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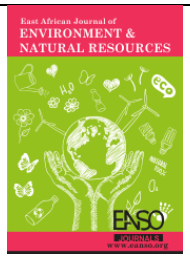

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Original Article

Assessment of the Impact of Community-Based Conservation Interventions to Biodiversity Conservation Around Protected Areas: Case of Nyungwe National Park

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Community-Based Conservation, Illegal Activities, Biodiversity Conservation, Attitude and Behavior Change towards Conservation.

ABSTRACT

Community-based conservation can be the venue to shape the attitude of local communities towards conservation and contribute to counter biodiversity losses in protected areas. This study aimed to assess the impact of community-based conservation interventions on biodiversity conservation around protected areas, specifically focusing on Nyungwe National Park (NNP). Primary data were collected using a checklist of the questionnaire, and secondary data were collected by reviewing Earth Ranger data on illegal activities from 2021-2024. The study utilized descriptive and correlational analysis research designs. A purposive sample of 225 individuals from seven cooperatives operated around NNP, constituted the study population, with a sample size of 144. Data were analyzed using descriptive and analytical statistics and were then processed by using SPSS. The correlation coefficient ® of 0.942, implies that community-based conservation interventions increase attitude and behaviour changes towards biodiversity conservation. From 2021 to 2023, the illegal activities spiked due to much effort applied by the management of NNP for diagnosing and collecting them. However, they were a significant decline in illegal activities in the year 2024, which implies that community-based conservation interventions have played a big part in this decline. The researcher revealed that in 2024, snares 6,831 were uprooted in NNP, where community-based conservation through community eco rangers played a crucial role in uprooting 3,848 snares (56.3%) within the park through their joint patrols with park rangers. For maintaining the positive attitude and behaviour changes towards conservation and momentum of the decline of illegal activities in NNP, it is recommended to enhance the involvement of local communities in deterring illegal activities mostly community eco-rangers; to scale up and monitoring income-generating projects throughout the parks; To intensify environmental education and awareness programs for curbing the culture and beliefs of local communities on wildlife animals.

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INTRODUCTION

Globally, Protected areas such as national parks and wildlife reserves are vital to biodiversity conservation strategies. The main role of biodiversity is to ensure the functioning of ecosystems and their ability to provide services to humans and other living organisms that comprise them. Human beings are the pivot to illegal activities in protected areas, which harm the wildlife population and compromise the development of the present and future generations.

Historically, the nature conservation paradigm in Africa started with the fortress approach, which denied the local communities to participate in conservation activities and people to use protected natural resources for their basic needs. Local communities were viewed as be threat to the environment rather than a solution to the conservation of the environment (Mariki, 2016). In the 1970s, the Fortress conservation Approach met with the crisis of failing to achieve conservation goals. In an attempt to reconcile human needs and conservation goals, in the 1980s, a new conservation approach called "People-centered conservation", and "Community-based conservation (CBC)" was shaped to involve local people around parks in conservation. It is also apparent that co-management efforts in the form of community-based conservation projects have made it possible to help reduce the severity of problems of dislocation, violence, poaching, and poverty among the local people and management around national parks **(**Matose, 2006).

Nyungwe is among the highly populated areas with 456 people/km2 (NISR, 2012). Local communities living around NNP live under subsistence agriculture, the soil is poorly productive, and the population has difficulty accessing the market (Masozera, 2002). The poor soil leads to poor agricultural production and consequently a high food shortage (Halwart, 2008; Crawford, 2012). The National Institute of Statistics of Rwanda (NISR) has documented that about 48.4% of the community in the southwestern part of Rwanda where NNP is located live in poverty (NISR, 2012) and consequently, these communities find themselves heavily reliant on the natural resources within their proximity seeking for multiples sources of income. Human population increase, poverty, conversion of land for agriculture and resource extraction are major threats that NNP has experienced since its establishment as a forest reserve in 1933. For instance, twenty-one (21.8% of

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the park) has been converted into agricultural land during the 35 years from 1960 to 1996 (Gapusi, 1998).

Since 2005, the Rwanda Development Board (RDB), a government institution which manages national parks, has started to allocate 5% of annual tourism revenue from national parks into a national pool. Since 2017, the funds available to support the revenue share program increased from 5% to 10% of all tourism revenue. The amount goes back to the communities surrounding the 3 national parks. From 2005 to 2024, over US$9.6 million has been spent on more than 1,108 community-based projects in four main national parks. However, this program is small relative to the population density of poor smallholder farmers around the parks (Andrew, & Masozera, 2010).

African Parks (AP) through Nyungwe Management Company Ltd (NMC) started to build robust community constituency conservation by not only supporting financial resources in the local communities through income-generating projects around the parks but also educating and engaging the community in sustainable conservation of Nyungwe National Park (NNP). My research comes in for assessing the impact of Community Conservation Interventions Around Protected Areas to Biodiversity Conservation, specifically at Nyungwe National Park from 2021 to 2024.

Problem Statement

Protected areas play a crucial role in safeguarding biodiversity and ecosystem integrity. In the context of the scarcity of natural resources, the government of Rwanda attaches high importance to natural resource conservation by creating protected areas to increase GDP and ensure sustainable biodiversity conservation. Extreme poverty in the communities surrounding NNP is the main cause of illegal activities and constitutes a big challenge to the sustainable conservation of the park.

RDB and WCS tried to invest in socio-economic development projects for the Community living around NNP, but many illegal activities that were perpetrated by local communities are still encountered in NNP (Dushimimana, 2022). Rija (2017), researched the spatial pattern of illegal activities and the impact on wildlife populations in protected areas in the Serengeti ecosystem, and results indicated that illegal activities are most likely to cause species declines of large-bodied animals in protected areas in resource-poor countries. He realized that trapping wire snares in the Serengeti ecosystem, resulting in the killing of approximately 14% of the animal population available each year, increases the risks of wildlife animals' mortality and potential population declines.

Since October, 2020, African Parks through NMC Ltd started to build a robust community constituency conservation with the ultimate objective of gaining a loud voice of local communities to the sustainable conservation of NNP. The central challenge lies in understanding what are and how community conservation interventions will enhance alternative livelihoods, and community conservation awareness and engage the local people to counter biodiversity loss. To what extent do those interventions contribute to attitude and behaviour changes towards conservation, and is there any relationship between those attitudes and behaviour changes that contribute to the pattern of illegal activities?

The existing research conducted in NNP focused on Tourism Revenue sharing projects, Poaching, HWCs and environmental awareness, with less research conducted on assessing the impacts of CBC interventions on biodiversity conservation in NNP.

Objectives of the Study

The specific objectives were:

- To identify community-based conservation Interventions and their implications in the management of the biodiversity of Nyungwe National Park

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- To assess the perceptions of local communities towards the biodiversity conservation interventions for the Nyungwe National Park.
- To investigate the patterns of illegal activities that are addressed through community-based conservation interventions.

Research Questions

- What are the community-based conservation interventions and their contribution to biodiversity conservation?
- What is the level of community perception towards biodiversity?
- Does biodiversity conservation in or around NNP depend on community-based conservation interventions?

