iii. Establish the level of habitat degradation as a result of encroachment and propose ecological measures to restore it
iv. Propose possible recommendations for the proper management of SNR.

4. Methods

4.1 Household surveys and Interviews

The Sarambwe forest household survey used a semi-structured questionnaire interview to generate household survey data from community members who live in the encroached area and are directly affected as individual households. The Interviews included all the community members with households in the SNR. Residents around the SNR area were also randomly selected for interviews. The household interviews were intended to give all residents equal chances of being interviewed to get all round views on the socioeconomic status of the encroachers.

4.2 Ecological surveys of the SNR

4.2.1 Indigenous tree species abundance and distribution

A forest survey exercise to assess the abundance and distribution of the indigenous within the SNR was carried out. Belt transects were placed in two distinct strata of forested and “Cleared forest” areas of the SNR for comparisons purposes. Methods used were those generally employed to assess woody plants (trees and shrubs) species. The Forest survey involved a team moving along belt transects while compiling cumulative lists of tree species within the belt transects. Randomly placed belt transects of 10m widths and 700m lengths were used to assess the tree life species in both forested and “Cleared forest” areas of SNR. Subsequent belt transects were placed after every 20 meters from each other. Belt transects account better for heterogeneity of the forest than a quadrat of the same area while assessing tree life-forms (Hladik and Dounias 1993, Tuxill and Nabhan, 1998). We used four belt transects (two placed in the forested area and two in the “Cleared forest” area) for assessing the tree species in SNR.

On each transect nested square quadrats of 5m x 5m and 1m x 1m were regularly placed at 10m intervals alternating from the right to left along the belt transects to assess tree species saplings and seedlings respectively (ITFC 1999). Systematic sampling plots have the advantage of estimating population abundance and density well, can be done without prior knowledge of the total area (Tuxill and Nabhan, 1998). Specimens of the tree species encountered for the first time were collected for verification at the ITFC field herbarium. The

specimens were pressed, dried and later taken to the ITFC Herbarium for identification and confirmation. Botanical identification of the plants were done with the help of taxonomic literature such as Flora of tropical East Africa (FTEA), Eggeling and Dale (1951) and Hamilton (1991). In the field, bark slash characteristics and local names of plants were helpful for preliminary identifications.

4.3 Fauna Species abundance and distribution

4.3.1 large mammals diversity and distribution

The purpose of the mammal surveys was to develop a checklist of large diurnal mammals within the SNR. The large mammals species diversity and abundance was compared in the forested and “Cleared forested” areas of SNR. Both direct and non-direct methods of inventory were used during the survey walks along belt transects established to assess the large mammals in SNR. We also used indirect methods for large mammal assessments and these included the use of dung, tracks (footprints), and nests.

4.3.2 Bird species abundance and distribution

The purpose of the bird species surveys was to develop a checklist of diurnal birds within the SNR. The bird species were observed and assessed using binoculars during the transect walks while assessing the tree species. Timed Species-counts (TSCs) were used to record the birds because of their advantage as quick and simple methods of gaining a measure of relative abundance of bird species in a fairly large, defined area. Birdcalls were also used in the identification of species. Records of species present (p) included those made outside the count times and or opportunistically made. Names of the bird species were determined mainly from field guides using color pictures/photos.

4.4 Data analysis

4.4.1 Tree species density, abundance and distribution

Data on tree species’ stem densities in the forested areas were pooled together and then compared with those of the “Cleared forested” areas to test for any significant differences using following Binh (2009. Tree life forms stem densities were used as a measure of abundance and this was calculated as an average number of individuals stems per ha (Peters, 1994; Wong, 2003). The tree

from the “Cleared forested” areas and statistically tested using Chi-square (χ^2) for any differences (Boot & Gullison, 1995; Botha *et al*, 2004). The Chi-square (χ^2) statistical analysis was performed using Systat 10.2 and Excel 2010.

Stem density per hectare = $\frac{\{\text{Total number of individual plant stems}\}}{\text{Total number of plots x plot area in hectares}}$

4.4.2 Tree species size class distributions

Diameter at Breast height data from the forested areas were pooled together and then compared with those from the “Cleared forested” areas. Diameters at breast height were used as a measure of size class distribution of the different tree species within the two forest strata (forested area and “cleared forested” areas). The size class distribution of the tree species within the forested areas were then compared with those from the “cleared forested” areas and statistically tested using a Wilcoxon test for any differences following Siegel & Castellan (1988. The Wilcoxon test was performed using Systat 10.2 computer software and Excel 2010.

4.4.3 Tree species diversity

Tree species diversity was compared in the forested and “cleared forested” areas of SNR. We used the Shannon diversity index (*H*) to test for differences in species diversity between the two strata (forested and cleared forest areas). The Shannon diversity index (*H*) was used to characterize species diversity in the two forest strata (forested and “cleared forest areas”). Shannon's index accounts for both abundance and evenness of the species present. The Shannon index increases with the number of species in an area and in theory can reach large values. In a biological community (natural forest) the H value does not exceed 5.

$$H = \sum_{i=1} - (Pi * \ln Pi)$$

where:

H = the Shannon diversity index

Pi = fraction of the entire population made up of species i

S = numbers of species encountered

$\sum$ = sum from species 1 to species S

1n=natural log

4.4.4 Large Mammal species abundance diversity

We analyzed the large mammal observation data using the Simpson's diversity index for assessing the large mammals abundance and diversity. The Simpson's diversity index was compared in forested and "Cleared forested areas of SNR for any significant difference. The Simpson's Diversity Index is a measure of diversity that takes into account the number of species present, as well as the relative abundance of each species. As species richness and evenness increase, so diversity increases.

