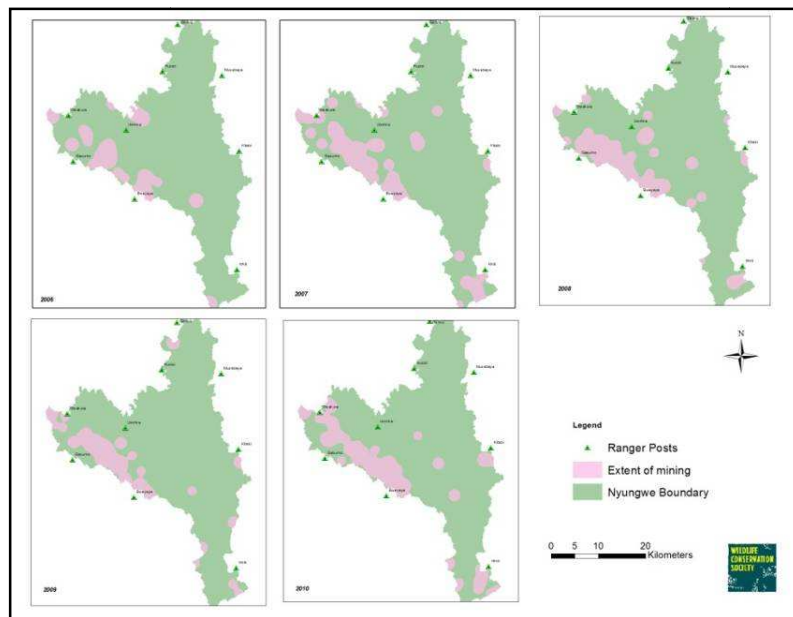


Nyungwe National Park, Rwanda

5-Year Ranger-based Monitoring Comparison Report 2006 to 2010



Produced by: Wildlife Conservation Society, Rwanda Program. Dec 2011.

By Mulindahabi Felix, Aaron Nicholas, Rugerinyange Louis



Acknowledgements

This report was produced with the support of grants from the United State Agency for International Development (USAID) and the Wildlife Conservation Society (WCS). We would further like to thank all the staff of Nyungwe National Park who made invaluable contribution to the accomplishment of this work. To all rangers who collect RBM data day-to-day may find our sincere acknowledgement for their tireless commitments

Acronyms and Abbreviations

ACNR : Association pour la Conservation de la Nature au Rwanda

ADENYA : Association pour le Developpement de NYABIMATA

ANICO: Animateur de Conservation

ARDI : Association Rwandaise de Developpement Integre

DAI: Development Alternatives Incorporated

GIS: Geographical Information System

IUCN: International Union for Conservation of Nature

KNP: Kibira National Park

MIST: Management Information System and Technology

NNP: Nyungwe National Park

ORTPN: Rwanda Office of Tourism and National Parks

PAB: Protected Areas Biodiversity Project

PCFN: The Nyungwe Forest Conservation Project

RBM: Ranger-based monitoring

RDB/TC: Rwanda Development Board/Tourism and Conservation

RS: Revenue Sharing

WCS: Wildlife Conservation Society

Table of Contents

Acknowledgements	ii
Acronyms and Abbreviations	iii
Table of Contents	iv
List of figures.....	vi
Introduction	1
History of threats to biodiversity in Nyungwe National Park.....	1
Management of Nyungwe National Park	4
Law Enforcement Unit	4
Community Conservation Unit.....	6
Partners in the management of Nyungwe.....	7
Part A. Ranger-based monitoring and park management.....	8
Ranger-Based Monitoring background.....	8
Resources.....	8
Training of staff	10
Ranger-Based Monitoring Data collection.....	11
Management Information System and Technology	11
RBM data analysis	12
Distance walked.....	12
Observations and encounter rates for illegal activities	12
RBM information for management of the park	13
Part B. 5-Year findings 2006 to 2010.....	15
Patrol effort- Patrol coverage	15
Patrol effort- Variation in the number of days patrolled over time.....	17
Illegal incidences	19

Current RBM records related to the threats to biodiversity in Nyungwe National Park.....	19
Part C. Summary of major findings	31
Part D. Major recommendations to improve the effectiveness of anti-poaching efforts.....	32
References	34

List of figures

Figure 1. Location of Nyungwe National Park and other National Parks in Rwanda	1
Figure 2. Population density in administrative sectors around Nyungwe National Park (source Rwanda Population census 2002).	3
Figure 3. Location of patrol zones and their respective ranger posts in and around Nyungwe National Park.....	5
Figure 4. Location of some cooperatives and Revenue Sharing supported projects in sectors around Nyungwe National Park from the period from 2006 to 2011.....	7
Figure 5. Organizational chart of human resources involved in the RBM program at park level.....	9
Figure 6. Patrol effort explained by number of kilometres walked and number of patrols (days) each year of monitoring in Nyungwe National for the period from 2006 to 2010. More than one patrol was carried out in one day)	15
Figure 7. Patrol effort explained by area covered in Nyungwe national for the period from 2006 to 2010	16
Figure 8. Patrol Coverage in Nyungwe National Park each year from 2006 to 2010.....	17
Figure 9. Number of patrol days and kilometer walked in Nyungwe National Park for each year of Ranger-based monitoring (N=5 years)	18
Figure 10. Number of patrol days and kilometers walked per month from 2006-2010 (N= 60 months) ..	18
Figure 11. Encounter rates of all illegal activities per kilometer in Nyungwe National Park for the period from 2006 to 2010 (Mean = 0.061/km).....	19
Figure 12. Mean values of Encounter rates per kilometer walked of illegal activities in NNP (5 years from 2006 – 2010)	20
Figure 13. Number of kilometer and encounter rates of illegal activities kilometer in Nyungwe National Park for the period from 2006 to 2010	21
Figure 14. Number of days and encounter rates of illegal activities per kilometer patrolled in Nyungwe National Park for the period from 2006 to 2010	22
Figure 15. Encounter rates of snares, tree cutting, beehives and mining per kilometer in Nyungwe National Park.....	23
Figure 16. Number of poaching incidents per effort (kilometer walked) each month of five years from 2006 to 2010 in Nyungwe National Park (correlation coefficient of 0.49788 N=60 months)	23

Figure 17. Spatial distribution of snares in NNP for the period from 2006 to 2010	24
Figure 18. Encounter rates of mining per kilometer in Nyungwe national Park for the period of 5 years (N=711)	26
Figure 19. Extent of gold mining in Nyungwe National Park in five years (2006 - 2010)	27
Figure 20. Encounter rates of beehives per kilometer removed in NNP in the period of 5 years (N=1325)	28
Figure 21. Encounter rates of wildfires, encroachment and livestock per kilometer in NNP for the period of 5 years (N=119 fire incidences, 646 signs of livestock, and 129 observation of encroachment)	29
Figure 22. Encounter rates of people, medicinal plant and mushroom per kilometer walked in Nyungwe National Park from 2006 to 2010.....	30

Introduction

The Nyungwe National Park (NNP) represents an excellent example of Congo-Nile Afrotropical forest. The Nyungwe ecosystem is part of the Albertine Rift Afrotropical forest and constitutes an important habitat of very high biodiversity value in terms of endemic and range-restricted species. The forests of the Albertine Rift shelter a number of IUCN categorized rare, vulnerable and endangered species such as the Golden monkey and Mountain Gorilla in the Volcanoes National Park, and Eastern chimpanzee, Owl-faced monkey, L'hoest's monkey, Grauer's Rush Warbler in Nyungwe National Park (NNP). The NNP is the largest conservation area in the country.

NNP is situated in the hills of southwestern Rwanda (Musabe 2002) (Figure 1) between a latitude of 2°15' and 2°55'South and longitude 29°00' and 29°30'East and at an altitude of between 1,600 m and 2,950 m (Plumptre et al. 2002). The forest is contiguous with the Kibira National Park in Burundi (Budowski 1975) forming one of the largest blocks of lower montane forest in Africa (Weber, 1989; Dowsett, 1990; Vedder, 2002). Nyungwe forest is recognized internationally for its role in the conservation of many animal species, particularly birds, primates, and some invertebrates despite the fact that this particular fauna (invertebrates) is not yet well studied (Kanyambwa, 1992).

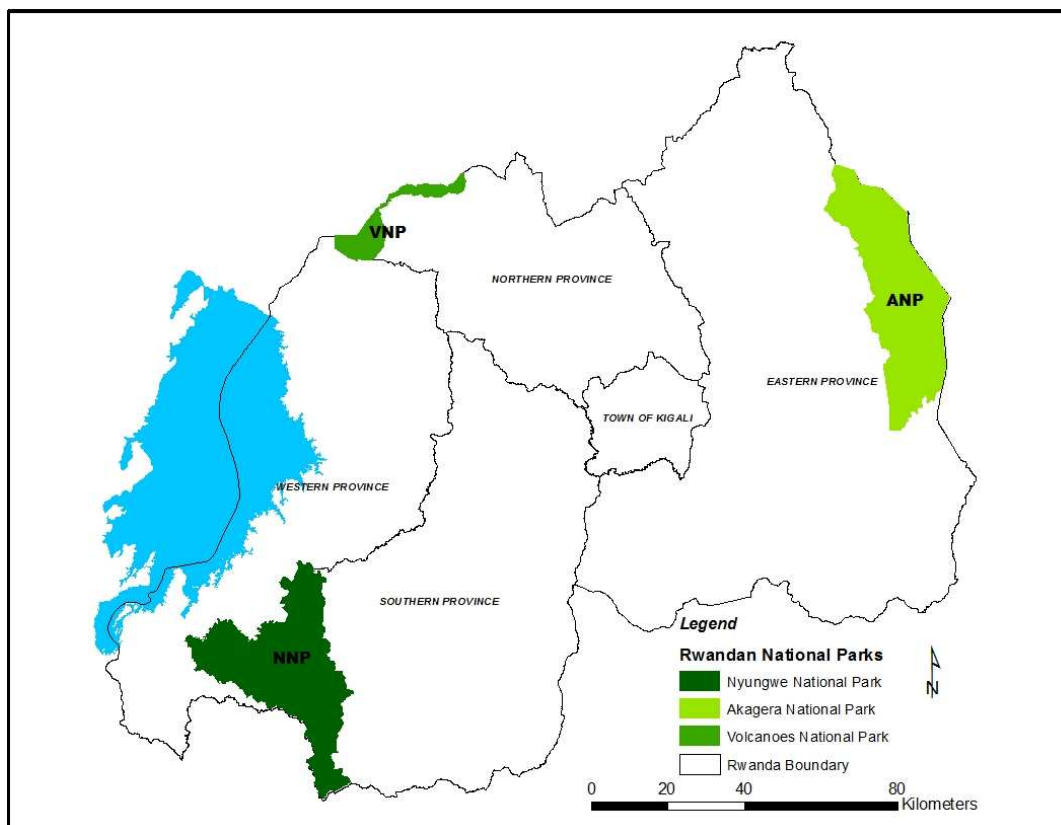


Figure 1. Location of Nyungwe National Park and other National Parks in Rwanda

History of threats to biodiversity in Nyungwe National Park

Like in any other forest in Rwanda, communities living in and around the Nyungwe forest have always relied on the forest as a source of subsistence, providing goods such as wood, food, medicines,

construction materials and tools. Only the indigenous hunter-gatherers lived within and survived entirely from the forest, whilst pastoralists and small scale farmers converted forest habitat to farmland (Newbury, 2001). At the beginning of the 20th century, parts of the forest were cleared for farmland including tea plantations and the discovery of gold in the 1930s led to establishment of villages such as Pindura and Karamba inside the park. Up until the early 1990s, more than 3,000 people were permanently living in the park (Kristensen & Fimbel (1994). An area of ~1,000/ha/year was lost to various illegal activities between 1958 and 1973 (Gapusi, 2007).

Threats to the biodiversity of Nyungwe are, in most cases, the results of human activities driven by dependency on park resources by community surrounding the park (Masozera, 2002). Communities around Nyungwe national park are primarily subsistence agriculturists (Gapusi, 2007; Plumptre, 2004; Masozera, 2002). The dependency on natural resources can be explained by the low agriculture income, limited access to job opportunities and large size of local households, among other things. The human population density around NNP is among the highest in Rwanda with a range of 250 to 500 people/km² (Gapusi, 2007) (Figure 2). A high percentage of the people living near NNP live in poverty characterized mainly by lower education levels, large family members, poor housing, limited access to basic infrastructure, shortage of land and limited food production (Plumptre et al., 2004). The average size of households around Nyungwe is over 6 people per household (Masozera, 2002).