REVIEW OF LITERATURE

Community-Based Conservation

The establishment of protected areas was identified as a key strategy to reduce biodiversity loss in tropical rainforests. However, in many places, it has proven difficult to manage protected areas (Rao, & Geisler 1990) because of the higher dependency of the population on natural resources for agricultural, energy, nutritional, medicinal, and other needs. Community-based Conservation is the protection of biodiversity and ecosystems by, for, and with the local community (Berkes, 2021; D Western, & Wright, eds, 1994). Conservation strategies in Africa have been characterized by the exclusion of human use of resources in protected areas. In particular, this approach is often described as "fortress conservation" or "the fines and fences" (Wells & Brandon, 1992). Local communities were viewed as be threat to the environment rather than a solution to the conservation of the environment (Mariki, 2016). In the 1970s, the Fortress conservation Approach met with the crisis of failing to achieve conservation goals. In an attempt to reconcile human needs and conservation goals, In the 1980s, a new conservation approach called "People-centred conservation", and "Community-based conservation" was shaped to involve local people around parks in conservation. It is also apparent that co-management efforts in the form of community-based conservation projects have made it possible to help reduce the severity of problems of dislocation, violence, poaching, and poverty among the local people and management around national parks (Matose, 2006).

Livelihoods and Benefit Sharing

Local communities living around NNP live under subsistence agriculture, their soils are poorly productive, and the population has difficulty accessing the market (Masozera, 2002). The poor soil leads to poor agricultural production and consequently a high food shortage (Halwart, 2008; Crawford, 2012). Nyungwe is among the highly populated areas with 456 people/km2 (NISR, 2012). The National Institute of Statistics of Rwanda (NISR) has documented that about 48.4% of the community in the south-western part of Rwanda, where NNP is located, lives in poverty. (NISR, 2012) and consequently, these communities find themselves heavily reliant on the natural resources within their proximity, seeking multiple sources of income. The anthropogenic threats are often correlated with human population growth and poverty levels, with protected areas situated in regions characterized by rapidly growing, poverty-stricken human populations generally facing the highest levels of threats (Butchart *et al*., 2010; Challender, & MacMillan, 2013; Craigie *et al*., 2010).

Community Education and Conservation Awareness

Community conservation awareness is essential for sustainable environmental management, as it influences how local people interact with and protect natural resources. Since the 1992 UN Conference on Environment and Development, environmental education has been recognized as a key tool in fostering positive attitudes and

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behaviours toward conservation. Research shows that increased education leads to stronger community support for protected areas and encourages sustainable practices. Conservation awareness also reduces resource-use conflicts and promotes collaboration among stakeholders by highlighting the link between ecosystem health and human well-being. Successful cases from Madagascar and Rwanda demonstrate that education, coupled with development support, strengthens local engagement, builds trust, and reduces pressure on natural areas, making education a cornerstone of effective and lasting conservation efforts.

Illegal Activities and Conservation Law Enforcement Interventions in Protected Areas

Illegal activities in protected areas (PAs) are a major conservation problem linked to biodiversity loss. This implies that biodiversity is under increasing pressure. Habitats available to wildlife have undergone dramatic modifications, and significant biodiversity has already been lost over modern times (Cipullo, 2016). In many protected areas, poaching is the largest threat to wildlife and is the cause of population declines as well as shifts or reductions in the distributional range of many species (Newmark, 2008; Stoner *et al*., 2007). Annually, a lot of animals such as primates, antelopes, elephants etc., are killed for bush meat which has led to the extinction of many populations of animal species. Rija (2017), researched the spatial pattern of illegal activities and the impact on wildlife populations in protected areas in the Serengeti ecosystem and results indicated that illegal activities are most likely to cause species declines of large-bodied animals in protected areas in resource-poor countries. He realized that trapping wire snares in the Serengeti ecosystem, resulting in the killing of approximately 14% of the animal population available each year, increases the risks of wildlife animals' mortality and potential population declines. Poaching adversely affected vulnerable species such as duikers, and bush pigs, while buffalos and elephants were poached to extinction (RBM, 2017). Chimpanzees are being trapped by snares set by poachers inside the park (Moore *et al*., 2017). However, managing anthropogenic threats to wildlife often depends on cultural, social and economic contexts, and there is no single solution that is likely to be appropriate for all regions (McNeely *et al*., 1994). Many countries have put in place laws that prohibit poaching, but their enforcement is still difficult (Library of Congress, 2013). Effective management of protected areas and conservation law enforcement to mitigate these threats is vitally important for global biodiversity conservation (Brandon *et al*., 1998; Dudley, & Stolton, 2008).

Attitude and Behaviours Towards Conservation

The creation of protected areas is aimed at achieving sustainable biodiversity conservation and the well-being of the people. This implies that to conserve biodiversity sustainably, it is necessary to understand local communities 'attitudes and behaviours for long-term sustainable conservation of biodiversity. The conservation of biodiversity in national parks is facing pressures from economic development activities, which have led to the degradation of the ecological values of the national parks. People's awareness and their participation in conservation management are crucial to the sustainable management of national parks (Truong, 2021) The people living in or adjacent to protected areas may incur costs arising from the existence of parks and their wildlife. How they view the value of these areas to them and their communities will have a significant influence on the future sustainability of the park. The attitudes of local communities are largely influenced by a greater sense of participation, ownership and level of engagement in conservation programs. Infield, M., &Namara, A. (2001) researched assessing community attitudes and behaviour towards conservation around Lake Mburo National Park (Uganda) and the findings indicated that the local communities who had positive attitudes; held stronger perceptions of its

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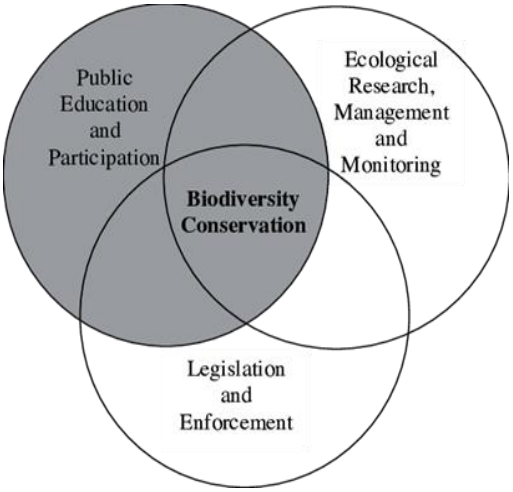
values, and were more willing to see it remain as a park were influenced by communities receiving development assistance through community conservation programme.

