



Community Perceptions of Human–Mountain Gorilla Interactions and Their Implications for Conflict Mitigation and Benefit-Sharing around Volcanoes National Park: Evidence from Kinigi Sector, Rwanda

Hussein Nsabimana^{1*} , David Murindababisha²

¹Department of Environmental Management, Faculty of Sciences of Development, Institut Catholique de Kabgayi (ICK), Rwanda

²Director of Research and Professionalization Centre, Institut Catholique de Kabgayi (ICK), Rwanda

Abstract

Article information

This study assessed community perceptions of human–mountain gorilla interactions and their implications for conflict mitigation and benefit-sharing around Volcanoes National Park (VNP), using Kinigi Sector, Musanze District, Northern Rwanda, as the study area. A convergent mixed-methods design was used, combining quantitative data from 99 households selected through simple random sampling and qualitative data from eight purposively selected key informants, with the two strands integrated through a joint display that classifies findings as convergent, complementary, or divergent. Data were collected using questionnaires, key informant interviews, and document review, and were analysed using descriptive statistics and thematic analysis. In the household survey, perceived gorilla-related crop raiding was the most commonly reported interaction (46.5%), followed by tourism-related interactions (26.3%) and direct encounters (19.2%). Crop loss (49.5%), property damage (25.3%), and income loss (20.2%) were the principal negative livelihood impacts reported by respondents. Most respondents held positive perceptions of mountain gorilla conservation (62.6% positive or very positive; 95% CI: 52.8–71.5%) and 53.5% supported conservation efforts (95% CI: 43.8–63.0%), so majority support among all households in the sector cannot be inferred; 27.3% opposed conservation efforts. Key informants explained the positive perceptions by reference to employment, tourism income, infrastructure development, and community programmes; these are informants' explanations, not relationships demonstrated by the survey data, which were descriptive, cross-sectional, and drawn from a single sector, and therefore indicate association rather than causation.

Keywords: Community perceptions; Human–mountain gorilla interactions; Mountain gorilla conservation; Livelihood impacts; Human–wildlife conflict; Kinigi Sector; Rwanda

Received date: 12/09/2026;
Reviewed: 18/09/2026;
Revised date: 24/09/2026;
Accepted date: 26/09/2026

* **Corresponding author:** Hussein Nsabimana (nsabimanahussein222@gmail.com)

How to cite this article: Nsabimana, H., en Murindababisha, D. (2026) 'Community Perceptions of Human–Mountain Gorilla Interactions and Their Implications for Conflict Mitigation and Benefit-Sharing around Volcanoes National Park: Evidence from Kinigi Sector, Rwanda', *Journal of African Research and Developmental Studies*, 3(1), pp. 1-19. Available at: <https://doi.org/10.58197/a19bfd81>

Introduction

Wildlife conservation is central to preserving biodiversity and ecological balance, and protected areas remain among the most important instruments for safeguarding threatened species and their habitats (Watson et al., 2014). The mountain gorilla (*Gorilla beringei beringei*) is one such endangered species conserved within Volcanoes National Park (VNP) in Rwanda, the Rwandan part of the Virunga Massif shared with Uganda and the Democratic Republic of the Congo, where a minimum of 604 individuals were counted in 2016 (Granjon et al., 2020). The park is recognised for its exceptional biodiversity and its substantial contribution to national tourism and conservation revenue (Snyman et al., 2023; Spenceley et al., 2017). Communities living adjacent to VNP, particularly those in Kinigi Sector, Musanze District, experience frequent encounters with mountain gorillas because of their proximity to the park boundary. These encounters generate both positive outcomes, such as tourism-related income (Sabuhoro et al., 2021), and negative outcomes, such as crop raiding and other livelihood challenges (Hill, 2015).

Community perceptions of these interactions are critical to conservation success because they shape local attitudes and behaviour towards wildlife protection (Bennett, 2016). Rwanda has invested considerably in mountain gorilla conservation through protection measures, tourism development, and community-based conservation initiatives, including tourism revenue-sharing schemes intended to strengthen relationships between protected areas and neighbouring communities (Sabuhoro et al., 2021; Snyman et al., 2023). Despite these achievements, communities bordering VNP continue to experience recurrent human–wildlife interactions, most notably crop raiding (McGuinness, 2016; Ndayishimiye et al., 2023), which can undermine agricultural production and household livelihoods and, in turn, affect attitudes towards conservation (McGuinness & Taylor, 2014).

Although previous research has examined community-based conservation, tourism benefits, and human–wildlife interactions in Rwanda and the wider Albertine Rift region, localised empirical evidence on community perceptions of human–mountain gorilla interactions and their implications for conflict mitigation and benefit-sharing specific to Kinigi Sector during 2021–2025 remains limited. Specifically, existing studies have evaluated Rwanda's Tourism Revenue Sharing programme at national level (Snyman et al., 2023); examined support for conservation and attitudes towards tourism policy among communities neighbouring VNP in relation to ecotourism opportunities and perceived benefits (Kalulu et al., 2016; Sabuhoro et al., 2021); analysed crop-raiding perceptions in relation to land tenure or focused on primates other than gorillas (McGuinness & Taylor, 2014; McGuinness, 2016; Ndayishimiye et al., 2023); or assessed human–wildlife conflict across Rwandan ecoregions (Sun et al., 2025). To our knowledge, none has jointly estimated, for households in Kinigi Sector during 2021–2025, the types and frequency of interactions with mountain gorillas, the principal livelihood costs and benefits that residents associate with them, and attitudes towards conservation, with measures of precision and with key-informant explanations of the pattern. This gap constrains the ability of conservation institutions and local authorities to design context-specific interventions that reconcile mountain gorilla protection with the livelihood needs of neighbouring communities. This study

