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ASSESSMENT OF STAKE HOLDER PERCEPTIONS AND THEIR RECOMMENDATIONS FOR POTENTIAL MITIGATION SOLUTIONS FOR ROAD KILLS IN MURCHISON FALLS NATIONAL PARK, UGANDA

BY

MARK SSENIDDE

REGISTRATION NO: 23/U/1421

STUDENT NO: 2300701421

SPECIAL PROJECT REPORT SUBMITTED TO THE SCHOOL OF FORESTRY, ENVIRONMENTAL AND GEOGRAPHICAL SCIENCES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF SCIENCE IN TOURISM AND HOSPITALITY MANAGEMENT OF MAKERERE UNIVERSITY

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DECLARATION

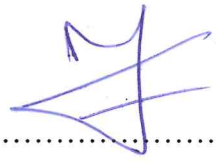
I, Mark Ssenidde, declare that this special project report is my original work. It has never been submitted to any other university or institution for any award. All information obtained from other sources has been duly acknowledged and cited in accordance with academic principles.

Signature..... Date.....03/09/2026.....

Mark Ssenidde

APPROVAL

This special project report is submitted for examination with my approval as the appointed academic supervisor.

Signature.....  Date.....03/09/2026.....

ASSOC. PROF. GERALD EILU

SUPERVISOR

DEDICATION

I dedicate this research to my beloved family, whose endless love, prayers, and financial support have been the cornerstone of my academic journey. I also dedicate this work to the conservationists and the Uganda Wildlife Authority who work tirelessly every day to protect Uganda's rich biodiversity. May this study contribute meaningfully to your efforts in reducing road kills in conservation areas.

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ABSTRACT

This study assessed stakeholder perceptions and their recommendations for potential mitigation solutions for road kills in Murchison Falls National Park (MFNP), addressing three specific objectives: 1) To identify road kill prevention measures stakeholders perceive as most effective; 2) To assess the level of awareness and attitudes of stakeholders towards road kill incidents; and 3) To identify more sustainable solutions for mitigating road kills. Questionnaires were administered to 75 respondents and semi-structured interviews conducted with 30 key informants. Data were analyzed using SPSS software version 26. The findings revealed a high level of awareness among stakeholders. Most key informants reported that motorists routinely ignore speed regulations and noted that collisions are rarely reported voluntarily. Among existing mitigation measures, speed indicators were rated most effective. Wildlife warning signs received the highest least-effective rating. Infrastructure and road engineering solutions were identified as the most preferred long-term strategy, followed by community engagement and education, policy, planning and enforcement. A Pearson Chi-square test confirmed a statistically significant association between stakeholder category and preferred long-term strategy (χ^2 (6) = 13.765, p = 0.032). Support for the installation of physical barriers at wildlife crossing hotspots was nearly evenly split. The majority of key informants recommended an integrated approach combining road engineering measures, enforcement, public awareness, and wildlife crossing infrastructure as the most sustainable strategy. In conclusion, while stakeholder awareness is high, inadequate enforcement undermines existing mitigation efforts. Nonetheless, strengthened enforcement, targeted driver education, can help to mitigate road kills. There is a gap between what stakeholders report and the actual driving behavior on ground.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Road Kills in Protected Areas

Road infrastructure development has become a threat in global conservation efforts, facilitating human mobility and economic growth while posing severe threats to wildlife through vehicle collisions. Reports from PAs show an average of two or three road kills daily by over speeding vehicles (Kagoro 2024). A 2023 analysis revealed that Protected areas intersected by roads experienced 30-50% mortality rates compared to undisturbed habitats (Pinto et al., 2025). While some measures (e.g., signage and speed limits) have been implemented, their effectiveness remains limited. Fixed road signs showed no reduction in deer vehicle collision rates with motorists often ignoring them after initial exposure (Darcy et al. 2013). Worldwide, road kills result in millions of animal deaths annually, ranking as the third-largest anthropogenic cause of vertebrate mortality and exacerbating biodiversity loss in fragmented habitats. These incidents lead to direct population declines and disrupt ecological processes, such as gene flow and predator-prey dynamics, with vulnerable taxa like amphibians, reptiles, and large mammals suffering disproportionate impacts (Grilo et al., 2025). Recent reviews highlight the escalation of this issue amid a projected 60% increase in global road networks by 2050, particularly in biodiverse regions where road density correlates with higher collision rates and extinction risks (Schwartz et al., 2021; Moore et al., 2023).

In protected areas, where roads often traverse critical habitats, the problem is amplified, turning conservation zones into high-mortality corridors. Studies show that factors like vehicle speed, seasonal animal migrations, and road design contribute to spatiotemporal hotspots, with up to 0.75 animals killed per kilometer daily in tropical ecosystems (Aquino & Nkomo, 2021).

In Africa, rapid infrastructure expansion has intensified these threats, with roads fragmenting savannas and forests, leading to barrier effects that isolate populations and increase vulnerability to poaching and disease (Ascensao et al., 2022). Within Murchison Falls National Park, the Masindi-Pakwach tarmac road exemplifies these issues, serving as a vital transport link while bisecting prime wildlife habitats. Increased traffic, spurred by regional developments like bridge repairs and oil exploration, has heightened collision risks, with reports of animals such as elephants,

baboons, and ungulates being injured or killed weekly (Naleba, 2025). Oil and gas activities have further compounded pressures, causing habitat displacement and elevated mortality rates through road kills, as nocturnal species face disruptions from light pollution and vibrations (AFIEGO, 2024). Despite mitigation efforts, such as fines for reckless driving and underreporting due to penalties, comprehensive data on impacts remain limited, underscoring the need for stakeholder inclusive approaches (Naleba, 2025).

Stakeholder perceptions encompassing motorists, tourists, and park managers are crucial for effective mitigation, as they influence compliance with speed limits, signage, and conservation policies. However, research gaps persist in understanding these human dimensions in African contexts, where biophysical studies dominate (Sukhontapatipak et al., 2025). This study addresses this by assessing perceptions along the Masindi-Pakwach Road, aiming to inform tailored strategies that enhance wildlife protection and sustainable park management in Murchison Falls National Park.

1.2 Problem statement

Roads through protected areas (PAs) pose risks to biodiversity and long-term conservation. These roads fragment habitats, disrupt animal movement, and contribute significantly to wildlife mortality through vehicle collisions, commonly referred to as road kills (Grilo et al., 2021). Although various mitigation strategies such as speed reduction measures, wildlife crossings, warning signage, and awareness campaigns have been implemented in protected areas globally, their effectiveness often depends on local context, driver behavior, and stakeholder collaboration (Collinson et al., 2019; Hlatshwayo et al., 2024). Despite the studies done about these measures put to mitigate road kills, a critical gap exists in understanding the perceptions of key stakeholders regarding road kills (Gruas et al., 2020). This lack of insight into stakeholder perspectives often hinders the development and implementation of potential mitigation measures against road kills (Kadoma et al., 2023). This study will aim to bridge this gap by systematically assessing stakeholder perceptions and identify potential mitigation measures towards animal road kills in conservation areas.

1.3 Objectives

1.3.1 Main Objective

The main objective of the study is to assess the perceptions of stakeholders and their recommendations for potential mitigation solutions for road kills in Murchison falls national park.

1.3.2 Specific Objectives

The specific objectives are;

1. To identify road kill prevention measures stakeholders perceive as most effective in Murchison Falls National Park.

2. To assess the level of awareness and attitudes of stakeholders towards road kill incidents in Murchison Falls National Park.

3. To identify more sustainable solutions towards mitigating road kills.

1.3.3 Research Questions

The following questions were answered:

1. Which road kill prevention measures do stakeholders perceive as the most effective at reducing road kills in Murchison Falls National Park?