Figure 1: Effective Biodiversity Conservation (Hansel *et al*., 2008)



MATERIALS AND METHODS

Study Area

Nyungwe is one of the oldest rainforests in Africa, and the largest expanse of forest in Rwanda, covering 1,019 km2 of dense Afromontane forests, bamboo-covered slopes, grasslands and wetlands. It lies on the watershed divide of two of the world's largest rivers, the Congo and the Nile, providing a significant portion of the country's freshwater. Nyungwe is known to be a regional biodiversity hotspot, situated within the Albertine Rift biodiversity hotspot, and has incredibly high species diversity and endemism of plants, birds, and mammals. Over 1,068 recorded plant species, 320 bird species and 75 known mammal species, including 13 of Africa's primates – notably, chimpanzee and the elusive Hamlyn's and L'Hoest's monkeys, Nyungwe's rich fauna and flora was exposed to rampant poaching, illegal mining and agricultural encroachment, all endangering the survival of its unique biodiversity. Acknowledging the successful partnership with the Rwanda Development Board (RDB), which saw the ecological and economic revival of Akagera National Park, the Rwandan Government invited African Parks to sign a 20-year agreement in 2020 to manage the Park and ensure its protection for both wildlife and communities. Nyungwe National Park is home to intact forests and peat bogs, moors, thickets and grasslands, providing habitats to highly diverse flora and fauna and is also internationally recognized as a priority site for conservation, and its vital watershed as is further emphasized by its recent classification as a natural UNESCO World Heritage Site (NNP, 2023).

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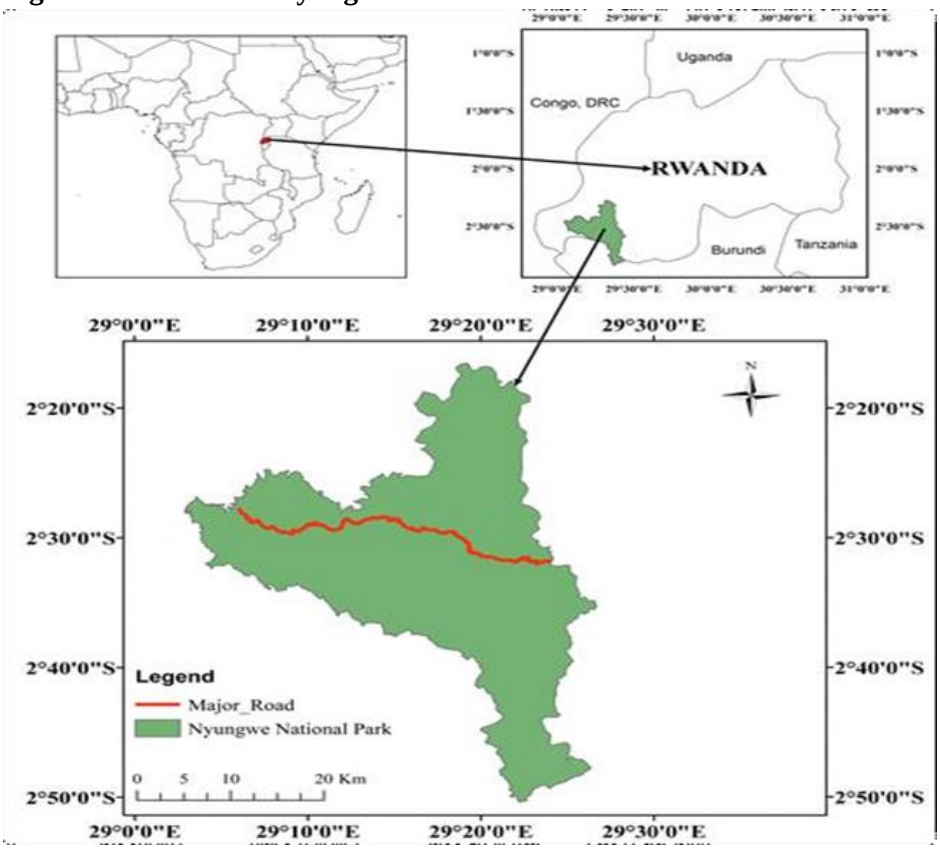
Figure 2: Location of Nyungwe National Park



(**Source**: NMC, 2024)

Research Design

This research design served as the general framework for the collection, measurement, and analysis of data (Akhtar, & Islamia, 2016). It described the overall strategy you selected to integrate the various study components coherently and logically, ensuring you effectively addressed the research problem. A research design, according to Vogt et al (2014), is a master plan that outlines the techniques and steps to be taken to gather and analyze the necessary data. This study used a descriptive and correlational research design because it allowed the researcher to gather information, summarize, present and interpret for clarification.

Target Population, Sample Size and Sampling Procedure

Population can be defined as the totality of persons or objects with which a study is concerned. Thus, population is any group of people or organization about which one wants to conclude (Garg, 2016). The target population is defined as the entire aggregation of respondents that meet the designated set of criteria (Kothari, 2004). The population, also called the universe, is the set of people or entities to which findings are to be generalized and the population must be defined explicitly before a sample is taken (Garson, 2012).

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Table 1: Target Population and Sample Size

Cooperative/Institution name	Population Target	n =(Ni*n)/N	Sample size
TwitezimbereTwororaAmafi Cooperative	32	$\frac{32 \times 144}{225}$	20
Cyamudongo Community Tourism Promotion Cooperative	67	$\frac{67x\ 144}{225}$	43
TwitezimbereTubungabungaIbidukikije Cooperative	33	$\frac{33 \times 144}{225}$	21
Terimbere Nyungwe Cooperative	28	$\frac{28 \times 144}{225}$	18
Sugira Nyungwe Cooperative	20	$\frac{20 \times 144}{225}$	13
Umuturanyiwa Nyungwe Coop	20	$\frac{20 \times 144}{225}$	13
Nyungwe Community Freelance Guid Cooperative	18	$\frac{18 \times 144}{225}$	12
Park Staffs	7	$\frac{7 \times 144}{225}$	4
TOTAL	**225**		**144**

Figure 3: Research Design

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Data Collection Instruments

During the study, the researcher used a questionnaire, an interview and a documentary as data collection instruments.

Questionnaire

The questionnaire included closed-ended questions. A questionnaire will be chosen because of the following advantages: it saves time since many respondents can be dealt with at once, it allows easy analysis of data collected, and it is easy to administer when the sample is literate. In designing questionnaires, the researcher used the Likert scale to measure the respondents' views Assessment of the impact of Community Conservation Interventions Around Protected areas to Biodiversity Conservation: In the case of Nyungwe National Park by Using the Likert Scale, the respondent indicated whether he/she strongly agree (SA), agree (A), disagree (D), or strongly disagree (SD).

Interview

Structured interviews with one-on-one interviews with single participants were used during data collection.

Document Review

It is important to indicate the review of existing literature by different authors. The researcher visited the UNILAK library, electronic sources, websites, documents, and Reports from NNP, where a great deal of literature by different authors about the subject matter was reviewed.

Data Quality Control

This part of the third chapter will present the data quality control through validity and reliability.