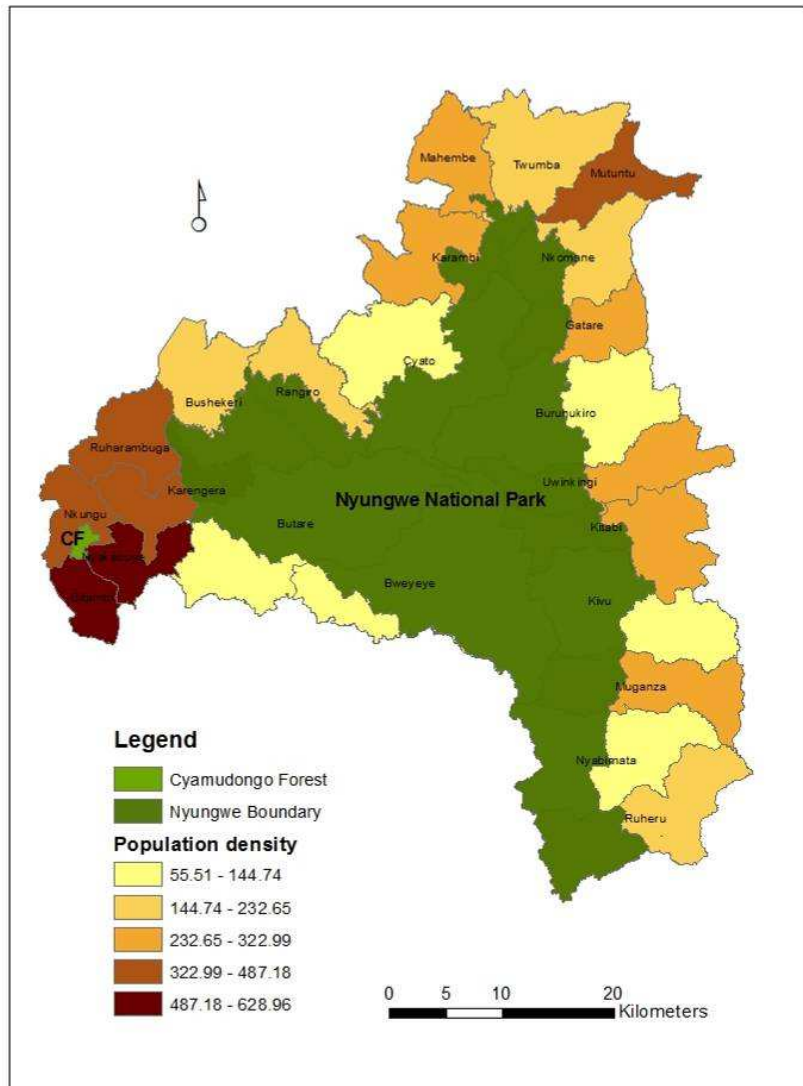


Figure 2. Population density in administrative sectors around Nyungwe National Park (source Rwanda Population census 2002).

The impact of human activities on the park resources can take the form of a decrease or depression of animal or plant populations, local disappearance of species, habitat degradation and damage to plant species. In Nyungwe, poaching has led to the local extinction of large animals such as the African Buffalo (*Syncerus caffer*) and African Elephant (*Loxodonta africana*) and has significantly reduced the population of duiker species and indirectly affected carnivorous species. Crop raiding by animals (in most cases primate species) is the major source of human wildlife conflict in Nyungwe National Park.

Nearly 13,000ha (about 12% of the park) was lost to wildfires during 5 year the period from 1997 to 2003. These fires completely removed above-ground vegetation and led to the invasion of ground ferns (*Pteridium* sp.). Today, bamboo (*Arundinaria alpina*) continues to be illegally harvested for the production of baskets and light furniture and bamboo resources within the park are being used at an

unsustainable level. In the study on socio-economic of bamboo cutting and its impact on Owl-faced monkey (Ndayisaba, 2009) countered 1396 bamboo stems (199 bamboo/km) cut along 7 kilometers



Objects (baskets and ceiling roof (left) and spits (right)) made from bamboo are readily sold in local market. 'Spits' present a new source of income and their production from NNP bamboo is increasingly apparent in the Nshili area. (Photos by RDB).

Management of Nyungwe National Park

A major restructuring process aimed at transforming the Rwanda Development Board (RDB/TC)-formally the Rwanda Office of Tourism and National Parks (ORTPN)- into an effective and efficient conservation institution has been ongoing since 2002. As results, the organizational structure of NNP management is composed of five units or departments, which include: Monitoring and Research, Tourism Management, Community Conservation, Law Enforcement, Veterinary unit, and a Finance and Administration unit. The number of staff has increased over time from 30 staff in 2002 to 120 staffs to date and more specifically from 18 rangers to 70 park rangers over the same time period.

Law Enforcement Unit

The responsibility of the Law Enforcement Warden is to ensure that the park and its biodiversity is protected and maintained. He is responsible for overseeing the work of the 70 park rangers who operate out of 10 ranger posts in 3 patrol zones in and around Nyungwe National Park (Figure 3). Head Rangers for each zone are not yet recognized in the RDB organization chart though they operate under the supervision of the Law Enforcement Warden. The Law Enforcement Warden coordinates daily surveillance and law enforcement activities in Nyungwe National Park. One ranger controls an area of approximately 1,455.71 ha. The staff number is reasonable enough to ensure protection of Nyungwe National Park if we consider the global average of park field staff per 1000 km² being 27 (GRAY and KALPERS, 2004).

Location of Ranger Posts around NNP

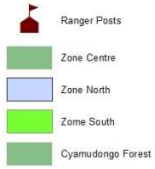
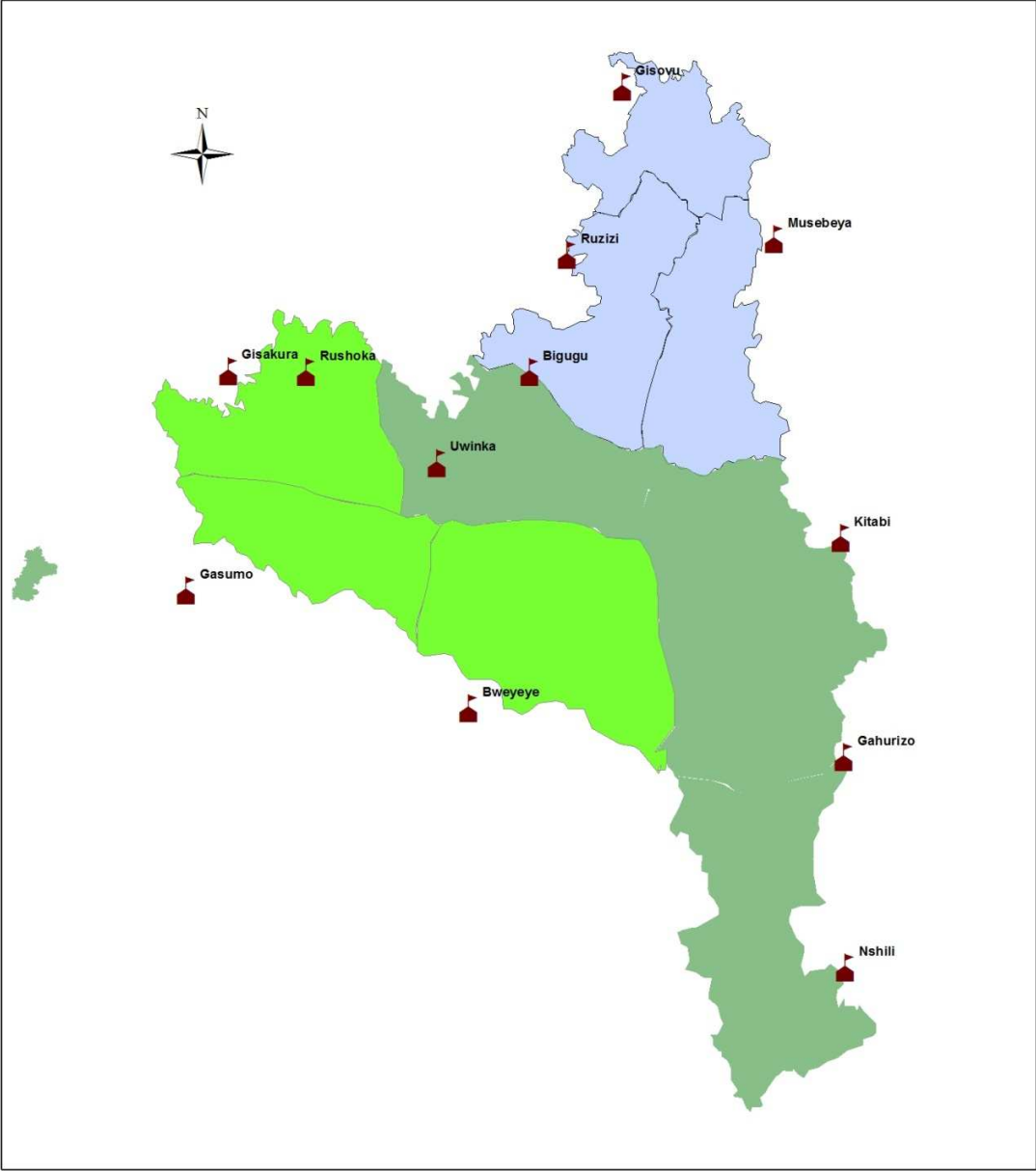


Figure 3. Location of patrol zones and their respective ranger posts in and around Nyungwe National Park

Community Conservation Unit

Community Conservation Unit in NNP is headed by 3 Community Conservation Wardens. The objective of community conservation program is “To ensure the active and effective involvement in conservation activities of local communities neighboring protected areas” (ORTPN, 2005).

The unit provides a link between the NNP and local communities with the aim of optimizing collaboration with local populations for improved park management and to foster good relations. The unit liaises with different conservation and development NGOs and local government officials to identify and fund needed income generating projects- especially those that are directly related to solving a conservation problem while improving the welfare of the people. A ‘Revenue Sharing (RS)’ program was established by RDB (formally ORTPN) in 2005 and has funded at least 40 projects around Nyungwe National Park. The goal of the revenue sharing program is to “ensure the sustainable conservation of the National Parks with the participation of the neighboring communities by contributing to the improvement of their living conditions” (ORTPN, 2005).

One of three major objectives identified for the RS Program is related to establishing “Conservation impact objectives”. This is aimed at reducing illegal activities; to ensure sustainable conservation; and to increase community responsibility for conservation. Since the community conservation unit was established, at least 18 (78.26%) administrative sectors have benefitted from RS. Thirty four cooperatives of which 14 are bee-keeping, 2 are handcraft making, 2 are community tourism, 5 are small livestock keeping, 4 are trail maintenance (temporarily work with RDB for trail maintenance), 1 pottery and 1 brick making are now involved in conservation linked activities around Nyungwe National park (Figure 4). For example, 1,371 bee-keepers and 217 ex-poachers are formed cooperatives and funded to reduce bushfires and poaching on Nyungwe resources.

funded to develop tourism related activities with the financial support of USAID. Other partners include a number of local associations (ADENYA, ACNR, ARDI etc) which focus on community development.

Part A. Ranger-based monitoring and park management

Ranger-Based Monitoring background

The Ranger-based monitoring (RBM) system relies on data collected by park rangers whose primary focus is law enforcement (Gray and Kalpers, 2004). Ranger-based monitoring was designed so that data are collected on a routine basis by park rangers as they patrol the park. This information is then used to guide the day-to-day management of the park.

In Rwanda, RBM was first introduced in 1997 in Volcanoes National Park (VNP) (Gray and Kalpers, 2004) and later in 2003 in Nyungwe National Park. The Wildlife Conservation Society (WCS) introduced RBM to NNP, establishing basic protocols for data collection and established a Management Information System and Technology (MIST GIS) to manage RBM data. RBM program is a key management tool for park authorities in such way it provides accurate and timely information to park managers. Since RBM was introduced in Nyungwe in 2003, it has enabled the gathering of extensive information on illegal activities and information on key wildlife species from often remote areas and at effective costs. It has provided park managers with information that prompts appropriate responses to threats within the park. The information is used at various park management levels including but not limited to park rangers, researchers, local authorities and higher level of park management for planning management actions related to protection, tourism, community conservation etc.

The park rangers are increasingly using the results of previous months patrol activities to plan and deploy new patrols. RBM is also being used to locate sites for the construction of new patrol posts.

Until the introduction of RBM in Nyungwe, patrol records were sporadic and disorganized and not presented to park managers in a clear and meaningful way.

The main characteristics of RBM are:

- i. a system making full use of the presence of rangers in the forest, without increasing their workload;
- ii. a system for data collection in a systematic and organized way with limited funds;
- iii. a system using basic observations that aims to detect broad trends within the ecosystem.

Resources

Headed by Law Enforcement Warden and his assistants (head of zones), there are at least 70 (60% of park human resources) rangers deployed and operationally based in 10 ranger posts (Figure 5). Each ranger post is headed by a 'Ranger Post Head' who is in-turn under the supervision of a Zone Coordinator. (Neither Ranger Post Head nor Zone Coordinator position is recognized under the present

organizational structure). Ranger posts were established in and around the park boundary for best patrol coverage. Park rangers are equipped with standardized data sheets that are systematically filled out by patrol rangers on routine patrols.

