Preliminary Report on the Research Project: Ezechiel Turikunkiko, ID: 40727-2

Title of the Project: Assessing the factors leading to the frequent livestock killings towards the protection of carnivores in Gishwati-Mukura National Park and Biosphere Reserve

Funded by Rufford Foundation

Presented by Ezechiel Turikunkiko

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I. INTRODUCTION

With the funds from Rufford Small Grants, the research project titled "Assessing the factors leading to the frequent livestock killings towards the protection of carnivores in Gishwati-Mukura National Park and Biosphere Reserve" with ID: 40727-2, was undertaken to contribute to the responses on the problem animals that are facing the Gishwati-Mukura Landscape, especially the increase of unprecedented livestock deaths since 2019 around this newly established protected area in Rwanda.

Before becoming a National Park and Biosphere, no problem animals were ever reported in both Gishwati and Mukura Forests. However, these assumptions did not justify the absence of carnivores in the area as Parsons et al (2022) have mentioned that many predators can switch strategies when the population of prey declines, relying on alternative prey or adapting new foraging such as scavenging as well as hunting in camouflage due to human aggression.

After having the legal status, mainly from 2019, frequent cases have been raised reporting that unknown animals are killing livestock around Gishwati-Mukura National Park and the entire landscape in general. This issue became a concern on a large scale and alerted the government and private institutions.

In this regard, we have undertaken this research to contribute to finding out the factors of reportedly livestock killings in the newly established Gishwati-Mukura National Park and Biosphere to help address the issue of the problem animals and propose solutions to these carnivores-livestock conflicts.

II. METHODOLOGY

This research was conducted in farms and forest plantations around Gishwati-Mukura Gishwati National Park and Biosphere Reserve.

This research used camera traps, community surveys, and the literature on human-wildlife conflicts.

A total of 52 trapping points, using 18 camera traps (Reconyx, Moultries, and Bushnell) have been covered for each deployment phase. Camera traps were retrieved from the field after remaining at least 30 days at trapping locations, checked, and moved to other places.

Deployments were carried out in buffer zones, pastures, remnant forests, and planted/community forests, and at the edges of the core forest. Camera photos were stored, proceeded, and annotated in WILD.ID software. Excel was used in data analysis. In data processing, human pictures and pictures of live baits (sheep, goats, calves), and plant photos were removed before analyzing the data.

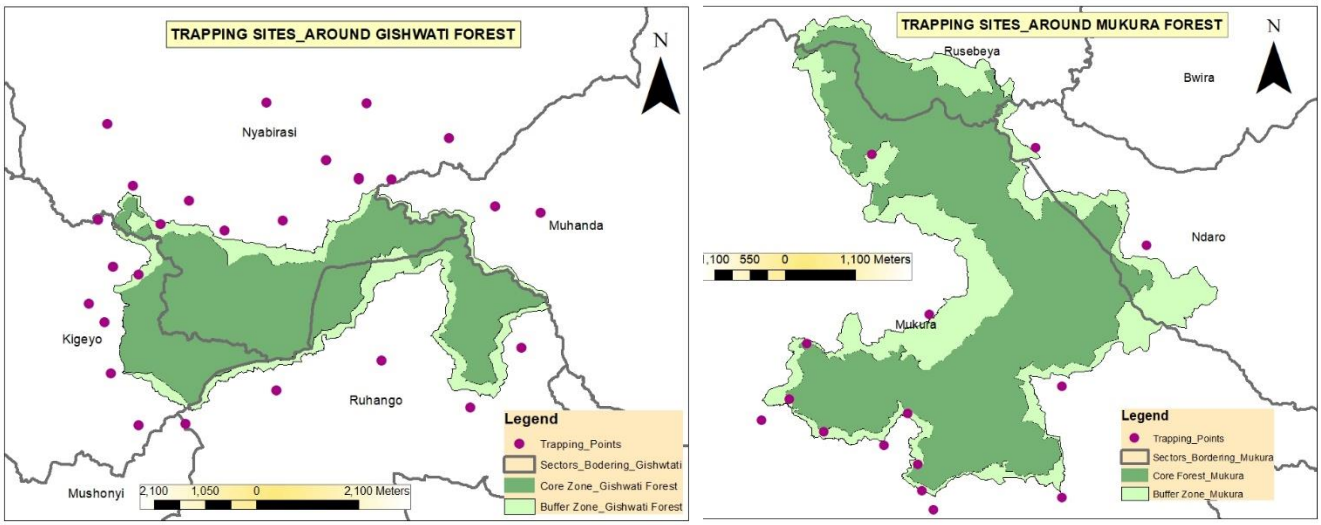

Figure 2.1. Map of the distribution of trapping sites

Because the study area is composed of forest patches and other forms of land with irregular shapes, camera traps were deployed on an irregular basis (Weiskopf, 2019; Wentzel et al, 2021). Camera traps were mounted at 50cm height on trees along animal signs like trails, dung, etc…(Weiskopf, 2019, Derugin *et al.* 2016). Aside from irregularities in forest patches, at least a camera was put in a grid of 1 km. In almost all trapping locations, baits of carcasses or live livestock were used to attract predators (Wearn and Kapfer, 2017; Linnell et al.,1999; Khanal1, 2020). Watchmen were engaged to ensure the security of the cameras and baits.

Furthermore, the research was done by using the inception meetings and workshops with local leaders, park staff, and local communities to discuss on project overview and preliminary findings. From those meetings and workshops, key questions have been drafted to guide questionnaires and comments given to improve the preliminary report. Moreover, the data collection proceeded with group discussions and questionnaires to the local communities, park staff and local leaders, livestock producers including victims (who lost their livestock to predators). In this report, 323 persons have responded to the questionnaire.

Besides the questionnaire, conversations with respondents and other participants in this research project were done to clarify and get details on some responded items(Gálvez et al.2021).

Meetings and workshops have been organized to take the project concept, understand the issue of livestock deaths, and carnivores, and share the updates from data collection. Training was organized for 20 cowboys/watchmen on how to protect livestock and behave in the areas used by carnivores.

Field observations have been conducted to see the field realities in line with the data collected from camera traps and questionnaires.

The literature on human-wildlife conflicts, livestock killings, carnivores, and people interactions was reviewed. Ranger-based monitoring data collected by park management especially data on illegal activities were checked through to see if illegal activities can influence livestock killings.

For data processing and analysis, Wild.ID was used for data entry and image annotation. Human pictures and plank images were removed in data processing and analysis. The camera trap data were exported in Excel and Excel was used in data analysis for both camera trap data and community survey data (Banamwana, 2021; Yazezew, 2022).

III. KEY PRELIMINARY FINDINGS

3.1. Identification of carnivores involved in killing livestock and other possible causes of livestock deaths

These results were obtained from camera trap data, the questionnaire, clarifications from research participants, field observations, and information from the literature.

3.1.1. Animals recorded by camera traps

The deployment phases have covered 52 trapping points in total; using 18 camera traps (Reconyx, Moultries, and Bushnell). The pictures of carnivores were most targeted, while prey and livestock data were in addition (Wentzel et al., 2021). Human photos have been removed in data processing.

5 species of carnivores have been recorded. Those species are Side Striped Jackal (*Canis adustus/Lupulella adusta*), Serval (*Leptailurus serval*), Feral dog (*Canis lupus familiaris*), Large-spotted Genet (*Genetta maculate),African*

civet (Civettictis civetta). Other wild animals (non-carnivore) species recorded include eastern chimpanzees, mountain monkeys, golden monkeys, Handsome francolin, and pied crow. The species of livestock recorded are cows, ships, and goats. A total number of 8,921 pictures have been recorded as categorized in the table below:

Table 3.1: Recorded and Identified animals captured by camera traps

#	Species	Order	Total number of pictures	Percentages
1	Side Striped Jackal (*Canis adustus)*	Carnivora	785	8.8%
2	Serval cat (*Leptailurus serval*)	Carnivora	54	0.6%
3	Feral dog (*Canis lupus familiaris*)	Carnivora	3,562	39.9%
4	Large-spotted Genet (*Genetta maculate)*	Carnivora	176	2.0%
5	African civet (*Civettictis civetta*)	Carnivora	6	0.1%
6	Eastern Chimpanzee (*Pan troglodytes schweinfurthii)*	Primates	6	0.1%
7	Mountain Monkey (*Allochrocebus lhoesti)*	Primates	11	0.1%
8	Handsome Francolin (*Pternistis nobilis /Francolinus nobilis*)	Galliformes	3	0.0%
9	Golden monkey (*Cercopithecus mitis kandti*)	Primates	23	0.3%
10	Cow (Bos p.)	Artiodactyla	1,991	22.3%
11	Sheep (*Ovis sp.*)	Artiodactyla	2,119	23.8%
12	Goat (*Capra sp.*)	Artiodactyla	178	2.0%
13	Pied crow (*Corvus albus*)	Passeriformes	7	0.1%
	Total		**8,921**	**100%**

Considering the table above of the pictured animals by camera traps, there are 3 categories of photographed animals: carnivores with 51.4% of all captured pictures, other wild species with 0.6% of captured animals, and Livestock with 48% of all photographed images. This indicates that the recorded carnivore species are approximately sharing the same areas with livestock.