Primary Data

The researcher obtained the primary data using the questionnaire and interview during this research. In designing questionnaires, the researcher used closed questionnaires to measure the respondents' views on the Assessment of the impact of Community Conservation Interventions Around Protected Areas to Biodiversity Conservation: Case of Nyungwe National Park, where the respondent answered the question according to his/her knowledge. There was a collection of quantitative information to better understand, explain, and interpret the impact of Community Conservation Interventions Around Protected Areas to Biodiversity Conservation: Case of NNP. Hence, understanding trends in resource dynamics required historical information, which was achieved using quantitative data collected through interviews and questionnaires. Accordingly, detailed individual interviews and a questionnaire were conducted around the park. Quantitative analyses were used to achieve research Objectives by use of Descriptive analyses and content Analytical Tools, while Measurement of the "Effect" was done using Regression Analysis.

Secondary Data

To collect the secondary data, the researcher read documents such as textbooks, the internet, magazines, PowerPoint presentations and especially reports concerning the subject matter of the study. The researcher used the data on illegal activities from 2021 to 2024, as retrieved from the Earth Ranger software of Nyungwe National Park.

Data Processing

Raw data will be transformed into a meaningful interpreted report using different techniques. In order to get quality information, there was generally a need for standard checking so that the researcher could end up with realistic data, which clearly reflects the depicted situation. Thus, stand-checking will be done through editing, coding, and tabulation. This will be done to reduce detailed data to manageable proportions.

Data Analysis

For analyzing the level of community towards conservation and community-based conservation

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interventions, Statistical Package for the Social Sciences (SPSS) and Excel will be used by the researcher in processing and analysis of data, which informed the presentation of findings, analysis and interpretation. The presentation focused on the research questions. Quantitative data analysis will be used to analyze numerical data, this data will be presented in the form of tables and graphs to enhance its proper understanding. Data to be obtained from close-ended responses was analyzed using the SPSS (Statistical Package Social Scientist) computer package. These findings will be interpreted while discovering the level of household participation in solid waste management. Using SPSS and EXCEL, Data from the interview and questionnaire will be analyzed. Charts, tables, and graphs will be used to present the findings. The questionnaires will be screened for completeness by the researcher, coded and entered into the statistical packages for scientific solutions (SPSS) version 16.0 software.

Limitation of the Study

The findings of this study should be interpreted and generalized in the light of several limitations. Since the study will be conducted in Rwanda and the sample selected from the NNP and generalizability of the results will be limited to Nyungwe National Park and those in similar institutional contexts. This calls for caution when generalizing these results to organizations operating in different institutional and cultural contexts. The approach of sampling cooperatives from different cooperatives instead of a single cooperative will be adopted because cloud computing adoption is still in the early stages in Rwanda, making it difficult to collect adequate data from a single cooperative**.**

Ethical Consideration

Greater accountability during the data collection was considered by much attention on ethical conduct (personal, professional, and during this research activity) In addition, there were two crucial components—"informed" and "consent"—that each call for careful thought to ensure that Participants/respondents are fully aware of what was requested of them, how the data was used, and what (if any) consequences there may be. The following information was provided to the participants: Who the researcher(s) are, what the research's purpose is, what participant data were gathered, and how the participants' data were collected. What degree of dedication is expected of participants? How were these data reported and used? What are the potential risks of taking part in the research? The questionnaires and interview guides must be robust, clear, and well-written. If they are unclear, it will result in unreliable data, which may compromise the quality of data collected due to mistrust and not provide good protection for the participant or the researcher (Fleming, & Zegwaard, 2018).

RESULTS AND DISCUSSIONS OF FINDINGS

Gender Status

Table 2: Gender Level		**Frequency**	**Percent**
Valid	Male	72	50
	Female	72	50
	Total	144	100.0

Source: Primary data, 2024

Table 2 shows the gender distribution of participants in community-based conservation efforts around NNP. Females represent 50% of the participants and 50% of males. This highlights that women and men are actively engaged in these conservation initiatives. The significant percentage of female participants indicates that women are essential to biodiversity conservation efforts in this area.

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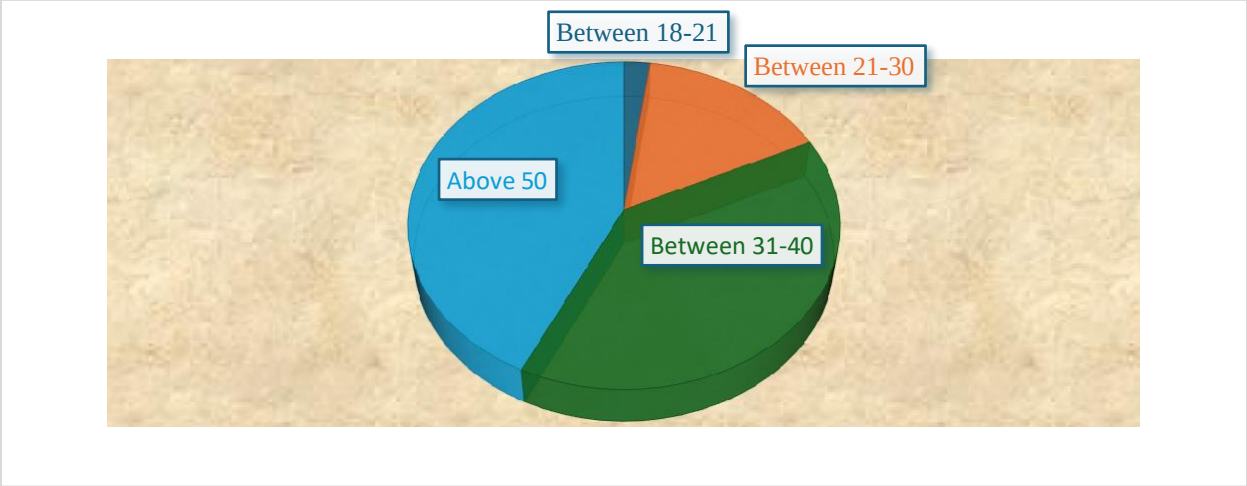
Age Level

Figure 4: Age Level

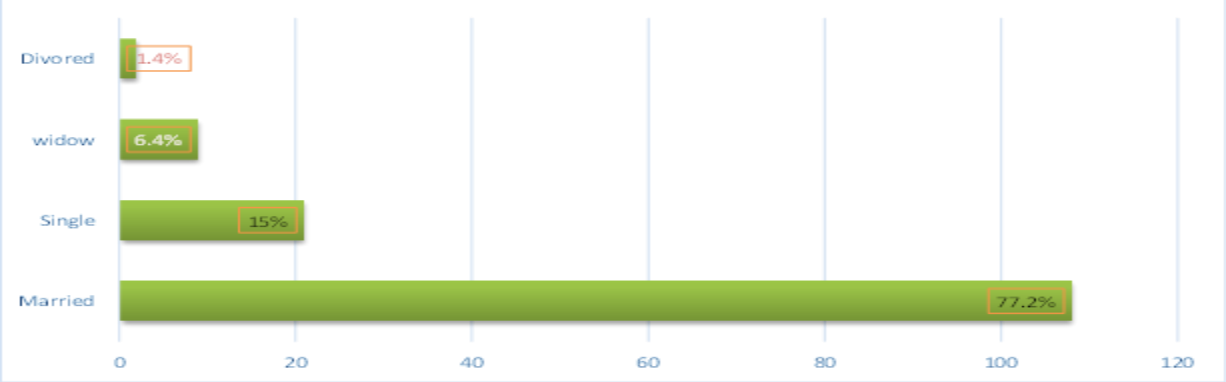


Source: Primary data, 2024

Figure 4 shows that most participants belong to the older age groups, with the highest percentage being over 50 years old (43%), followed by those aged 31-40 (39%). Younger individuals, specifically those under 21 and those between 21-30, represent a smaller share of the participants, at just 2% and 16%, respectively.