The rangers are also equipped with hand held Global Positioning System (GPS) to gather more specific geo-referenced data on the locations of illegal activities and/or key animal species. This enables the calculation of encounter rates of illegal activities and wildlife observations and distance covered on patrol, and data that can be mapped.

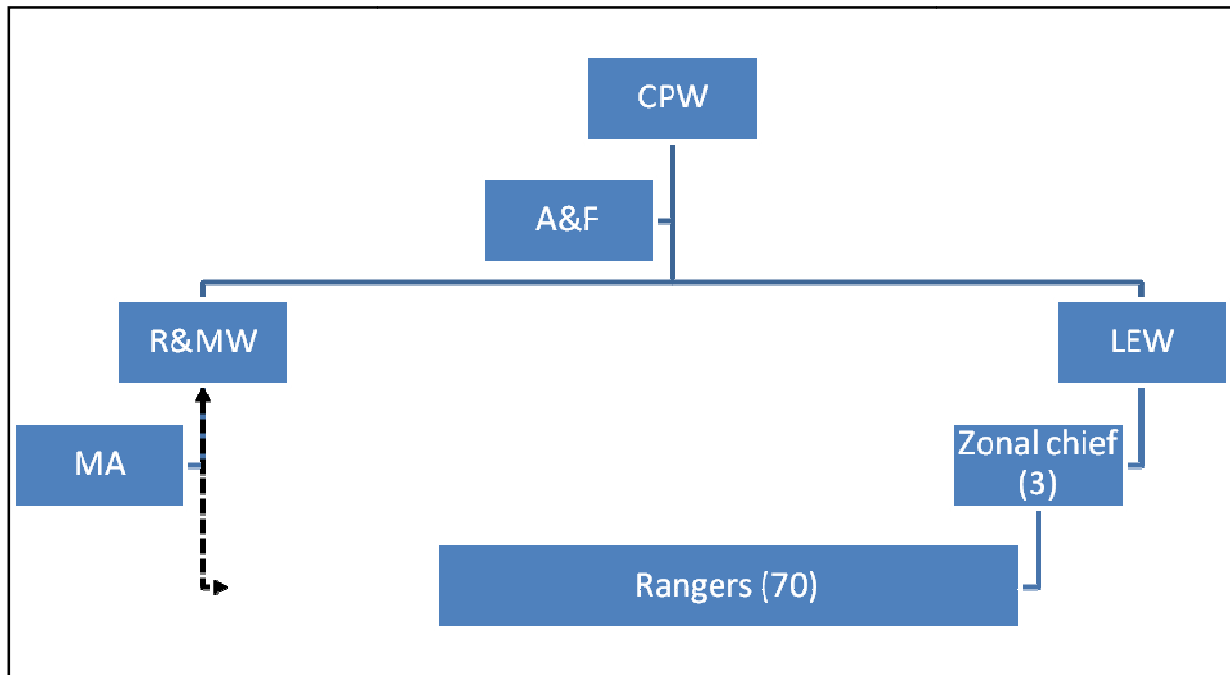


Figure 5. Organizational chart of human resources involved in the RBM program at park level.

Key: Chief Park Warden (CPW), Admin and Finance Officer (A&F), Research and Monitoring Warden (R&MW), Law Enforcement Warden (LEW), and Monitoring Agent (MA).

The role of Park management level in Ranger-based Monitoring

❖ Rangers

- Patrol planning and deployment on daily basis;
- RBM data collection on daily basis;
- Taking care on data collection equipment (GPS, datasheet etc.).

❖ Chief of zones

- Patrol planning and supervision;
- Data download from GPS;
- Data entry and cleaning;
- Replication and data transfer using modem to Research and Monitoring Warden;

- Production of preliminary report and map and use results for planning activities of following month;
- Provide feedback of patrol performance to rangers;
- Distribution and collection of datasheets and batteries to ranger posts.
- ❖ **Monitoring Agent**
- Supervision and practical training in data collection (zones and patrol post) at least one camping with one ranger post each month;
- Provide feedback on patrol performance to rangers;
- Ensure datasheet and batteries reaches rangers in time;
- Insure datasheets are collected from zones to HQ after data entry;
- Active involvement in monthly planning with Zone heads;
- Database maintenance.
- ❖ **Law Enforcement Warden**
- Oversight of park protection planning at park level;
- Supervision and ensure compliance with RBM data collection protocols;
- Provide feedback on patrol performance to rangers.
- ❖ **Research and Monitoring Warden**
- Data analysis and produce report for the whole park;
- RBM information sharing among department through monthly reports;
- Quarterly report and information sharing to key partners;
- Maintenance of central MIST database including MIST replication from patrol zones;
- Monthly planning at park and zone level.
- ❖ **Financial & Administration Officer**
- In relation with RBM, the financial and administration officer is responsible for handling of all financial and human resource issues in NNP.
- ❖ **Chief Park Warden**
- Based at Kitabi head quarters, the Chief Warden (CW) is responsible for the management of the park. He oversees day-to-day activities in NNP and coordinates all Wardens and their activities in the park.

Training of staff

The Wildlife Conservation Society (WCS) and the management of the park have organized the training of park staff at 2 levels: data management level and data collection level:

Data collection level: Key rangers from each patrol post were trained in techniques of data collection for monitoring, and in the use of data collection equipment. Trained personnel act as trainers and also train their colleagues. Refresher training courses are also organized on a yearly basis and are considered as essential in terms of maintaining compliance with data collection protocols.

Data management level: Senior staff in charge of research and monitoring compiles the data into monthly or quarterly reports and field maps. At least 9 park staff including those in charge of Research and Monitoring and Zonal Chiefs have received training on GIS for RBM data analysis and the production

of basic reports. Data is analyzed regularly to determine the levels of threats to various parts of the park, and observations of large mammals are also reviewed. The results are then compared to previous months, quarters and years to analyze longer term trends.

Ranger-Based Monitoring Data collection

Park rangers collect a range of information on major illegal activities/human signs and key animal species in the park. Major illegal activities in NNP include animal poaching, bush fires, tree felling, artisanal mining, park encroachment for agriculture and illegal entry into the park. Key animal species include species of conservation importance, animal species which can be easily seen and easy for identification such as all diurnal primate species, all duiker species, bushpig and 4 species of birds (Great Blue Turaco (*Corythaeola critata*), Black-billed Turaco (*Tauraco schouetti*), Rwenzori Turaco (*Tauraco johnstoni*), and Black-and-White-casqued Hornbill (*Bycanistes subsylindricus*)).

The observation recorded by rangers are either direct (such as poacher arrested or snare removed and animal species seen) or indirect (such as animal species heard, dung of bushpig, signs of mining, signs of tree/bamboo cutting) etc.

For each observation, the type of observation are also recorded such as animal seen, heard or trace found. Observations on illegal activities are categorized as new/active for those that are quite fresh (less than one month), recent (less than 3 months) and old (older than 3 months). Fires are ranked as fires of more than 1 ha or fires of less than 1 ha (area destroyed was either greater or less than 1 ha). In addition to direct and indirect observations, rangers also record GPS coordinates for each observation to facilitate estimation of the patrol effort (distance walked) and to map the geographical distribution of illegal activities and key animals in the park. Whenever rangers walk 30 minutes with no observation, they recorded a geographical position.

Management Information System and Technology

Management Information System and Technology (MIST GIS) is an easy to use, flexible and powerful tool which gives managers access to information for protected area management. It is user friendly- it can be completely controlled by clicking on map items, page tabs, list entries and buttons of the MIST query wizards. Additional visual tools enable advanced users to create any kind of query not included in the custom-made wizards. Fast and accurate data entry in MIST GIS is guaranteed through data download from GPS units (Global Positioning System) and the use of look-up tables and wizards for data entry. Using RBM data in MIST, it is possible to draw the route followed by the ranger for any specific patrol and overlay all waypoints recorded, estimate the patrol effort (days and kilometer walked) etc. MIST draws the ranger's patrol routes by linking the waypoints belonging to a single patrol following their chronological order.

MIST GIS was designed to provide various reports:

- Patrol coverage maps showing areas patrolled in grid cells and percentage of park area patrolled;

- Illegal activities reports and distribution maps with indices (observation per kilometer) and numbers, maps showing the spatial distribution of illegal activities;
- Key animal species reports and distribution maps providing indices, numbers and the maps showing the spatial distribution of key wildlife species.

RBM data analysis

Distance walked

Distance walked is used to capture patrol effort in terms of detecting illegal activities and key animal species. Encounter rates per kilometer walked are used to express the frequency at which these observations are made- representing an abundance index of illegal activities and key animal species in the park. MIST GIS is used to generate distance walked (patrol effort) and illegal activities observed for the whole park and when plotted against patrol effort generates an abundance for illegal activities. MIST GIS has some mapping limitations and so is used in conjunction with ArcMap 9.3 to generate illustrative maps, and to estimate intensity of patrol coverage over time.

Observations and encounter rates for illegal activities

The information on illegal activities is currently collected in various ways. Patrol teams report their findings in terms of observations. Fire observation is characterized as one of two categories: “fire greater than 1 ha” and “fire less than 1 ha”. Agriculture is recorded in one of three categories: “abandoned cropland”, “active cropland”, and “marijuana”. Fire and agriculture when recorded have their locations and extents marked/estimated. The location of snares, signs of mining, signs of tree cutting, beehives, signs of livestock, mushroom and medicinal plant collection are also located using the GPS, counted and recorded. Additionally, observations are coded according to three different levels; “active”, “recent” and “old”. As we are primarily interested in what the current activities in the park are, we tend to only consider observations coded as “active” and “recent”. However, in the following 5-year analysis we have included also observations coded as being “old” for snares (wire and nylon), beehives, and poaching camps (hut) because they may still indicate ongoing illegal activity presence within the park.

GPS locations have been downloaded to a computer in a Management Information System (MIST GIS) and observations recorded in it. Illegal activities are grouped in 10 “general codes” and 26 “observation codes” (Table 1) following the relatedness of observation codes and general codes. Abundance of illegal activities has been measured by patrol effort expressed in this report as the number of kilometers walked in the park when on patrol. Encounter rates are expressed as the number of observations per kilometer walked.

Table 1.A summary table of general code and observation code

General code	Observation code
Beehives	Beehives
Encroachment	Marijuana
	Cropland
Fire	Fire <1Ha
	Fire > 1Ha
Mushroom	Sign of mushroom collection
Livestock	Sign of fodder collection
	Sign of livestock grazing
	Cattle traffic
Medicine	Ecorse
Mining	People arrested while mining
	Signs of mining
Person	Agriculture
	People arrested while cutting trees
	Pedestrian
Poaching	Animal carcass
	Poaching camp (hut)
	Poacher seen or arrested
	Snare made in nylon
	Snare made in wire
	Hole dug to trap animals
Tree cutting	Signs of bamboo cutting
	Signs of firewood collection
	Signs of small tree cutting
	Signs of sawmill
	Signs of tree burned/cut/wounded for honey collection

We used a “general code column” to create a summary of the mean number of observations for each month and each year and then the mean was divided by the number of kilometers walked in each month of each year to calculate encounter rates for different observations per kilometer walked. We also used a correlation index (statistical package in excel) to evaluate the number of snares (poaching signs) and patrol effort (number of kilometer and number of days on patrol).

RBM information for management of the park

Like any monitoring information, RBM information is only relevant to the management of the park if it is used in appropriate ways. Currently, RBM information is used for management of the park at three different levels:

- (i) The summaries and maps generated from RBM data are presented monthly through meetings between the Chief Wardens and all park departments including heads of zones and patrol post

heads who discuss results and together plan for the most appropriate management decisions. Rangers therefore use RBM data to plan the deployment of patrols;

- (ii) Information from RBM is also shared through meetings and workshops with illegal resources users such as ex-poachers, beekeepers or honey collectors. It is also used for training and sensitization;
- (iii) The results from RBM are shared with administrative local leaders through Joint Action Forum (JAF), partners and *Animateur de Conservation* (ANICO) through meeting and workshops on a 6-monthly basis. In these meetings, participants share information and commit to working together in different practical ways to alleviate various park threats.

Part B. 5-Year findings 2006 to 2010

Patrol effort- Patrol coverage

The total number of patrol days was 8,410 days/patrols with an annual average of 1,682 days or 140.16 days/month on average. The cumulative number of patrol kilometres walked in the park was 31,687.9 kilometres (an average of 528.09 Km/month or 6,337.17 kilometres/ year) (Figure 6).