2. How informed are stakeholders about road kill incidents in Protected Areas such as Murchison Falls National Park?

3. How do stakeholders in Murchison falls national park view and interpret road kill incidents?

4. Based on the feedback from stakeholders, what long term and sustainable approaches do they suggest to reduce road kills in Protected Areas?

1.3.4 Research Hypotheses

The study tested the following hypothesis:

H_0 : There is no statistically significant association between stakeholder category and preferred long-term strategy for mitigating road kills in Murchison Falls National Park.

1.4 Scope of the Study

Regarding the identification of road kills prevention measures which stakeholders perceive as most effective in mitigating road kills, the study was scoped to examine existing and proposed road kill mitigation interventions such as speed bumps, warning signage, wildlife crossings, and speed limit enforcement within MFNP. For the assessment of the level of awareness and attitudes of stakeholders towards road kill incidents, the study scope encompassed stakeholders' knowledge of road kill causes, consequences for biodiversity, and their personal attitudes toward wildlife protection along park roads. Third, with respect to identifying more sustainable solutions for mitigating road kills, the study explored opinions of stakeholders that were long term, ecological, and socially acceptable as mitigation strategies towards road kill incidents.

1.5 Significance of the Study

This study addressed road kills which are a serious and growing threat to wildlife in Murchison Falls National Park. Recent reports show that speeding vehicles kill an average of two to three animals every day along key routes inside the park, with larger species such as elephants also falling victim (Nile Post, 2024). As tourism and transit traffic continue to increase, these collisions not only reduce important wildlife populations but also create safety risks for drivers and passengers. By exploring how different stakeholders perceive the problem and what solutions they find most effective, the research gives park managers, the Uganda Wildlife Authority, and local communities practical, locally accepted ideas for reducing road kills. Understanding people's awareness levels and attitudes is especially important, because real change in driving behavior often depends on how seriously drivers and road users take the issue. The findings help park managers to design more sustainable mitigation measures that fit the unique conditions of Murchison Falls National Park. In the long run, this work supports better conservation of the park's rich biodiversity including its large populations of giraffes, elephants, buffaloes, and many bird species while also improving road safety. Ultimately, the study contributes to the broader effort of balancing tourism development, infrastructure needs, and wildlife protection in Uganda's protected areas (Tayebwa et al., 2025).

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Impacts of Road Kills in Protected Areas

Wildlife-vehicle collisions are a widespread conservation challenge. Globally, roads kill hundreds of millions of animals every year, and the problem is growing as road networks expand (Grilo et al., 2021; Balčiauskas et al., 2025). In Africa, where many national parks sit along important transport routes, the impacts are especially worrying because of high biodiversity and increasing tourism.

In Uganda, recent evidence shows the scale of the issue. Tayebwa et al. (2025) recorded 161 wildlife vehicle collisions over 4 years in south central Uganda, involving 178 individual animals from 12 mammal families, five reptile families, two amphibian families, and 32 bird families. Hotspots often appear near wetlands and farmlands, where animals move frequently. In Murchison Falls National Park specifically, reports indicate that speeding vehicles kill an average of two to three animals daily along key routes, with baboons heavily affected and occasional deaths of larger mammals such as elephants (Nile Post, 2024; Uganda Wildlife Authority, 2024). One high-profile case in November 2024 involved a speeding truck killing an elephant on the Karuma-Pakwach highway inside the park (Nile Post, 2024).

Beyond direct mortality, road kills fragment habitats, alter animal movement, and add stress that can affect breeding and survival. In protected areas with rich wildlife like MFNP, these collisions threaten species recovery and reduce the park's ecological and tourism value. Similar patterns appear elsewhere in East Africa. For example, studies in Kenya's Tsavo ecosystem and Rwanda's Nyungwe National Park also document high roadkill rates for mammals and birds, showing that the problem is regional (Lala et al., 2021; Kayitare, 2019). Without effective action, continued road kills risk weakening conservation efforts in Uganda's national parks.

2.2 Stakeholder Perceptions of Road Kill Prevention Measures

Stakeholders including park staff, local communities, drivers, tourists, and conservation groups often have different views on which road kill prevention measures work best to encourage safer driving. Common measures include speed limits and bumps, wildlife warning signs, fencing with crossing structures, awareness campaigns, and penalties for reckless driving.

A major meta-analysis by Rytwinski et al. (2016) found that mitigation measures overall reduce road kills by about 40% compared to untreated areas. Fences (with or without crossing structures) perform particularly well, cutting road kills by 54%. For large mammals, combining fencing and crossing structures can achieve an 83% reduction. However, cheaper options like wildlife reflectors or simple signs show much weaker results sometimes close to zero improvement.

In African protected areas, perceptions vary. In Nyungwe National Park, Rwanda, over 80% of road users saw mammals and larger animals as valuable, but many viewed slow-moving species as less important. Most respondents supported awareness campaigns as the top solution, though they questioned long term effectiveness without strong enforcement (Kayitare, 2019; Rufford project insights). In Pilanesberg National Park, South Africa, Collinson et al. (2019) found that visitors were more likely than staff to cause collisions, especially when speeding, and that warning signs depicting charismatic animals (like cheetahs) influenced public opinion more than less popular ones (like snakes). Yet actual behavior change was stronger with practical measures such as speed bumps.

Drivers and local communities in East Africa often rank behavioral tools (education and fines) and physical infrastructure (speed calming and signage) highly, but they stress that measures must fit local realities for example, realistic speed limits that do not overly delay travel through tourist areas like Murchison Falls (Mukomberanwa et al., 2025). These differing perceptions show why involving stakeholders early is important: solutions that people see as fair and practical are more likely to succeed.

2.3 Awareness and Attitudes Towards Road Kill Incidents

Awareness of road kills and attitudes toward them differ widely across stakeholder groups and strongly influence support for mitigation. Park rangers and conservation workers usually show high awareness and see road kills as a serious biodiversity threat. In contrast, local residents and frequent drivers may have lower awareness or view the issue as less urgent than daily livelihood challenges (Kidane, 2024; Tayebwa et al., 2025).

In south-central Uganda, Tayebwa et al. (2025) noted that some collisions appear intentional for example, when drivers fear or dislike certain animals like snakes. This highlights how attitudes shaped by cultural beliefs or personal experiences can worsen the problem. In Nyungwe National Park, many road users saw the park mainly as a tourism site rather than a conservation area, with only 10% recognising its role in wildlife protection and jobs (Kayitare, 2019). Such views can reduce willingness to slow down or support stricter rules.

Tourists often express more positive conservation attitudes but may not connect their own driving behavior to road kills. A study in Tasmania found that most tourists viewed wildlife-vehicle collisions as serious for both biodiversity and animal welfare, and many were willing to change their driving habits (Leurs et al., 2024). In East Africa, Borza (2023) showed that drivers who had personally experienced or frequently seen collisions had stronger awareness and greater support for prevention. However, fear of large animals during collisions can create negative attitudes that make people less careful.

Overall, low awareness and mixed attitudes limit the success of mitigation efforts. Research consistently suggests that targeted education linking wildlife protection with personal road safety can shift attitudes and encourage voluntary safer driving (Aquino et al., 2021; Balčiauskas et al., 2025).

2.4 Sustainable Solutions for Mitigating Road Kills

Wildlife crossing structures (underpasses or overpasses) paired with fencing are among the most effective long-term options because they reduce collisions while maintaining habitat connectivity (Soanes et al., 2024; Rytwinski et al., 2016). However, in resource-limited African parks, high costs and maintenance needs can make them challenging.