Marital Status

Figure 5: Marital Status



Source: Primary data, 2024

Figure 5 reveals that a substantial majority of participants in conservation efforts are married, comprising 77.2% of the total. This indicates that married individuals are significantly more engaged in conservation activities, likely due to their family structures and household responsibilities, which foster a commitment to sustainable resource management. In contrast, single individuals represent a smaller portion at 15.0%, suggesting that their priorities may lean towards education or career development, or they may face barriers to participation. The participation rates of widowed and divorced individuals are notably low, at 6.4% and 1.4%, respectively.

Occupation

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Table 3: Occupation/Job Title

		Frequency	Percent
Valid	Farmer	111	77
	Business/Trader	12	8.3
	Employees from cooperatives	17	12
	Park Manager/Park staff	1	0.7
	Community Development Manager/Park staff	1	0.7
	Head of Law Enforcement Manager/Park staff	1	0.7
	Deputy Head of Law enforcement in charge of operations and welfare	1	0.7
	Total	144	100.0

Source: Primary data, 2024

The data in Table 3 reveals that a significant majority of participants in conservation efforts are farmers, accounting for 77% of the total. This indicates that agriculture serves as the primary source of income for many individuals involved in these initiatives. The close relationship between agriculture and natural resource use underscores the importance of integrating agricultural practices into conservation programs to ensure they align with the livelihoods of the farming community. In addition to farmers, there are smaller groups of participants from other sectors, including business/traders (8.3%) and employees from cooperative respondents (12%).

Table 4: Community-Based Conservation Interventions

Participation and Local Knowledge	SD	D	N	A	SA	Mean	Stv.
To use ex-poachers along with other mechanisms are beneficial in conserving biodiversity in NNP	6 4.3%	3 2.1%	1 .7%	66 47.1%	64 45.7%	4.25	1.003
The local knowledge of communities is an integral part in the reduction of snare in and around the park.	4 2.9%	8 5.7%	0 0%	61 43.6%	67 47.8%	4.31	.923
The major factor that stimulates poaching in NNP is the culture and the belief of communities on the bush meat	9 6.4%	29 20.7%	2 1.4%	47 33.6%	53 37.8%	3.56	1.376
Limited income alternatives are a major factor that stimulates poaching in NNP	11 7.8%	27 19.3%	2 1.4%	47 33.6%	53 37.8%	3.35	1.370
To inform competent authorities at the right time is my contribution to halting biodiversity loss in NNP.	18 12.8%	27 19.3%	2 1.4%	47 33.6%	46 32.8%	3.21	1.398

Source: Primary data, 2024

Table 4 indicates that the statement "Using ex-poachers and other mechanisms for biodiversity conservation" indicates that 45.7% Strongly Agree and 47.1% Agree that involving ex-poachers is beneficial for conservation. This shows strong support for integrating ex-poachers into conservation efforts, suggesting that their local knowledge and experience can be valuable in reducing poaching and promoting biodiversity. Meanwhile, the statement "Local knowledge as integral to reducing snare" reveals that 47.8% Strongly Agree and 43.6% Agree that local knowledge is crucial for reducing snares in and around the park. Additionally, the statement "Culture and belief in bush meat as a factor stimulating poaching" indicates that 33.6% Agree and 37.8% Strongly Agree that cultural beliefs about bush meat contribute to poaching.

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Table 5: Community Conservation Awareness

COMMUNITY CONSERVATION AWARENESS	SD	D	N	A	SA	Mean	Stv
Environmental education and community meetings at different levels are crucial for successful biodiversity conservation in NNP.	**0 0%**	**0 0%**	**0 0%**	**55 39.3%**	**85 60.7%**	**4.61**	**.491**
Illegal tree cutting and poaching in NNP is still occurring due to inadequate knowledge of the importance of biodiversity.	10 7.1%	**0 0%**	**0 0%**	50 35.8%	80 57.1%	4.39	.878
I become happy if I get the opportunity to visit NNP	**0 0%**	**0 0%**	6 4.3%	47 33.6%	87 62.1%	4.71	.560

Source: Primary data, 2024

Tale 5 indicates that Environmental education and community meetings play a vital role in biodiversity conservation, with 60.7% of respondents strongly agreeing and 39.3% agreeing that these elements are essential for effective conservation efforts. There is a clear consensus that education and community involvement are key to preserving biodiversity. This indicates that we should prioritize ongoing and expanded environmental education programs and community meetings to achieve conservation success.

Livelihood Development

Table 6: Livelihood Development

Livelihood development	SD	D	N	A	SA	mean	Stv
The park supports the projects of the coops based on the agenda of the coop	1 .7%	4 2.9%	0 0%	60 42.8%	75 53.6%	4.38	.745
I feel that income-generating projects will counter biodiversity loss in NNP.	0 0%	0 0%	1 .7%	65 46.4%	74 52.9%	4.50	.520
I got adequate skills in cooperative management and tax compliance	46 32.8%	60 42.8%	0 0%	22 15.7%	12 8.6%	2.23	1.234
If the park supports income-generating projects for women around NNP will contribute to the reduction of illegal activities (Poaching, tree cutting, etc.).	0 0%	7 5.0%	1 .7%	49 35%	83 59.3%	4.56	.652

Table 6 displays the results of a finding regarding livelihood development initiatives, whereby the statement regarding “Income-generating projects as a counter to biodiversity loss” shows that 52.9% Strongly Agree and 46.4% Agree that these projects can help mitigate biodiversity loss. There is a strong consensus that livelihood development initiatives, particularly income-generating activities, can significantly reduce illegal practices such as poaching and tree cutting.