therefore assessed community perceptions of human–mountain gorilla interactions and their implications for conflict mitigation and benefit-sharing around Volcanoes National Park, with a focus on Kinigi Sector. Throughout, “implications” refers to implications for human–wildlife conflict mitigation and benefit-sharing that can be derived from (a) the costs and benefits respondents reported, (b) the attitudes they expressed, and (c) key informants' explanations; these are study-informed inferences, not effects demonstrated by the data. The study contributes (i) sector-level quantitative estimates with measures of precision, (ii) qualitative evidence from institutional and community key informants, and (iii) *study-informed* recommendations addressed to specific conservation and local-government institutions.

Research Objectives

The overall objective of this study was to assess community perceptions of human–mountain gorilla interactions and *their implications for conflict mitigation and benefit-sharing in Kinigi Sector*. Specifically, the study sought to:

1. Identify the types of interactions between local communities and mountain gorillas around the park.
2. Examine community perceptions and attitudes towards mountain gorillas and conservation efforts.
3. Assess the impacts of human–mountain gorilla interactions on local livelihoods.
4. *Derive study-informed implications for conflict mitigation and benefit-sharing from the costs and benefits respondents reported, the attitudes they expressed (including the minority who oppose conservation), and key-informant explanations.*

Literature Review

Theoretical Framework

This study is anchored in a stewardship perspective that draws on the ecosystem stewardship framework (Chapin et al., 2010) and community-based conservation thinking (Berkes, 2004), and which holds that communities living near natural resources play a central role in conservation through their everyday actions and decisions. Building on this perspective, this study assumes that when local communities perceive tangible benefits from conservation and are actively involved in related decision-making, they are more likely to support and protect natural resources; conversely, negative experiences such as crop damage can weaken this support. In the context of Kinigi Sector, this perspective helps explain how community members can become positive stewards of mountain gorilla conservation when they perceive benefits, while adverse encounters with gorillas may erode that support. Accordingly, the study examines both the perceived costs (crop raiding, property damage, and income loss) and the perceived benefits (employment, tourism income, and infrastructure) that are theorised to shape community perceptions.

To make the framework operational, and not only a lens for interpreting findings after the fact, three propositions derived from it guided the study: (P1) perceived costs of coexistence (crop loss, property damage, income loss) are expected to be associated with less favourable attitudes towards conservation; (P2) perceived benefits (employment, tourism income, infrastructure, community programmes) and perceived inclusion are expected to be associated with more favourable attitudes; and (P3) the balance between perceived costs and benefits indicates the potential for community

stewardship. These propositions guided (i) the choice of variables (interaction type, frequency, and seriousness; livelihood impacts; benefits received; general perception; and support for conservation); (ii) the organisation of the questionnaire into interaction, livelihood-impact, and perception and attitude sections, and the topics explored with key informants; (iii) the analysis, in which the prevalence of costs, benefits, and attitudes was described and key-informant explanations were used to interpret them; and (iv) the interpretation, in which findings are reported as consistent or inconsistent with each proposition. The framework was used as a sensitising rather than a hypothesis-testing framework: because the analysis was descriptive, P1–P3 were not tested statistically, and findings are described as consistent with them, not as confirming them.

Human–Wildlife Interactions and Community Perceptions

Human–wildlife interactions occur where human activity overlaps with wildlife habitat, producing outcomes that range from crop raiding and property damage to shared tourism benefits (Hill, 2015). Community perceptions, meaning the attitudes, beliefs, and opinions that local people hold about such interactions, are shaped substantially by the benefits and costs that communities experience from living near protected areas (Bennett, 2016). Research consistently shows that frequent crop raiding is associated with negative attitudes towards wildlife (Hill, 2015). In western Rwanda, McGuinness and Taylor (2014) documented substantial crop losses to primates among farmers bordering Gishwati Forest, while in the Volcanoes National Park landscape specifically, McGuinness (2016) demonstrated that perceptions of crop-raiding conflict are influenced by factors such as land tenure and agro-industry, underscoring the localised nature of these perceptions. Crop raiding around VNP is also not attributable to gorillas alone: golden monkeys (*Cercopithecus mitis kandti*), for example, are frequent crop foragers around the park (Ndayishimiye et al., 2023), so residents' perceptions of “gorilla” interactions may partly reflect wider interactions with wildlife. More recently, Sun et al. (2025) confirmed that the intensity and type of human–wildlife conflict across Rwandan ecoregions continue to shape community perceptions of conservation status.

It is important to distinguish general human–wildlife conflict from gorilla-specific interactions. Much of the crop-raiding literature cited above concerns forest-dwelling primates at Gishwati (McGuinness & Taylor, 2014), golden monkeys (Ndayishimiye et al., 2023), or human–wildlife conflict in general (Hill, 2015), rather than mountain gorillas specifically, and community-perspective evidence on gorilla-specific interactions is comparatively scarce in the sources reviewed here. This literature is therefore used as context and for comparison, not as evidence that the crop damage reported in Kinigi Sector is caused by gorillas. Accordingly, this study treats crop raiding as a perceived, respondent-attributed interaction and makes no claim of species-level attribution.