Calculation for Simpson's Diversity Index = 1-Ds

Where Ds =Simpson's index

And Ds= $\sum_n(n-1)/N(N-1)$

Where n=Total number of organisms of a given species and N=total number of organisms in the community

5. Results

5.1 Household surveys

5.1.1 Location of households that are encroaching the SNR

A total of 40 households all located in the SNR were interviewed and of these, 23 were located in Democratic Republic of Congo (DRC) while 17 were located in Uganda. Some of the houses located in DRC in as a result of the border demarcation exercise recently carried out by GVTC in 2018/19 did not know that they were in DRC, but thought they were located in Uganda (Figure 1).

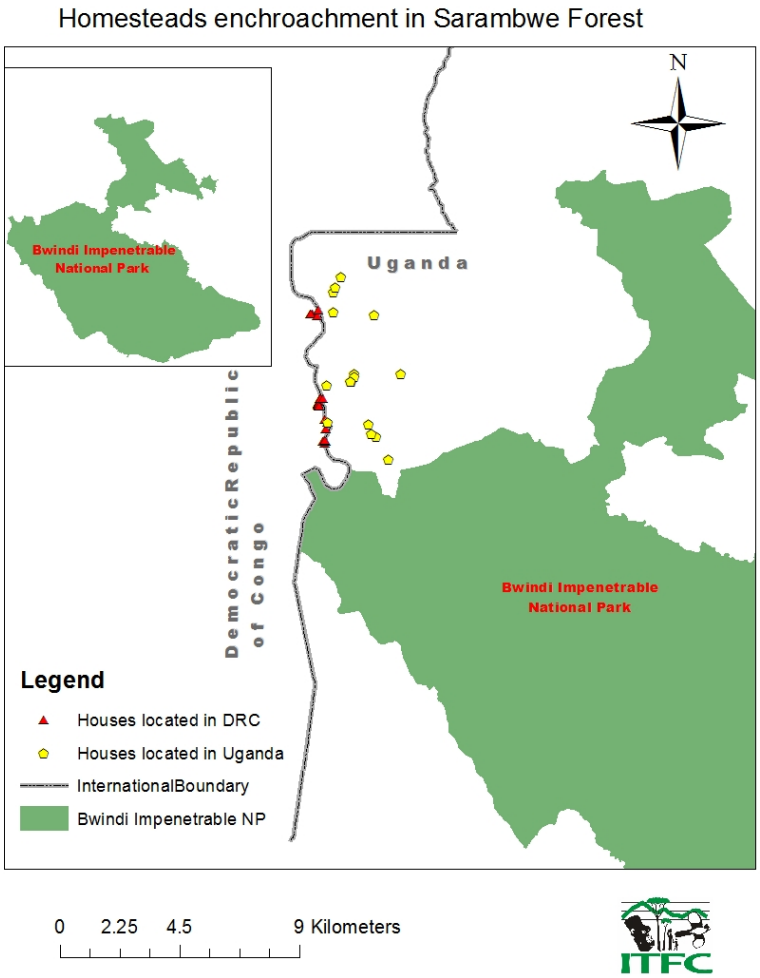


Figure 1 Map showing location of households in SNR in both Uganda and DRC

5.1.2 Categorizations of respondents

Interviewed respondents were categorized into four categories: husbands (men who are usually household heads), wife (women), child, workers (can be both men and women) and others (e.g. relatives). Figure 2 shows the

distribution of the interviewed categories of respondents in the study area. As the figure shows, the men (husbands) were the majority of the interviewed respondents. Overall, the husbands (men) contributed to highest percentage of respondents interviewed (over 35%) for both residents and non-residents of SNR households.

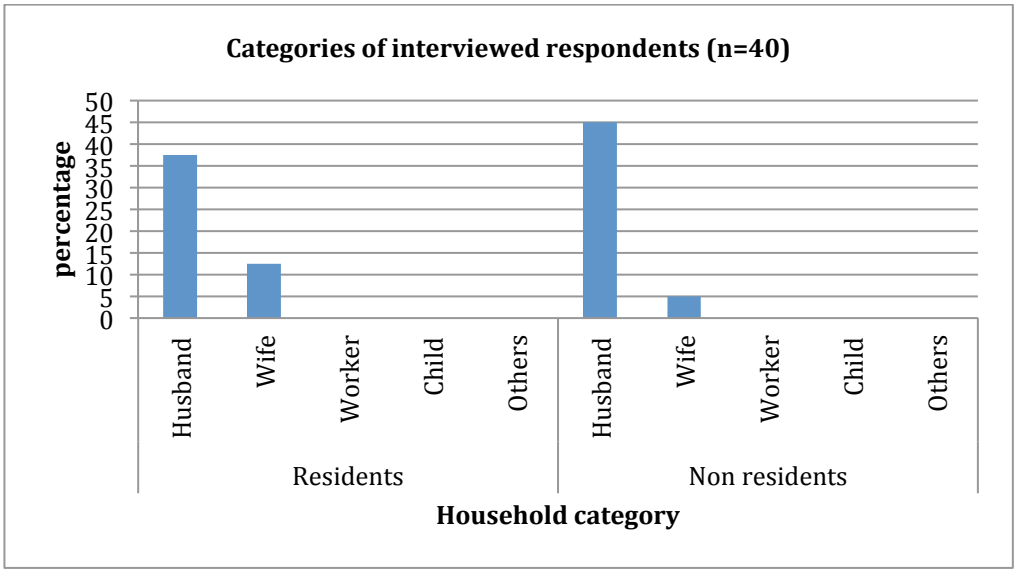


Figure 2 Categorizations of interviewed households in the study area

5.1.3 Age groups of respondents

Age composition of a population has significant implications for the reproductive potential, human resource and service delivery in a household. Sex and age are also important because they inform the kind of responses that can be generated from the respondents (Kumar, 1989). Majority of respondents interviewed were in the age category of 21-40 (Figure 3) and these constituted about 30% of household located in SNR and about 18% for non-residents of SNR. The least age group of interviewed respondents was those below 20 years, these constituted about 5% of total respondents.