3.1.2. Responsible carnivores identified by camera traps for livestock deaths

Camera traps have shown that almost all recorded carnivore species (aside from Serval Cat) eat on carcasses (meat baits) of large prey, and only one species of carnivore was captured attacking and killing live prey (live baits) of medium-large mammals like sheep.

- **Feral dogs**

Camera traps recorded many photos of feral/domestic dogs (*Canis lupus familiaris*) with 39.9% of all recorded pictures. It was observed that trapping sites, especially those with baits (meats or live baits: sheep or goats) were frequently visited by dogs to look for food (meats-prey). At different trapping sites, it was seen that almost the same individuals of dogs used to visit those sites as they primarily got the diets at the same places.

Figure 3.1: Recorded dogs by camera traps attacking and killing live sheep

Feral/domestic dogs have been recorded by camera traps attacking and killing live sheep as well as the carcasses. However, it was observed that the habituated domestic dogs couldn't attack the live sheep/goats, instead, they were able to eat the meat baits deposited around the live sheep/goat.

In that regard, it is to confirm that the abandoned dogs, which have been released in the bushes are the best carnivores to kill livestock in the Gishwati-

Mukura Landscape. Those categories of maltreated and abandoned dogs have developed a strong mechanism of hunting and losing human-livestock familiarity (Walker, 2018) which ends with killing any encountered large mammals like captured sheep with the possibility of attacking humans as local communities declared to be anxious when they see those stray dogs. Our findings on dogs are similar to the ones found by Gálvez et al (2021), who argued that free-roaming domestic dogs (*Canis lupus familiaris*) as the main cause of livestock losses in farming/Agricultural Landscapes of southern Chile.

- **Side Striped Jackal (*Canis adustus*)**

Side Striped Jackal (*Canis adustus*) is the second carnivore shown by camera traps with 8.8% of all pictures.

Figure 3.2: Side Striped Jackal captured eating on meat baits

Although some authors have suggested that when side-striped Jackal (*Canis adustus)*are in groups can attack large mammals like sheep and goats (Hayes and Bodenchuk, 2010), in this project, jackals were found eating meat baits, but they were not found attacking live livestock though the jackals crossed around live baits (livestock). More monitoring is needed to find how side stripe jackal attack and kill live pets of medium or large prey.

- **Large-Spotted Genet (*Genetta maculate)***

The camera trap pictures of r large-spotted Genet (*Genetta maculate)* are 2% of all recorded pictures. A large-spotted Genet (*Genetta maculate)* was found approaching the meats with limited eating behavior on the meats.

Figure 3.3: Large Spotted Genet captured by camera traps eating on meats

- **Serval cat (*Leptailurus serval*)**

Photographs of a serval cat comprise 0.6% of all images that were taken by camera traps. Serval cats were observed ignoring meat baits that are placed in front of camera traps. But, according to Furstenburg, 2009, serval cats depend on live baits and are not scavengers, they cannot be drawn to dead baits. Hence, more research is necessary to determine whether serval cats in the Gishwati-Mukura Landscape can consume dead baits or attack large mammals like goats, sheep, or calves.

Figure 3.4: Serval cat captured around meat bait without eating on eat

- **African civet (*Civettictis civetta*)**

The pictures of African civets were 0.1% of all images taken by camera traps. Though camera traps have recorded few images of African civets, it was seen that African civets have shown the moral courage of eating on meat baits.

Figure 3.5: African civet pictured by camera trap eating on meat baits

- **No records of spotted hyena in this study**

It was expected that the camera traps could record spotted hyena as was pictured by a camera trap in Gishwati in 2022 (Uzabaho et al.,2022), but it was not photographed during this project's camera trap deployments. There are assumptions that since spotted hyena was recorded recently in Volcanoes National Park (Uzabaho et al.2023), and it is known to use a big home range in length and width (Mhlanga, 2018), we can assume that the same individuals from volcanoes National Park or Virunga massif can use Gishwati-Mukura Landscape because the Volcanoes National Park and Gishwati-Mukura Landscape are separated with a distance of below 40 kilometers. However, The study will continue to explore the presence or absence of spotted hyenas in the Gishwati-Mukura Landscape.

3.1.3. Community knowledge of carnivore species involved in killing livestock

During discussions and the inception meetings, and while presenting the preliminary report the participants assumed that feral dogs are more contributors to the killings of livestock.

From the questionnaire (by using levels: None, Low, Medium, High), when we considered the high-level ranks, 72.1% of respondents agreed that feral dogs are expected to kill livestock, while this involvement expectation of high-level is at 59.7% of respondents for the side-striped jackal and 57.4% for unknown animals. Although spotted hyena was not recorded by camera traps, 58.1% of respondents have assumptions at a high level that the spotted hyena is very questionable for killing livestock. However, these assumptions for spotted hyena should remain searchable because even if camera traps have recorded spotted hyena in the area in 2022, this was not previously recorded and from 2022 to now, in 2024, there are no other signs of spotted hyena being recorded.

Moreover, the details in the responses stated by respondents on involved carnivore species in killing livestock in the area of Gishwati-Mukura National Park and Biosphere Reserve are presented in the chart below:

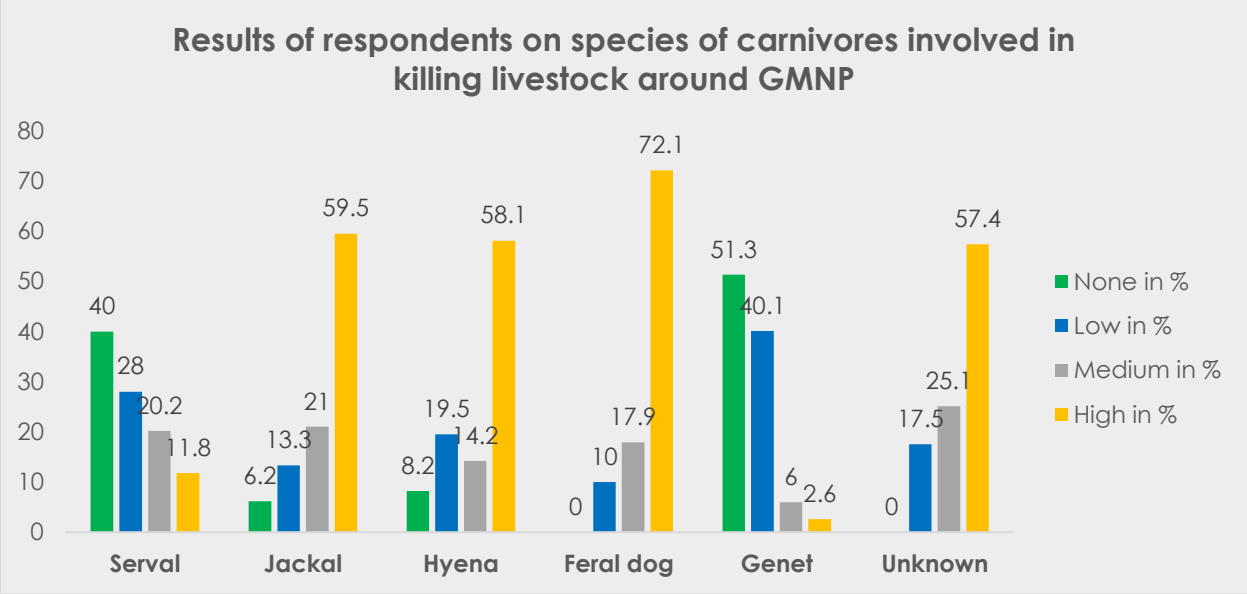

Figure 3.6: Feedback from respondents on carnivore species involved in killing livestock

When we tried to request more details from respondents about expected animals in killing livestock, there was some confusion for the local communities about differentiating between jackals, hyena, and unknown animals when those animals are attacking livestock at night. People were also confused between serval, civet, and large spotted genet. But for dogs, local people were good at identification and had more information and clarifications about feral dogs. In addition, during the meetings and group discussions with the local community, local leaders, and park staff, it was underlined that a number of fearsome feral dogs (bigger than the ones living in homes) can be identified crossing in bushes, tea plantations, and forest plantations.

3.1.4. Direct observations of predator attacks by local communities

In the questionnaire, when the people were asked to mention if they have seen by their eyes the suspected predators attacking livestock they responded as follows:

Table 3.2: Responses from the interviewees on observations by eyes for predators attacking livestock

NO	Statement	Unseen in %	Seen in %	Most seen in %	100 %
1	Serval	89.1	8.8	2.1	100
2	Jackal	34.5	25.3	40.2	100
3	Feral dog	7.1	19.5	73.4	100
4	Genet	93	5	2	100
5	Hyena	90.3	8.5	1.2	100
6	Unknown	55.5	33.3	11.2	100
	Average	**61.6**	**16.7**	**21.7**	**100**

Except for the feral dogs which were seen at a high level (73% of most seen) and jackals (45.2% of most seen), most of the respondents on the questionnaire mentioned that they have not seen predators that prey on people's livestock as clarified by respondents that in most cases, livestock predation events occur at night or in the day times like when it is raining or when livestock are released carelessly in the bushes without cowboys to look for them.