Community Participation and Benefits of Conservation

A substantial body of evidence indicates that community participation and equitable benefit-sharing improve conservation outcomes. Berkes (2004) argued that conservation is more effective when local communities are involved in decision-making, since participation fosters a sense of ownership and responsibility towards natural resources. Bennett et al. (2017) similarly emphasised that mainstreaming social science perspectives, including community perceptions and participation, is essential for effective conservation governance. In the Rwandan context, tourism revenue-sharing programmes have been central to building local support for protected areas: Sabuhoro et al. (2021) found that ecotourism opportunities generate meaningful support for mountain gorilla conservation among communities neighbouring VNP, while Snyman et al. (2023), reviewing fifteen years of

Rwanda's Tourism Revenue Sharing programme, reported that consistent benefit-sharing has strengthened community–park relationships over time. Kalulu et al. (2016) similarly found that local communities around VNP hold generally favourable attitudes towards tourism conservation policy when they perceive direct benefits. Beyond Rwanda, Bushell et al. (2007) observed that tourism in and around protected areas can extend benefits beyond park boundaries to surrounding communities when properly managed, while Plumptre et al. (2007) demonstrated that transboundary conservation initiatives in the Greater Virunga landscape depend on the cooperation and engagement of communities across the region.

Challenges in Human–Wildlife Interactions

Despite these benefits, unresolved challenges persist. Sabuhoro et al. (2020) found that where conservation benefits are perceived as inadequate, some community members resort to illegal use of protected area resources, reflecting the tension between conservation restrictions and livelihood needs. Twinamatsiko et al. (2014), examining Bwindi Impenetrable National Park in neighbouring Uganda, similarly found that a lack of fair benefit-sharing can generate conflict and negative attitudes towards conservation authorities. Robbins et al. (2011), while documenting the successful recovery of the Virunga mountain gorilla population through intensive conservation measures, noted that this recovery has occurred alongside continued interaction between gorillas and adjacent agricultural communities. Collectively, these studies indicate that conservation success in the Virunga landscape is inseparable from how well conservation institutions manage the costs and benefits experienced by neighbouring communities.

Summary and Research Gap

The reviewed literature demonstrates that community perceptions play a decisive role in conservation outcomes around Volcanoes National Park and comparable protected areas in the Albertine Rift. Positive perceptions are consistently linked to tourism benefits, employment, and participatory governance, while negative perceptions arise from crop raiding, property damage, and inequitable benefit-sharing (Bennett, 2016; Berkes, 2004; Sabuhoro et al., 2021; Twinamatsiko et al., 2014). However, much of this evidence is drawn from broader regional or national assessments, and localised, current evidence specific to Kinigi Sector, one of the sectors bordering VNP, remains limited. Much of the available evidence on crop raiding also concerns wildlife other than gorillas, so gorilla-specific perceptions in Kinigi Sector are not yet established. This study addresses that gap by generating recent, sector-specific evidence on community perceptions of human–mountain gorilla interactions and their implications for conflict mitigation and benefit-sharing.

Methodology

Study Area

This study was conducted in Kinigi Sector, Musanze District, Northern Province of Rwanda, which borders Volcanoes National Park. VNP forms the Rwandan part of the Virunga Massif, a transboundary landscape shared with Uganda and the Democratic Republic of the Congo that supports one of the world's two remaining mountain gorilla populations (Granjon et al., 2020). Farming was the main occupation of respondents (61.6%), and Kinigi Sector was selected *because of* its direct boundary contact with the park and the frequency of human–gorilla encounters.

Research Design, Population and Sampling

The study adopted a convergent mixed-methods research design, combining quantitative and qualitative approaches to generate a comprehensive understanding of community perceptions. *In this design, quantitative and qualitative data were collected during the same period, analysed separately, and then integrated at three levels: (i) at the design level, both strands addressed the same objectives and constructs (interactions, perceptions, livelihood impacts, and benefits); (ii) at the methods level, survey indicators and key-informant themes were merged in a joint display organised by objective (Table 6); and (iii) at the interpretation and reporting level, each merged item was classified as convergence (the strands agree), complementarity (the qualitative strand explains or extends the quantitative result), or divergence (the strands differ, or one strand does not address the finding), following Fetters et al. (2013) and Creswell and Plano Clark (2018).* Quantitative data were collected from households in four cells bordering the park (Bisoke, Kaguhu, Nyabigoma, and Nyonirima), which together comprise approximately 6,890 households. A sample of 99 households was determined using Yamane's (1967) formula at a 10% margin of error ($n = N/[1 + N \times e^2] = 6,890/[1 + 6,890 \times 0.10^2] \approx 98.6$, rounded up to 99) and selected through simple random sampling, proportionally distributed across the four cells (33 in Nyonirima, 27 in Kaguhu, 21 in Nyabigoma, and 18 in Bisoke). A 10% margin of error was adopted, rather than the conventional 5%, for four reasons. First, the study was an exploratory, sector-level descriptive study intended to produce first estimates for Kinigi Sector, not to test hypotheses. Second, a 5% margin would have required about 379 households ($6,890/[1 + 6,890 \times 0.05^2]$), which exceeded the resources and field access available. Third, Yamane's formula assumes maximum variability (a proportion of 50%), which yields the widest possible interval; estimates far from 50% are therefore more precise than the nominal margin suggests (Israel, 1992). Fourth, precision is reported openly: with $n = 99$ the 95% interval for a proportion near 50% is roughly ± 10 percentage points, and Wilson confidence intervals are given for all key indicators so that readers can judge how far each result can be relied upon. The wider intervals are taken into account in interpretation: small differences between categories are not interpreted, and majority claims are made only where the interval excludes 50%. In addition, eight key informants (comprising the Kinigi Sector Executive Secretary, a Rwanda Development Board conservation officer, a Dian Fossey Gorilla Fund conservation officer, two community leaders, a tourism sector representative, a women's representative, and a youth representative) were purposively selected for their direct involvement in, and knowledge of, mountain gorilla conservation and community affairs.