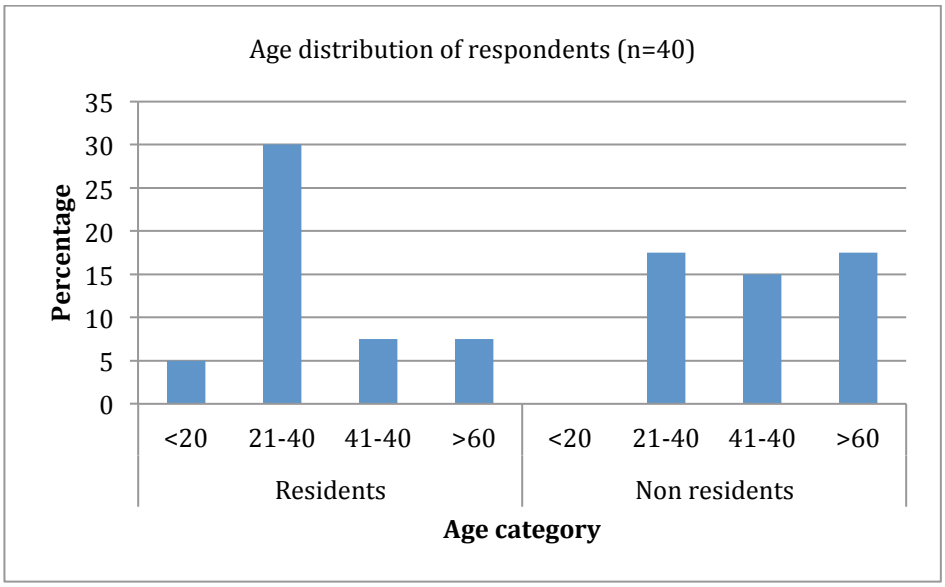


Figure 3 Age distribution of respondents in the study area

5.1.4 Origin and place of birth of respondents

As Figure 4 shows, majority of the respondents (over 80%) were born outside the SNR and only the 20% were born from inside the nature reserve. These results give precedent to the information that most of the households and resident are new encroachers to the SNR and only came to settle there recently.

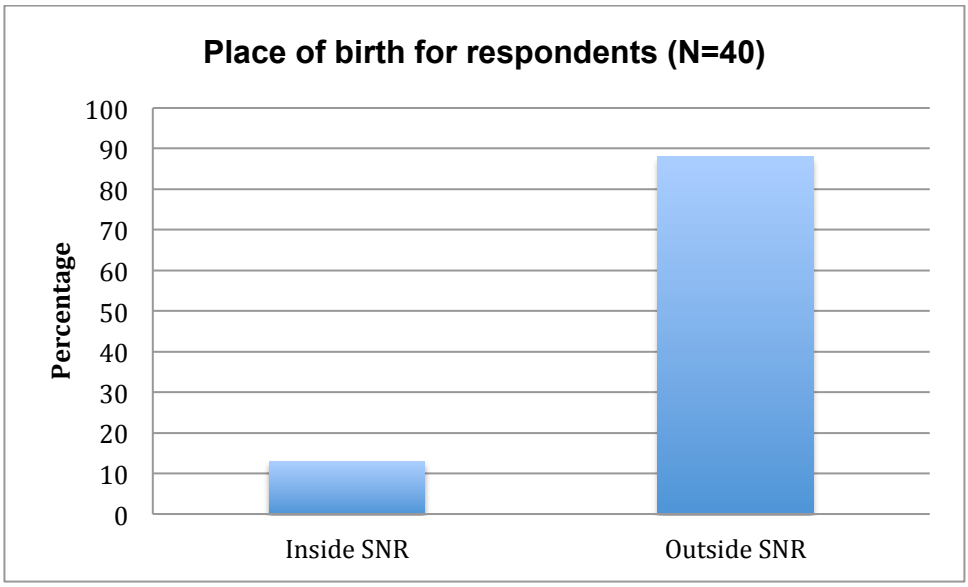


Figure 4 Origin and place of birth of respondents

5.1.5 Sources of income and land use practices

The major sources of income for respondents correlates with the relationship between the livelihood status of a respondents and key related issues to do with natural resource management especially use of natural resources from

subsistence farming and 30% from commercial farming (tea and coffee) while the least got income from beekeeping and livestock farming (Figure 5). Of particular noting is that none of the respondents were formally employed.