Considering the overall averages from answers given by respondents in this research, only 38.4% (most seen: 21.7% and seen: 16.7%) of respondents have confirmed that at least they did direct sight of predators attacking or chasing livestock. Whereas, 61.6% of respondents's average disagreed with seeing carnivores attaching or chasing livestock. Specifically, respondents have shown their feedback of not seeing serval, genet, and hyena which can lead to think that their involvement in killing livestock is low or absent as also camera traps did not record their high participation in eating meats.

In this study, it was found that the predators can not be seen not only because their attacks happen during the night (or rare events of carnivore behaviors), but also be associated with other causes that can increase the reports of the killed livestock for different reasons, which at the end can result in concluding that the livestock kills are caused by carnivores for further reasons behind the scene.

3.1.5. Targeted and encountered types of reportedly killed livestock

By responding to the questionnaire, respondents have shown that sheep are more targeted by carnivores than other livestock, followed by calves and goats. In contrast, big cows are lower or not targeted by carnivores. In the averages of 5 categories of livestock (goats, sheep, calves, big cows, and chickens), 36.28% of

respondents have shown that all of those livestock are not targeted which can show that the listed carnivores in this research have other source of diets to feed on. The details are in the table below:

Table 3.3: Responses on targeted and most reported types of livestock for suspectly being killed by carnivores

NO	Statement	Not targeted:%	Low targeted: %	Medium Targeted: %	Most targeted:%	100 %
1	Big cows	70.4	18.6	9	2	100
2	Calves	6.9	13.5	22.5	57.1	100
3	Sheep	5.5	4.2	22.2	68.1	100
4	Goats	16.3	17.5	14.5	51.7	100
5	Chickens	82.3	10.4	5.6	1.7	100
	Average	**36.28**	**12.84**	**14.76**	**36.12**	**100**

3.1.6. Habitat and Origin of Carnivores Attacking Livestock

When we were in the field by our observations, we found other possible habitats like tea and forest plantations that can host wildlife. During the meetings and workshops, the local community shared information explaining that there are wild species of carnivores and others that from many years ago live permanently outside the park, in the planted forest, tea plantation, remnant forest, and abandoned mining holes and caves which are not included in the area of Gishwati-Mukura National Park boundaries. These kinds of other animal shelters became permanent homes for wildlife. They can encourage wild animals to remain outside the park boundaries and use those places by moving from one site to another without turning back inside the park.

The following chart shows other homes for carnivores that attack livestock:

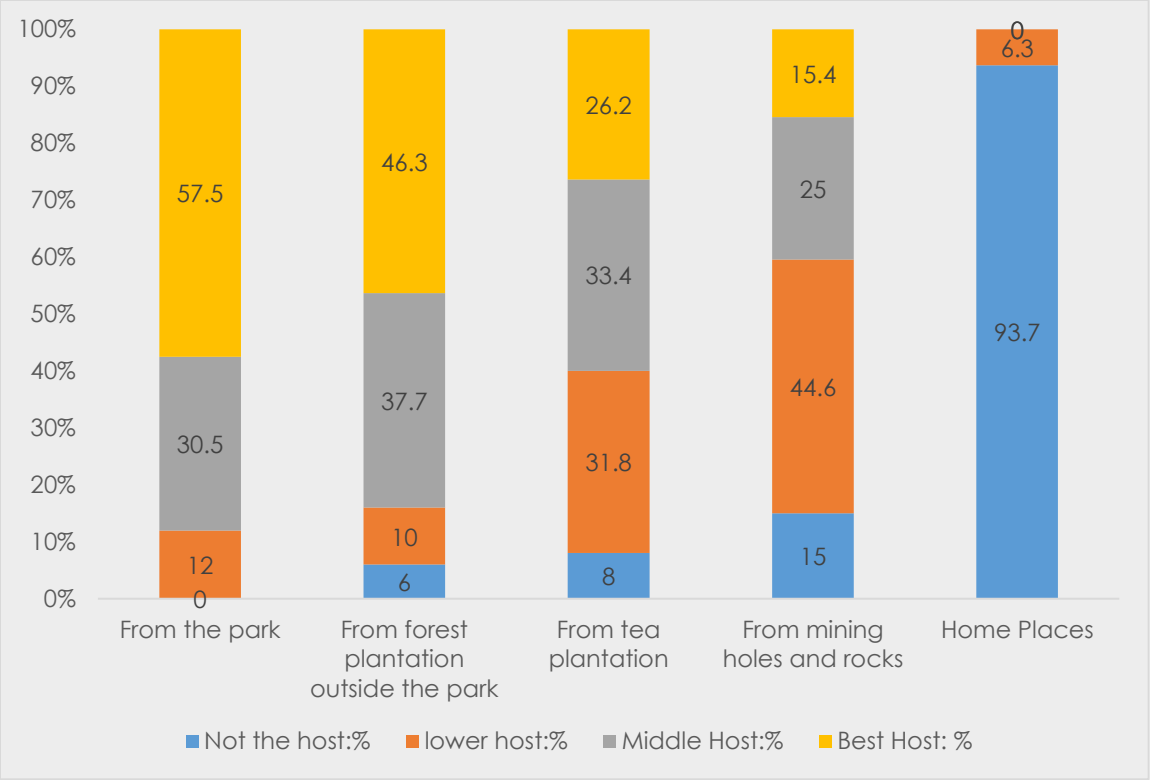

Figure 3.7: Answers from respondents on the origin of carnivores attacking livestock

Although it was found that the above-mentioned habitats are home to carnivores, local people mentioned that those areas host the endangered golden monkeys. This research finds that those permanent shelters for carnivores outside the park areas are susceptible to creating long-term conflicts if no strict management measures are taken to manage the wild animals living in those habitats.

Despite (the existing Gishwati Mukura boundaries of the national park and biosphere reserve) being a vast area incorporating two major protected reserves (Gishwati and Mukura), its considerable wildlife may require access to large ranges including agro-pastoral human communities (Walpole et al 2003). Local communities confirmed that because these shelters are very close to livestock locations or home places, attacking livestock can occur in the evenings, nights, early mornings, and during the daytime, especially when it is raining even if it can be in days.

3.1.7. Other no-carnivore causes of reportedly livestock deaths

According to Hodgson et al. (2020); Bulte and Rondeau (2020) the livestock producers or their relatives and neighbors can fail to prove that the damages were caused by predators or wildlife which results in cheating the system by reporting that the origin of the losses was wild animals for getting more compensation benefits on lost properties.

During this research's inception meetings, it was mentioned that in addition to carnivores, there can be other factors contributing to the exaggeration in reporting the cases of livestock killed/damaged by carnivores. This can happen for the target of receiving compensation since it is well known that the Government pays for damages caused by wild animals.

The key mentioned reasons in the meetings included theft, diseases, natural deaths (accidents, herd fights, while giving birth and old age), and thunderstorms. The average scores of 19.8 % (High: 3.8%, Medium: 6.2%, and Low: 9.8%) of respondents have shown that these no carnivores mentioned causes are the cases that can increase frequent reports of livestock killings, while the average scores corresponding to 80.2% of respondents from the questionnaire has shown that those cases are not among the causes fueling livestock killings like carnivores are.

These no-carnivore causes should be taken into consideration among the factors causing the increase of reports about livestock killings around Gishwati-Mukura National Park and Biosphere Reserve especially theft as on this case 36% (Hig:7.7%, Medium: 12.2%, and Low:16.1%) of respondents agreed that stealing of livestock case of the livestock theft case, 59% of respondents have said that theft is not among the cases that increase reports, while 41% (high: 9.7%, medium: 11.2%, and low: 20.1%) of respondents indicated that case of stealing is the side causes that heighten the reports on livestock killings to predators because it involves illegal livestock slaughtering for commercial meats. As a result, those stolen livestock products can be added to the reports of carcasses killed by carnivores.

Also, 25.7% (High: 5.3%, Medium:7.2%, and Low: 13.2%) of respondents confirmed that natural death can be another cause to increase the reports of livestock killings because livestock can die from accidents (falling from steep terrain, bad tying), herd fights, time of giving birth or old age.

All of these above side causes are among the factors increasing the reports of killed livestock by carnivores mostly in favor of expecting compensation profits.