People’s Perceptions Towards to Biodiversity Conservation

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Table 7: People's Perceptions

People's Perceptions Towards Conservation	SD	D	N	A	SA	Mean	Stv
NNP has the bequest value for the future generation	9 6.4%	29 20.7%	2 1.4%	47 33.6%	53 37.8%	3.76	1.222
It is a waste of money and time to conserve biodiversity	11 7.8%	27 19.3%	2 1.4%	47 33.6%	53 37.8%	3.96	1.155
I become happy if NNP is cleared for getting the land for agriculture rather than using it for conserving biodiversity	106 75.7%	28 20%	4 2.9%	0 0.0%	2 1.4%	2.18	1.235
My lifestyle is anchored on biodiversity such as bees, and birds. Therefore, I'm not afraid of living close to NNP	1 .7%	4 2.9%	0 0%	60 42.8%	75 53.6%	4.02	1.030
When I get a fire incident in/around the park, immediately inform my president of coop or village chef and have part in mobilizing my neighbours to set out	4 2.9%	8 5.7%	0 0%	61 43.6%	67 47.8%	3.96	1.159
When I get the wild animals get out of the park, I inform the Park staff and translocate to their habitat.	0 0%	7 5.0%	1 .7%	49 43.6%	83 59.3%	3.82	.865

Source: Primary data, 2024

Table 7 displays survey findings on public perceptions, attitudes, and knowledge regarding biodiversity conservation, focusing on NNP and community-based conservation (CBC) initiatives. Regarding the statement "NNP's Bequest Value for Future Generations," 33.6%% Agree and 37.8% Strongly Agree that NNP holds intrinsic value for future generations, underscoring a strong appreciation for the park's long-term ecological and cultural importance and reflecting a forward-looking perspective among participants. In the statement "I become happy if NNP is cleared for getting the land for agriculture rather than using it for conserving biodiversity "A vast majority of respondents (75.7% Strongly Disagree and 20% Disagree) do not support clearing natural areas for agriculture over conservation. This reflects a strong preference for preserving biodiversity over short-term economic gains.

On the other hand, the statement "Lifestyle Anchored on Biodiversity" shows that 42.8% Agree and 53.6% Strongly Agree that their way of life is deeply connected to biodiversity (e.g., bees and birds) and that they are comfortable living near NNP. This highlights a strong bond between local communities and the natural environment, emphasizing the integral role biodiversity plays in their daily lives.

Table 8: Correlations

Correlations		Participation &Engagement	Environmental awareness	Livelihood development	Attitudes & Knowledge
Participation &Engagement	Pearson Correlation	1	.885**	.922**	.925**
	Sig. (2-tailed)		.000	.000	.000
	N	144	144	144	144
Environmental awareness	Pearson Correlation	.885**	1	.817**	.861**
	Sig. (2-tailed)	.000		.000	.000
	N	144	144	144	144
	Pearson Correlation	.922**	.817**	1	.913**

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Correlations		Participation &Engagement	Environmental awareness	Livelihood development	Attitudes & Knowledge
Livelihood development	Sig. (2-tailed)	.000	.000		.000
	N	144	144	144	144
Attitudes & Knowledge	Pearson Correlation	.925**	.861**	.913**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	144	144	144	144

**. Correlation is significant at the 0.01 level (2-tailed).

Table 8 shows a Strong Positive Correlation Between CBC interventions and biodiversity conservation. Positive correlations among Participation & engagement, Environmental Awareness, Livelihood Development, and Attitudes & Knowledge. These relationships imply that improvements in one area are likely to positively affect the others. Key Relationships: Education, Engagement, and livelihood development significantly impact conservation.

Table 9: Regression Analysis Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.942[a]	.888	.885	.31094

a. Predictors: (Constant), **Community conservation Interventions:**

Source: Primary data, 2024

Table 9 shows the Model Summary: $R^2 = 0.888$, indicating 88.8% of the variance in biodiversity conservation is explained by CBC interventions. This implies that enhancing community conservation efforts can lead to notable improvements in biodiversity, community well-being, and environmental outcomes. Key Predictors: Livelihood development (Beta = 0.403) and environmental awareness (Beta = 0.379). This implies that engaging local communities and utilizing their knowledge is important, but it should be paired with stronger influences like livelihood development and awareness programs.

Table 10: ANOVAa

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	104.057	3	34.686	358.751	.000[b]
	Residual	13.149	136	.097		
	Total	117.207	139			

Dependent Variable: **Biodiversity Conservation**

a. Predictors: (Constant), Community conservation Interventions**:**

Table 10 indicates that the analysis of the regression model shows that Community Conservation Interventions have a significant impact on Biodiversity Conservation outcomes. This is demonstrated by the highly significant F-statistic (p = .000), indicating that the model is statistically significant. The large Regression Sum of Squares (104.057) in comparison to the Residual Sum of Squares (13.149) suggests that the predictors explain a substantial portion of the variance in Biodiversity Conservation. The R Square value of 0.888 indicates that the model accounts for 88.8% of the variability in the dependent variable, reinforcing the importance of the predictors. The low Residual Mean Square (0.097) indicates a good model fit, with minimal unexplained variance,

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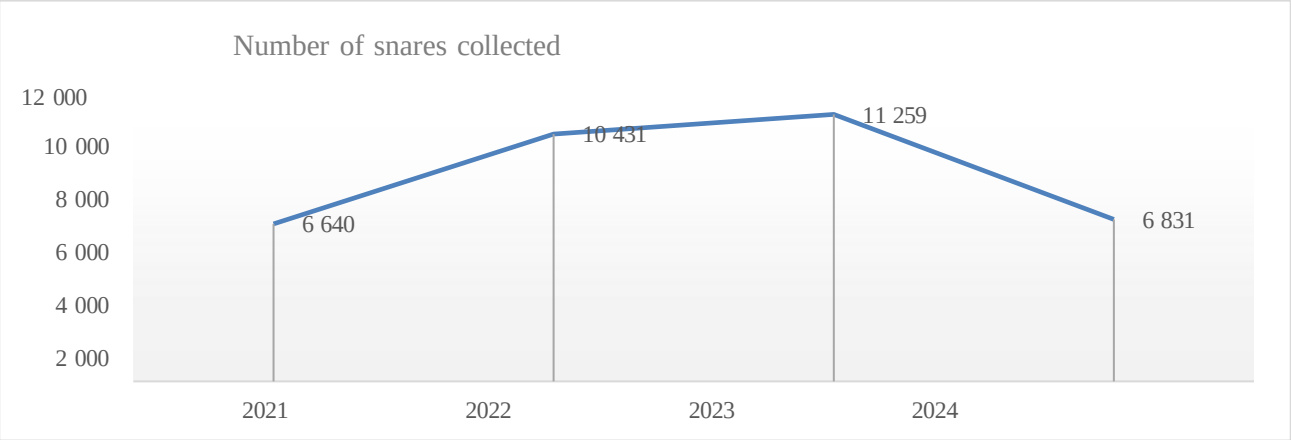
which supports the model's reliability. The ANOVA table further confirms the significance of the regression model, highlighting that Community Conservation Interventions are a strong predictor of Biodiversity Conservation.