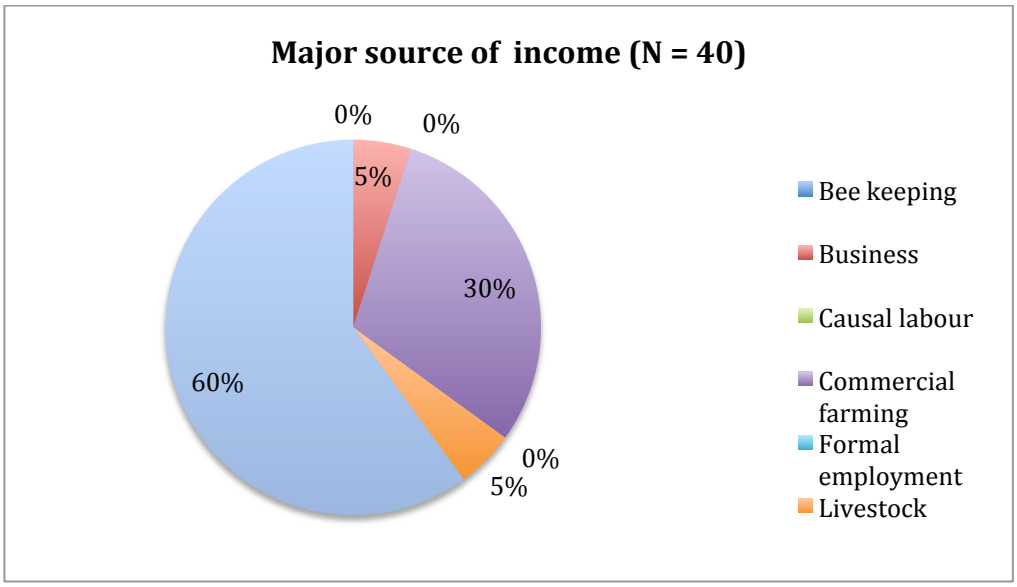


Figure 5 Major sources of income for respondents in the study area

5.1.6 Land acquisition by respondents in SNR

Respondents claimed to have acquired land in the SNR through either customary or purchase of land acquisition (Figure 6). Sixty percent of households located in SNR claimed to have acquired their land through purchase from other individuals while 40% claimed to have acquired the land through customary land ownership (Figure 6). This trend was almost similar with the non-residents who owned land in the SNR.

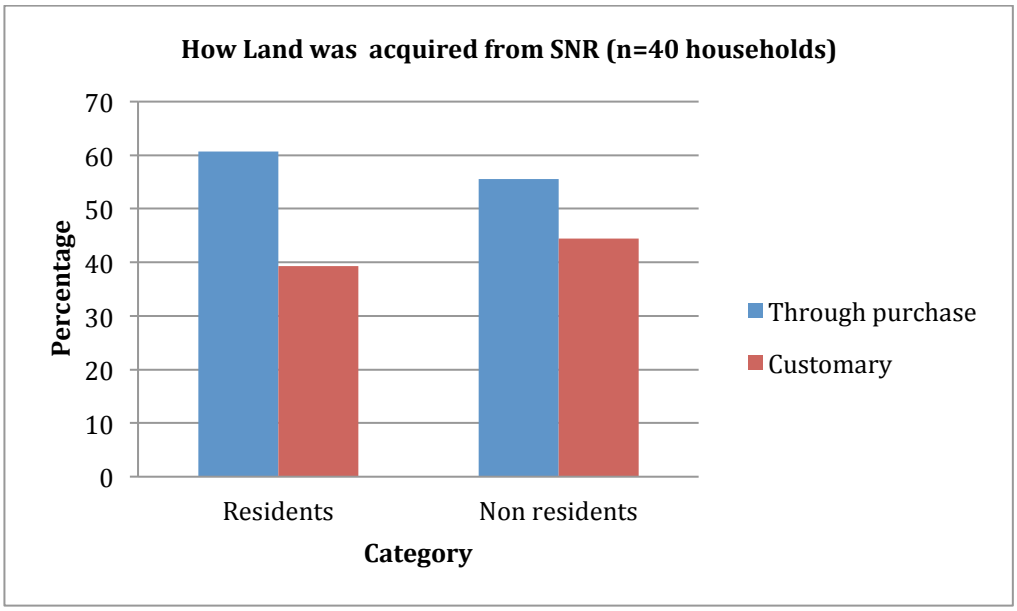


Figure 6 How land was acquired by respondents in the study area

5.1.7 Total land acreage owned by respondents

The total land owned by the respondents is shown in Figure 7. The figure shows that majority of the respondent owned a piece of land less than 5 acres while the least owned land between 15 to 20 acres (and these were mostly non-residents). These results are consistent with what was discussed above that most of the respondents were subsistence farmers who own small pieces of land for agriculture.

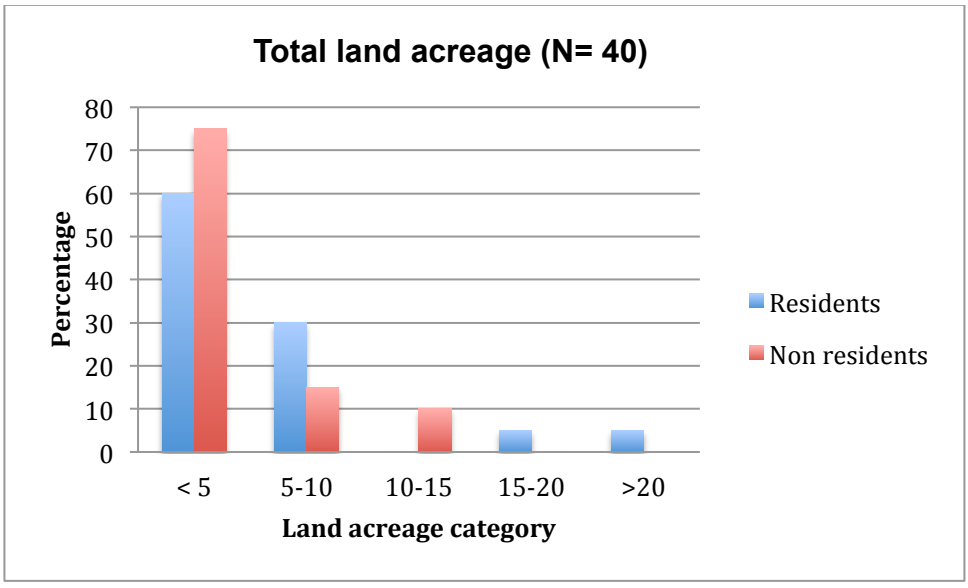


Figure 7 Total land acreage owned by respondents in the study area

5.2 Tree species stem densities

The tree species stem densities are shown in table 1. Stem density of the tree species was significantly different between forested and the cleared forested areas (χ^2 = 191.6, df 28, p value< 0.05, chi-square goodness of fit). Table 1 shows that the tree species stem density were highest in the forested areas than in the cleared forested areas. Tree species with high stem densities were those in the forested areas and included the *Psychotria mahonii* (34±0.5)*,* *Myrianthus holstii* (34±0.9) and *Milletia dura* (29±0.9) while those with low stem densities were in the cleared forested areas and included the *Carapa procera* (0.7±0), *Leplaea mayombesis* (0.7±0) and *Shirakiopsis ellaptca* (0.7±0). Most of the indigenous tree species were at 0 stem density in the cleared forested areas while the this was also similar true for exotic tree species in the forested areas.