Other details stated by respondents on other susceptible factors of reportedly livestock killings are in the table below:

Table 3.4: Other non-carnivore causes suspected to increase reportedly livestock deaths

NO	Statement	Not the case: %	Low in %	Medium in %	High in %	100 %
1	Theft	64	16.1	12.2	7.7	100
2	Diseases	87.3	7	3.5	2.2	100
3	Natural death	74.3	13.2	7.2	5.3	100
4	Thunderstorms	95	3	2	0	100
	Average	**80.2**	**9.8**	**6.2**	**3.8**	**100**

3.1.8. Illegal use of park resources and livestock predation

In this project, we wanted to know if illegal activities can be among the reasons behind livestock predation and can influence livestock killings (Gálvez et al. 2021). The general concern was that the main illegal activities encountered in Gishwati-Mukura National Park are targeting the destruction of wildlife habitat and sharing the resources with wildlife which can result in a lack of food for wild animals, extinction, or refugees for wild animals from one plane to another.

Those major illegal activities include mining, tree cutting, grazing in the park, encroachment, and grass cutting. During the interviews with questionnaires for the further underlying causes of livestock killings, the averages of respondents have shown that illegal activities are not the case at 43.64% while 56.36% (with low: 24.76%; with medium: 18.18%; with high:13.42) confirmed that illegal activities are among the cases that contribute to the livestock killings.

One of the comments given to these results on illegal grazing in the park is that when the livestock are released in the park, it is easy for carnivores to find and attack them because they are closer to them. However, the presence of human activities in wildlife habitats has forced some predators to switch to livestock as their food source (Lyamuya et al.2017).

The detailed results from respondents on illegal activities as the causes of stimulus for reporting frequent livestock predation are shown in the table below:

Table 3.5: Concerns of respondents on park illegal activities to stimulate carnivore attacks on livestock

NO	Statement	Not the case	Low in %	Medium in %	High in %	100 %
1	Illegal mining	50.2	19.3	18.4	12.1	100

2	Tree cutting	38.6	25	20.4	16	100
3	Grazing in the park	41.9	25.1	18.5	14.5	100
4	Encroachment	61.4	31.2	4.3	3.1	100
5	Grass cutting	26.1	23.2	29.3	21.4	100
	Average	**43.64**	**24.76**	**18.18**	**13.42**	**100**

3.2. Historical conservation and characteristics of Gishwati-Mukura forests landscape and habitat in regards to livestock predation

3.2.1. Land use change - converting forest into multi-use activities

The findings on the land use change and livestock predation effect for this project carried out in Gishwati Mukura-National Park and Biosphere Reserve, are similar to the statement of Ruschkowski and Mayer (2011) who argued that conventional land uses have been a challenge to disturbance of the conservation of wildlife and national parks where landscapes have been used intensively for agriculture, forestry, resource extraction, and recreational purposes over several years which resulted in having numerous conflicts between land users and wildlife.

From the views of people who gave ideas in this research project, it was mentioned that Gishwati-Mukura Landscape experienced different land use activities that changed its regime and reduced it from a formerly big area to the current small one with fragmented and separated patches.

The participants in this research project clarified that the conversion of land into multiple activities and priorities over time in the Gishwati-Mukura Landscape has disturbed the current system of wild animals in terms of presence or absence on an irregular basis well as disturbing the niche of wild animals that led to migration or extinction of wild animals or extinction from one place to another due to the small sizes of scattered and fragmented forests in the Gishwati-Mukura Landscape.

Also, the participant in this research commented that this long-term disturbance has led to the reduction or lack of food, habitat, and security for wild animals that might lead to the attacks of livestock being faced today.

Nevertheless, the average equal to 22.95% of respondents have said that land conversion activities (agriculture, establishment of pastures, settlements, Illegal activities) over time are not a reason to lead to current predations or attacks on livestock, whereas 77.05% (High: 25.2%, Medium: 27.5% and Low: 24.35%) of respondents have agreed that those activities have been among the long-term

causes that indirectly contributed the completion in use of resources in Gishwati-Mukura Landscape, increasing human-wildlife conflicts especially the current killings of livestock. The table gives a picture of details from respondents about land use change towards current encountered livestock deaths.

Table 3.6: Respondent feedback about multiple land use activities over time and current carnivores-livestock conflicts

NO	Statement	Not the case in %	Low in %	Medium in %	High in %	100 %
1	Agriculture	19	12.2	37.7	31.1	100
2	Establishment of pastures	4.5	27.5	26	42	100
3	Settlements	24.7	33	28	14.3	100
4	Illegal activities	43.6	24.7	18.3	13.4	100
	Average	**22.95**	**24.35**	**27.5**	**25.2**	**100**

3.2.2. Conservation efforts and best practices as motivation for carnivore predation on livestock

In this research project, it was found that there are conservation efforts and best environmental practices (reforestation and afforestation, creation of a national park, tea plantations, making terraces, protection of state-remnant forests, protection of wild animals) done for Gishwati-Mukura Landscape that contributed to the recovery of habitat and rehabilitation or increase of animals especially carnivores in the landscape.

Therefore, as per some authors, a package of efforts in the conservation of wildlife, conservation objectives, and different inputs attributed to the protection of the environment can motivate the increase of predators which results in having drivers of human-wildlife conflicts in one or another way (Gálvez, 2021; Ruschkowski and Mayer, 2011) as it was shown in this research project that some efforts done for the conservation and recovery of Gishwati-Mukura Landscape enabled also the recovery of animal shelters and rehabilitation of carnivores which is resulting in conflicts with local communities by attacking and killing livestock.

That increase in wildlife especially carnivores requires enough food/prey which can result in killing livestock in the absence of wild prey (Hayes and Bodenchuk, 2010). However, with averages, it was shown by 18% of respondents that those above-mentioned conservation practices do not contribute to livestock predation in Gishwati-Mukura Landscape; while 82% (High: 56%, Somehow:13%

and low: 18%) of respondents stated that those conservation activities and best practices done for through Gishwati-Mukura might contribute to the killlings of livestock as it was explained by respondents and other participants in thtis reserach that the number of carnivores kept increasing due to not only the aforesaid landscape restoration practices but also the protection by laws of forests as well as prohibitions and punishment for killing wild animals**.**

However, the combination of those above positive conservation efforts contributed to the increase of animals in the area whereas those animals need prey in one or another way that involves livestock predation. The chart below gives details of the results from respondents.

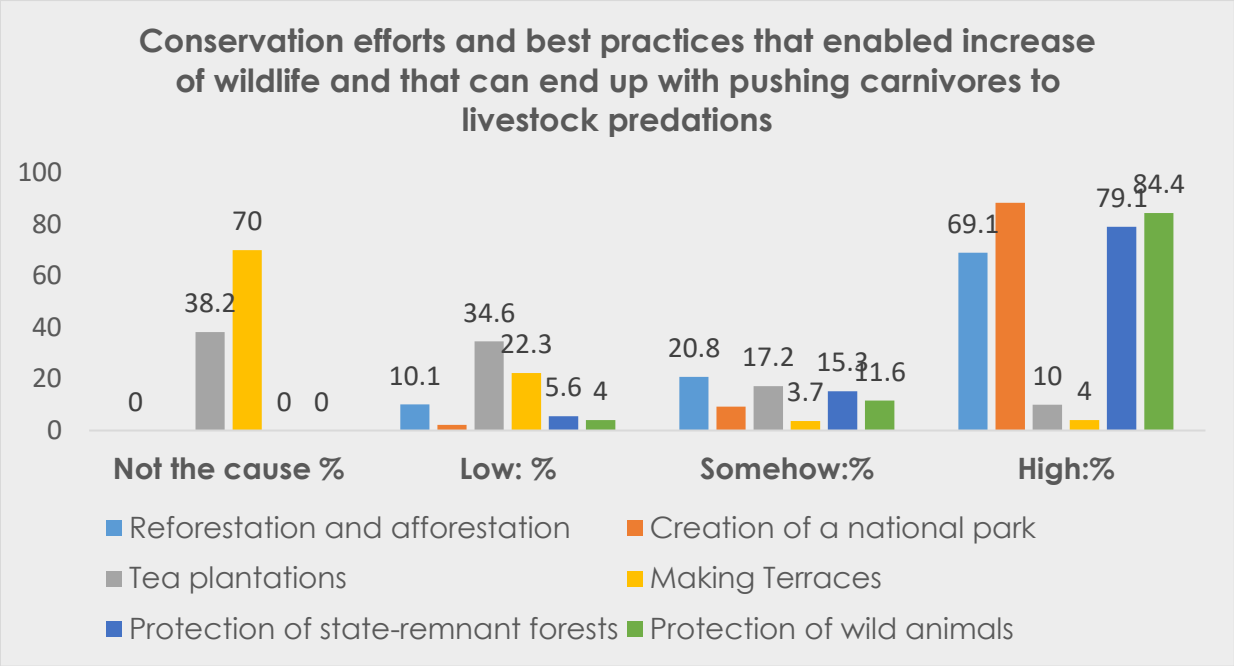

Figure 3.8: Respondent ideas on conservation efforts to motivate carnivore predations on livestock

In addition, the clarifications of responses given by respondents and the participants in meetings and workshops, are in line with the arguments of Lyamuya et al.(2017) who found that the increase in carnivore conservation initiatives has resulted in the recovery and expansion of carnivore populations, which also escalates the problem of killing livestock. Lyamuya et al.2017 continue arguing that the creation of protected areas or another form of conserved areas that serve as refuges from which predators can populate the surrounding area can escalate the problem in most adjacent areas.