Operational Definitions and Terminology

Human–mountain gorilla interaction. In this study, an interaction is any contact with mountain gorillas, or any effect attributed to them, that respondents reported experiencing during 2021–2025. Four categories were recorded: perceived gorilla-related crop raiding (crop damage that the respondent attributed to gorillas); tourism-related interaction (contact arising through gorilla-tourism activities, including tourism-related work); direct encounter (a reported sighting or physical encounter with gorillas outside tourism activities); and other. All interaction data are therefore respondent-reported and perception-based.

Perceived versus verified crop raiding. Crop damage and its attribution to gorillas were not verified in the field or through park records, and golden monkeys and other wildlife also forage around VNP. The term “perceived gorilla-related crop raiding” (shortened to “perceived crop raiding” hereafter) is

therefore used for all survey-based figures. The term “verified” is reserved for damage whose causal species has been confirmed independently, which this study did not do.

Perceptions and support. General perception (very negative to very positive) refers to respondents' overall evaluation of mountain gorillas and their conservation; support for conservation (strongly oppose to strongly support) refers to their endorsement of conservation efforts. The two are reported separately because they are not interchangeable.

Implications. “Conservation implications” are the implications for conflict mitigation and benefit-sharing that follow from four types of evidence: the costs respondents reported (Table 4), the benefits they reported, including the share reporting none (Table 4), their attitudes, including those of the minority who oppose conservation (Table 3), and key-informant explanations (Table 6). Each implication is labelled study-informed, and Table 7 states which finding it rests on and whether the study tested it.

Data Collection

Data were collected using structured questionnaires administered to households, semi-structured interview guides administered to key informants, and document review of relevant conservation reports and policies. The questionnaire captured data on respondents' socio-demographic characteristics, the types and frequency of human–mountain gorilla interactions, community perceptions and attitudes towards conservation, and the livelihood impacts of these interactions. Perceptions, support for conservation, and the frequency and seriousness of interactions were measured on ordinal response scales (e.g., very negative to very positive). Household data were collected between May–July 2026, and respondents were asked to recall interactions during the reference period 2021–2025. Questionnaires were administered face to face in Kinyarwanda by researchers. The questionnaire was pre-tested with 6 households outside the sample and revised for wording and sequence before fieldwork. Content validity was reviewed by two conservation-social-science lecturers], and reliability was assessed by Cronbach's alpha for any multi-item scale; not applicable to single-item indicators. Key informant interviews were conducted in Kinyarwanda, lasted about 40 minutes on average, and were audio-recorded with consent and documented in detailed notes and transcribed and translated into English for analysis.

Data Analysis

Quantitative data were coded and analysed using IBM SPSS Statistics Version 27 and Microsoft Excel, with descriptive statistics (frequencies and percentages) used to summarise and present findings in tabular form. Where response categories were combined (“positive” and “very positive”), percentages were calculated from raw counts, and 95% confidence intervals were calculated using the Wilson score method (Wilson, 1927) to indicate the precision of key estimates. Qualitative data from key informant interviews were analysed thematically following the six phases of Braun and Clarke (2006): familiarisation with the transcripts, generation of initial codes, searching for themes, reviewing themes, defining and naming themes, and reporting. Coding was combined inductive and deductive: codes were derived from the data and then organised under the study objectives. The first coding was carried out by the first author, and second author independently reviewed a sample of coded extracts and the draft themes; disagreements were resolved by discussion until consensus. Themes were developed by grouping related codes and checking each theme against the full set of coded extracts. Saturation was judged at the code level: interviews were considered sufficient when the last 2

interviews yielded no new codes relevant to the main themes (crop raiding, benefits, and community involvement). Guest et al. (2006) found that basic themes can emerge within the first few interviews of a relatively homogeneous sample; because the eight informants here held different institutional and community roles, saturation is claimed only for the themes reported in this paper and does not imply generalisability. Integration of the two strands followed the procedure described under Research Design and is presented in a joint display (Table 6). No inferential tests were performed: associations between perceptions and respondent characteristics, benefit receipt, or crop-loss experience were not tested.

Results and Discussion

Socio-Demographic Characteristics of Respondents

Of the 99 household respondents, 53.5% were female and 46.5% were male, indicating a relatively balanced sample. Respondents aged 26–35 years formed the largest age group (29.3%), followed by those aged 36–45 years (28.3%). The majority of respondents were married (64.6%), had attained only primary education (47.5%), and were engaged in farming (61.6%) as their primary occupation, with smaller proportions in business (17.2%) and tourism-related work (13.1%). Table 1 summarizes these characteristics.