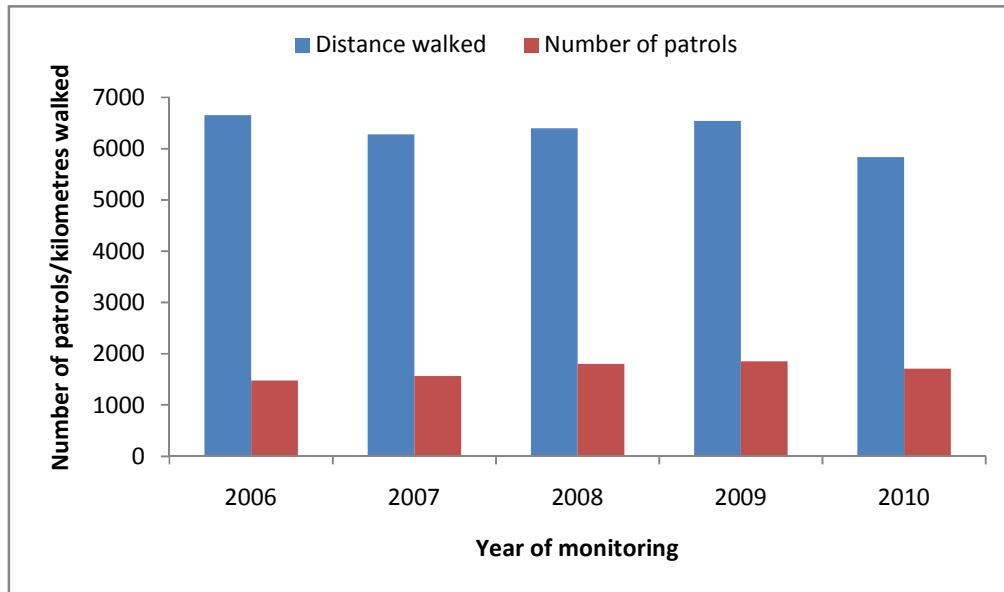


Figure 6. Patrol effort explained by number of kilometres walked and number of patrols (days) each year of monitoring in Nyungwe National for the period from 2006 to 2010. More than one patrol was carried out in one day)

In terms of the amount of the park covered by patrols, in 2007 ~46.9% of the park benefited from patrol coverage, rising to ~59.5% in 2010 (Figure 7).

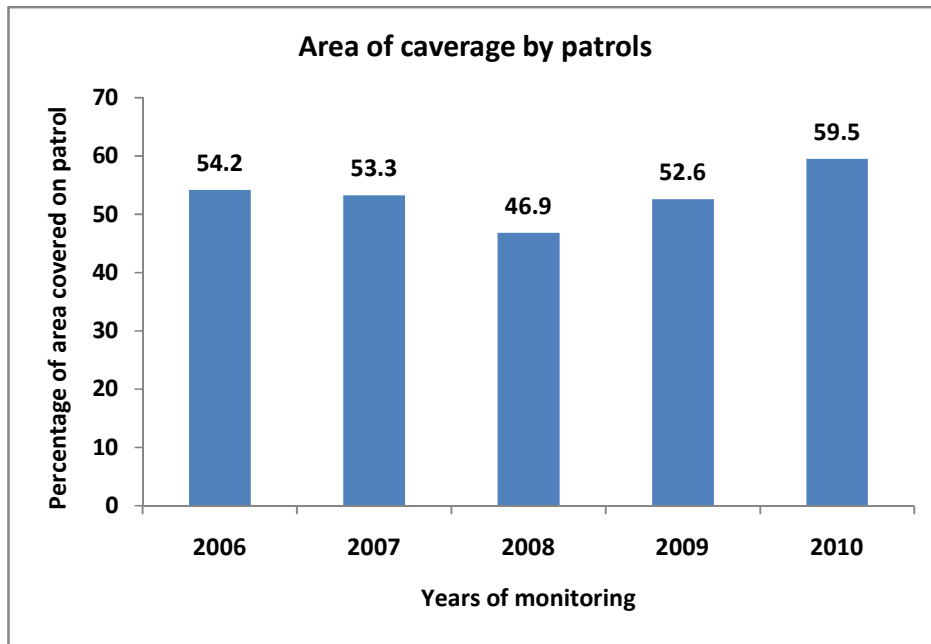


Figure 7. Patrol effort explained by area covered in Nyungwe national for the period from 2006 to 2010

Figure 8 illustrates how patrol effort was spatially distributed over the period of 5 years. The western and northern parts of the park were well covered in all years. In contrast, the central part of the park was poorly patrolled for all years. Patrol coverage was increasingly extended to new areas in 2010. The frequency of patrols in different areas was influenced by roads, existing pathways, tourism trail systems and by the location of ranger post; unsurprisingly, areas closer to ranger posts received more patrols than those areas which are far from ranger posts.

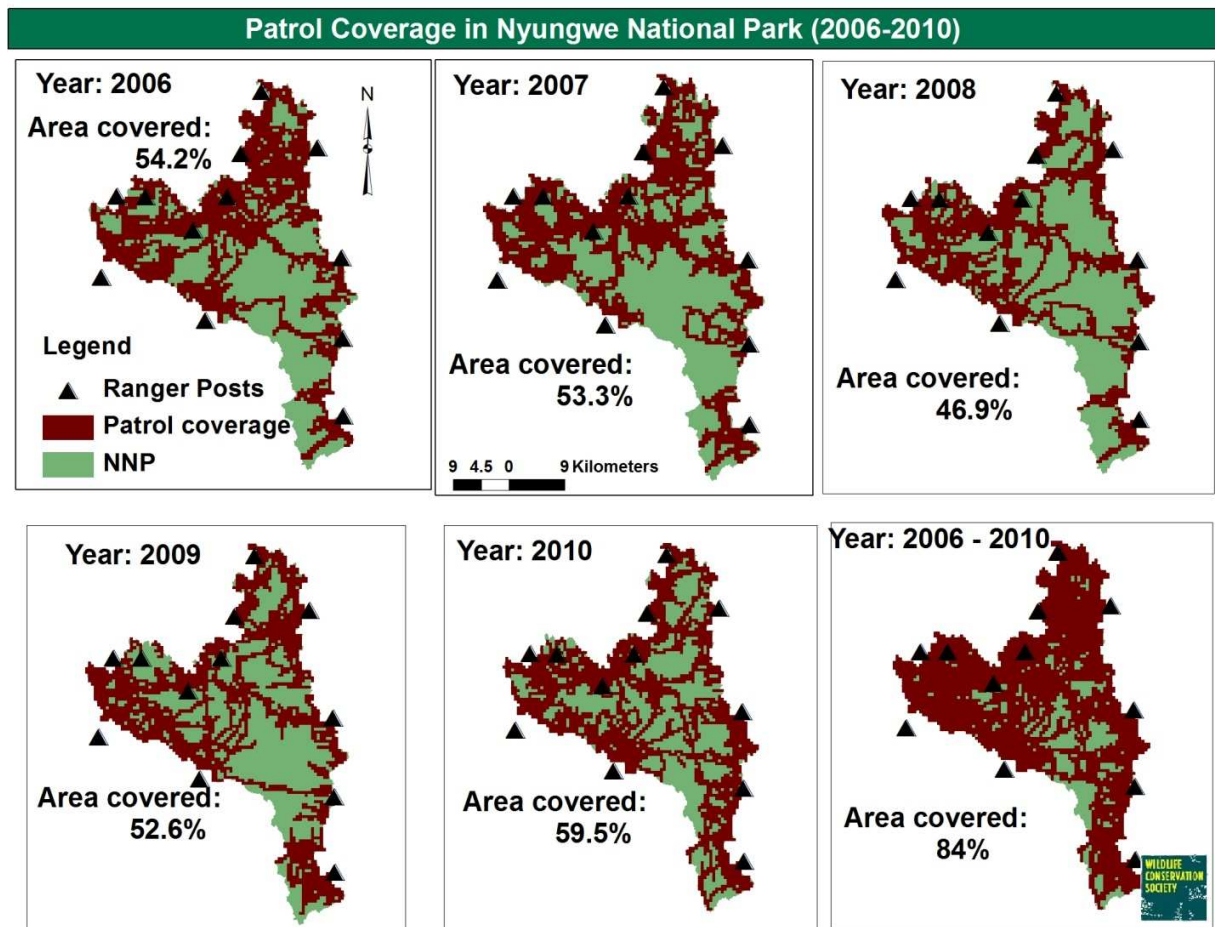


Figure 8. Patrol Coverage in Nyungwe National Park each year from 2006 to 2010

Patrol effort- Variation in the number of days patrolled over time

The number of days and number of kilometer patrolled are presented in Figures 9 and 10. An overall decline in number of kilometers walked can be seen in 2010. The number of kilometer covered was less in 2010 but roughly the same as for years 2006 to 2009. This may be attributed to the increased effort made to search new, less accessible areas which had not been visited in previous years. In contrast, the number of days spent on patrol remained almost the same throughout the five years. The number of days positively correlated (75.9%) with the number of kilometers walked during the 5 year period. (Figure 9).

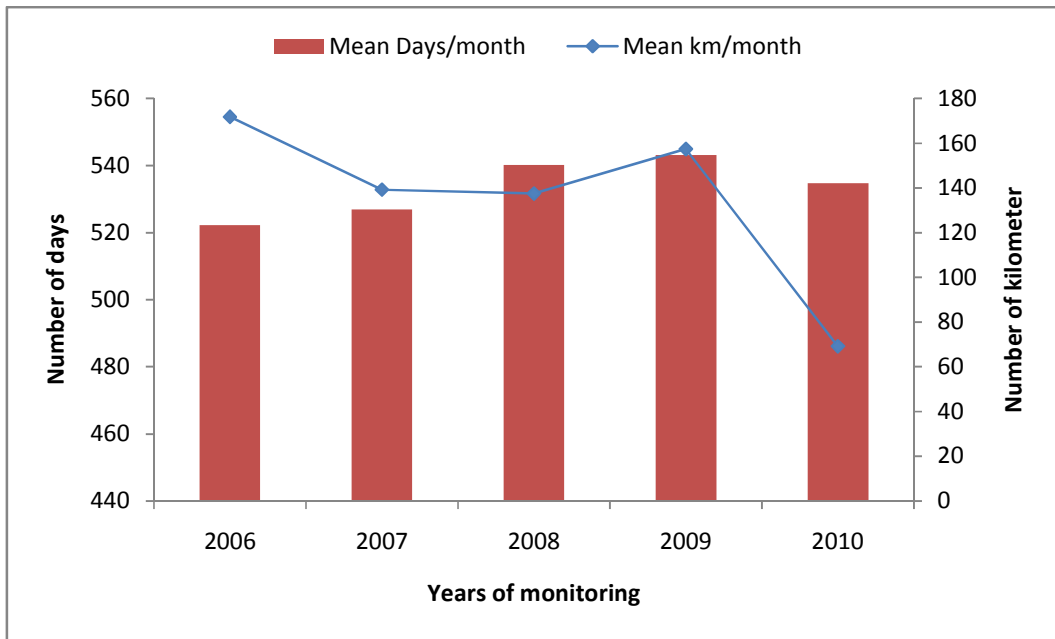


Figure 9. Number of patrol days and kilometer walked in Nyungwe National Park for each year of Ranger-based monitoring (N=5 years)

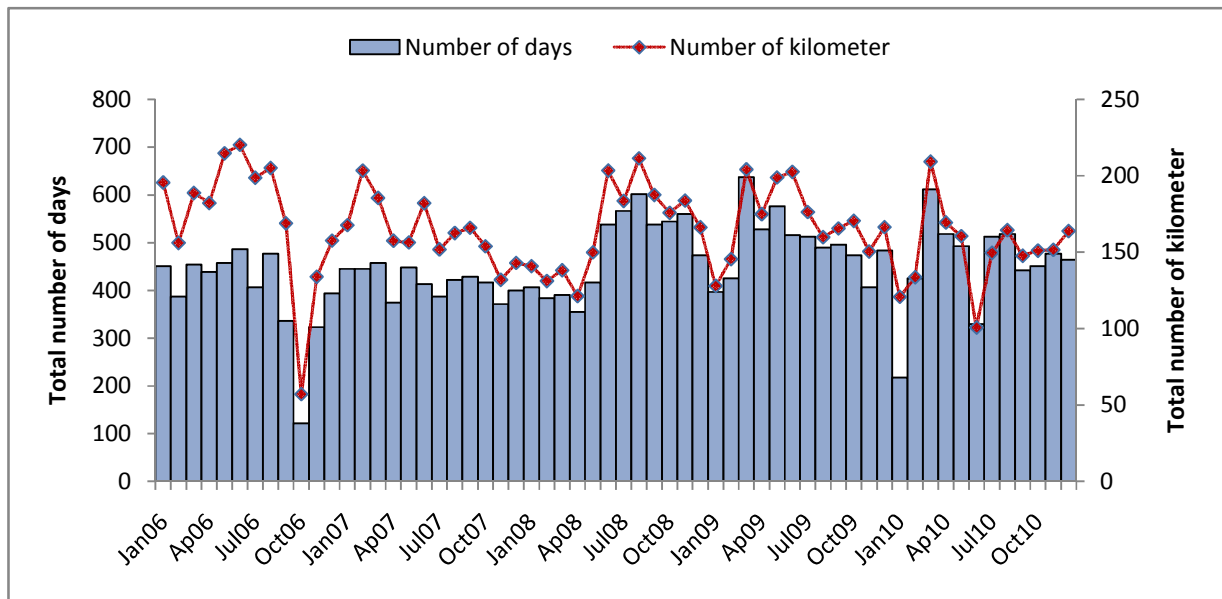


Figure 10. Number of patrol days and kilometers walked per month from 2006-2010 (N= 60 months)

Illegal incidences

Current RBM records related to the threats to biodiversity in Nyungwe National Park

Today, threats to Nyungwe include poaching, tree harvesting for firewood and house construction, bamboo harvesting for housing and basket weaving, artisanal mining. When combined with the lack of alternative income-generating opportunities, these activities all contribute to the ongoing exploitation of the forest resources.