Other promising approaches include dynamic warning systems that detect animals and alert drivers, habitat management to guide animals away from roads, and spatial modelling to identify high-risk hotspots for targeted action (Fedorca et al., 2021; Perez-Guerra et al., 2024). In Uganda, experts recommend integrating mitigation into road upgrades from the planning stage instead of adding measures later (Tayebwa et al., 2025).

Community based solutions also matter. When local people, drivers, and park authorities participate in designing interventions, acceptance and compliance improve on road. In Nyungwe, stakeholders called for ongoing awareness campaigns and ranger training for monitoring (Kayitare, 2019). Broader reviews stress that the most sustainable strategies balance ecological benefits with social and economic feasibility, especially in tourism heavy areas like Murchison Falls (Balčiauskas et al., 2025; Collinson et al., 2019).

Despite growing global knowledge, there is still a clear gap in deep, stakeholder focused research inside Ugandan national parks. While studies from Kenya, Rwanda, and South Africa provide useful lessons, few examine perceptions and attitudes specifically in Murchison Falls. This study aims to help fill that gap by listening directly to local stakeholders and identifying practical, acceptable ways to reduce road kills while supporting conservation and safe tourism

CHAPTER THREE

3.0 STUDY AREA AND METHODS

3.1 Study Area

3.1.1 Location

The study was conducted in Murchison Falls National Park, a protected area at approximately 2°11'N, 31°44'E in north western Uganda. The Park is made up of seven administrative units which include research and monitoring, veterinary, law enforcement, tourism, finance, community conservation and engineering unit. The Masindi Pakwach tarmac road serves as a major transport corridor linking Bunyoro and the West Nile region. It bisects key wildlife habitats, including savanna grasslands, woodlands, and riverine areas.

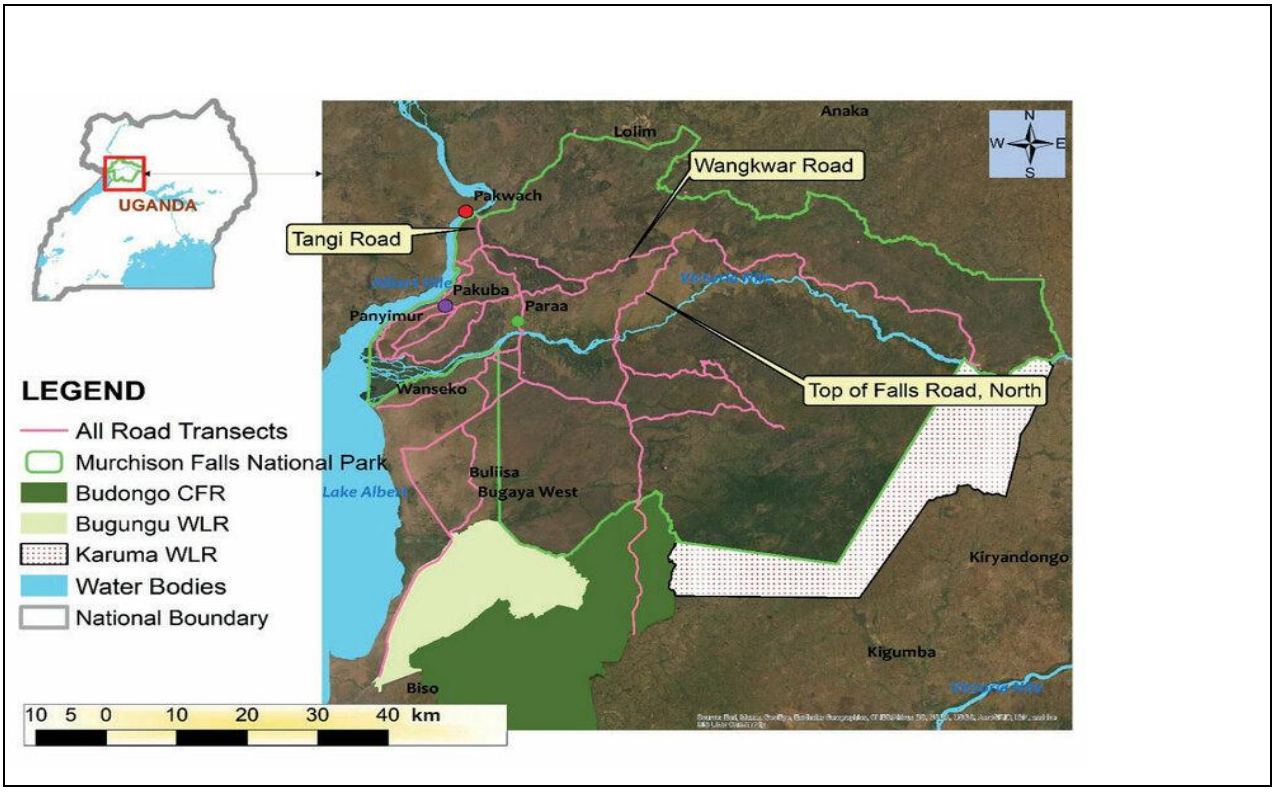


Figure 3.1: Location of Murchison Falls National Park in north western Uganda

3.1.2 Human Population and Economic Activities

The human population within the park is primarily Uganda Wildlife Authority staff which include the rangers and park wardens. Another group of park residents include the workers within the various lodges inside the park. All local people live outside the park boundaries. The primary economic activities around MFNP revolve around tourism, subsistence agriculture, fishing, and limited livestock keeping. Many communities engage in tourism-related enterprises, including tour guiding, accommodation, handicrafts, and cultural tours. However, high dependence on natural resources and limited alternative income sources often lead to human-wildlife conflicts, including poaching and encroachment, which indirectly exacerbate threats to wildlife such as road kills (Mugizi & Obua, 2018).

3.1.3 Geology and Topography

Murchison Falls National Park lies at the northern end of the Albertine Rift Valley, a tectonically active zone characterized by faulting and rifting. The Park spans an altitudinal range of approximately 650–1,290 meters above sea level and features relatively flat to gently rolling terrain dominated by savanna and woodland (Key Biodiversity Areas, 2024). The iconic Murchison Falls result from the Victoria Nile River forcing its way through a narrow Precambrian rock gorge (about 7 meters wide) before plunging 43 meters, exposing ancient crystalline rocks resistant to erosion (Uganda Wildlife Authority, 2024). The topography is bisected by the Victoria Nile, which flows from Karuma Falls in the east to the Albert Delta in the west, creating diverse landscapes including riverine valleys, escarpments, and deltaic wetlands. The southern sections near Budongo Forest exhibit higher elevation and more forested terrain, while the northern areas are flatter with open savanna and Borassus palm associations. These geological and topographic features influence animal movement patterns, concentrating wildlife near water sources and roads, thereby increasing vulnerability to vehicle collisions (Key Biodiversity Areas, 2024; Uganda Wildlife Authority, 2024).

3.1.4 Climate and Weather

Murchison Falls National Park experiences a tropical climate with relatively stable temperatures throughout the year. Daytime temperatures typically range from 25°C to 32°C, while night time temperatures drop to 18–22°C (SafariBookings, 2025). The Park receives an average annual rainfall of about 1,000–1,500 mm, with two main rainy seasons: March to May (long rains) and August to November (short rains). The driest months occur from December to February and a brief drier period in June–July (Safari Bookings, 2025). Rainfall patterns significantly affect vegetation growth, animal distribution, and road conditions within the park. Heavy rains during wet seasons can make roads slippery, encouraging higher speeds or poor visibility that contribute to road kills, while dry seasons concentrate wildlife around permanent water sources along the Nile and roadsides (Uganda Wildlife Authority, 2024). Climate variability and changing rainfall patterns pose additional challenges to biodiversity conservation and management in the park (Global Conservation, 2026).