Table 1 Stem density of tree species in Forested and "Cleared Forested" areas

Tree Species	Forested area		Cleared Forest area	
	Stem density/ha	SD	Stem density/ha	SD
Alangium chinense	11.43	0.99	0.00	0.00
Albizia adianthifolia	11.43	0.83	0.00	0.00
Anthno cleista vogellii	0.00	0.00	0.00	0.00
Carapa procera	**11,43**	**1,11**	***0,71**	**0.00**
Entandrophragma excelsum	5.71	3.52	0.00	0.00
Erythrina abyssinica	**0.00**	**0.00**	***0.71**	**0.00**
Eucalyptus grandis	**0.00**	**0.00**	***6.43**	**0.33**
Drypetes gerradii	6.43	1.27	0.00	0.00
**Ficus sur*	0.71	0.00	1.43	0.00
Leplaea mayombesis	**12.14**	**0.69**	***0.71**	**0.00**
Lepotonychiea mildbraedii	8.57	1.88	0.00	0.00
Jack fruit	**0.00**	**0.00**	***0.71**	**0.00**
Macaranga capensis	10.00	0.56	0.00	0.00
Maesa lanceolata	7.86	1.41	0.71	0.00
Markhamia lutea	7.86	1.31	2.14	0.74
Milletia dura	***29.29**	**0.93**	***4.29**	**0.46**
Myrianthus holstii	***34.29**	**0.88**	**0.00**	**0.00**
Neoboutonia macrocalyx	9.29	0.94	0.00	0.00
Newtonia buchananii	10.00	2.44	0.00	0.74
Nuxia congesta	0.00	0.00	1.43	0.00
Pauridiantha callicapoides	8.57	1.39	0.00	0.00
Persea Americana (Avacado)	***0.71**	**0.00**	**1.43**	**0.00**
Polyscias fulva	14.29	1.42	0.00	0.00
Psychotria mahonii	***34.29**	**0.48**	**0.00**	**0.00**
Sapium ellipticum	18,57	2,29	0,00	0.00
Shirakiopsis ellaptca	**0.00**	**0.00**	***0.71**	**0.00**
Strombosia scheffleri	7.14	1.68	0.00	0.00
Trilepsium madagascariensis	5.71	1.35	0.00	0.00
Xymalos monospora	15.00	0.64	0.00	0.00-

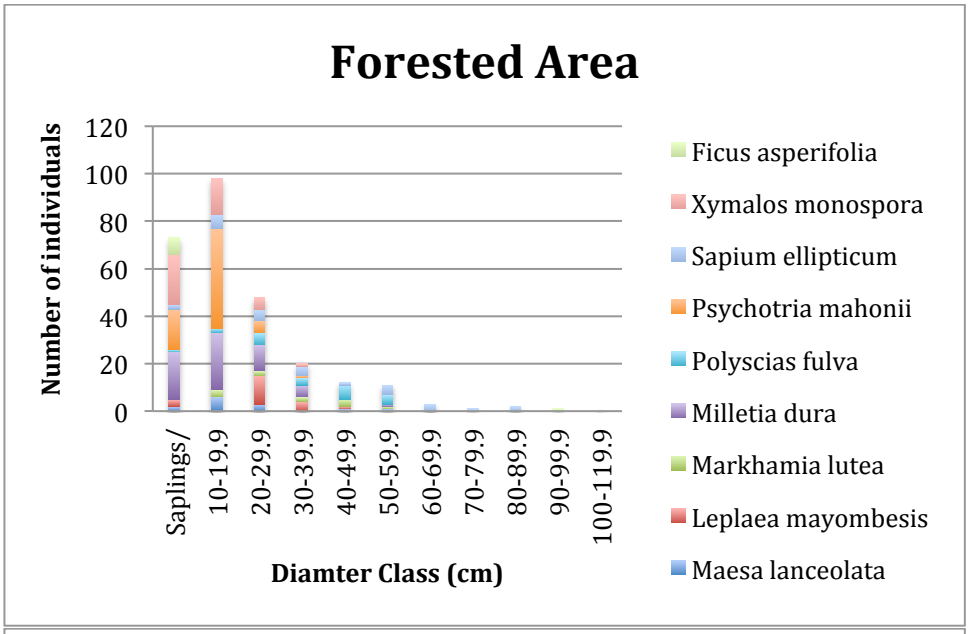
***high and low stem densities**

5.3 Tree species size class distributions

The diameter class distributions compared between the forested and cleared areas are shown in Figure 8. The size class distribution of the different tree species was significantly different between the forested and cleared forested areas (P values were < 0.05, Wilcoxon's test). Large sized tree individuals

(adults) were more abundant in the forested areas than in than in cleared forested areas and vice versa for small sized individuals (Figure 8).

The size class distribution of the tree species in the forested area showed a typical “inverted” J type of diameter size class distribution unlike that of the cleared forested area (Figures 8). The tree species diameter distribution in the cleared forested areas showed a population with very many seedlings and juveniles but no harvestable mature or adult individuals (those >18mm) and showed an “L” type of size class distribution as shown in figure 8.