The results from Ranger-based Monitoring covering 5 year period from January 2006 to December 2010 show that encounter rates for illegal activities varied from an average of 0.045/km the lowest (2007) to 0.088/km the highest (2010) with a mean of 0.061 signs/km walked (Figure 11). The overall, the encounter rate for illegal activities as whole has increased between 2006 and 2010 by roughly 12%.

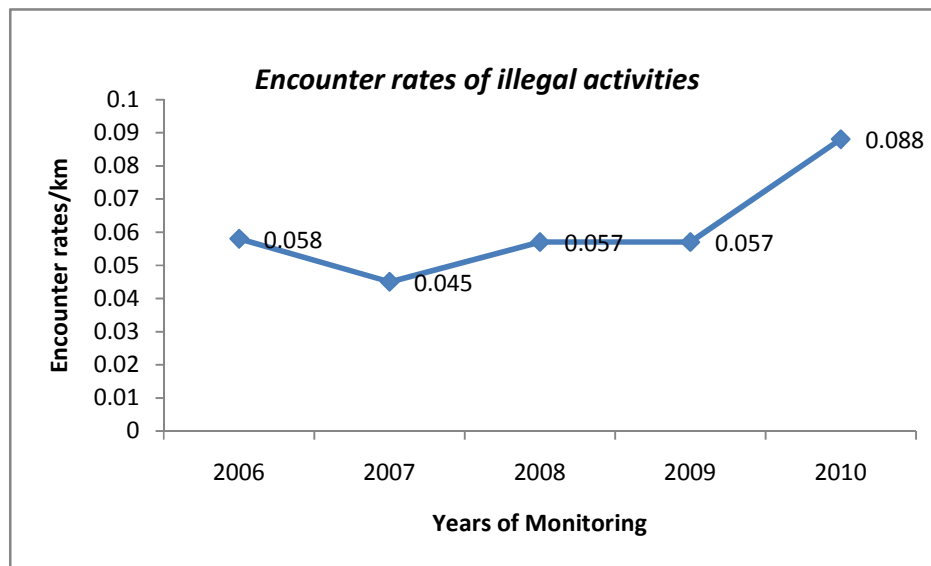


Figure 11. Encounter rates of all illegal activities per kilometer in Nyungwe National Park for the period from 2006 to 2010 (Mean = 0.061/km)

The major threats encountered for this period were animal poaching (62.34% of all illegal activities recorded), tree harvesting (20.87%), placing beehives in the park (7.01%), mining (gold and coltan) (3.76%), livestock grazing (3.32%), and wildfires. Encounter rates varied between illegal activities- poaching had an average of 0.372/km, tree cutting 0.131/km and mining 0.04/km walked (Figure 12). Illegal hunting in the Nyungwe National Park is dramatically higher than any other threats recorded throughout this period. Encroachment, medicinal plant and mushroom collection were present at very low encounter rates per kilometer walked.

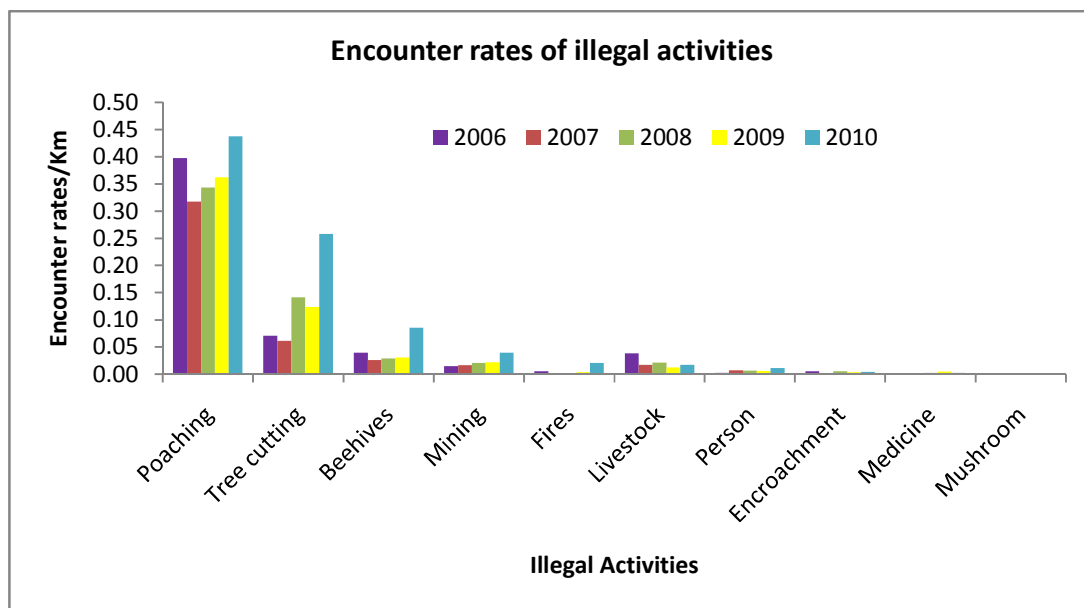


Figure 12. Mean values of Encounter rates per kilometer walked of illegal activities in NNP (5 years from 2006 – 2010)

Figures 13 and 14 show the results of plotting overall encounter rates of illegal activities against the total number of kilometers walked and total number of days for each month (60 months in 5 years) using a coefficient of correlation. There is a weak positive correlation in both number of days, number of kilometers walked and encounter rates of illegal activities. The coefficient correlation (27.37%) between the encounter rates of illegal activities and number of days was higher than the coefficient correlation (16.56%) between the number of kilometer patrolled and encounter rates for illegal activities. This may indicate that the number of kilometers walked is dependent on accessibility for patrols- days spent in areas of poor access may yield more illegal activities per km patrolled, although the overall distances will be less.

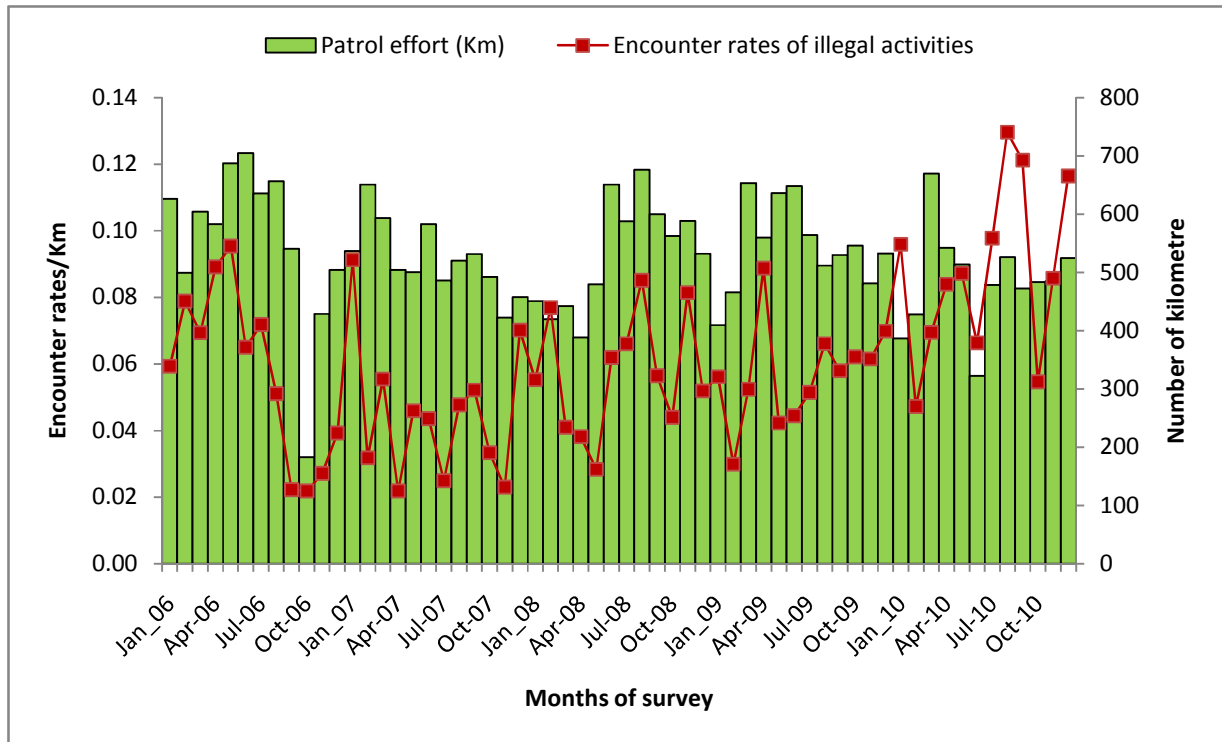


Figure 13. Number of kilometer and encounter rates of illegal activities kilometer in Nyungwe National Park for the period from 2006 to 2010

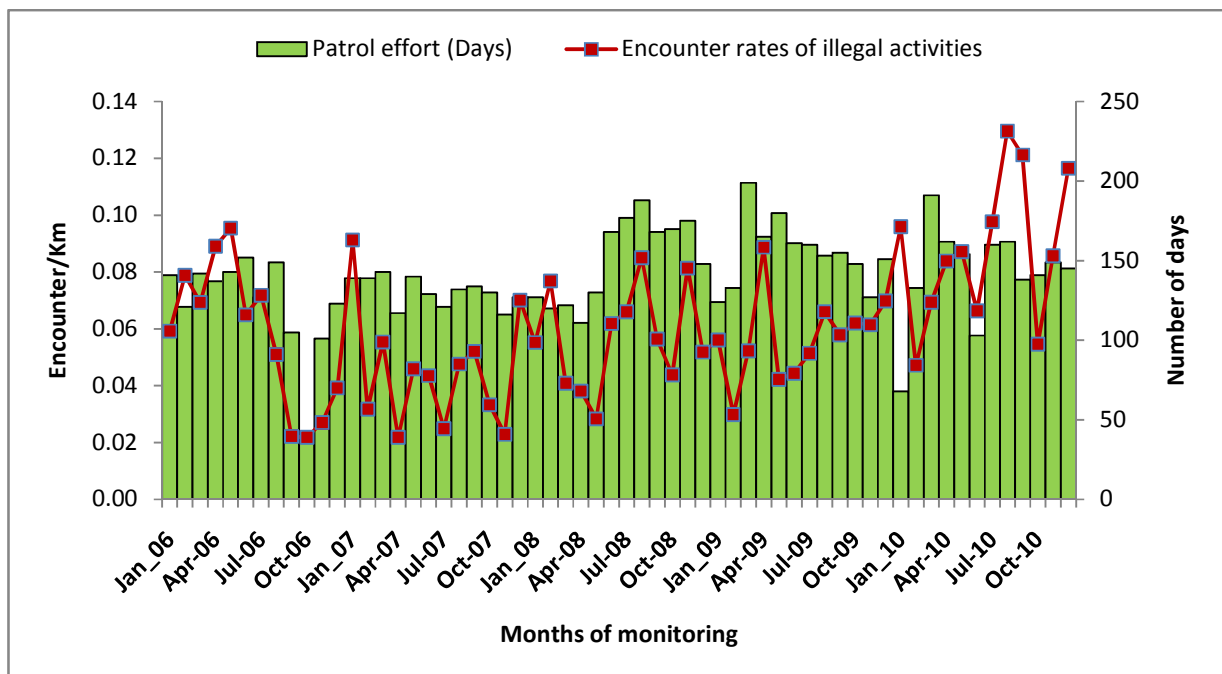


Figure 14. Number of days and encounter rates of illegal activities per kilometer patrolled in Nyungwe National Park for the period from 2006 to 2010

Poaching

Poaching is mostly carried out using traditional methods, either with spears or snares targeting large to small sized mammals and/or ground dwelling birds such as francolins. Poaching is still believed to be carried out mainly for subsistence needs although there is evidence that it is sometimes also commercial in nature- serving local markets. The devastating effect of poaching is evident through the low abundances of medium and large-bodied mammals in the park. During this period, at least 11,180 snares (mostly wire and nylon) were removed (average of 2,236 snare per/year and 183.22 snares per/month) with an average encounter rate of 0.372 snares removed per/km patrolled. There is, however, a significant reduction in the number of snares that were removed from the forest as compared to the late 1990s when nearly 4,000 were removed in 1996 and more than 3,000 snares were removed in 1997 (Masozera, 2002). However, the concern now is that encounter rates of snares between 2006 and 2010 have shown no further reduction (Figure 15). Overall, the encounter rate for poaching as a whole has increased between 2006 and 2010 by about 2.2%. There was actually an increase (rate of change of 15%) in the encounter rate for snares in 2010, possibly because of the combination of increased patrol effort to search new areas, mobilization and initiation of joint patrols with ex-poachers.