3.1.5 Flora and Fauna

The vegetation of Murchison Falls National Park consists of open savanna grasslands, wooded savanna with Borassus palms and acacia species, riverine forests, and patches of tropical woodland, particularly in the southern and eastern sectors. These diverse plant communities support high biodiversity (Uganda Wildlife Authority, 2024; Key Biodiversity Areas, 2024). The Park is renowned for its rich fauna, hosting over 72 mammal species including four of the Big Five (lion, leopard, elephant, and buffalo). It supports the world's largest population of Rothschild's giraffe (approximately three-quarters of the global total), over 10,000 buffaloes, 35,000 Uganda kobs, elephants (over 900 individuals) and hippopotamus. The Victoria Nile and its delta are home to large numbers of Nile crocodiles and abundant waterbirds. Over 450–556 bird species have been recorded, including the rare shoebill stork and several Albertine Rift endemics. Primates such as chimpanzees (over 600 in adjacent Budongo Forest) are also present (Global Conservation, 2026; Uganda Wildlife Authority, 2024; Key Biodiversity Areas, 2024).

3.1.6 Conservation Status and Management

Murchison Falls National Park, gazetted in 1952 (originally as a game reserve in 1926), is Uganda's largest protected area, covering approximately 3,840 km². It forms part of the Murchison Falls Conservation Area, which includes adjacent wildlife reserves. The Park is managed by the Uganda Wildlife Authority (UWA) under a General Management Plan that emphasizes biodiversity conservation, tourism development, and community involvement (Uganda Wildlife Authority, 2024; Global Conservation, 2026). The conservation status of MFNP is generally positive, with recovering populations of large herbivores following past declines due to poaching and instability. Recent efforts include habitat restoration (e.g., clearing invasive species on thousands of hectares), anti-poaching operations, and community conservancies. Tourism revenue sharing supports local development, while infrastructure such as roads and lodges is managed to minimize environmental impact (Global Conservation, 2026; Key Biodiversity Areas, 2024). However, challenges persist, including oil exploration activities nearby, climate change effects, human-wildlife conflict, and increasing road traffic that leads to wildlife mortality. UWA collaborates with partners for enhanced ranger patrols, wildlife monitoring, and sustainable tourism practices to maintain the park's integrity while addressing emerging threats like road kills (Uganda Wildlife Authority, 2024).

3.2 Methods

3.2.1 Sampling design

Purposive sampling was used for park stakeholders that were key informants. I selected 30 park staff and assessed their level of awareness about road kills and which sustainable mitigation measures they recommended. This ensured inclusion of individuals with expertise on current strategies. Convenience sampling was used for park staff, motorists and tourists. For this sampling design, I selected 25 tourists, 25 motorists and 25 park staff. From this target population, I assessed the best current mitigation measure that they thought is best to reduce road kills. I also assessed their level of awareness and attitude about road kill incidents. The selected stakeholders recommended the sustainable measures they thought could be adopted against road kill incidents. I accessed them from the boat jetty at wild frontiers. This is where most tourists and drivers

converged as they waited to go for a 3 hours boat cruise on the Victoria Nile to the bottom of Murchison falls.

3.2.2 Data Collection

Road kill prevention measures stakeholders perceive as most effective

The questionnaire indicated how strongly they agreed or disagreed with statements about different prevention measures such as speed limits, wildlife warning signs, speed bumps, wildlife crossings, awareness campaigns, and penalties. Respondents ranked these measures according to how effective they believed each one is, in encouraging safer driving and reducing road kills. Semi-structured interviews allowed participants to explain in their own words why certain measures work better than others.

Level of awareness and attitudes towards road kill incidents

The questionnaire included both closed-ended and open-ended questions to measure awareness and attitudes. Respondents answered questions about how often they see or hear about road kills, which animal species they knew are most affected, and their level of agreement with statements such as "Road kills are a serious threat to wildlife conservation" or "Drivers should face stricter penalties" Semi-structured interview guides helped me explore these issues in greater depth. Participants shared their personal experiences, cultural views, and feelings about road kill incidents (Aquino et al., 2021).

Identification of more sustainable solutions towards mitigating road kills

Data on sustainable solutions were collected using two questionnaire items. The first was a single-choice item in which respondents selected their most preferred long-term sustainable strategy for mitigating wildlife road kills while maintaining transport operations from four options which included infrastructure and road engineering solutions, wildlife conservation and habitat management, policy, planning and enforcement, community engagement and education. This item was designed to identify which broad strategic approach commanded the greatest stakeholder support and to enable a cross-group comparison of solution preferences by stakeholder category.

The second item was a dichotomous yes/no question in which all respondents indicated whether they would support the installation of physical barriers at known animal crossing hotspots as a specific infrastructure intervention. This item was included to test stakeholder support for one of the most frequently recommended but also most contested infrastructure measures, given the ecological and logistical trade-offs associated with large-scale barrier construction within a protected area.

3.2.3 Data Analysis

Perceived Effectiveness of Road Kill Mitigation Measures: Descriptive statistics were used to compute frequency distributions and percentages for each effectiveness rating category across all six mitigation measures, enabling a cross-measure comparison of perceived performance.

Level of Awareness and Attitudes Towards Road Kill Incidents: Descriptive statistics, including frequencies and percentages, were used to summarise the distribution of perceptions and awareness levels across the three stakeholder groups. Specifically, frequencies and percentages were computed for variables such as respondents' agreement that wildlife road kills represent a major threat to biodiversity and their identification of overspeeding as the primary cause of animal deaths. A multiple-response analysis was applied to the species identification question, since respondents could select more than one species, producing frequency counts and percentages of cases for each species mentioned. Qualitative data from the 30 key informant interviews were subjected to thematic analysis to generate themes around stakeholders' personal experiences with road kills, perceived causes, and emotional or ethical attitudes toward wildlife loss, providing richer contextual interpretation of the quantitative findings (Braun & Clarke, 2006).

Sustainable Solutions Towards Mitigating Road Kills: Frequency distributions and percentages were computed for each preferred long-term strategy to identify which interventions were most consistently favoured across all stakeholder groups.

A Pearson Chi-square test of association was then conducted to determine whether there was a statistically significant relationship between stakeholder category (tourists, motorists, and park staff) (Field, 2018). The test was conducted at the 5% significance level ($\alpha = 0.05$). The null

hypothesis was rejected when the p-value was less than 0.05 and retained when the p-value was greater than 0.05.

Support for physical barrier installation was analyzed using frequency distributions and percentages for the respondents' dichotomous (yes/no) responses. Qualitative data from the 30 key informant interviews were subjected to thematic analysis, with themes organised around infrastructure-based, behavioural, and policy-based solutions, the perceived feasibility of physical barriers and wildlife crossing structures, and recommendations for an integrated mitigation approach (Braun & Clarke, 2006).

CHAPTER FOUR

4.0 RESULTS

4.1 Level of awareness and attitudes of stakeholders towards Road kills

Most of the respondents frequently travelled through Murchison Falls National Park (59.7%, n = 43), followed by those travelling through the park for the first time (20.8%, n = 15) and those travelling occasionally (19.4%, n=14). The multiple-response analysis revealed that Oribi (*Ourebia ourebi*), followed by Common Warthog (*Phacochoerus africanus*) were the species most frequently perceived to be affected by wildlife-vehicle collisions.