Pattern of Illegal Activities in NNP over the Years

Snares Collection

Figure 6: Snares Collection

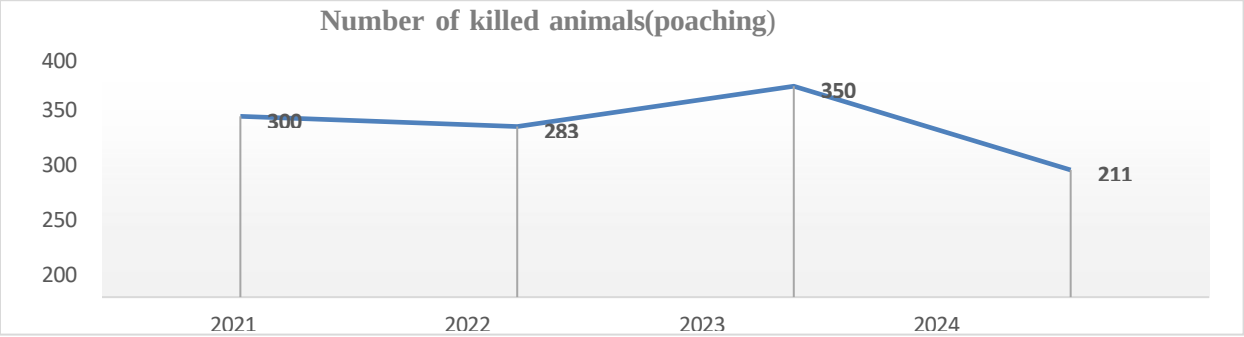


Source: Secondary data,2024

According to Figure 6, the number of snares collected reached its highest point in 2023 with 11,259 Due to conservation efforts, notably CBC interventions and Conservation law enforcement of identifying and collecting. This led to a significant decline in 2024, dropping to 6,831. This implies that 4,428 wildlife animals were saved.

Killed Wildlife Animals

Figure 7: Killed Wildlife Animals (Poaching)



Source: Secondary data, 2024

Figure 7 indicates that in 2022, the number of animals killed due to poaching decreased by 5.67% compared to 2021. This indicates a slight improvement in poaching control or a reduction in poaching activity during this period. In 2023, the number of animals killed due to poaching increased by 23.66% compared to 2022. This suggests a significant rise in poaching activity due to efforts to combat the illegal poaching have not reached on stable state. In 2024, the number of animals killed due to poaching decreased by 39.71% compared to 2023. This indicates a substantial improvement in

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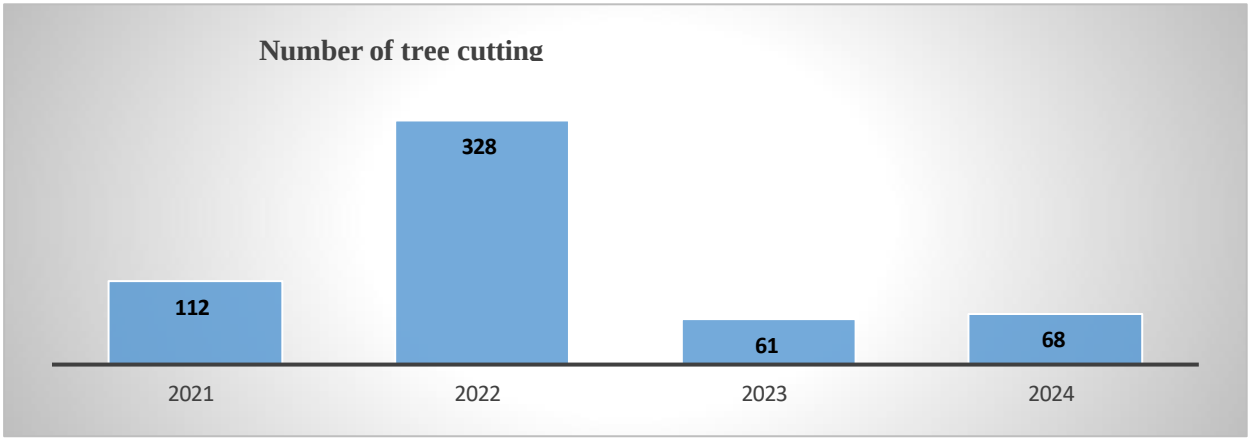
poaching control, possibly due to significant efforts in conservation, notably CBC interventions and conservation law enforcement.

Trees Cutting

Figure 8: Tree Cutting

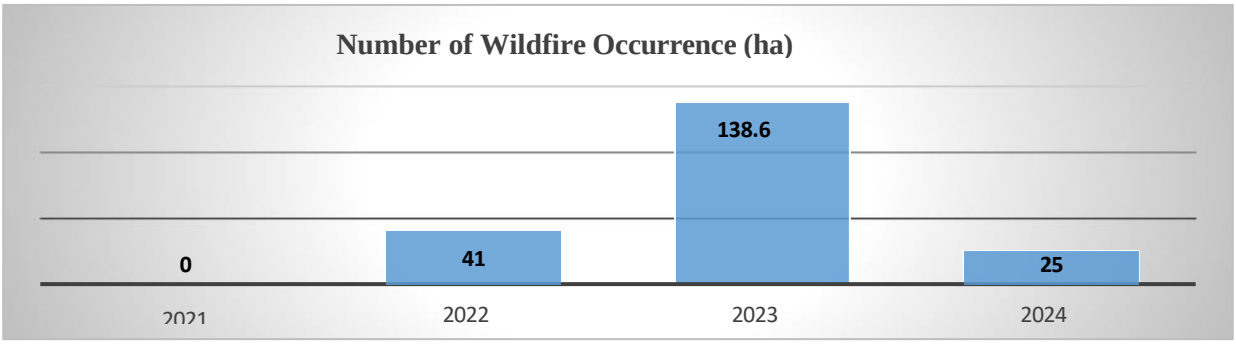


Source: Secondary data, 2024

Figure 8 illustrates that illegal tree cutting experienced a sharp increase in 2022, with 328 incidents reported, but this number fell significantly in the following years, with only 61 in 2023 and 68 in 2024. This decline may indicate the efforts of community-based conservation interventions and conservation enforcement to combat illegal logging in different regions.

Wildfire Occurrence

Figure 9: Wildfire Occurrence



Source: Secondary data, 2024

According to Figure 9, Wildfires were absent in 2021 due to COVID-19, where people were in lockdown but spiked in 2023 (138.6 hectares) before dropping in 2024 (25 hectares). This could be due to climatic conditions (e.g., droughts) or human activities such as poaching, honey harvesting, arson or negligence. With climate change increasing the risk of droughts, wildfires could become more frequent and severe.