Table 1: Socio-Demographic Characteristics of Respondents (n = 99)

Variable	Category	Frequency	Percent (%)
Gender	Female	53	53.5
	Male	46	46.5
Age	18–25	14	14.1
	26–35	29	29.3
	36–45	28	28.3
	46–55	17	17.2
	56–65	8	8.1
	Above 65	3	3.0
Marital status	Married	64	64.6
	Single	27	27.3
	Widowed	8	8.1
Education level	No formal education	11	11.1
	Primary	47	47.5
	Secondary	33	33.3
	University	8	8.1
Occupation	Farmer	61	61.6
	Business	17	17.2

Tourism-related work	13	13.1
Other	8	8.1

Source: Field survey data, 2026

Types and Frequency of Human–Mountain Gorilla Interactions

The findings show that interactions between communities and mountain gorillas are common in Kinigi Sector: 31.3% of respondents reported frequent interactions and 22.2% very frequent interactions (53.5% combined; 95% CI: 43.8–63.0%), while only 5.1% reported never interacting with mountain gorillas. As shown in Table 2, perceived gorilla-related crop raiding was the most commonly reported form of interaction (46.5%), followed by tourism-related interactions (26.3%) and direct encounters (19.2%). Because respondents' attribution of crop damage to gorillas, rather than to other wildlife, was not independently verified, this figure, and every crop-raiding figure in this paper, should be read as perceived gorilla-related crop raiding (hereafter “perceived crop raiding”) and not as verified gorilla crop raiding (see Operational Definitions and Terminology and Limitations of the Study). Most respondents (68.7%; 95% CI: 59.0–77.0%) perceived these interactions as serious or very serious.

Table 2: Types of Human–Mountain Gorilla Interactions (n = 99)

Type of Interaction	Frequency	Percent (%)
Perceived crop raiding	46	46.5
Tourism-related interaction	26	26.3
Direct encounter	19	19.2
Other	8	8.1

Source: Field survey data, 2026

These results are consistent with previous research on human–wildlife interaction patterns in Rwanda, most of which concerns wildlife other than gorillas, so the comparison is contextual and not species-specific. Hill (2015) similarly identified crop raiding as the dominant form of human–wildlife conflict at the wildlife–agriculture boundary, while McGuinness and Taylor (2014), studying farmers around Gishwati Forest in western Rwanda, reported substantial crop losses to forest-dwelling primates, with replacement costs possibly reaching 10–20% of total household income, and Ndayishimiye et al. (2023) described golden monkeys as frequent crop foragers around VNP. Key informants in the present study corroborated this pattern, explaining that gorillas periodically leave the park to forage in nearby farms during crop maturity, with Irish potatoes (*Solanum tuberosum*), pyrethrum (*Tanacetum cinerariifolium*), and young *Eucalyptus* spp. plantations most affected. These informant accounts attribute the damage to gorillas but, like the survey, were not supported by field verification of the species responsible. As one Rwanda Development Board conservation officer explained, crop raiding remains common because many households cultivate close to the park boundary, although gorilla tourism has simultaneously created employment opportunities that benefit local residents. This convergence between quantitative and qualitative evidence, and its consistency with McGuinness (2016) on the role of land tenure and agro-industry in shaping perceptions of conflict, suggests that boundary-zone agriculture may contribute to the frequency of reported interactions in Kinigi Sector. However, this study did not measure distance from the park boundary or farm-level exposure, so this link could not be tested directly.

Community Perceptions and Support for Conservation

Despite the prevalence of perceived crop raiding, community perceptions of mountain gorillas and their conservation were largely positive. As shown in Table 3, 32.3% of respondents reported positive perceptions and 30.3% very positive perceptions (62.6% combined; 95% CI: 52.8–71.5%), compared with 23.2% who reported negative or very negative perceptions. Support for conservation followed a similar pattern, with 53.5% of respondents supporting or strongly supporting conservation efforts (95% CI: 43.8–63.0%) a slim majority of the sample, but with an interval that includes 50%, so majority support among all households in the sector cannot be concluded, against 27.3% who opposed or strongly opposed them and 19.2% who were neutral. Although positive views predominate, the sizeable minority who oppose conservation (27.3%) or hold negative perceptions (23.2%) is not negligible: dissatisfaction with benefit-sharing has been linked to negative attitudes and to illegal use of protected area resources in comparable contexts (Sabuhoro et al., 2020; Twinamatsiko et al., 2014), so this group merits particular attention in outreach and benefit-sharing. The 27.3% who opposed conservation (27 of 99; 95% CI: 19.5–36.8%) deserve analytical attention equal to that given to the supportive majority. Two features can be established from the tabulated data alone. First, only six respondents (6.1%) reported receiving no conservation benefit, so at least 21 of the 27 who opposed conservation (78%) reported receiving at least one benefit; opposition therefore cannot be explained mainly by an absence of any benefit. Second, 27 respondents opposed conservation but only 23 held negative perceptions, so at least four opponents did not report negative perceptions, which indicates that perception of gorillas and support for conservation measures are not interchangeable. Whether opponents differ from supporters in occupation, benefit receipt, interaction frequency, or livelihood impact was not examined, because the analysis was descriptive and no cross-tabulations were run; with only 27 opponents, subgroup cells would in any case be very small. This is identified as a priority for future work (see Limitations of the Study). One possible explanation, offered in comparable settings but not tested here, is that benefits are perceived as insufficient relative to the costs incurred (Sabuhoro et al., 2020; Twinamatsiko et al., 2014).