In the table below, frequency is the number of people who selected a particular animal species out of the total 75 respondents. Percentage of cases = (frequency /N) * 100. N is the total number of respondents (75 respondents)

Table 4.1: Animal Species Perceived to be Most Affected by Wildlife-Vehicle Collisions1 (n=22)

Name	**Species**	**Frequency**	**% of Cases**
Oribi	*Ourebia ourebi*	33	44.0
Common Warthog	*Phacochoerus africanus.*	28	37.3
Olive Baboons	*Papio Anubis*	26	34.7
African Elephant	*Loxodonta Africana*	24	32.0
African Buffaloe	*Syncerus caffer*	19	25.3
Uganda kob	*Kobus kob thomasi*	17	22.7
Snakes (Various species)	*Suborder (Serpentes)*	16	21.3
Vervet Monkeys	*Chlorocebus pygerythrus*	11	12.0
Birds (Various species)	*Class (aves)*	12	18.7
Bushbuck	*Tragelaphus scriptus*	7	9.4
African Savannah Hare	*Lepus microtis*	6	8.0
Jackson's hartebeest	*Alcelaphus buselaphus lelwel*	3	4.0
Striped Ground Squirrel	*Euxerus erythropus*	2	2.7
Defassa Waterbuck	*Kobus ellipsiprymnus defassa*	2	2.7
Guinea fowl	*Numida meleagris*	1	1.3
Hippopotamus	*Hippopotamus amphibius*	1	1.3
Rothschild's Giraffe	*Giraffa camelopardalis rothschildi*	1	1.3
Lion	*Panthera leo*	1	1.3
Banded Mongoose	*Mungos mungo*	1	1.3
Savannah Monitor lizard	*Varanus exanthematicus*	1	1.3
African Rock Python	*Python sabae*	1	1.3
Insects	*Class (Insecta)*	1	1.3
Total responses		**216**	**288.0**

Most respondents expressed positive perceptions across the three statements. They strongly agreed that road kills threaten biodiversity, over speeding causes animal deaths and drivers should be heavily fined for animal collisions (Figure 4.1).

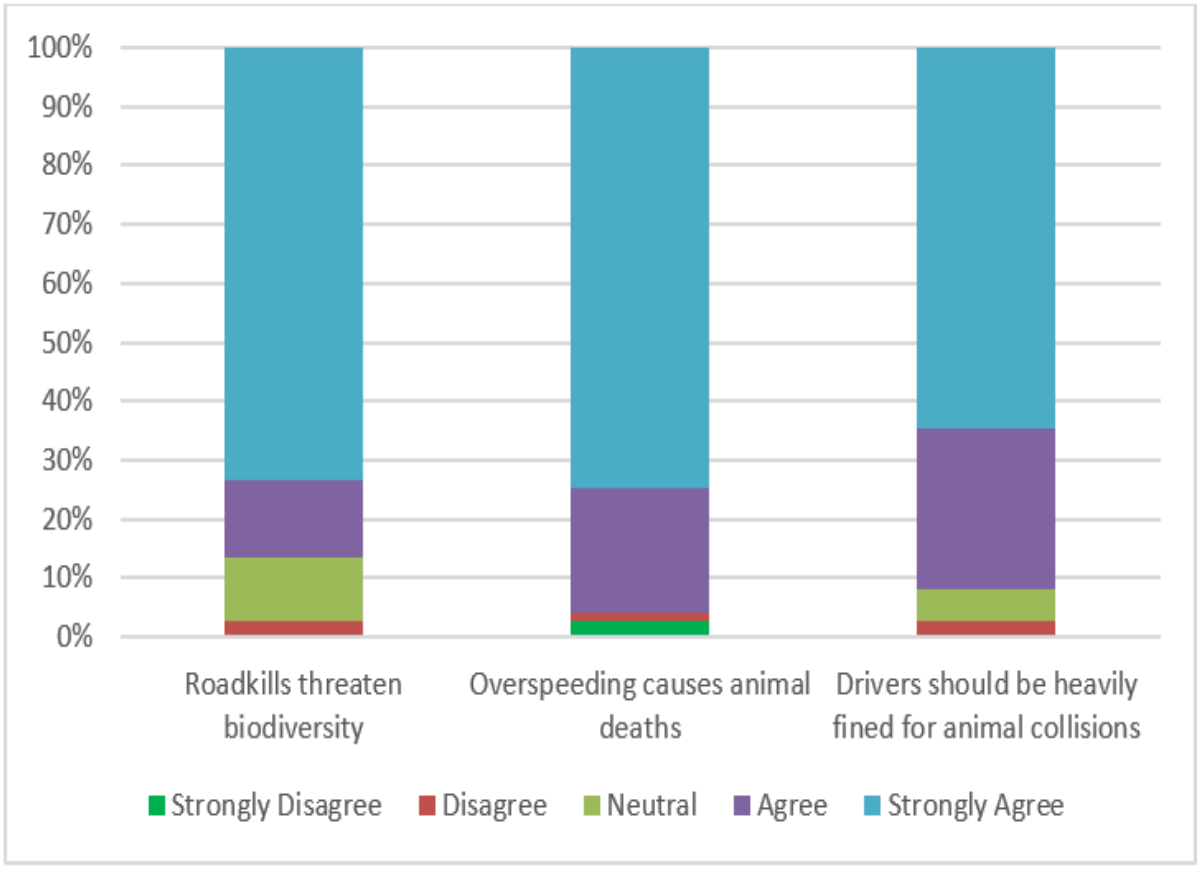


***Figure 4.1*: Stakeholders' perceptions of wildlife roadkill and road safety measures**

4.2 Perceived Most Effective Prevention Measures

Stakeholders ranked Speed indicators as the most effective measure in reducing road kills in Murchison falls national park

Table 4.2: Perceived Effectiveness of Existing Roadkill Mitigation Measures

Mitigation measure	Least effective (%)	Fairly effective (%)	Moderately effective (%)	Most effective (%)
Road bumps	10.8	17.6	51.4	20.3
Wildlife warning signs	16.0	10.7	45.3	28.0
Fines and penalties	6.8	21.6	44.6	27.0
Underpasses and overpasses	4.1	11.0	39.7	45.2
Awareness campaigns	8.1	14.9	41.9	35.1
Speed indicators	12.2	4.1	17.6	66.2

The majority of the respondents strongly agreed that they significantly adjust their speed when they see a wildlife warning sign (Figure 4.2).

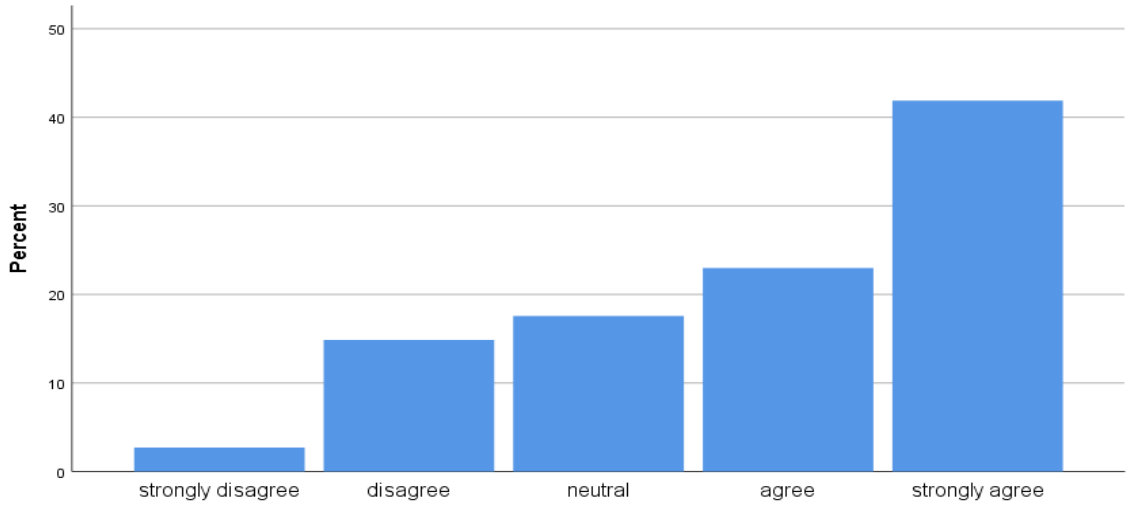


Figure 4.2: Speed adjustment behavior when approaching wildlife warning signs

4.3 Sustainable solutions towards mitigating road kills

Respondents identified infrastructure and road engineering solutions as the most sustainable approach to mitigating wildlife road kills while maintaining transport activities.