Detention/Arrested Persons

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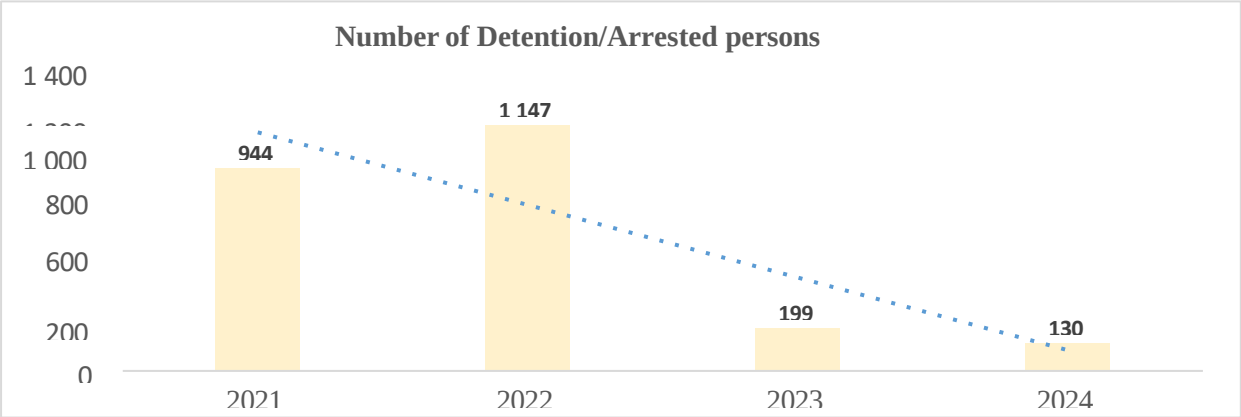
Figure 10: Arrested Persons



Source: secondary data, 2024

Figure 10 indicates that the number of apprehended illegal resource users peaked in 2022 (1,147) but dropped sharply in 2023 (199) and 2024 (130). Those declines might be attributed to community-based conservation interventions and conservation law enforcement.

SUMMARY OF KEYS FINDINGS

Objective 1: To Identify Community-based Conservation Interventions and their Implications in the Conservation of the Biodiversity of Nyungwe National Park

Education interventions through environmental education and community meetings play a vital role in biodiversity conservation, with 60.7% of respondents strongly agreeing and 39.3% agreeing that these elements are essential for effective conservation efforts. There is a clear consensus that education and community involvement are key to preserving biodiversity. A significant 31.6% of respondents strongly disagree, and 46.5% disagree that they possess adequate skills in cooperative management and tax compliance. This indicates that many in the community feel unprepared to effectively manage cooperatives and adhere to tax regulations. There is a clear need for capacity-building programs aimed at improving skills in cooperative management and financial literacy.

Engagement intervention is a critical component to ensure that adjacent communities are informed about park management interventions, and involved in decisions that affect them. 45.1% of respondents strongly agree and 47.1% of respondents agree that the use of ex-poachers with other anti-poaching mechanisms is beneficial in conserving biodiversity in NNP. Additionally, the statement “the local knowledge of communities is an integral part in the reduction of snares in and around the park”. To involve local communities in conservation, in 2022, the management of Nyungwe National Park established an anti-poaching program known as Community Eco-Rangers which aimed at information sharing, Joint patrols with park rangers for removing the snares in the Park, patrols around the park and assistance to community education and conservation awareness at household level. In 2024, 6,831 snares were uprooted in NNP, where community eco rangers played a crucial role not only in uprooting 3,848 snares (56.3%) within the park through their joint patrols with park rangers but also 14 poachers were arrested of 14 poachers, and 3 miners apprehended (NMC, 2024). This indicated that incorporating indigenous and local knowledge as well as involving local communities contribute to safeguarding biodiversity loss

Livelihood development intervention plays a significant contribution in biodiversity conservation

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by creating alternative livelihoods for local communities living around the park by reducing their dependences on natural resources through income-generating projects such as improved fish ponds, improved pig rearing, NTFP like Mushroom, community-based tourism projects. 52.9% Strongly Agree and 46.4% of respondents agree that income-generating projects as a counter to biodiversity loss. There is a strong consensus that livelihood development initiatives, particularly income-generating activities, can significantly reduce illegal practices such as poaching and tree cutting. This underscores the importance of incorporating economic incentives into conservation strategies. Similarly, Dushimimana (2022) found that offering more temporary jobs to communities surrounding the park, creating more cooperatives of ex-poachers, providing domestic animals and involvement of local authorities at the village level in conservation activities will be a viable solution to stop continuous poaching in NNP.

Objective 2: To Assess the Perceptions of Local Communities towards Biodiversity Conservation in NNP

The findings on perceptions of local communities towards biodiversity conservation in NNP indicated that 37.8% Agree and 33.6% of respondents strongly agree that conserving biodiversity is not a Waste of Time and Money" reveals. This implies broad support for conservation efforts and a consensus that biodiversity conservation is a valuable investment. For the statement "NNP's Bequest Value for Future Generations. The statement "Lifestyle Anchored on Biodiversity" shows that 42.8% Agree and 53.6% Strongly Agree that their way of life is deeply connected to biodiversity (e.g., bees, birds) and that they are comfortable living near NNP. This highlights a strong bond between local communities and the natural environment, emphasizing the integral role biodiversity plays in their daily lives. This is in line with the study conducted by Umuziranenge et al, 2021)

Objective 3: To Investigate the Patterns of Illegal Activities that are Addressed through CBC Interventions

Poaching trends fluctuated between 2021 and 2024, with a 5.67% decrease in 2022, a 23.66% increase in 2023, and a significant 39.71% decline in 2024, reflecting improved conservation efforts and community-based interventions. Similarly, illegal tree cutting and wildfires saw sharp increases in 2022 and 2023 but declined in 2024, likely due to enhanced conservation law enforcement and community conservation measures, though climate change remains a risk for wildfires. The number of snares collected peaked in 2023 (11,259) but dropped to 6,831 in 2024, saving an estimated 4,428 animals, while arrests and beehive installations also declined, indicating shifting conservation dynamics and challenges.

CONCLUSION

This research underscores the significant impact of community-based conservation interventions on biodiversity conservation around Nyungwe National Park, showing a strong positive correlation (R = 0.942) between these efforts and improved conservation outcomes. Education, engagement, and livelihood initiatives have driven attitude and behavioural changes, leading to a notable decline in illegal activities like poaching and tree cutting, with community eco-rangers playing a pivotal role by uprooting 56.3% of snares, highlighting the importance of local involvement in sustainable conservation. CBC interventions have significantly contributed to biodiversity conservation in NNP through the reduction in illegal activities and positive community attitudes. Further research on Evaluating the Socio-Economic and Ecological Impacts of Community-Based Conservation Programs on Biodiversity in Nyungwe National Park

Recommendation:

Recommendations for Assessing the Impact of Community-Based Conservation Interventions on

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Biodiversity Conservation around Protected Areas: Case of Nyungwe National Park. Community-based conservation (CBC) interventions are critical for promoting biodiversity conservation while ensuring the well-being of local communities. Below are key recommendations addressed to the management of Nyungwe National Park:

- The strong involvement of local communities in biodiversity conservation is mostly through community eco-rangers. Extend and proper monitoring of community eco-rangers by regularly training them on the code of conduct in the local communities and in the area of collaboration with the management of the park.
- To intensify environmental education and awareness programs for curbing the culture and beliefs of local communities on wildlife animals (bushmeat) to encourage attitudes and behaviours towards conservation by upgrading the knowledge of local communities on biodiversity conservation.
- To scale up income-generating projects throughout the parks as alternative livelihoods for the local communities to reduce the dependence on natural resources from the parks. This will be collated with capacity building on cooperative management, as well as proper monitoring of those projects.
- To enhance the collaboration with different stakeholders, mostly those in charge of law enforcement in the field of biodiversity and environment, for collective actions to counter wildlife crimes or illegal activities.

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