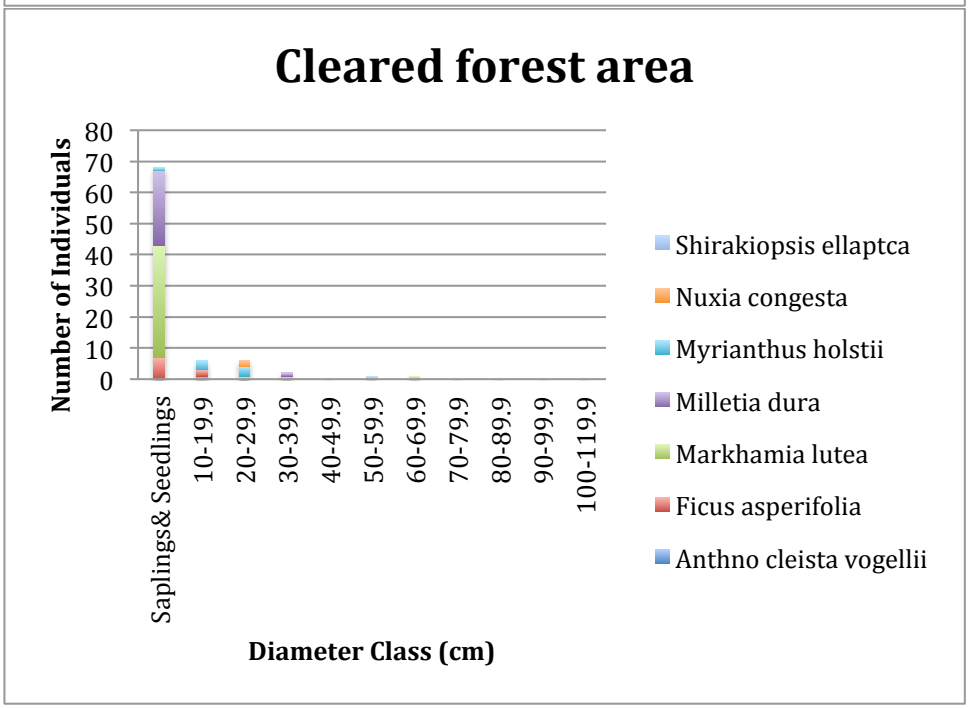


Figure 8 Diameter size class distribution of indigenous trees in forested and "cleared forested" areas

5.4 Tree species diversity

Tree species diversity was highest in the forested areas than in the cleared forested areas as shown in Figure 9. The Shannon diversity (H) for the tree species in the forested area was 3.3 while that for tree species in the cleared forested areas was 1.8. As expected, we therefore expect more indigenous tree species in the forested areas than in the cleared areas (Figure 9).

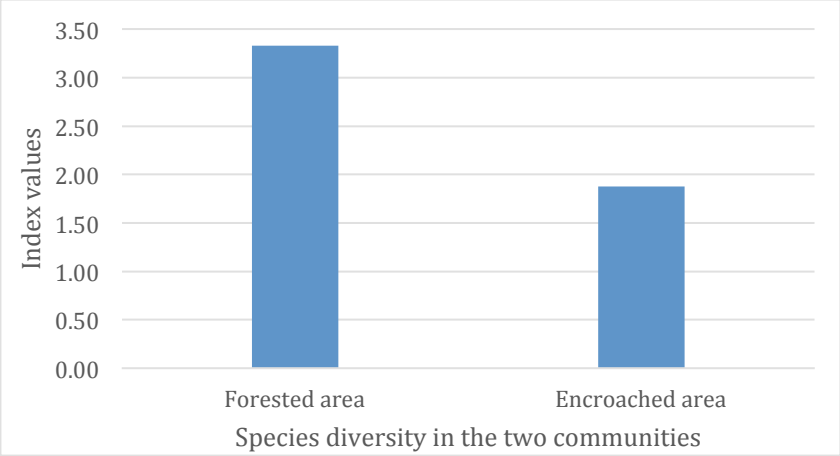


Figure 9 A comparison of tree species diversity between forested and "Cleared forested areas

5.5 Large Mammal species abundance and diversity in SNR

Four types of large mammals were encountered (either directly or signs) in the study area. These were Black and White Colobus monkey (*Colobus angolensis)*, Black Fronted Duiker (*Cephalophus nigrifrons*), Bush pig (*Potamochoerus larvatus*) and Red tailed monkey (*Cercopithecus ascanius*) (Table 2). Apart from the bushpigs (dung signs), all the other large mammals were directly observed during the study.

The Simpson's diversity index for the diversity of large mammals in the SNR forested was 0.73 while that of the "cleared forested; area was 0.The value of this index ranges between 0 and 1, the greater the value, the greater the sample diversity. This undoubtedly indicates that the forested area of SNR is an important habitat for the large mammals in SNR. The cleared forested part of SNR therefore needs to allowed to recover by evicting the encroachers to increase on the large mammals habitat range.

Table 2 Number of large mammals encountered in SNR

Species	Number in forested area	Number of "cleared forest" area
B & W Colobus monkey	3	0
Black fronted duiker	3	0
Bush pigs	3	
Red tailed monkeys	8	0
Total	**17**	**0**

5.6 Birds species abundance and diversity

Using point counts as described above, 87 species of birds were recorded in both forested and "cleared forested" areas of SNR recorded (table 3). Most of the species are Albertine Rift Endemics. Others are highland species such as Mountain Buzzards (*Buteo oreophillus*), African Harier Hawk (*Polyboroides typus*), Regal Sunbird (*Cinyris regia*), and Doherty's bush shrike (*Malaconotus dohetyi*). Species richness per site varied from 3 to 15 while Shannon diversity index varied from 1.1 to 2.7 per study site. There was no discernible difference in the spatial distribution of species richness and diversity across the two forest strata. The most commonly observed bird species were the Ludher's bush shrike and the African paradise flycatcher while the least observed were the African green pigeon, Bearded wood pecker, Black crowned wax bill etc. as shown in Table 3. At the Congo border with open steep slopes, many species of Swallows were observed. A woodland generalist species (Brown Crowned Tchagra) was also recorded near the DRC boarder.