Table 4.3: Preferred sustainable solutions for mitigating wildlife road kills while maintaining transport operations

Strategy	**Frequency (n)**	**Percentage (%)**
Infrastructure and road engineering solutions	26	34.7
Wildlife conservation and habitat management	4	5.3
Policy, planning and enforcement	22	29.3
Community engagement and education	23	30.7
Total	**75**	**100**

A Pearson Chi-square test was conducted to examine whether there was a significant association between stakeholder category and the preferred long-term strategy for ensuring wildlife safety without hindering transport. The test revealed a statistically significant association between stakeholder category and Preferred Long-term Strategies (χ^2 (6) = 13.765, **p = 0.032)**.

Table 4.4: Chi-square test of association between stakeholder category and preferred long-term strategies for ensuring wildlife safety without hindering transport

Chi-Square Tests	**Value**	**df**	**Asymptotic Significance (2-sided)**
Pearson Chi-Square	13.765[a]	6	.032
Likelihood Ratio	14.406	6	.025

The responses were relatively evenly distributed between respondents who supported the installation of physical barriers as a long-term roadkill mitigation measure (Figure 4.3).

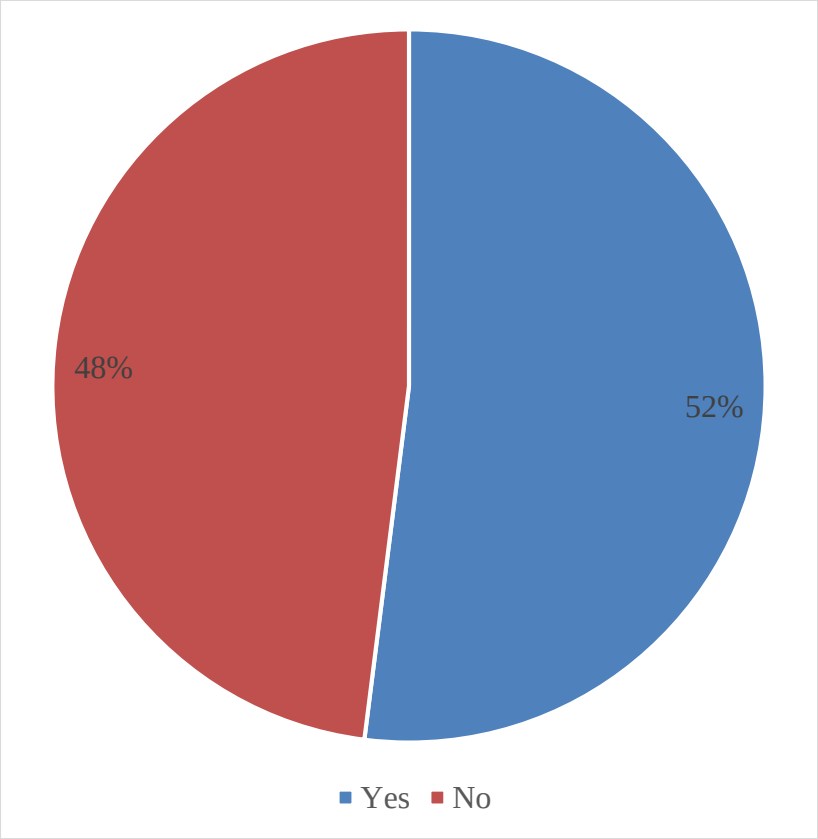


Figure 4.3: Support for installation of physical barriers in wildlife crossing hotspots

Semi-structured interviews were conducted with Uganda Wildlife Authority (UWA) staff, including rangers, wardens, and experienced tour guides. Most key informants reported that excessive vehicle speed remains the principal contributor to wildlife road kills and identified speed indicators and road bumps as the most effective existing mitigation measures. Physical barriers and ditches were considered useful in specific locations; respondents emphasized their ecological and financial limitations. Overall, the majority recommended an integrated approach that combines road engineering measures, enforcement, public awareness, and wildlife crossing infrastructure as the most sustainable strategy for reducing wildlife road kills.

Table 4.5: Summary of Themes from Key Informant Interviews

Theme	Representative responses	Frequency (n=30)
Motorists ignore speed regulations	• Motorists exceed speed limits because they are in a hurry • Motorists become overconfident on straight road sections • Motorists disregard wildlife warning signs.	24
Speed indicators and road bumps are the most effective measures	• Speed indicators turn red once driver over speeds • Road bumps force drivers to slow down	22
Wildlife collisions are rarely reported voluntarily	• Drivers leave the scene after collisions • Few drivers notify park authorities about road kills.	19
Increased transit traffic has increased roadkill incidents and patrol workload	• Oil mining vehicles knock down animals • Increased demand for monitoring.	26
Physical barriers and ditches have limited feasibility	• Ditches and continuous barriers could interfere with wildlife movement • Ditches require extensive maintenance.	21
Integrated mitigation measures are the most sustainable solution	• Combine engineering measures and enforcement • awareness campaigns, and wildlife crossing structures reduce road kills	27

CHAPTER FIVE

5.0 DISCUSSION

5.1 Level of Awareness and Attitudes of Stakeholders Towards Road Kill Incidents

One of the strongest and most consistent findings in this study is the high level of awareness that stakeholders demonstrated across all three groups. Most respondents strongly agreed that wildlife road kills are a major threat to biodiversity, and nearly all identified over speeding as the primary cause of animal deaths along park roads. This degree of awareness is not self-evident in protected area contexts. Kidane (2024), working in a national park in northern Ethiopia, found that awareness levels among local communities and frequent road users were often surprisingly limited, with many people underestimating the conservation significance of road kills.

The species that most respondents frequently identified as affected by vehicle collisions were oribis, common warthogs, olive baboons, and African elephants match closely with the ecological reality of animal movement patterns along the Masindi–Pakwach road. Oribi are small, fast-moving antelopes whose antipredator flight response involves sudden directional changes that can take them directly across the path of oncoming traffic (Kanga et al., 2017). Warthogs and baboons are highly visible along road margins where they graze and forage, making them among the most frequently encountered species by drivers and therefore among the most frequently perceived as road kill victims. The prominent listing of elephants is ecologically significant. Ferretti et al. (2019) found in an Italian protected area that large-bodied megafauna face distinctive collision risks because they cross roads primarily at night or during dawn and dusk hours when visibility is poor, and because of their size, a collision is almost always fatal.

The positive attitudes towards conservation prevailed across tourists, motorists, and park staff alike is an encouraging result for mitigation planning. Pooley et al. (2017), argue that attitude alignment across stakeholder groups is a necessary enabling condition for conservation programmes to gain traction, because people who share a concern are more likely to cooperate with measures designed to address it. This shared foundation of concern is present at MFNP. Leurs et al. (2024) found a similar pattern among tourists at wildlife collision sites in Tasmania, where positive attitudes towards wildlife conservation were strongly associated with expressed willingness to modify

driving behaviour, a link that appears to hold at MFNP, given that most respondents agreed they adjust their speed when they see warning signs.