Although there is now a carnivores-livestock conflict, it is pleasing to see that the recovered areas of Gishwati-Mukura Landscape may attract wild animals that

should not have been present in the previous years in Gishwati-Mukura Landscape that experienced the threats of reducing and degrad a big part area of its natural habitat (Arakwiye, 2020) and with the time of its huge degradation it was not easy to see carnivores crossing the areas as communicated by respondents and local communities in the meetings during this research.

3.2.3. Field Characteristics

In this project, the terrains, field features, and shapes of the Gishwati-Mukura Landscape were found among the things that can channel the predators toward searching for prey in the local community's livestock. The key identified things in this research project include forest fragments and the dis-connectivity of Gishwati and Mukura forests; the small size of the park and its irregular shape; many forest plantations in the park neighborhoods; complex land uses by the community and topography and Relief. Durant et al.(2022) support our findings by saying that environmental conditions, field characteristics, and human behaviors are among the things that increase the likelihood of carnivore attacks on humans and livestock.

Also, in this study, it was observed that these above-mentioned field characteristics can facilitate speed-up or cut off animal movements from place to places, which can result in a lack of equilibrium in finding food or shelters for animals as well as fueling human-wildlife conflicts.

The average resultants from respondents to the questionnaire in this research project have stated that the field characteristics are very enabling livestock predation at an average of 41.64% of respondents, and those characteristics enabling in the medium at an average of 23.3% of respondents, while the average of 35.06% of respondents confirmed that those field characteristics do not enable the predators for killing or attacking livestock. The details on this point are as follows in the table:

Table 3.7: Responses on field characteristics that can lead carnivores to livestock attacks

NO	Statement	Not enabling:%	Enabling:%	Very Enabling:%	100 %
1	Forest fragments and dis-connectivity of Gishwati and Mukura forests	12	26	62	100
2	The small size of the park and its irregular shape	39	27	34	100

3	Many forest plantations in the park neighborhoods	7.1	20.5	72.4	100
4	Complex land uses by the community	40.2	31	28.8	100
5	Topography and Relief	77	12	11	100
	Average	**35.06%**	**23.3%**	**41.64%**	**100%**

Several elements of field characteristics have been observed in this study. Some parts are hilly/slop areas, wetlands, and water courses. Some extremities or middles of the Gishwati-Mukura park core area (from one side to another side) do not even measure 100 meters in width and it is very easy to be crossed by animals because it is difficult for them to spend a lot of time in such small parts.

Forest recovery is still ongoing in many places and we expect that forest still needs diverse food chains. Many corners of the park are bordered by farming activities (pastures, agricultures) and settlements. Many scattered forests of different kinds that are most time separated by pastures can be used by wild animals and carnivores specifically, at the same time being used by cattle/livestock grazing in those pastures.

3.3. Prey availability and presence of predators towards the livestock-carnivore conflicts

Over the years, the drastic reduction of Gishwati-Mukural natural habitat, forest conversion, and fragmentation had a big influence on the loss of biodiversity and most have disappeared (Nyandwi and Mukashema, 2011). As evidenced by camera trap data today, more individuals of carnivores were recorded than herbivores in the Gishwati-Mukura Landscape.

Apart from primates, it is not guaranteed to record herbivores of at least mid-sized mammals even if some literature reiterates the presence of carnivores of such antelopes which might be among the prey of carnivores in the Gishwati-Mukura Landscape.

However, the depletion of wild prey as a result of human activities has forced some predators to switch to available livestock as their food source (Lyamuya et al.2017). In addition, the recovery of Gishwati-Mukura forests is still ongoing in many places and we expect that forests still need diverse food chains that will occur accordingly. Further assessment of predator-prey availability can help in understanding this process.

Considering the data recorded in this research by camera traps, only 0.6 of recorded pictures are non-carnivore wild animals specifically primates and birds, and they are not preferred meats for carnivores and can't be easily hunted by carnivores while 48% of recorded pictures are livestock which are available and easy to be attacked by carnivores and become the nearest prey for predators instead of hardly looking for wild prey from very far.

On the other hand, the existing literature like Ugarte et al (2019) found that the recorded wild animals in our research such as serval, side-stripped jackal, and genet are not responsible for killing large mammals like goats, sheep, or cows. But, according to Hayes and Bodenchuk (2010)when side-stripped jackals are in groups can attack large mammals like sheep, goats, and calves. Except for several, all other carnivores recorded by camera traps in this research are responsible for eating on carcasses of large mammals, and feral dogs are responsible for killing live mammals and eating their carcasses.

From local knowledge and experiences shared by the local community through the questionnaires, an average of 17.6% of respondents have said that the recorded carnivores by camera traps in this study are not involved in killing livestock (calves/cows, goats, sheep, and chickens), while for targeted and reported cases of killed livestock, an average of 36.28% of respondents said that those livestock are not targeted in this frequent reported livestock killings. This might mean that these carnivores can get other non-livestock sources of diets that can include insects, fruits, rodents, or carrion because some of those carnivores like feral dogs and side-striped jackals have higher scavenging behaviors.

According to Sun et al.(2022), the GMNP Biodiversity Survey Report of 2017, and the unpublished report of IGCP-RDB of 2022 on assessing the mammalian community of GMNP, more than 80% of recorded animal species are carnivores which means that there is a disequilibrium in finding diets for those carnivore animals that can lead to the frequent conflicts with local communities through finding food from killing livestock. More research on predator-prey is needed to understand this scenario.

3.4. Responses and feedback of livestock producers in the matters of preventing livestock killings

3.4.1. Protection and prevention of livestock deaths

The research project wanted to assess how prevention and protection of livestock killing is done we assessed 6 items in the table below. We have found the average from those items that nothing is being done with the average of 35.2%, weakly being done with 28.1% and strongly being done with 36.7%. The details are in the table below:

Table 3.8: Respondent views on protection of livestock and prevention of carnivore attacks

NO	Statement	Nothing done:%	Weakly done:%	Strongly done:%	100 %
1	Construction of cow shelters/kraals	48.2	34	17.8	100
2	Watch over livestock/Living closer to livestock	34.1	29	36.9	100
3	Tolerance for predators when livestock are killed	15.7	29.3	55	100
4	Reporting the cases and claim for compensation	11.2	15.7	73.1	100
5	Killing the predator/retaliation	71	21	8	100
6	Chasing the predator	31.3	39.5	29.2	100
	Average	**35.2**	**28.1**	**36.7**	**100**

During the field observations, where it is was clarified that protection and prevention of livestock are not being done or weakly being done due to for example slow ongoing activities in the construction of cow shelters/kraals, it is because most areas are still in pastures, others do not have a capacity of enclosing on their livestock huts, and some of those with financial capacity can ignore/skip to do so. While this research project has revealed that there are no kraals in most pastures and homeplaces, it was found that where there are some constructed shelters for livestock, a majority of these shelters are not strong

enough to provide minimum safety through which a predator can pass to get in or livestock to get out; very few of them are in good status.

For watching over livestock/living closer to livestock/chasing the predators, it was noted that some people are hiding from predators because they are fearness of being attacked by predators. Also, It was clarified that weakness in watching over livestock can happen due to the lack of enough livestock care or inattention to protecting livestock. For reporting compensation claims, it was found that there can be laziness or cheating in reporting cases to local leaders or park management.

In addition, our findings are in direction with the assertions of Lyamuya et al.(2017) who argued that in some cases depredation can occur because domestic livestock have evolved only weak anti-predatory strategies; whereas as a result the livestock are easily killed with little effort by the predator. During our field observations, some livestock were seen freely grazing and ranging without a herder/cowboy in nearby forests, bushes, and tea plantations as homes to predators, which can be an attempt for predators to attack those livestock. However, not all farmers ignore livestock protection, because some visited livestock pastures and homeplaces were fenced.

In this project, 20 Local communities/cowboys have been trained about the protection of livestock, how to behave in front of predators, and be aware of the behaviors of predators which was found to be contributing to the safety of livestock even if the trained people are not enough.

3.4.2. Level of fairness in reporting incidents of livestock deaths

In the bellow chart, it is shown that 84.6% (54.3%: most happening and 30.3%: happening) of respondents agreed that there is fairness in reporting exact information on predation cases; 16.6% (4%: most happening and 12.6%) of respondents confirmed that there can be cheats and exaggerations in reporting predation cases to get more compensations; while 21.3% (10.2%: most happening and 11.1%: happening) agreed that there is fail (laziness and ignorance) in reporting predations cases once the predations do kill or injury their livestock.