Ex-poachers contributed to some extent to anti-poaching activities by informing park management of the location where snares have been set and reporting their neighbors to park managers. At least 227 poachers were arrested or observed involved in poaching activities. Despite the effort of park management to reduce poaching activities in Nyungwe National Park, poaching still poses the most significant threat to the wildlife populations. Though the larger mammals such as bushpigs and duikers are certainly still targeted by poachers, most snares removed in the park were targeting at smaller animal species such as pouched rats, squirrels and porcupines- this is a worrying trend and indicates that poachers are switching to smaller prey in the absence of larger mammals. Ground dwelling birds (*Francolinus nobilis*) are also a target for poachers. During this 5-year period, 1,029 (9.2%) snares removed that were set for francolins (*Francolinus nobilis*).

Primate populations at least seem to have remained fairly stable, due to local taboo's related to primate hunting (long-term large mammal monitoring from transects will soon prove/disprove this). However, colobus monkeys were ranked second (after duikers) as the most frequently encountered animal carcasses found/hunted in the park during this period.

Commercial poaching has to be tackled head-on. A hunting camp was found in August 2008 where the horns of at least 49 duikers were recorded and in January 2009 discarded skins of 30 Colobus monkeys were found near Kitabi. The carcasses of primates such as blue monkey and L'Hoesti's monkey were also recorded. This indicates that poaching is an issue that must be addressed urgently.

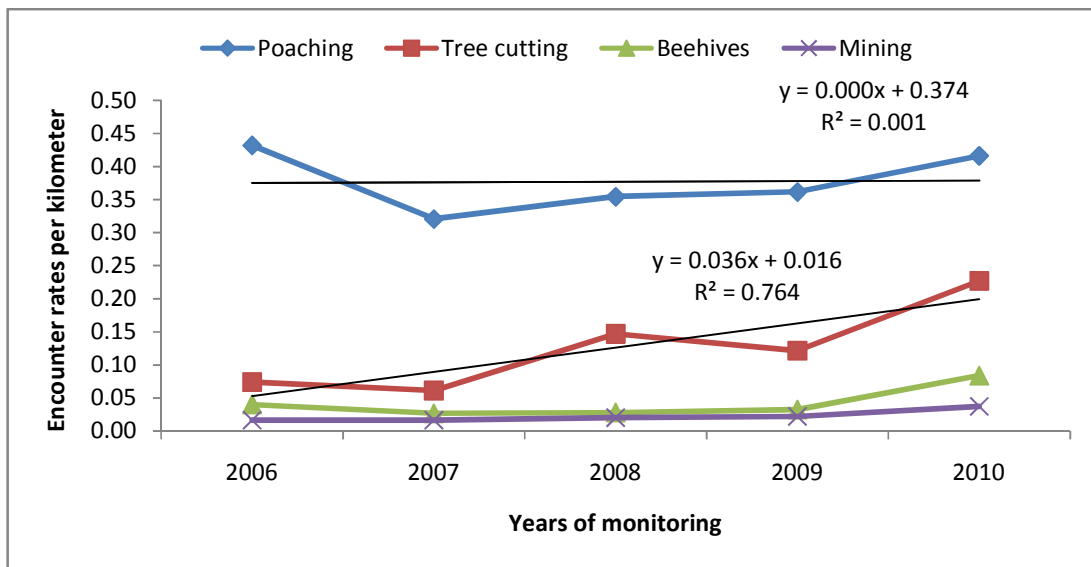


Figure 15. Encounter rates of snares, tree cutting, beehives and mining per kilometer in Nyungwe National Park

More patrol effort is needed

Below, a computed correlation coefficient of total number of signs of poaching against total number of kilometers walked on patrol is plotted (Figure 16). There is a positive correlation (49.78%) between the number of kilometers patrolled (effort to search snares) and the number of poaching signs detection.

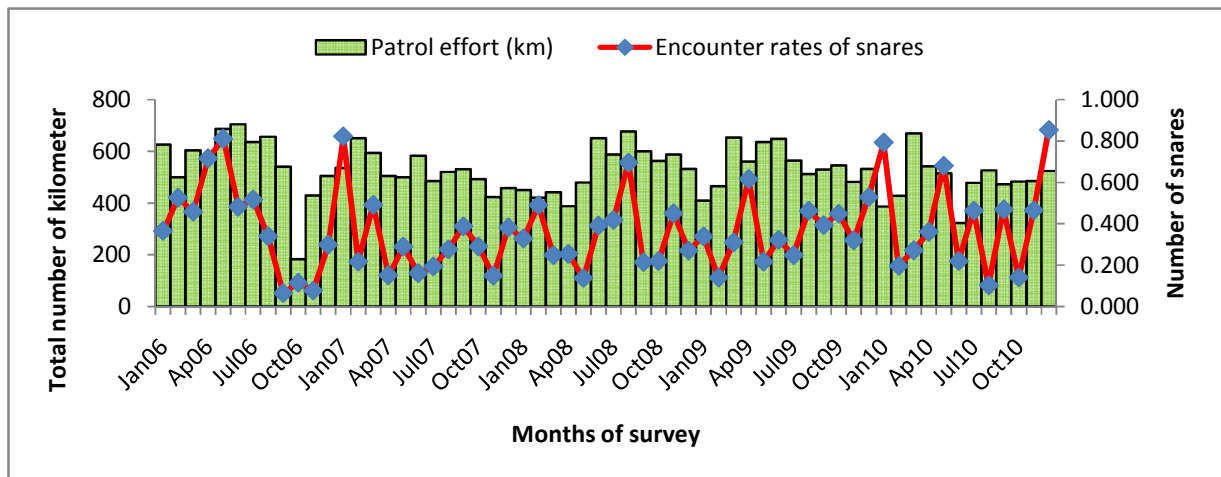


Figure 16. Number of poaching incidents per effort (kilometer walked) each month of five years from 2006 to 2010 in Nyungwe National Park (correlation coefficient of 0.49788 N=60 months)

Figure 17 shows the spatial distribution of snares in Nyungwe National Park. It is clear that poachers reach deep into the park to set snares. The map shows that all areas are affected by poaching pressure, the worst affected areas include Ruzizi, Gisovu, Gisakura, Uwinka, Bweyeye, Gasumo and Kitabi. Therefore, one assumes that areas not patrolled (green areas in this map) should also be experiencing similar poaching pressure.

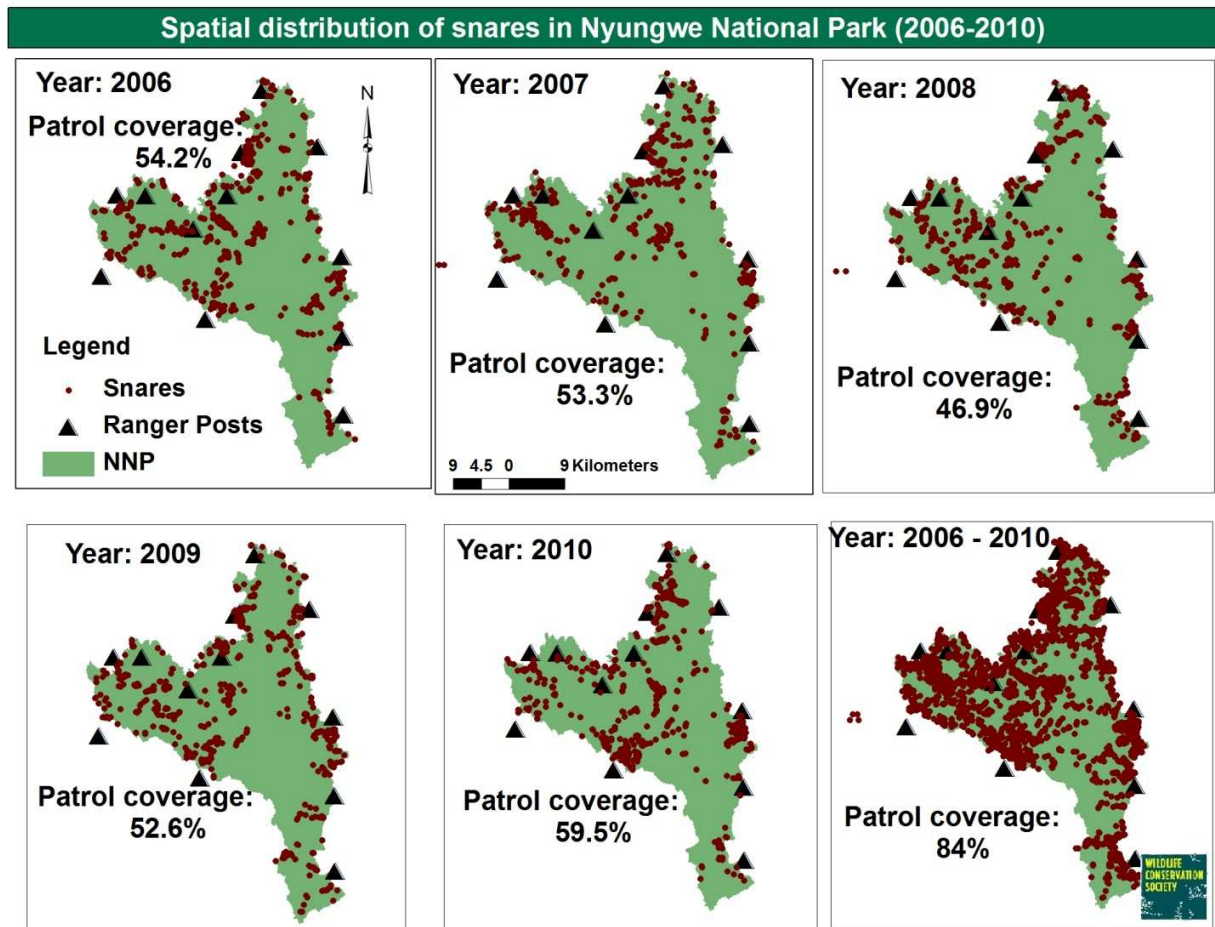


Figure 17. Spatial distribution of snares in NNP for the period from 2006 to 2010

Tree felling and commercial sawing

The communities surrounding Nyungwe National park have been using wood products for a long time. Fire wood, domestic tools, sawmill, bamboo products and house construction poles and small trees/shrubs are cut for construction and/or for crop supports.

During this period, 3,939 observations of tree cutting were recorded with a mean encounter rate of 0.131 per/km patrolled. Encounter rate of tree harvesting show an increase (rate of change of 46%) from the lowest rates of 2007 (0.06/km) to a peak in 2010 (0.25/km) (Figure 15). These encounter rates would arguably be even higher if the buffer zone was not there. The (2006 study by WCS on “The status of fuel wood utilization around Nyungwe National Park” showed that 88 % of households around Nyungwe use firewood (cooking and heating). The same study also showed that 98% of households in Bweyeye and 84% of households in Ruhuru (Nshili) do not possess their own wood lots and

consequently use fuel wood from government forests (buffer zone or national park) (Barakabuye et al., 2006). Firewood collection is severe in areas of the park where there is no buffer-zone or the buffer zone was severely degraded. At least 219 examples of tree cutting for timber were also recorded in Nyungwe during this period.

Despite ongoing small-scale projects aimed at reducing reliance on bamboo, cutting bamboo continues and supports a number of local markets which seem to be rapidly growing.



Bamboo cut from NNP ready to be used for house construction (left) and crafts (right). Photos by RDB

Mining

Mining in Nyungwe dates back at least to the 1930s' when various minerals were discovered within the forest. As many as 3,000 people at one time lived in Nyungwe and practiced artisanal mining. Mining is also associated with other threats to conservation including stream channel destruction and diversion, pollution of waterways with sediment, and loss of the vegetation surrounding the rivers. Miners also had a serious impact on the forest fauna with thousands of snares being placed in the forest combined with other forms of hunting.



Impact of mining on water and tree species

Today, encounter rates of mining are increasing (by ~ 25%), compared to the lower rates encountered in 2006 (0.017) to 2010 (0.037) (Figure 18). Mining is practiced on a small scale by people living outside the park but coming in and out or spending some nights inside the park. For this period, the total number of observation on mining was 711 mining signs (of which 28 people were arrested while mining in the park) with mean encounter rate of 0.023 per kilometer (Figure 16).