Table 3: Community Perceptions and Support for Mountain Gorilla Conservation (n = 99)

Indicator	Category	Frequency	Percent (%)
General perception	Very positive	30	30.3
	Positive	32	32.3
	Neutral	14	14.1
	Negative	15	15.2
	Very negative	8	8.1
Support for conservation	Strongly support	18	18.2
	Support	35	35.4
	Neutral	19	19.2
	Oppose	18	18.2
	Strongly oppose	9	9.1

Source: Field survey data, 2026

These findings are consistent with Sabuhoro et al. (2021), who found that ecotourism benefits generate meaningful support for mountain gorilla conservation among communities neighbouring VNP, and with Snyman et al. (2023), who reported that Rwanda's long-running Tourism Revenue Sharing programme has strengthened community–conservation relationships over time. Key informants explained the largely positive perceptions by reference to tourism income, employment, infrastructure development, and conservation awareness programmes (an interpretation offered by informants, not a relationship demonstrated by the survey data), echoing Kalulu et al. (2016), who found favourable local attitudes towards conservation policy in areas surrounding VNP where tangible benefits were perceived. The results are also consistent with the stewardship perspective (Chapin et al., 2010) and Berkes' (2004) argument that community participation and perceived ownership strengthen conservation support: almost all respondents (93.9%; 95% CI: 87.4–97.2%) reported receiving a conservation benefit, and most held positive views despite widely reported crop damage. This pattern suggests, but does not demonstrate, that community attitudes in Kinigi Sector may be associated less with the mere occurrence of human–wildlife interaction than with whether communities perceive themselves as benefiting from, and included in, conservation; this is a proposition for future testing (P2 and P3), not a finding of this study. The data also show that receiving some benefit is not sufficient for support: near-universal benefit receipt (93.9%) coexists with a slim, statistically inconclusive majority in support (53.5%), which qualifies P2 and points to the need to examine the adequacy and fairness of benefits, not only their receipt. Testing this proposition would require cross-tabulating or modelling perceptions against benefit receipt and crop-loss experience, which was beyond the descriptive scope of this study.

Livelihood Impacts and Conservation Benefits

The study further assessed the livelihood implications of human–mountain gorilla interactions. Overall, 64.6% of respondents (95% CI: 54.8–73.4%) reported high or very high livelihood impacts. As shown in Table 4, crop loss (49.5%), property damage (25.3%), and income loss (20.2%) were identified as the principal negative effects. At the same time, most respondents acknowledged deriving benefits from conservation activities, most commonly employment opportunities (28.3%), infrastructure development (26.3%), and tourism income (23.2%), while only 6.1% reported receiving no benefit. Respondents were asked to select one principal negative impact and one principal benefit (single-response items; see Data Collection), so the responses in each block of Table 4 sum to 99. The figures therefore reflect the main effect perceived, and households experiencing several impacts or benefits cannot be identified.

Table 4: Livelihood Impacts and Benefits from Conservation Activities (n = 99)

Category	Type	Frequency	Percent (%)
Negative livelihood impact	Crop loss	49	49.5
	Property damage	25	25.3
	Income loss	20	20.2
	Other	5	5.1
Conservation benefit received	Employment opportunities	28	28.3

Infrastructure development	26	26.3
Tourism income	23	23.2
Other	16	16.2
No benefit received	6	6.1

Source: Field survey data, 2026 Crop loss is respondent-reported; attribution to gorillas was not independently verified. Impacts and benefits were single-response items.

This dual pattern of costs and benefits mirrors findings from earlier studies in Rwanda. McGuinness and Taylor (2014) documented substantial crop losses to primates among farmers bordering Gishwati Forest, and Ndayishimiye et al. (2023) reported that crop foraging by golden monkeys is frequent around VNP; the present findings on livelihood costs are consistent with this evidence for the 2021–2025 period (that evidence concerns other primates, so the comparison is of the type of impact and not of the species responsible) and indicate that crop damage remains a substantial livelihood challenge despite years of conservation investment. Conversely, the benefits reported by respondents correspond closely with Spenceley et al. (2017), who found that well-managed tourism partnerships around protected areas can generate sustainable revenue that supports both conservation and community development, and with Bushell et al. (2007), who observed that tourism benefits can extend meaningfully beyond park boundaries when properly structured. Key informants explained that repeated destruction of Irish potatoes, pyrethrum, and young *Eucalyptus* plantations directly threatens household food security and income among farming families, a concern that resonates with Sabuhoro et al. (2020), who found that perceived inadequacy of conservation benefits relative to livelihood costs can drive illegal resource use in protected landscapes. Taken together, the results suggest, as a study-informed interpretation, that sustainable coexistence in Kinigi Sector may depend on maintaining and where possible strengthening the balance between mitigating crop-raiding losses and sustaining equitable, visible conservation benefits, a balance also emphasised by Twinamatsiko et al. (2014) and Plumptre et al. (2007) in comparable Albertine Rift contexts.

Summary of Key Indicators and Precision of Estimates

Table 5 consolidates the main indicators by combining adjacent response categories and reporting 95% confidence intervals (Wilson score method), which show how precisely each proportion is estimated from a sample of 99 households.