Most informants reported that motorists routinely exceed speed limits despite their professed concern for wildlife. Borza (2023) documented the same pattern among European drivers at wildlife collision sites, finding that people who scored highly on conservation attitude scales were not significantly safer drivers than those who scored lower

The underreporting of road kill incidents add another layer to this picture. 19 0ut of 30 key informants described a pattern in which drivers who hit an animal leave the scene quietly, and only a handful ever contact park authorities. This is not simply an administrative inconvenience. It means that road kill databases at MFNP are almost certainly underestimates, and that any management decision based on recorded incident data is working from an incomplete picture of the actual problem. Schwartz et al. (2021) identified underreporting as one of the most serious data quality challenges in road kill research globally, arguing that true mortality rates in African parks are likely to be two to three times higher than officially recorded figures.

5.2 Perceived Effectiveness of Existing Road Kill Mitigation Measures

Speed indicators stood out clearly as the measure stakeholders trusted most. This finding lines up well with what the road ecology literature says about real-time feedback tools. Langbein et al. (2020) explained that dynamic speed displays work partly because they introduce an element of accountability that static signs cannot provide. when a driver sees their own speed reflected back to them, the psychological impulse to comply is immediate and difficult to ignore. Unlike a fixed warning sign that can fade into the roadside scenery after repeated exposure, a speed indicator presents new, personally relevant information on every pass. This psychological distinction matters a great deal in a park like MFNP, where the Masindi–Pakwach road is used daily by the same transit motorists and park staff. The biggest number of Stake holders supported this by identifying speed indicators and road bumps as the two interventions that had produced the clearest visible drop in speeding behaviour. Their on-the-ground observations add weight to what the quantitative scores suggest.

Underpasses and overpasses received the second highest most-effective rating. This confidence in crossing structures is well supported scientifically. Rytwinski et al. (2016) systematically reviewed evidence from hundreds of road segments and concluded that underpasses combined with exclusion fencing can reduce wildlife-vehicle collisions by up to 83% at treated locations. More recently, Soanes et al. (2024) confirmed in a global review that crossing structures are the single most consistently effective engineering intervention for reducing road barrier effects on wildlife.

Road bumps were rated moderately effective which reflects a mixed but broadly positive view. They are widely accepted as physically forcing speed reduction at specific points, and their placement near animal crossing zones particularly around water sources and salt licks where animal movement concentrates has been shown to cut collision rates in other African park road contexts (Kanga et al., 2017). The limitation raised by key informants, however, is an important one. Bumps slow vehicles at the bump itself but do little for the long straight sections between them, where drivers quickly accelerate back to unsafe speeds. Mukomberanwa et al. (2025) made a similar observation in the Mid-Zambezi Valley, noting that isolated speed calming points produce localised rather than corridor-wide risk reduction. For MFNP, this suggests road bumps are a necessary but insufficient tool on their own.

Wildlife warning signs were ranked more effective than road bumps. The reason for this is well understood in road safety research. Sullivan et al. (2018) demonstrated through field and laboratory studies that drivers who encounter the same sign repeatedly undergo a process of habituation, they become used with these signs until it is essentially invisible to the regular road user. The implication for MFNP is direct. The finding that approximately one-third of respondents did not strongly agree that they adjust their speed upon seeing a wildlife warning sign is a practical expression of habituation at work. Darcy et al. (2013) reached the same conclusion in a controlled study of deer–vehicle collision sites, finding that fixed road signs produced no measurable reduction in collision rates over time. These results do not mean that signs are worthless; they suggest that signs must be dynamic, context-sensitive, or paired with enforcement to remain effective.

Fines and penalties were rated moderately effective, yet a bigger percentage of respondents agreed or strongly agreed that drivers should be fined heavily even for accidental animal collisions. People

believe in the principle of financial deterrence but are less convinced that the current system delivers it. Park staff and rangers were particularly clear in their qualitative responses about why this gap exists. without systematic monitoring and a credible probability of being caught, a fine on paper carries little weight. Newmark et al. (2017) argues that deterrence-based wildlife management tools only function when detection probability is high. At MFNP, detection is compromised by the voluntary reporting problem. 19 of the 30 key informants noted that most drivers involved in collisions simply leave the scene, meaning enforcement is largely reactive to incidents that are never officially recorded.

Awareness campaigns were ratedsecond best effective measure. This relatively modest rating reflects an honest appraisal of what education campaigns can realistically achieve. Their value, as several key informants noted, lies in shifting long-term attitudes and creating a culture where road safety in wildlife areas is taken seriously. Balčiauskas et al. (2025) described awareness interventions as foundational complements to engineering and enforcement rather than standalone solutions, and Dietz et al. (2018) caution that education programmes only produce durable behaviour change when they are sustained over multiple seasons and tied directly to observable consequences. A single campaign in a park with shifting visitor populations is unlikely to produce lasting results without reinforcement.

5.3 Sustainable Solutions Towards Mitigating Road Kills

Infrastructure and road engineering solutions were the most preferred long-term strategy. Community engagement and education came second. Policy, planning and enforcement followed third. Wildlife conservation and habitat management was the least preferred option reflecting the practical difficulty of redirecting animal movement in a large, open savannah park.

The preference for engineering solutions is scientifically well founded. Van der Ree et al. (2015) reviewed decades of road ecology evidence and concluded that physical interventions particularly wildlife crossing structures combined with exclusion fencing offer the most reliable and durable reductions in collision rates, because they change the physical environment rather than relying on sustained changes in human behaviour. Soanes et al. (2024) arrived at a similar conclusion, finding in a global systematic review that crossing structures significantly reduce both the number of road kills and the barrier effect of roads on wildlife movement. The appeal of engineering solutions at

MFNP goes beyond the evidence base. key informants noted that the growing volume of transit traffic linked to oil development in the Albertine Rift has stretched UWA patrol capacity and raised road kill incident rates simultaneously.

Park staff leaned towards engineering solutions that reduce the problem at source. Tourists showed stronger support for community engagement and education. Motorists were the most spread across the options, reflecting the diversity of that group which includes both transit drivers with little direct conservation interest and tourist drivers with high conservation awareness. Murphy et al. (2025), studying human–wildlife conflict stakeholder preferences in a different context, reached a comparable conclusion that the role a person plays in creating or experiencing the problem strongly shapes what kind of solution they consider appropriate. Kadoma et al. (2023) made the same point in the East African conservation context, arguing that ignoring stakeholder heterogeneity when designing mitigation programmes is one of the main reasons that well-intentioned interventions fail to achieve uptake.

Community engagement and education emerged as the second most preferred strategy, and its prominence deserves careful interpretation. Road kill mitigation through education works most effectively when it is embedded in broader conservation communication that links wildlife protection to personal values, road safety, and local livelihoods not just to abstract environmental ideals (Balčiauskas et al., 2025). In the MFNP context, this means orientation programmes that explain which species are most vulnerable at which times of day, why sections of the Masindi–Pakwach road are particularly dangerous, and what the legal consequences of a wildlife collision are. Gruas et al. (2020), working in a participatory framework with road users in a European protected area, found that when drivers understood the ecological reasons behind speed limits rather than simply being told to comply with them, voluntary compliance rates rose significantly.

Policy, planning and enforcement was supported by 29.3% of respondents, with particularly strong backing from park staff during the qualitative interviews. The key informants who discussed enforcement were consistent in identifying two structural problems: the current speed limit is frequently violated on the long straight road sections with no consequences, and the fine regime for wildlife collisions is undermined by the fact that collisions are rarely reported. Clevenger and Wierzbowska (2017) point out that enforcement-based deterrence requires both a credible penalty

and a credible probability of detection. Strengthening enforcement is therefore not primarily a matter of increasing fine amounts but of creating conditions under which violations are systematically identified and acted upon.