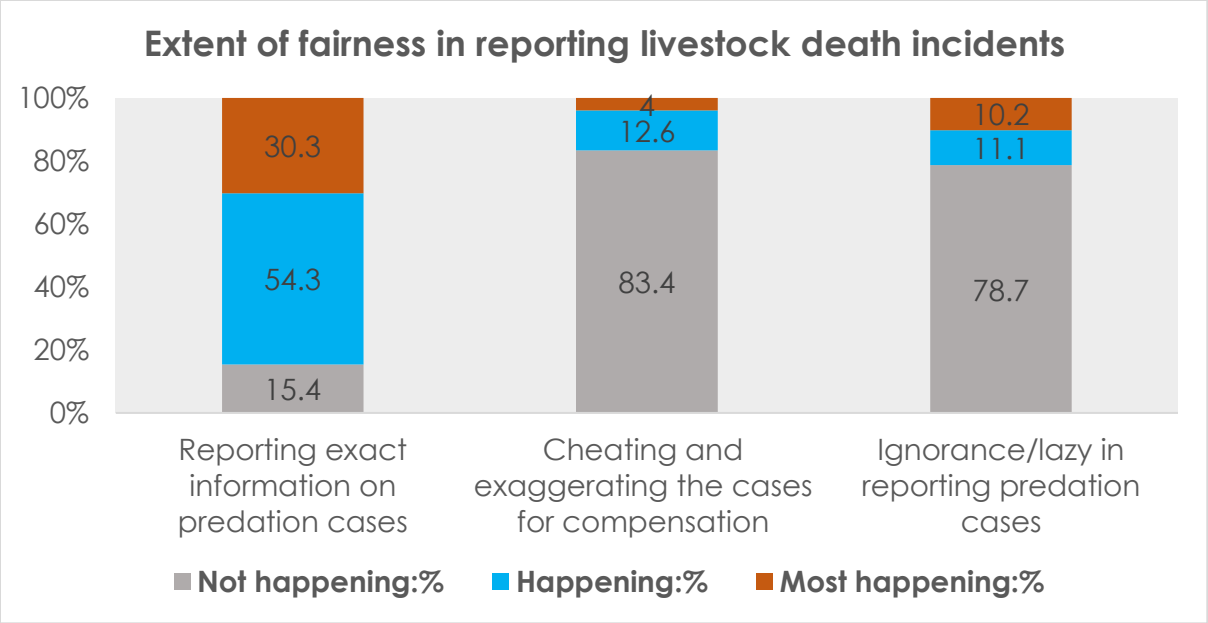

Figure 3.10: Feedback from respondents on fairness in reporting the cases of livestock deaths

For where it was agreed (84.6% of respondents) that there is fairness in reporting exact information on the predation case, it was clarified that livestock producers and farmers, do not need to see their livestock killed by predators because their purpose is to get long-term fruitfulness husbandry practices rather than receiving compensation. Also, It was added that the received compensation in money can not bring similar things to the lost ones.

As agreed and clarified by respondents at 16.6%, there can be cheating and exaggeration in reporting the predation cases for getting compensation. This is because when the producers fail to prove the predation by wildlife carnivores, or when the damages caused by other non-carnivores are caused with no responsible person to pay him the damages. In this case, unfaithful producers can need to find ways of recovering losses through cheating or exaggerating in reports (claiming that the origin is wild carnivores) or informing deaths of livestock in place of injuries to receive compensation benefits.

Regarding performance in reporting, 21.3% of respondents have demonstrated that there can be laziness and ignorance in reporting livestock killings because the livestock producers lack convincing evidence to prove the involvement of carnivores in the cases. Another reason is that some producers live far away from pastures where cattle are in the daily control of cowboys rather than owners. Whereas, the powers of reporting the cases for compensation, other benefits, or key obligations on livestock production are reserved for the persons with legal rights on properties that cowboys do not possess.

It was commented that since Gishwati-Mukura National Park and Biosphere Reserve is newly established, the ignorance and laziness in reporting livestock deaths occur because the local people do not have a high level of positive attitudes towards wildlife or they are not aware, or little informed about addressing the wildlife conflicts for compensation or other solutions.

However, most compensation schemes require more frequent and extensive education efforts delivered to all community members(Lyamuya et al. 2017) so that active participation and fairness in reporting and claiming compensation for the damages caused by the wild damages be well addressed around Gishwati-Mukura National Park and Biosphere Reserve.

3.5. Community Acceptance of human-wildlife Coexistence Approaches in Gishwati-Mukura Landscape

When this research project examined the human-wildlife conflicts by enabling the existence of livestock and the protection of carnivores sustainably, it looked at the paradigm of coexistence between humans and wildlife in the Gishwat-Mukura Landscape. This philosophy of interactions between local people and wildlife would happen in case the local communities accept to attribute the rights to animals and share their land with wildlife (Durant et al., 2022).

In this project, when we wanted to know the level of community acceptance of coexistence with wildlife, an average of 57.9% (strong willed:27.9%; and weak willed:29.9%) of respondents have shown that local communities are willing to coexist with wildlife while 42.1% responded that they are not willing to coexist with wild animals. These aggregated averages were assessed by detailing and leveling the following elements in the table below:

Table 3.9: Views from respondents on how local communities accept the coexistence with wildlife

N0	Statement	Not willed:%	Weak-willed:%	Strong-willed:%	100%
1	Sharing the landscape with wildlife and hosting wildlife in community land/forests	39.7	40.3	20	100
2	Through accepting the loss of livestock/property in favor of wildlife existence	81.2	14.6	4.2	100

3	Though benefits (tangible and intangible) received due to the wildlife hotspot area	35.5	34	30.5	100
4	Through built collaboration arrangements with the park management	37	31.5	31.5	100
5	Through requesting compensation instead of retaliation	13.6	16	70.4	100
6	By considering that killing or eating carnivores as taboo in the culture	36.2	42.6	21.2	100
7	Through recognizing the presence of animals in the vicinities as a neighbor for a long term ago	41.6	34.5	23.9	100
8	Ongoing community initiatives on established community groups for the protection of livestock	52.2	26.1	21.7	100
	Average	**42.125**	**29.95**	**27.925**	**100**

Considering that Gishwati-Mukura National Park and Biosphere Reserve is still new, where some conservation inputs, efforts/goals are not yet being attained, it is being shown that local people are developing positive attitudes toward the presence of wildlife/carnivores in their vicinity, even if the journey is still in long expectations as an average of 42.1% of respondents have shown that local people do not need to coexist with wildlife. However, these findings from this project are supported by the statement of Durant et al. (2022) who argued that coexistence is in a state where conflicts between local people and wild animals exist but where interactions are kept within acceptable limits because coexistence does not exclude the presence of conflicts, but at least it builds the hope and positive attitudes by local communities towards the presence of wild animals in their localities.

Also in line with our findings on point regarding the coexistence of local people and wildlife, Durant et al. (2022) continued suggesting that coexistence would stay a long life if these things are maintained by local communities with enabling condition of government measures on protecting wildlife including the application of punishments on irregularities.

In side clarifications during data collection, few of those local communities in our study area, supported coexistence with wild animals because they had cultural relationships of living with animals for many and many decades ago, where with time, they were bearing some costs of living alongside carnivores. From the

support of Lyamuya et al.(2017), positive attitudes among the public and local communities can increase tolerance for damages caused by wild animals.

Local communities also supported coexistence with wildlife because they hope to receive tangible benefits from the existence of wildlife as they gave examples of implemented community projects from tourism revenue sharing around GMNP for the public benefits as well-being as well as income generating activities being done by local communities including casual employment and support to strengthen community cooperatives.

3.6. Suggestions on what can be done to ensure the long-term management of carnivores – livestock conflicts and coexistence between humans and wildlife

In the following table, respondents have proposed a number of the things and their levels in percentages that can be done to promote coexistence between humans and wildlife while ensuring the protection of livestock and carnivores. The details are as follows:

Table 3.10: Suggested items by respondents in the research on what can be done to keep the coexistence of humans and wildlife

NO	Statement	Not needed:%	Lowly needed:%	Somehow needed:%	Highly needed:%	100%
1	Reinforcing the construction of shelters/kraals	7.2	6	33.8	53	100
2	Fencing the pastures	2.6	17.6	28.4	51.4	100
3	Staying close to the livestock	1.5	3.6	8.5	86.4	100
4	Killing the suspected carnivores	31.5	22.6	18.5	27.4	100
5	Relocating wild animals that cause conflicts	9.4	19.8	25.5	45.3	100
6	Moving livestock production away from the park boundaries	70.1	25.8	2.6	1.5	100
7	Fencing the park	14.4	12	13.5	60.1	100

8	Improving and enforcing laws and regulations on wildlife and land use	0	23	23	54	100
9	Strengthening compensation for damaged properties	0	5.2	12.5	82.3	100
10	Expanding the size of the park area and corridor connecting forest fragments	50.8	20.2	16.5	12.5	100
11	Offer to farmers incentives and training on the protection of predators and livestock	3.5	10.3	12.5	73.7	100
12	Continue research and monitoring on solutions to coexistence between humans and carnivores or wildlife in general	4.5	10.6	34.7	50.2	100
13	Connectivity corridor of forest patches	46.2	25.3	23	5.5	100
14	Improving education and mobilization on wildlife protection	3.3	9.3	37.5	49.9	100
15	Involving local communities in all processes of management of wildlife (planning, implementation, monitoring)	8.9	11.5	35.8	43.8	100

For land use, zonation, and livestock husbandry techniques

The above table shows the suggestions from the participants on what should be done and the level of how they are needed to ensure the good management of carnivores and livestock in the Gishwati-Mukura Landscape. Lyamuya et al.(2017) recommended that there is a need to improve livestock husbandry practices and strengthen wildlife conservation strategies to reduce livestock injury or loss as well as safeguard the carnivores, which is desirable for the conservation of Gishwati-Mukura National Park and Biosphere Reserve as shown by respondents in this research project.