Table 5: Key Indicators with 95% Confidence Intervals (n = 99)

Indicator	n / N	Percent (%)	95% CI (%)
Frequent or very frequent interactions	53/99	53.5	43.8–63.0
Interactions rated serious or very serious	68/99	68.7	59.0–77.0
Perceived crop raiding as the main interaction type	46/99	46.5	37.0–56.2
High or very high livelihood impact	64/99	64.6	54.8–73.4
Positive or very positive perception	62/99	62.6	52.8–71.5
Negative or very negative perception	23/99	23.2	16.0–32.5
Support or strongly support conservation	53/99	53.5	43.8–63.0

Oppose or strongly oppose conservation	27/99	27.3	19.5–36.8
Received a conservation benefit	93/99	93.9	87.4–97.2

Source: Field survey data, 2026; 95% confidence intervals computed using the Wilson score method

The intervals are wide (roughly ± 9 –10 percentage points), so differences of a few percentage points, such as those between employment (28.3%), infrastructure development (26.3%), and tourism income (23.2%) as the main conservation benefit, should be interpreted cautiously. The majority findings on interaction seriousness, livelihood impact, and positive perceptions are more robust, since their intervals lie above 50%. By contrast, the interval for support for conservation (43.8–63.0%) includes 50%, so it cannot be concluded that a majority of households in the sector support conservation efforts, even though a slim majority of the sample did. This caution applies wherever support for conservation is mentioned in this paper, including the Abstract and Conclusions: the figure of 53.5% describes the sample, and the sector-wide proportion could plausibly lie anywhere between 43.8% and 63.0%.

Integration of Survey and Key-Informant Findings

Table 6 presents the joint display. Reading across it, the two strands converged on the dominant perceived interaction (perceived crop raiding) and on the types of benefit received; the qualitative strand explained and extended the survey results on why crop loss matters and on what informants believe underlies the positive perceptions; and the strands diverged, or left a gap, on two points: the reasons why 27.3% of respondents oppose conservation despite widespread benefit receipt, and the species responsible for crop damage.

Table 6: Joint Display Integrating Household Survey and Key-Informant Findings

Objective and theme	Household survey (n = 99)	Key-informant evidence (n = 8)	Integration	What the integration adds
Obj. 1: Main interaction	Perceived crop raiding most reported (46.5%; 95% CI 37.0–56.2%); tourism-related 26.3%; direct encounters 19.2%; 53.5% frequent or very frequent interactions.	Gorillas said to leave the park periodically to forage in farms when crops mature; Irish potato, pyrethrum, and young Eucalyptus most affected; raiding common because many households cultivate near the boundary.	Convergence, with complementarity	Both strands agree that crop raiding is the main perceived interaction; interviews add which crops and when. Neither strand verifies the species responsible.
Obj. 3: Livelihood costs	Principal negative impact: crop loss 49.5%, property damage 25.3%, income loss 20.2%; 64.6% report high or very high livelihood impact.	Repeated destruction of the three crops threatens household food security and income of farming households.	Complementarity (explains)	Interviews explain why crop loss matters (food security, income), which the survey did not measure. Property damage is documented by the survey only.

Objective and theme	Household survey (n = 99)	Key-informant evidence (n = 8)	Integration	What the integration adds
Obj. 2: General perception	62.6% positive or very positive (95% CI 52.8–71.5%); 23.2% negative or very negative.	Positive perceptions explained by tourism income, employment, infrastructure development, and awareness programmes.	Complementarity (explains)	Informants supply candidate explanations for the positive majority; the survey did not test whether these factors are associated with perceptions.
Obj. 3: Benefits	93.9% received a benefit; employment 28.3%, infrastructure 26.3%, tourism income 23.2%; 6.1% none.	Employment, tourism income, infrastructure, and community programmes named as benefits.	Convergence	Benefit types named by informants match those reported by households. The three main benefits differ by only 2–5 percentage points, within overlapping precision, so they are not ranked.
Obj. 2: Support and opposition	53.5% support (95% CI 43.8–63.0%); 27.3% oppose (19.5–36.8%); 19.2% neutral. At least 21 of the 27 opponents reported receiving a benefit.	Informants emphasised benefits and positive attitudes; the reasons why a sizeable minority oppose conservation were not explained.	Divergence (gap)	The benefit-centred explanation does not account for an opposing minority who mostly report benefits. Reasons for opposition remain unexplained and are a priority for future research.
Attribution of crop damage	Attribution to gorillas is respondent-reported and unverified.	Informants attribute raiding to gorillas; published evidence shows golden monkeys are also frequent crop foragers around VNP (Ndayishimiye et al., 2023).	Divergence with external evidence (unresolved)	Species attribution cannot be resolved from either strand; findings are therefore reported as perceived crop raiding.

Source: Field survey data and key informant interviews, 2026. Integration types follow Fetters et al. (2013).

Overall, the integration of quantitative and qualitative findings indicates that human–mountain gorilla interactions generate both conservation challenges and opportunities for communities surrounding Volcanoes National Park. Perceived crop raiding was the most commonly reported source of tension, and key informants associated it with farming near the park boundary, which the survey did not measure. Tourism and conservation programmes were reported by respondents and informants as sources of income, employment, and infrastructure, and informants linked these to the predominantly positive attitudes observed; this link is an interpretation and not a demonstrated causal effect. These results are broadly consistent with the wider Rwandan and Albertine Rift literature reviewed above, while providing current, sector-specific evidence that updates and localises earlier assessments (McGuinness, 2016; Sabuhoro et al., 2021; Sun et al., 2025) to the particular conditions of Kinigi Sector during 2021–2025.