The nearly even split on support for physical barriers among respondents was one of the most revealing findings in the entire study. On the surface, a slim majority endorses the measure. But the substantial minority opposition, concentrated particularly among motorists who expressed concerns about travel delays and road access, signals that barrier installation without meaningful prior stakeholder engagement carries real risks. Ferretti et al. (2019) documented in an Italian protected area that wildlife management infrastructure that is perceived as imposed rather than negotiated tends to generate active resistance from road users, which can undermine the measure's ecological effectiveness by encouraging drivers to find workarounds. 21 out of the 30 key informants at MFNP raised ecological and financial concerns about large-scale continuous barrier systems, specifically noting that such barriers could block water and mineral access for animals in the drier northern sections of the park. Their position that barriers should be targeted at validated hotspot locations rather than deployed uniformly reflects precisely the site-specific, evidence-based approach that Perez-Guerra et al. (2024) recommend based on spatial modelling of road kill risk in wildlife-rich landscapes.

The convergence of views among the 27 key informants who recommended an integrated mitigation approach is perhaps the most important single finding of this study. These are people who work inside MFNP daily, who observe road kills and near-misses, who interact with motorists, and who are responsible for the practical management of the park road corridor. Their collective judgment that no single measure is sufficient, and that the most sustainable path forward combines engineering, enforcement, education, and wildlife crossing infrastructure aligns closely with what the global road ecology literature recommends as best practice (Rytwinski et al., 2016; van der Ree et al., 2015; Balčiauskas et al., 2025). It also reflects the lived experience of park managers in comparable African contexts. In Pilanesberg National Park, Collinson et al. (2019) found that multi-component interventions consistently outperformed single-measure approaches across a range of collision metrics.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Perceived effectiveness of existing road kill mitigation measures: There is no single existing measure that is adequate on its own, and that the measures respondents trusted most speed indicators and crossing structures are either under utilised or entirely absent along most parts of the road. However, the gap between what people say and what they do is one of the most consistently reported problems in the road ecology.

Level of awareness and attitudes of stakeholders towards road kill incidents: The positive attitudes observed across stakeholders indicates an enabling condition for conservation action, suggesting that public communication about road kills in MFNP does not face an audience that is indifferent or hostile. However, the study also found a significant gap between stated attitudes and actual driving behaviour. This means that awareness alone is not translating into the safer driving behaviour that stakeholders themselves say they support.

Identification of more sustainable solutions towards mitigating road kills: Support for physical barrier installation was nearly evenly split signaling that this specific intervention requires further stakeholder consultation before implementation. The majority of key informants recommended an integrated approach combining road engineering, enforcement, community education, and wildlife crossing infrastructure.

6.2 Recommendations

Perceived effectiveness of existing road kill mitigation measures: Government organisations in charge of wildlife can prioritize the expansion and systematic deployment of speed indicators at all high-risk sections of roads that cross national parks particularly on the long straight segments where key informants reported that speeding is most common and most dangerous.

Level of awareness and attitudes of stakeholders towards road kill incidents: Information on the park's most vulnerable species, the specific road sections with the highest collision risk, and the legal obligations of drivers involved in wildlife incidents should be available at park gates, distributed through tour operators, and reinforced through visible roadside displays. Given the finding that tourists expressed the strongest support for community engagement and education.

Identification of more sustainable solutions towards mitigating road kills:

Enforcement of speed regulations should be strengthened through increased ranger patrols particularly during early morning and late evening hours when wildlife movement and collision risk is highest.

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APPENDICES

Appendix 1: Questionnaire

Research topic: Assessment of Stake Holder Perceptions and Their Recommendations for Potential Mitigation Solutions for Road Kills in Murchison Falls National Park, Uganda

INFORMED CONSENT

Dear Respondent

My name is SSENIDDE MARK, I'm currently completing my Bachelors of science inTourism and Hospitality management at Makerere University Kampala. I am conducting a study on road kills in Murchison Falls National Park.

I would appreciate any help with this by feeling a questionnaire which shouldn't take more than 10-15 minutes of your time in this questionnaire you are invited to express your opinion about Road kills. All information regarding your identity is kept confidential as I will only be using the information you give me on the questionnaire which will also be kept safe and confidential.

PART I: STRUCTURED QUESTIONNAIRE

Target Groups: Rangers, Tourists and Motorists

SECTION A: DEMOGRAPHIC DATA

1. Stakeholder Category: [ ] Tourist [ ] Tourist Driver [ ] Transit Motorist (Non-Tourist) Ranger [ ]

2. Frequency of travel through MFNP: [ ] First time [ ] Occasionally (1-3 times a year) [ ] Frequently

3. Gender: [ ] Male [ ] Female

SECTION B: AWARENESS AND ATTITUDES (Objective 2)

4. How often do you witness or hear about road kill incidents within the park? [ ] Never [ ] Rarely [ ] Sometimes [ ] Often

5. Which three (3) animal species do you believe are most affected by vehicle collisions in MFNP?

i) _____

ii) _____

iii) _____

Please tick (✓) your level of agreement with the following statements:

Statement	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Wildlife road kills are a major threat to the park's biodiversity.					
Over-speeding is the primary cause of animal deaths along park roads.					
Drivers should be fined heavily even for accidental animal collisions.					
I adjust my speed significantly when I see a wildlife warning sign.					

SECTION C: EFFECTIVENESS OF MITIGATION MEASURES (Objective 1)

7. Rank the following measures from 1 to 6 based on how effective they are in reducing road kills (1 = least Effective, 2= Fairly effective, 3= effective , 4= averagely effective, 5= moderately effective, 6 = most effective):

[ ] Speed Bumps/Humps

[ ] Wildlife Warning Signs

[ ] Strict Speed Limit Enforcement/Fines

[ ] Wildlife Underpasses/Overpasses

[ ] Public Awareness Campaigns

[ ] Digital/Dynamic Speed Indicators

SECTION D: SUSTAINABLE SOLUTIONS (Objective 3)

8. What long-term strategy would you suggest to ensure wildlife safety without hindering transport?

_____

_____

9. Would you support the installation of physical barriers (e.g., ditches or fences) in known animal crossing hotspots? [ ] Yes [ ] No [ ] Not Sure

Appendix 2: Interview Guide

PART II: SEMI-STRUCTURED INTERVIEW GUIDE

Target Groups: UWA Staff.

Interview Questions

Objective 1: Perceived Effectiveness of current Measures to mitigate road kills

1. In your view, why do many motorists continue to speed despite existing signs and bumps?

2. Which existing prevention measure has shown the most visible success in your administrative unit?

Objective 2: Awareness and Attitudes of stakeholders towards Road kills

3. How do drivers typically react when they encounter a road kill? Is there a culture of reporting or hiding incidents?

4. How has the recent increase in transit traffic (due to oil/bridge works) changed your workload regarding road kills?

Objective 3: Recommendations for Sustainable Solutions against Road kills

5. There is a suggestion to dig ditches in animal-dense zones. How feasible is this ecologically and financially?

6. what sustainable measures do you think can be adopted against road kills in conservation areas?

Thank you for your valuable contribution!

Appendix 3: Demographic Characteristics of Respondents

Variable	Category	Frequency (n)	Percentage (%)
Stakeholder Category	Tourist	25	33.3
	Motorist	25	33.3
	Park Staff	25	33.3
Gender	Male	50	66.7
	Female	25	33.3
Frequency of Travel Through MFNP (n = 72; 3 missing responses)	First time	15	20.8
	Occasionally (1–3 times a year)	14	19.4
	Frequently	43	59.7