In this research 92.8% (53%:higly needed, 33.8% somehow needed, and 6%: lowely needed) of respondents have proposed that there should be the reinforcement of the construction of livestock shelters/kraals for the protection of calves, goats, and sheep. On the other side, they clarified that the kraals are not needed for big cows because big cows should be grazing freely in the pastures, and not easy for carnivores to attack big cows. Rather, 97.4% (51.41% as highly needed, 28.4% as somehow needed, and 7.6% as lowly needed) of respondents have suggested that there should be fencing of the pastures (padlocks) for not only protecting livestock but also showing the boundaries between pastures to make sure that cows are grazing in their zones without conflicting with other zones including forests or other use zones that host wild animals.

While Lyamuya et al.(2017) have suggested that the protection of of livestock from depredation should be significantly based on the distance from the protected area especially keeping livestock far away from the protected area boundaries, this can be a long-term debate for Gishwati-Mukura National Park. For example, when respondents were asked about moving livestock production away from the park boundaries, it was not well suggested as 71.1% of respondents rejected the idea, and 25.8% of respondents's thoughts said that it could be less needed. The participants in the research mentioned that the reason for rejecting this idea at a high level is that husbandry practices in pastures were there before establishing Gishwati-Mukura National Park.

They suggested that there should be relocation of those cattle kraals/shelters that were placed very close to the park boundaries to avoid hour-to-hour conflicts with the park. Again, most of the interviewees have noted that the Gishwati-Mukura Landscape is a good place with favorable environmental conditions for cattle raising. Instead, local people suggested that there should be strong and amicable measures and ways of promoting living together with wild animals in the Gishwati-Mukura Landscape.

Concerning the close guard or watching livestock, participants in this research have suggested at a high level (86.4% of respondents) that there is an urgent need to keep intensive livestock protection by producers, their representatives, or their cowboys by staying near livestock because it helps early detection of predators and preventing them from eating their livestock. These are similar to other places research findings where for example Lyamuya et al.(2017) suggested that herders should look after their livestock to reduce the likelihood of predation of livestock because when herdsmen are present, the predation rate is generally lower than that can occur in free-ranging herds. In addition, it was suggested that even if incidences of livestock depredation most of the time can happen in the evenings, nights, mornings, or when it is raining in the daytime, guarding intensity for livestock is required at all times.

Land use through zoning around protected areas reduces conflicts by creating different management zones in and around those protected areas Lyamuya et al.(2017). Also, as Lyamuya et al(2017) suggested, a zoning scheme should be applied and strengthened to reduce the frequency of carnivore contact with humans and livestock in the Gishwati-Mukura Landscape Biosphere Reserve.

For compensation of damaged properties and other incentives

As in this research, 100% (Highly needed: 82.3%; somehow needed: 12.5%; and lowly needed: 5.2%) of respondents suggested that there should be compensation for damaged livestock by receiving other significant alternatives. It was supplemented that fairness in compensation and on time by reimbursing people for their losses is a measure that aims to alleviate human-wildlife conflicts in Gishwati-Mukura Landscape. This is similar to what was found from other studies conducted in other places that suggested that a compensation scheme was used to enhance human-carnivore coexistence in a particular area because such schemes contribute to an increase in the tolerance of livestock keepers towards carnivores and prevent retaliatory killings (Lyamuya et al.,2017; Persson et al., 2015).

In addition, the local community living in Gishwati-Mukura Landscape expressed their interest in the coexistence with wild animals because they are aware that the other communities neighboring other Rwanda national parks received economic and social benefits over their years including tourism revenue sharing, local casual employment, training, study tours, non-tangible values among others. The local people of Gishwati-Mukura Landscape recognized that those kinds of benefits started being taken though it is still at a lower level.

In this research project also, respondents clarified that there should be incentives for cattle keepers by providing support to poor people about the construction of

livestock kraals/sheds because some of those poor people have received cattle/livestock from government support where making shelters for their livestock can be costly for them due to the limited financial capacities.

For conservation education and awareness

like (Gálvez et al.2021), this research has found in detail from respondents that conservation education can be used to increase the wakefulness of local people about the importance of wild carnivores to nature. It also improves community attitudes and behaviors towards carnivores.

During the mid-term project monitoring, it was seen that the sites located where 20 cowboys and watchmen who had received training on how to defend against livestock predation and behave around predators were observed with good performance in the prediction issue management process once the carnivores attempted to attach to nearby livestock. On the other hand, untrained areas did not handle the problem like trained areas. However, participants in this research suggested that different training activities should be offered to many members of farmers and local communities to help disseminate disciplinary and innovative techniques to protect livestock and carnivores without retaliation as well as keeping ethics in conflict resolution, living together with animals and increasing public understanding of animal rights.

Our study also has found that to ensure the coexistence of humans and wildlife in the Gishwati-Mukura Landscape, as suggested, there is a need for a strong wildlife conservation education program to be used to increase awareness and knowledge of wildlife and other natural resources in school children through systematic methods, programs, and activities using educational tools to promote changes in their feelings and behavior from their early childhoods. However, including local knowledge in natural resources management would be an inter-community learning exchange on natural resource management opportunities consistent and adapted environmental education outreach materials on biodiversity conservation (Gálvez et al.2021).

Again, the respondents in this research suggested ideas like the ones argued by Gálvez et al.(2021) who said that conservation awareness campaigns encouraging farmers to adopt predator prevention or have a positive attitude in the presence of predators could successfully reduce livestock predation encounter probabilities rather than purely disseminating information about prohibitive laws in Gishwati-Mukura Landscape.

For lethal control of involved carnivore species or relocating wild animals

The suggestions made by the research participants are in line with those made by Gálvez et al. (2021); and Durant et al.(2022) who proposed that when stray dogs are the primary predators, there should be an order in place to lethally control feral dogs that are abandoned and free-ranging within rural areas. This was supported in this research as feral dogs are not wild animals, as they attack livestock and wild animals, including golden monkeys of Gishwati-Mukura National Park. The fact that damages caused by feral dogs are not compensated for because they are not wild animals was once again stated by research participants as the rationale for the deadly management of abandoned dogs.

Nevertheless, participants have suggested that the domesticated dogs that live in households should not be put to death because their owners have to keep them with instructions. Instead, the respondents suggested that dogs that are domesticated in homes should have routine vaccinations to ensure that they are free of diseases like rabies that could infect humans throughout the Gishwati-Mukura Landscape.

Almost all the participants in this study did not suggest the application of lethal control to wild carnivores for several reasons: it is prohibited, compensation is provided for damages caused by wildlife, and wildlife is a draw for visitors to Gishwati-Mukura National Park, which eventually helps to generate tourism revenues that are distributed to the local communities for development activities.

Regarding the relocation or translocation of involved carnivore species, some local communities have suggested that the wild animals be taken from the forest plantations to the core zone area of the park. According to Lyamuya et al.(2017), carnivore translocations are time-consuming, and expensive because they use a big home ranger in their hunting strategies.

Since the size of Gishwati-Mukura National Park is small, it won't be easy to ensure that the brought animal through translocation will stay inside the park without running out again. Again, some populations of animals living in forest plantations, tea plantations, and bushes have been there for more than 20 – 30 years ago, and it can not be easy to have them translocated inside the park without making sure that their ecological niche is met.

For expanding the size of the park area and fencing the park

Some people suggested on this point that there should be a way of placing the other forests that host wildlife under the management of GMNP or the institution in charge of managing wildlife as well as connecting all forest patches to have

enough space for the park as well as improving buffer zone and applying expropriation where necessary and possible.

Also, as suggested by Lyamuya et al.(2017) fencing the fragmented forests should be an answer to reducing human-wildlife conflicts as it is for the case of Gishwati and Mukura forest patches of Gishwati Mukura National Park. On the other hand, this research has found that fencing GMNP is not easy today and can continue to be a theme to discuss among stakeholders. This is because the two forest fragments of the Gishwati-Mukura National Park are disconnected by long distances, and wild animals are still in other forest plantations that require relating them before fencing the park. Again, the park is under restoration activities, and it needs some expansion activities and expropriation for local communities for some corners.

For enforcing law

According to all of the research participants, maintaining local communities' peaceful cohabitation with wildlife requires strict adherence to laws and regulations regarding wildlife, land use, and livestock husbandry. Also, the respondent clarified that wildlife and national parks are not threatened because they are protected by laws. Enforcement of laws will be a tool to help keep sustainable collaboration between humans and wildlife in and around Gishwati-Mukura National Park and Biosphere Reserve.