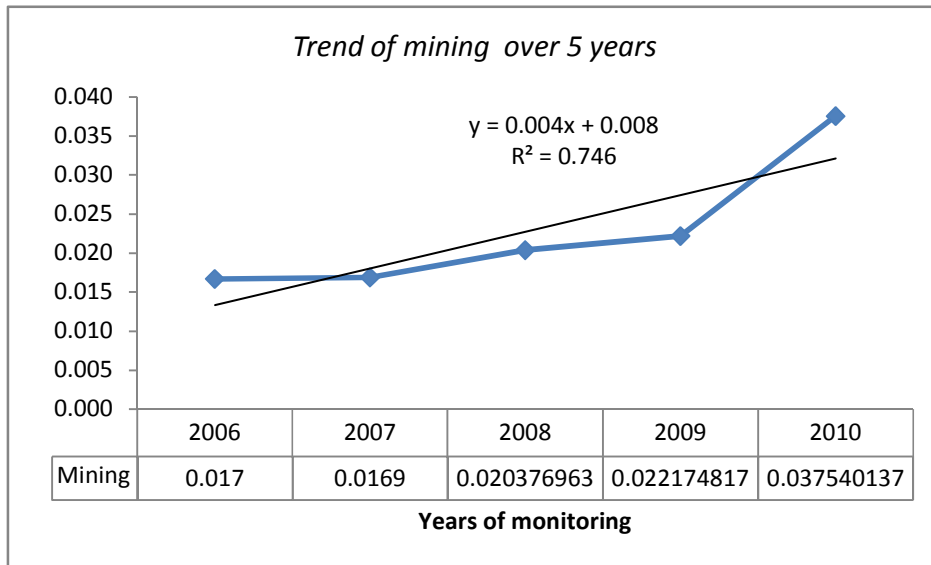


Figure 18. Encounter rates of mining per kilometer in Nyungwe national Park for the period of 5 years (N=711)

Gold mining activities have expanded to the western and southern drainages of Nyungwe from Nshili throughout Bweyeye, Gasumo and Gisakura (Figure 19). It was also found that mining activities have stopped at Uwinka towards Kitabi.

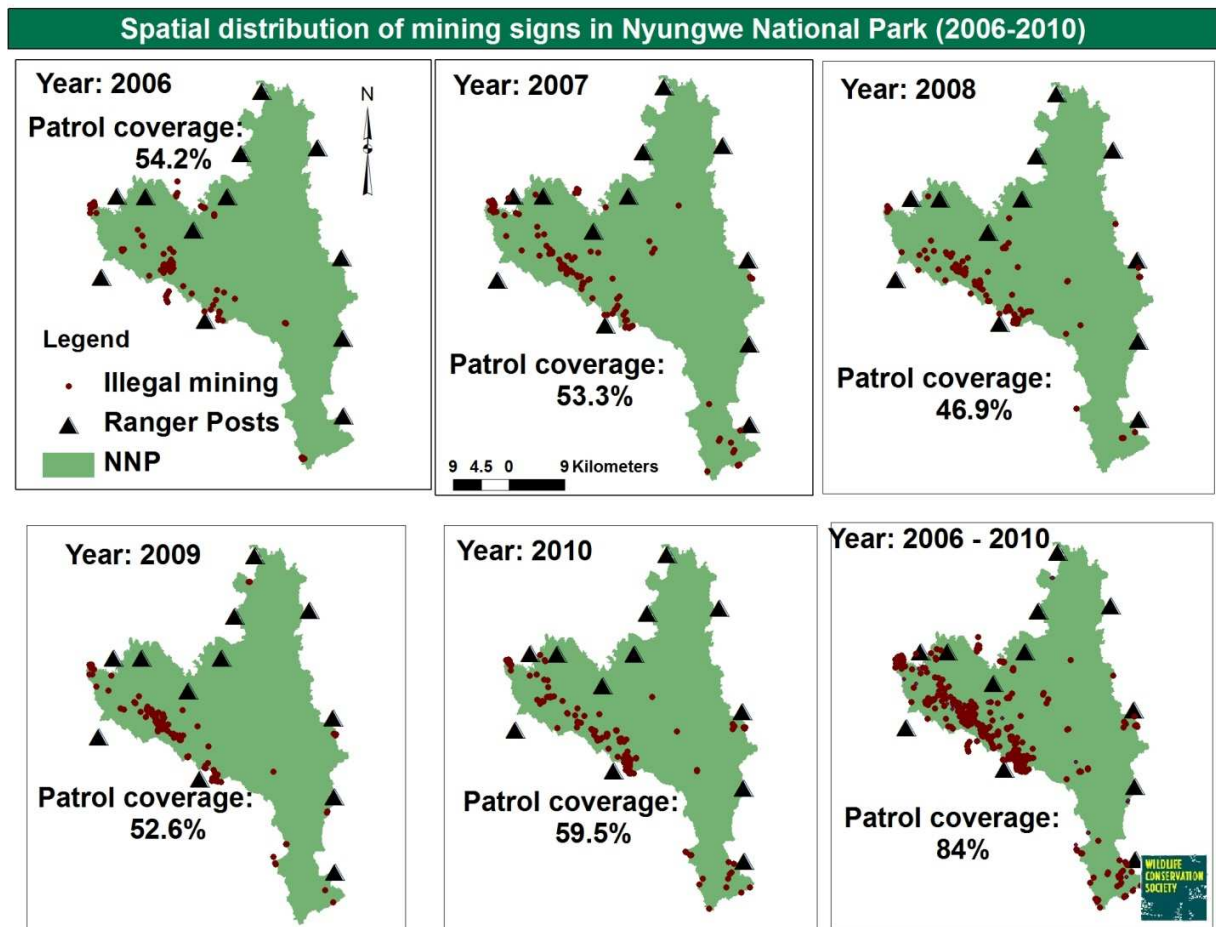


Figure 19. Extent of gold mining in Nyungwe National Park in five years (2006 - 2010)

Honey harvesting

The Nyungwe National Park is one of the richest areas for honey bee plants and is home to large populations of wild honey bees. Communities around Nyungwe have long been practicing traditional beekeeping in and around Nyungwe National Park and enjoy larger yields when they place hives within the botanically rich park. It seems clear that beekeeping and traditional honey gathering is the major cause of wildfire in Nyungwe National Park. A shift from traditional to modern beekeeping is one of strategies being promoted by conservationists and park managers in order to reduce the wildfire risks posed by the illegal placement of hives or illegal wild honey harvesting within the park. Today, ~1,4708 members in 23 beekeeping cooperatives (13 approved cooperatives and 10 in the process of getting approval) are being financially and technically supported for sustainable beekeeping by RDB and partners in the villages surrounding Nyungwe. However, a total number of 1,325 illegal beehives (average of 265 beehives/year) with a mean encounter rate of 0.043 beehives per/km were recorded during this period (Figure 20). Encounter rates of beehives dramatically increased in 2010- perhaps as a result of bee-keepers taking advantage of the flowering of a vine called *Sericostachys scandens* which

flowers en masse once every 15 years, and is a favored source of pollen. Another cause is that in 2010, the park managers and beekeepers organized a public campaign to remove beehives from the park (Musebeya and Ruzizi). One hundred beehives were removed from the park and given to beekeeper cooperatives in one campaign alone in Musebeya.

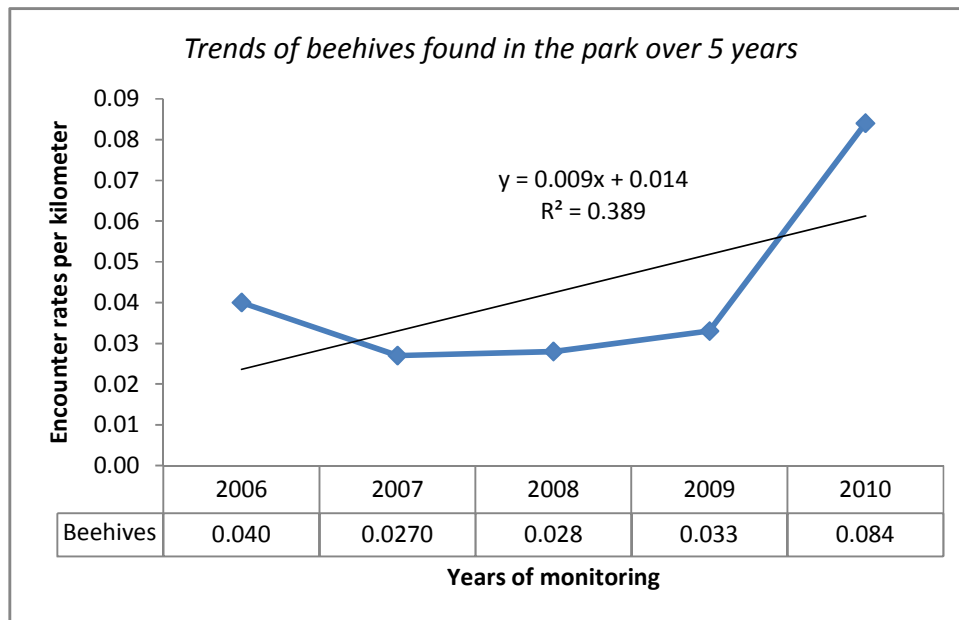
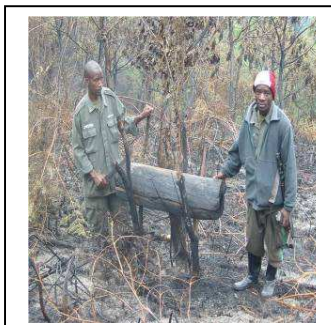


Figure 20. Encounter rates of beehives per kilometer removed in NNP in the period of 5 years (N=1325)

Fires, encroachment for farming, and livestock

(i) Fires

Though there are few records of the history or frequency of fire within Nyungwe, fire may have been a part of the forest system for hundreds of years, illustrated by charcoal layers in the soil layers around Uwinka. Wildfire is regarded as one of the major threats to Nyungwe and its biodiversity over the last 20 years. Large fires started in 1997 and up to 2003, the forest lost at least 12% of its habitat because of wildfires. In 2010, wildfires led to the loss of about 500 hectares of the park. At least 119 (average of 0.004/km) fire incidences were recorded in this 5 year period (Figure 21). The encounter rates of bush fires increased in 2010 following the flowering of *Sericostachys scandens*- almost certainly due to illegal wild honey harvesters using fire to extract honey from wild bee nests within the park.



(ii) Livestock

The records for livestock include any sign of livestock grazing or passage and any sign of fodder collection from the park. Communities use pathways between Musebeya, Ruzizi and Gisovu for local livestock trafficking, and use the edge of the park for livestock grazing and collecting fodder to feed their cattle. A total number of 646 (mean encounter rates of 0.020/km) signs of livestock were recorded (Figure 21). Fodder collection observation recorded was 538 (83.28%) observations followed by livestock grazing 89 (13.78%) and lastly livestock trafficking with 19 (2.94%) records. Fortunately, encounter rates of signs of livestock in the park show a clear decline over this monitoring period.

(iii) Encroachment

The encroachment for farming is a threat to biodiversity and includes crop farming and marijuana growing. In the late 1990's, encroachment for crop farming was high in some areas around Nyungwe National Park including Musebeya, Ruzizi, Bweyeye, and Kitabi. During this period, a total number of 125 (mean encounter rates of 0.004/km) records of encroachment were made of which 25 (20%) were for marijuana. The encounter rates of encroachment have shown no increase in year 2010.