Table 3 Bird species abundance and distribution in SNR

No	Birds Species observed	Number of counts in forested area	Number of counts in encroached area
1	African blue flycatcher	0	1
2	African citril	0	1
3	African fire finch	0	1
4	African green pigeon	1	1
5	African paradise flycatcher	12	0
6	Arrow marked babbler	0	2
7	Augur buzzard	0	1
8	Baglafecht weaver	0	12
9	Banded martin	0	3

11	Barn Swallow	0	1
12	Bearded wood pecker	1	0
13	Black and white Bronze mannilin	0	1
14	Black and white casqued horn bill	1	0
15	Black and white Mannikin	0	2
16	Black billed weaver	2	0
17	Black cap	0	2
18	Black crowned Tchagra	0	3
19	Black crowned wax bill	1	5
20	Black cuckoo shrike	3	0
21	Black headed wax bill	0	1
22	Black headed weaver	4	0
23	Black sawing	0	2
24	Black throated apalis	6	0
25	Blue headed coucal	2	0
26	Bronze sun bird	0	12
27	Brown capped weaver	3	0
28	Brown crowned Tchaga	0	2
29	Brown throated wattle eye	2	1
30	Cardinal wood pecker	1	1
31	Chinspot Baks	1	0
32	Cinnamon chested bee eater	1	1
33	Clubb's cisticola	0	12
34	Collered sun bird	7	0
35	Common bul bul	5	14
36	Common stone chat	0	4
35	Common wax bill	0	1
38	Crested guinea fowl	1	0
39	Diederik cuckoo	2	0
40	Doherty's Bush shrike	2	0
41	Dusky fit	2	0
42	Equatorial Akalat	1	0
43	Great blue Turaco	6	0
44	Green headed sun bird	1	1
45	Grey backed camaroptera	5	5
46	Grey headed Negrofinch	1	0
47	Grey throated barbet	1	0
48	Kivu ground thrush	1	0
49	Least honey guide	1	0
50	Little bee eater	1	0
51	Little sprrow hawk	1	0
52	Long crested eagle	2	0
53	Ludher's bush shrike	12	1
54	Mackinnon's Fiscal	0	7

55	Montane oviole	4	0
56	Mt. green bull	5	0
57	Mt. Illadopsis	1	0
58	Northern Puffback	4	0
59	Olive bellied sun bird	5	2
60	Olive pigeon	1	0
61	Priritailed whydah	0	1
62	Red faced woodland	1	0
63	Red headed blue bill	1	0
64	Red throated alethe	1	0
65	Ring necked dove	0	1
66	Rock martin	1	1
67	Sharpe's starling	1	0
68	Slender billed green bul	2	0
69	Sooty boubou	1	0
70	Speckled mouse bird	0	5
71	Steaky seed eater	0	3
72	Thick bellied seed eater	0	1
73	Trinker bird	1	0
74	Tullberg's wood pecker	1	0
75	Tumbourine dove	8	0
76	Variable sun bird	0	1
77	White breasted Negrofinch	1	0
78	White broured coucal	2	3
79	White browed crombec	4	0
80	White chinned prinia	5	2
81	White collere olive back	0	1
82	White eye slaty fly catcher	1	0
83	White headed sawwing	0	1
84	white headed woodhopoe	1	0
85	White starred Robin	1	0
86	White tailed Ant thrush	1	0
87	Yellow bellied wax bill	0	2

6.0 Discussions

6.1 Socioeconomic attributes of encroachers in SNR

Results from this study have clearly showed that over 80% of respondents interviewed in the study were not born in SNR. This is synonymous with the fact that the encroachment in SNR is a recent event (probably less than 20 years ago) when wars in DRC led to a breakdown in government structures and most especially protected area authority management. The fact that the majority of the respondents interviewed were aged between 21-40 years

further affirms that the SNR human encroachment is a recent activity. The major land use practice identified in the study area was subsistence agriculture with small pieces of land (less than 5 acres) being used for crop production. Therefore agriculture and settlement within the SNR are one of the major threats to the conservation of the Nature reserve. The 40 respondents interviewed and that are settled in SNR are recent residents in SNR and therefore encroachers of the nature.

6.2 Tree species stem density and abundance in SNR

The abundance of the indigenous trees is highest in the forested areas of SNR than in the "cleared forested" areas. These results are consistent with those of Hegarty & Caballe, (1991); Peters (1994); Shackleton *et al* (1994); McGeoch *et al.,* (2008) and Ghazoul & Sheil (2010). They reported that plant stem densities are often high in forest regenerating areas such as those that have previously experienced disturbance. This is true for the SNR forested area. Most of the tree species in the SNR are secondary forest species that are colonizing the forest after past human disturbance (Wild & Mutebi, 1996). This is the reason most of the tree species with the highest stem densities were the secondary forest species that vigorously sprout after disturbances (Hegarty & Caballe, 1991; Peters, 1994; Shackleton *et al.,* 1994; Cunningham, 2001; McGeoch *et al.,* 2008). This is the same situation in SNR and if the cleared forest area is allowed to recover, the indigenous tree species would prevail.