Involving local communities in all process

This research has found that involving local communities in all processes of management of wildlife (planning, implementation, monitoring)is necessary as shown by 91.1% (Hghly needed:43.8%, Medium needed: 35.8%, and lowly neeed:11.5%) of respondents.

The findings from this research clarified that this involvement requires the engagement of several stakeholders in relationships with conservation and livestock keeping including park management, government institutions, local leaders, security organs, NGOs, farmers, cattle keepers, local cooperatives and companies, local communities, and external actors which is in line with the statement of Durant et al. (2022), to reduce the threats to wild carnivores or livestock attacks to ensure the coexistence of humans and wildlife. These research findings also support the development of inter-community networks in different areas around the Gishwati-Mukura National Park in informing any issue relating to wildlife in the landscape.

Active participation of local communities in the protection of carnivores contributes to a reduction in retaliatory killing and wildlife crime and keeps

individual or communal ownership to safeguard wildlife movements(Durant et al., 2022). However, collaboration through multi-stakeholder dialogue about the coexistence of wildlife and livestock will be a sustainable answer to strengthen the conservation of Gishwati-Mukura National Park and Biosphere Reserve.

For continuing research and monitoring on solutions to coexistence between humans and carnivores or wildlife in general:

Measures to prevent attacks on livestock should be co-designed with livestock keepers, prioritizing herder knowledge and experience, while providing scientific, technical, and material support to build on existing capacity (Lyamuya et al., 2017)

Our work through this research project provides a baseline to assist in monitoring the occurrence of predators in the community to avoid the death of livestock and loss of those wild carnivores. The respondents have shown that many research activities should continue to be conducted. They have shown that research is always needed to inform the public about the status of human-wildlife conflict management in and around Gishwati-Mukura National Park.

As commented by respondents, different techniques and research themes need to be taken to answer the issues of livestock predation and guide the local community on sustainable coexistence with wildlife. These are in support of Jessop and Gillespie (2023) who stated that the use of multi-method monitoring techniques to monitor wild animals would allow finding more solutions in handling wildlife conflicts because the more the research and monitoring techniques increase, the more the probability of detecting the movement of wildlife, knowing their occupancy, their activity pattern and behavior to to inform the public the best practices on how to deal with problem animals.

However, 95.5% (Highly needed: 50.2%, Medium needed: 34.7%, and lower needed:10.6%) of respondents have suggested that the research and monitoring should continue on solutions to coexistence between humans and carnivores or wildlife in general, and especially focusing on the themes that advocate the protection of both livestock and wild carnivores.

IV. CONCLUSION AND RECOMMENDATIONS

The research project taken on assessing the factors leading to the frequent livestock killings towards the protection of carnivores in Gishwati-Mukura National Park and Biosphere Reserve contributed to finding out the ways of solving the carnivores-livestock issues around this newly established protected area through

gathering the information from camera traps and local communities, livestock producers, park management and local leaders.

Both camera traps and community survey results confirm that wild carnivores are less blamed for killing livestock. At the same time, it is shown that feral dogs are higher predators to prey on livestock, which contrasts the previous assumptions expecting the involvement of wild predators only before conducting this research.

The research project has found that sometimes livestock are killed by carnivores due to the lack of effective protective measures. Also, this study found that in some cases, there has been a rise in reports of livestock deaths due to the combination of carcasses from carnivores' involvement and other non-carnivorous causes like theft, and natural death among others which can result in reporting that carnivores are the root cause for all occurred cases of livestock deaths.

This research project suggests positive attitudes toward wildlife, strengthening conservation activities and strategies regarding carnivore protection and animal husbandry practices; and enforcing mutual collaboration and participation for all concerned people in resolving conflicts between people and wildlife or in the management of both carnivores and livestock to ensure long-term coexistence between local people and wildlife in Gishwati-Mukura National Park and Biosphere Reserve because the research also has found that the carnivores have their habitat not only in the park but also in the community farmlands and vicinity.

The project found that there are still gaps in local community knowledge and skills in the identification of carnivores, protection of livestock, and how to behave in the areas of livestock use with free-ranging wildlife, they need much training. In this research project, many trainings on different themes of conservation of wildlife were suggested to a large number of people in this project to enforce coexistence.

The project report was discussed and disseminated to the Management of Gishwati-Mukura National Park and Rwanda Development Board, and their relevant stakeholder including institutions operating their activities in the Gishwati-Mukura landscape, local communities, and farmers.

Our work provides a baseline to assist in monitoring the predator-attacking livestock around Gishwati-Mukura National Park and Biosphere Reserve. In collaboration with the park management, the researcher arranged animal monitoring activities outside the park boundaries to involve all stakeholders in the follow-up and sharing of information on the carnivores or wildlife presence,

absence, causing conflicts or not. Within this collaboration, there will be field observations and discussions to update each other on the progress of the issues and successful stories on human-wildlife coexistence indicators in the Gishwati-Mukura Landscape.

However, based on project findings from the information collected from different sources, the project recommended the following items:

- Enhance the protection of the wild carnivores and communicate to the local communities that feral dogs are the major predators in the Gishwati-Mukura Landscape. Special management practices are needed for the free-ranging abandoned dogs throughout Gishwai-Mukura Landscape. An adequate collaboration between local communities, local leaders, security organs, park management, and institutions in charge of animal husbandry is needed to ensure that feral dogs ranging within community properties are deeply handled.

- Make sure that the damages caused by wild animals are fairly compensated and local communities are incentivized with different means to ensure the coexistence with wildlife. Government, conservation partners, park management, local leaders, and local communities are encouraged to put the accent on fair compensation and incentives for the sustainable conservation of wildlife and livestock around Gishwati-Mukura National Park and Biosphere Reserve.

- Elaborate and avail needs for livestock producers/keepers to handle predation issues in pastures and households. Local leaders and farmers should work together to track this recommendation

- Strengthening the guarding system including making strong livestock sheds with provision of support to those poor farmers. Develop the ability of neighborhood teams to serve as special guards tasked with defending livestock. In addition, there is a need to enforce regulations and laws on husbandry in pastures. Farmers, local communities, government, partners, and stakeholders for biodiversity conservation and animal husbandry should work together to find ways to strengthen this item.

- Take into consideration and pay attention to how to prevent problem animals that may have originated from other places that are not considered to be part of the Gishwati-Mukura National Park area, such as forest plantations, tea plantations, mining holes, or caves that are thought

to be home to predatory animals and other wildlife. Relevant government institutions should work together to make clarifications to help the local communities to know exact information on the hotspots of livestock predators for strengthening the safeguards of livestock.

- Improving awareness and education for good interaction between local communities and wild animals causing conflicts and awareness of fairness in reporting animal problems. Therefore, wildlife conservation education would promote and increase a community commitment towards wildlife conservation, their role in ecosystem function, and social-economic development in the Gishwati-Mukura Landscape. Local leaders, conservation actors, and park management would be at a glance to improve this awareness and education.

- Ensuring that livestock keepers collaborate with park managers through high participation of the local community in protecting the park including handling the issues of human-wildlife conflicts, and committing illegal activities while promoting livestock green husbandry practices in Gishwati-Mukura Landscape. Farmers, local leaders, park management, and livestock husbandry institutions are required to strengthen this collaboration.

- Keep investigating the community tolerance level and attitudes towards the negative effects of carnivores and other wildlife towards the long-term coexistence between humans and wildlife within a multi-disciplinary use of Gishwati-Mukura Landscape. Researchers, local authorities, and management to enhance these explorations.

- Strengthen the enforcement of training on how to prevent predators, and protect livestock from predation with the extended competencies on the techniques for human-wildlife conflict prevention, adaptation, and coexistence in Gishwati-Mukura Landscape. These kinds of training may involve different categories of people including cattle keepers, cowboys, opinion leaders, local specific groups (women, youth, and vulnerable people), and conservation or farmer cooperatives. Conservation partners, local leaders, park management, and government, in general, can leverage the capacity for the above mentioned categories of people to fast enforce the coexistence of humans and wildlife in the Gishwati-Mukura Landscape.

- Continue research and monitoring activities on the themes built mainly from

findings and suggestions raised from this research project and other related topics that can be towards the protection of livestock and carnivores targeting coexistence between humans and wildlife in Gishwati-Mukura National Park, Biosphere Reserve, and Gishwti-Mukura Landscape in general. The created teams for monitoring animal movements outside the park should be empowered to ensure their yield in park conservation. Further research and investigation are needed into feral dogs that kill livestock.

Researchers, park management; local leaders, and other volunteers can help to continue showing the knowledge, skills, and attitudes required to maintain the sustainable coexistence of humans and wildlife in Gishwati-Mukura National Park, Biosphere Reserve, or within the entire landscape.

- Propose key areas of Gishwati-Mukura National Park and Biosphere Reserve for future investments in human-wildlife conflict resolutions to leverage positive community attitudes and ecosystem interactions. The government, partners, and investors to explore any opportunity in this area.

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