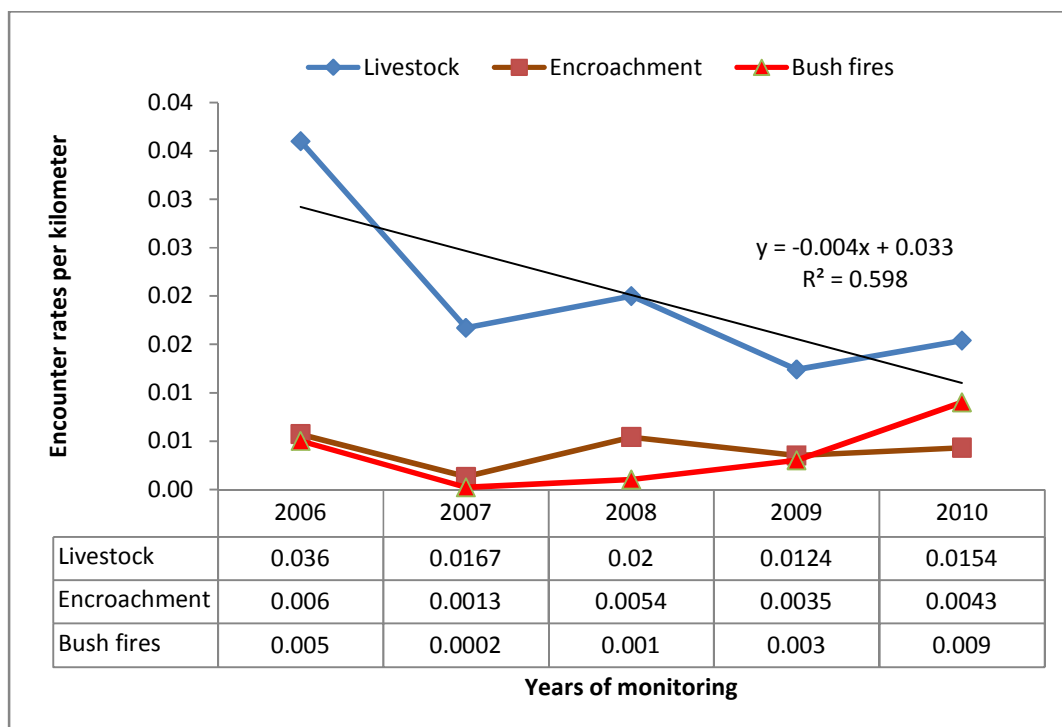


Figure 21. Encounter rates of wildfires, encroachment and livestock per kilometer in NNP for the period of 5 years (N=119 fire incidences, 646 signs of livestock, and 129 observation of encroachment)

Others illegal activities

Park rangers also recorded signs of collection of medicinal plants, mushrooms and persons. At least 68 (0.002/km) signs of medicinal plant and 18 (0.001/km) signs of mushroom collection were recorded. Both medicinal plant and mushroom collection were not common and their encounter rates per kilometer decline over time. During this period, at least 185 (0.006/km) people were arrested or observed of which 153 (82.70%) people were pedestrian using clandestine footpaths inside the park. The encounter rates of pedestrian per kilometer walked has shown an increase in year 2010 (Figure 22). A survey of road / path use within Nyungwe National Park (Barakabuye *et al.*, 2008) found that communities use footpaths through the park for two major reasons:

- Business – community use the footpaths in the park as shortcut to access to local market (for agriculture or small shop good and livestock exchange) in neighboring villages in either side of the park.
- Family visits – communities in either side of the park use footpaths in the park to visit their relatives and attending various family ceremonies.

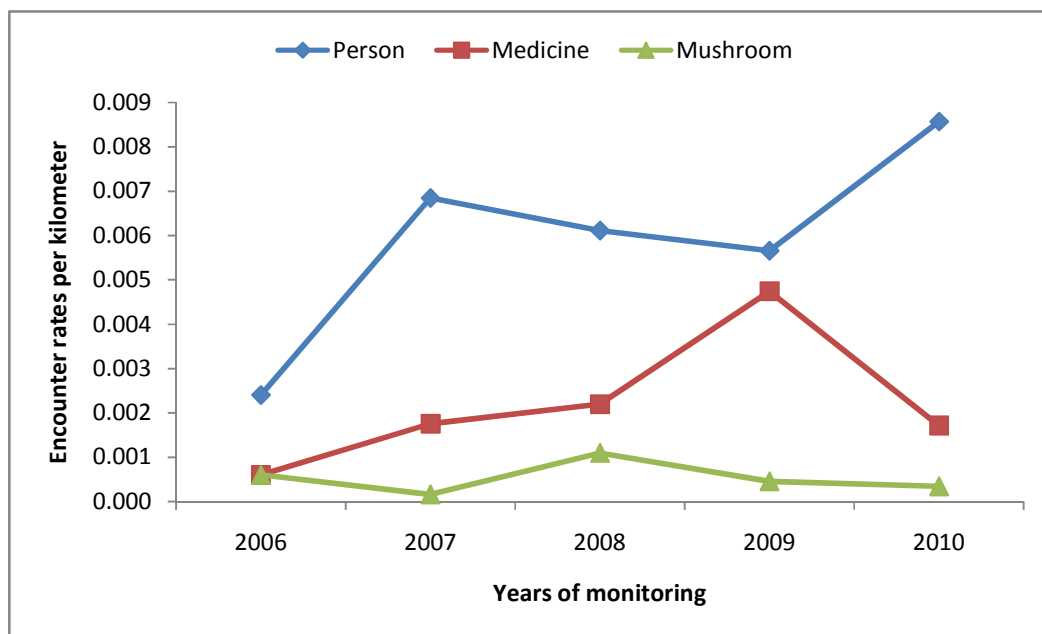


Figure 22. Encounter rates of people, medicinal plant and mushroom per kilometer walked in Nyungwe National Park from 2006 to 2010

Part C. Summary of major findings

1. There was an overall improvement in patrol coverage in general. The total number of 8410 days/patrols (average of 1682 patrols each year) or 140 patrols each month) have been carried out in Nyungwe National Park for the period of five years from 2006 to 2010. Total distance covered was 31705.8 kilometres (average of 6337.1each year and 528 kilometres every month). The overall area covered was 84% (an average of 53.3% each year). Given the coverage of illegal activities, it would be wise to assume that these areas also harbor hitherto un-quantified illegal activities. It can be expected that patrol effort (km walked) will probably decrease when these areas are visited as they are remote and probably far from access routes into the park. There is a correlation between those areas that are less patrolled and the incidence of illegal activities such as poaching, mining and marijuana growing.
2. Overall, the encounter rates of illegal activities as a whole increased between 2006 and 2010 by roughly 12%. The main threats currently facing Nyungwe National Park are poaching, tree cutting, illegal mining, human induced fires, livestock trespassing, encroachment and other non timber forest products such as honey collection. Encounter rates of poaching were higher (62.34%) than other illegal activities recorded for this period followed by tree cutting (20.63%). The persistence of illegal activities in Nyungwe National Park is a warning message for park managers and new strategies to combat illegal activities need to be developed.
3. Poaching is the biggest issue in Nyungwe National Park; the overall encounter rates for poaching as a whole increased between 2006 and 2010 by a rate of change of about 2.2% over this period. Snares were reported in most of areas in Nyungwe National Park. The areas of Ruzizi, Gisovu, musebeya, Bweyeye and Kitabi have shown higher involvement in poaching activities, but snaring is present across the park. Poaching is having a major impact on the population of large mammals and animals such as buffalo and elephants are locally extinct. Many of the hunted animals are also the most important seed dispersers. The most poached are Gambian rat, Cephalophus sp, bush pig and Bush-tailed porcupine (*Atherus africanus*). Primates are becoming increasingly targeted for poaching probably because of a decline of ungulate species.
4. The tree cutting for firewood was found to be more common in Gasumo, Bweyeye and Nshili across the years of study. It was noted that trees are the only source of energy available for households and tree lots are very limited to individual lands in these areas (Barakabuye at. Al., 2007). Consequently, people in these areas use the national park and buffer zone forests to satisfy their needs for firewood and other wood products (Musabe, 2002). Another study (Ndayisaba 2009) demonstrated that bamboo alone contributes 45.7% of household revenues for populations in the Nshili area alone. In the same study, 93% respondents admitted to collecting bamboo from either KNP or NNP and about 100% of households' houses surveyed were made to some extent from bamboo. The effectiveness of stopping the cutting of bamboo and woody vegetation in NNP requires not only park protection patrols but also an increased effort to establish bamboo and tree woodlots outside the park, KNP-NNP cross-border collaboration, energy efficient stoves, and availability of alternative to construction materials such as bricks and tiles.

5. Mining is also on the increase at rate of change of 25% over five years with a higher rate of increase in 2010. There was evidence of decreased mining around Uwinka and gold mining activities have expanded to the western and southern drainages of Nyungwe from Nshili throughout Bweyeye, Gasumo and Gisakura. Park patrols alone have shown some contribution in stopping mining activity in Nyungwe, but additional effort is needed to prevent further incursions as well as the greater engagement and role of other security forces, district authorities etc.
6. Livestock, encroachment, medicinal plant and mushroom collection were not major threats to Nyungwe National Park but livestock trespassing/illegal entry in the park seems to becoming more common in the northern areas the Gisovu and Musebeya-Ruzizi.
7. Fire poses a serious risk to Nyungwe and its own mitigation strategies are needed. A Fire Management Plan has been developed and needs to be fully implemented as soon as possible. T
8. Rangers need to maintain high levels of vigilance and recording throughout the duration of every patrol for both illegal signs and animal sightings/signs.

Part D. Major recommendations to improve the effectiveness of anti-poaching efforts

- It is essential to continue the process of building RDB's capacity at all levels to both manage and make use of RBM and MIST to guide the monitoring and effectiveness of law enforcement efforts. Annual refresher training in RBM / MIST is an important element of this strategy for all park rangers and Wardens.
- Additional effort is needed to ensure that all areas of the park are patrolled routinely. In the course of the last 5 years, 45% of the park remained unpatrolled. This means we have no idea of the nature and extent of illegal activities taking place in these areas. This situation must be rectified. In addition, strategies for patrol teams to patrol away from roads must be developed as much patrol effort is still centered on roads and paths.
- Rangers should be encouraged to undertake longer multiple-day patrols. They will need to be equipped accordingly. Patrols should always carry radios, GPS and spare batteries in addition to recording sheets etc.
- 5-yearly park-wide biodiversity surveys should be conducted to track the status of large mammal populations in particular as a baseline to compare with RBM.

- Many staff would benefit from basic navigation training and especially how to navigate using map, compass and GPS. This will give patrols confidence to explore all areas of the park.
- Coordination with other law enforcement agencies as well as counterparts in Burundi (Kibira National Park), and districts adjacent to Nyungwe is needed to share information on illegal activities and to jointly devise plans of action to mitigate various threats.
- It would be good to introduce a clear promotion and award system within the law enforcement section of the park to encourage and motivate rangers to perform better.

References

- Budowski, G. (1976). Propositions pour un Programme de Sauvegarde de la Forêt de Nyungwe. Coopération Technique Suisse / Gouvernement de la République Rwandaise.
- Dowsett, R. J. (1990). Enquete Faunistique et Floristique dans la Forêt de Nyungwe, Rwanda. Tauraco Research Report, No. 3.
- Gapusi, JR. (2007). Regeneration of indigenous species in Nyungwe buffer zone for biodiversity conservation and local people's livelihood in Rwanda. Master thesis for International Master Programme at the Swedish Biodiversity Centre. Uppsala, Sweden.
- Maryke Gray* and Jose´ Kalpers (2004). Ranger based monitoring in the Virunga–Bwindi region of East-Central Africa: a simple data collection tool for park management. International Gorilla Conservation Programme, BP 931 Kigali, Rwanda.
- Masozera, M. K. (2002). Socio-economic Impact Analysis of the Conservation of Nyungwe Forest Reserve, Rwanda. Unpublished MSc Thesis, University of Florida.
- MUSABE, T., (2002). Use of Non Timber Forest Products (NTFPs) and it Ecological Impact on the Conservation of Nyungwe Forest Reserve in Rwanda. A Thesis Submitted in Partial Fulfilment for the Award of the Degree of Master of Environmental Studies (Science), Kenyatta University
- Ndayisaba, E. (2009). Etude socio-économique de la coupe des bambous et de son impact sur le *Cercopithecus hamlyni* au Parc National de Nyungwe. Mémoire présenté en vue de l'obtention du grade de licencié (Bachelor's degree) en Biologie, Université National du Rwanda
- Newbury, D. (2001). Precolonial Burundi and Rwanda: local loyalties, regional royalties, The International Journal of African Historical Studies, 34, 255-314
- ORTPN, (2005). Tourism Revenue Sharing in Rwanda. Provisional Policy and Guidelines
- Plumptre, A., Masozera, M., Fashing, P. J., McNeilage, A., Ewango, C., Kaplin, B.A. & Liengola, I. (2002). Biodiversity surveys of the Nyungwe Forest Reserve in S. W. Rwanda, WCS Working Paper, 19.
- Plumptre, A.J., Kayitare, A., Rainer, H., Gray. M., Munanura, I., Barakabuye, N., Asuma, S., Sivha, M. & Namara, A. (2004). The Socio-economic Status of People Living near Protected Areas in the Central Albertine Rift. Albertine Rift Technical Reports, 4, IGCP, WCS, CARE.
- Vedder, A. & Fashing, P.J. (2002). Diet of a 300-member Angolan colobus monkey (*Colobus angolensis*) super group in the Nyungwe Forest, Rwanda. American Journal of Physical Anthropology, 3, 159- 160.
- Kanyamibwa, S. (1992). La biodiversité des forêts de montagne du Rwanda et les problèmes de leur conservation. Conférence Minagri, Journée Nationale de l'Arbre.
- Kristensen, K. A. & Fimbel, R. A. (1994). Gold Mining Activities within the UGZ 4 Management Zone Nyungwe Forest Reserve, Rwanda. PCFN unpublished report.