6.3 Tree species size class distributions in SNR

One first signal that a plant population is being subjected to an overly intensive level of disturbance is usually the manifestations of size-class distribution of that population (Peters, 1994; Hall & Bawa, 1993; Sampaio *et al.*, 2008). The differences in tree species size distributions between the forested and the cleared forested areas observed in this study could be from the differences in levels disturbances with the forested areas having less of disturbance than the cleared forested area of SNR.

Disturbance is highest in the cleared forested area than in the forested areas. The large sized individuals were more abundant in forested areas than in

cleared forested areas with the small sized individuals were most abundant in cleared forested areas. Hegarty & Caballe, (1991); Botha *et al* (2004); McGeoch *et al* (2008) and Ghazoul & Sheil (2010) reported that forest disturbance has a negative impact on plant sizes and distribution. Therefore, past forest disturbances by the encroachers in the cleared forested area may have influenced the indigenous tree size class distribution with more large sized individuals abundant in forested areas than in the cleared forested areas.

That the size class distribution of the tree species showed an “inverted” J type of size class distribution in the forested area, then we can comfortably say that the tree species in the forested areas have a typical natural population with self-replacing individuals as stated by Hall & Bawa (1993); Peters (1994); Tuxill & Nabhan (1998) and Sampaio *et al.* (2008). It is a kind of distribution that shows strong recent reproductions and establishments of individuals that are evenly distributed throughout all the size classes but the largest individuals-adults (Tuxill & Nabhan, 1998). However, for the cleared forested area, the size class distribution showed an “L” type of distribution that is typical of heavily harvested mature and juvenile individuals with very many sprouts and therefore need urgent monitoring (Tuxill & Nabhan, 1998). It therefore is as apparent that the cleared forest area needs urgent attention to allow its recovery.

6.4 Tree species abundance and diversity in SNR

The species area cumulative for the forested and “cleared forest” areas did not reach an asymptote in this study because both sites are still in state of succession (Musimami & McNeilage, 2003). The predominance of secondary tree species (*Psychotria mahonii, Myrianthus holstii* and *Milletia dura)* in the forested area is of paramount importance to its recovery as those are the first few species in the succession of mature forests (Katende et al 1995: Musimami & McNeilage, 2003). Forest succession to ultimate forest depends on a successful invasion of secondary forest by primary forest species (Musimami & McNeilage, 2003). This therefore implies that the forested part of SNR can easily recover to a natural forest if allowed to recover by the

6.5 Large mammals species abundance and diversity in SNR

A part from the Black and white Colobus monkey, all the other 3 types of mammals observed in SNR are listed in the IUCN red list as threatened species. Therefore, this part of SNR is an important forest habitat of important large mammals. The study results has shown that the cleared part of the SNR forest was not observed with any large mammal activity perhaps due to the intense human activities in the cleared part of SNR forest. Results suggest that forest clearing for agricultural activities in SNR has been detrimental to large mammals habitat. Of the four types of large mammals observed in SNR, none was detected in the “cleared forested” area of SNR. This is because of the different human activities in the cleared forested area of SNR but could also be due to hunting by the encroachers living in SNR. The bush pigs and black fronted duikers are favored for their meat by the local people there.

6.6 Bird species diversity and distribution

The fact that the Bwindi and SNR forests harbor a substantial number of Albertine Rift endemics and globally threatened bird species, the study area can be described as a biodiversity hotspot in terms of species rarity both nationally (Howard *et al*. 2000) and within the Albertine Rift (Plumptre *et al.* 2003). Bwindi contiguous with SNR is an Important Bird Area in Uganda (IBA) as noted by Byaruhanga *et al.* 2001. This study recoded 87 bird species of which 15 were Albertine Rift endemics. Despite the SNR having been intensively exploited the forest has considerable high bird species diversity, and contains many bird species of high conservation value, making it rank highly in terms of rarity value (Howard *et al*. 2000) and therefore of high conservation importance.

7.0 Conclusion

Past and present anthropogenic perturbations in Bwindi and SNR have largely played a role in the distributions of tree species in the forest. Almost all the recorded tree species in SNR are majorly secondary forest types that prefer disturbance and more light conditions since they responded by increased regeneration in highly disturbed areas. One potential critique of the this survey is that it was a snapshot in time and space and therefore it is possible that the large mammal taxa populations move around and this could have affected its

recording and observation. This is an issue that arises when short surveys are carried out. However, despite this, a considerable number of bird species were recorded by this study including the Albertine Rift endemics. Overall, we recorded less species of terrestrial large mammals compared with what would have been recorded with robust more surveys. to previous surveys. We therefore cannot attribute the less recording of the large mammals to defaunation by humans or to the failure of conservation efforts by protected area authorities. Nevertheless, this study highlights the high prevalence of human activity in SNR and the effect they could have on the density and distribution of the different Fauna and flora.

8.0 Recommendations

1. There is an urgent need of evicting the Encroachers from SNR. This exercises needs to be carried out urgently to prevent the loss of biodiversity especially the endemic and threatened species that inhabit the SNR. The status of SNR as Nature Reserve needs to be managed efficiently with less human perturbations. Currently, local people have been and continue to heavily exploit the SNR. It is recommended that the Strict Nature Reserve should be protected from all anthropogenic disturbances by marking its boundary so that it is made explicit that no human activities are allowed within. The area should be routinely patrolled to prevent any illegal activities taking place.

2. Protected area officials at SNR should immediately put to an end the homestead constructions, deforestation and cultivation of crops taking place within the reserve. The cleared part of the SNR needs to be actively planted with indigenous tree species while at the same time removing the exotics from the reserve.

3. More specific large mammal studies and inventories need to be carried out in the SNR to access effectively the density and distributions of the large mammal species including the mountain gorillas.

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