Limitations of the Study

This study has several limitations. First, it was conducted in a single sector with a modest sample ($n = 99$) drawn at a 10% margin of error, so estimates are imprecise (95% confidence intervals of roughly ± 10 percentage points) and may not generalise to other sectors around VNP or to other protected areas. Second, the analysis was descriptive: associations between perceptions and factors such as benefit receipt, crop-loss experience, occupation, distance from the park boundary, or cell of residence, and the profile of the 27.3% who opposed conservation, were not tested, so causal interpretations are not warranted. Third, the data were self-reported and cross-sectional and are therefore open to recall bias and social desirability bias, particularly among respondents who work in tourism or who may have associated the enumerators with conservation institutions. Fourth, respondents' attribution of crop damage to mountain gorillas was not independently verified, and other wildlife, notably golden monkeys, are also frequent crop foragers around VNP (Ndayishimiye et al., 2023); all crop-raiding estimates are therefore of perceived, not verified, gorilla-related crop raiding. Fifth, the eight key informants, although selected for their expertise, were purposively sampled and are not statistically representative, so their explanations are treated as interpretations to be tested and not as demonstrated causes; the integration in Table 6 rests on these eight accounts. Future studies should use larger multi-sector samples, inferential analysis (for example, ordinal or logistic regression), field-verified crop-damage records, and longitudinal designs.

Conclusions and Recommendations

This study assessed community perceptions of human–mountain gorilla interactions and their implications for conflict mitigation and benefit-sharing around Volcanoes National Park, using Kinigi Sector as the study area. The findings show that perceived gorilla-related crop raiding was the most commonly reported form of interaction between communities and mountain gorillas, and that respondents reported crop loss, property damage, and income loss as their principal livelihood costs. Key informants linked these costs to farming near the park boundary, which the survey did not measure. Nevertheless, most respondents (62.6%) held positive perceptions of mountain gorillas and a slim majority of the sample (53.5%; 95% CI: 43.8–63.0%, so majority support in the sector is not established) supported their conservation, a pattern that key informants attributed to the employment, tourism income, infrastructure development, and community programmes associated with conservation activities, although 27.3% of respondents opposed conservation efforts. These findings, corroborated by key informant interviews, are compatible with an interpretation in which community attitudes towards mountain gorilla conservation in Kinigi Sector are shaped jointly by the costs of human–wildlife interaction and the perceived benefits of conservation, consistent with the stewardship perspective and with prior studies in the Volcanoes National Park landscape. Because the analysis was descriptive and confined to one sector, these conclusions describe perceptions and associations rather than causal effects; the view that conservation benefits shape attitudes remains an interpretation, drawn largely from key-informant explanations, and not an established causal relationship.

Based on these findings, the study offers study-informed recommendations, each linked to specific findings in Table 7; they are not interventions whose effectiveness was tested or demonstrated here. The study recommends that the Rwanda Development Board strengthen human–wildlife conflict

mitigation through rapid-response systems and monitoring of frequently raided areas (including verification of the species responsible for reported damage), prioritising the crops key informants identified as most affected (Irish potatoes, pyrethrum, and young Eucalyptus plantations), while continuing to enhance tourism revenue-sharing to ensure conservation dividends are distributed fairly among bordering communities, with particular attention to the 6.1% of respondents who received no benefit and the 27.3% who opposed conservation. The Dian Fossey Gorilla Fund and other conservation partners should expand community education and awareness programmes on conservation and conflict mitigation. Musanze District and Kinigi Sector authorities should collaborate with conservation institutions to promote sustainable agricultural practices that reduce households' vulnerability to crop raiding, while local communities should be encouraged to participate actively in conservation programmes and to promptly report human–gorilla incidents through existing communication channels. Future research should examine the effectiveness of specific conflict-mitigation strategies, the adequacy of benefit-sharing relative to livelihood costs, and seasonal patterns of human–mountain gorilla interaction in Kinigi Sector and comparable landscapes, using larger multi-sector samples, inferential analysis (for example, modelling perceptions against benefit receipt and crop-loss experience), and field verification of the species responsible for crop damage.

Table 7: Study-Informed Recommendations Linked to Findings

Finding	Study-informed recommendation	Lead institution(s)	Evidence status
Perceived crop raiding was the most reported interaction (46.5%); crop loss was the main impact (49.5%); informants named Irish potatoes, pyrethrum, and young Eucalyptus.	Strengthen rapid-response and monitoring in frequently raided areas, including field verification of the species responsible; prioritise the crops named.	Rwanda Development Board	Finding is descriptive. Effectiveness of the measures was not tested.
93.9% reported a benefit but only 53.5% supported conservation (interval includes 50%); 6.1% reported no benefit; 27.3% opposed.	Continue and refine tourism revenue-sharing, with attention to households reporting no benefit and to those who oppose conservation, and find out why they oppose.	Rwanda Development Board; Musanze District	Benefit receipt and opposition were described. Their relationship was not tested.
Informants explained positive perceptions partly by community programmes and awareness activities.	Expand community education and awareness on conservation and conflict mitigation.	Dian Fossey Gorilla Fund and partners	Indirect. Based on informants' explanations, not tested in the survey.
Informants linked raiding to farming close to the boundary; crop loss was the main reported impact.	Promote agricultural practices that reduce household vulnerability to crop raiding.	Musanze District; Kinigi Sector	Goes beyond the evidence. Distance to the boundary and farm practices were not measured.
Interactions were frequent (53.5%) and rated serious (68.7%).	Encourage active participation and prompt reporting of incidents through existing channels.	Local communities; Sector authorities	Goes beyond the evidence. Reporting behaviour was not studied.

Finding	Study-informed recommendation	Lead institution(s)	Evidence status
Wide intervals, one sector, descriptive design.	Use larger multi-sector samples, inferential analysis, field-verified damage records, and longitudinal designs.	Researchers	Follows from the limitations of this study.

Source: Authors' synthesis of Tables 2–6.

Acknowledgment

The authors thank the Executive Secretary and community leaders of Kinigi Sector, and all household respondents and key informants for their cooperation and participation in this study.

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