Phase 2 evaluation of the community-based monitoring program in Bundibugyo district, Uganda

A report from STOP Spillover

February to March 2023

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ACRONYMS

AFROHUN	Africa One Health University Network
ODK	Open Data Kit
OH-DReaM	One Health Design Research and Mentorship
PA	Participatory Assessment
PS	Participatory Surveillance
SBC	Social Behavioral Change
SOP	Standard Operating Procedure
STOP	Strategies to Prevent Spillover
USAID	U.S. Agency for International Development

STOP SPILLOVER

Strategies to Prevent (STOP) Spillover, a USAID-funded project led by Tufts University, is a global consortium of experts in human, animal, and environmental health who will take the next step in understanding and addressing the risks posed by known zoonotic viruses that have the potential to spill over and cause pandemic crises.

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INTRODUCTION

Since 2000, Uganda has documented a total of six Ebola outbreaks involving the districts of Gulu (2000), Bundibugyo (2007), Luwero (2011 & 2012), Kibaale (2012), Luwero (2012), and Mubende and Kasanda (2022). Additionally, three outbreaks of Marburg viral haemorrhagic fever have occurred in the country in recent years in Ibanda district (2007), Kabale district (2012), and Kween district (2017). The recent Marburg outbreak in Kween district was traced to rock salt mining in a bat cave [1].

While the viral reservoir for Ebola virus disease has not been definitively determined, Rousettus aegyptiacus has been identified as the reservoir for Marburg virus. Zoonotic spillover has been associated with activities that increase human-bat contact [1]. Likely bat-human interface areas include caves and mines with roosting cave-dwelling bats (especially *R. aegyptiacus*); human dwellings for tree-dwelling insectivorous bats [2], and bat hunting, processing, and consumption. Other identified activities that may lead to increased spillover risk include land-use change, development, large-scale agricultural intensification, and deforestation [3-5].

Within Bundibugyo district, a community-based bat-human interface monitoring program was established to both improve understanding of the risk factors for potential spillover and to develop interventions to reduce human exposure to bats, which would reduce spillover risk. The bat-human interaction monitoring was conducted by fifteen (15) bat monitoring agents, with each agent representing a parish within the interface area. The agents specifically, identified bat roosts, feeding sites and bat-human interfaces that might pose risks for zoonotic spillover events.

The plan was to monitor bats for a period of 6-12 months. However, due to financial constraints, the activity was halted after only two months of active monitoring. This report thus presents results obtained during the two months monitoring period. However, it should also be noted that discussions are under way with the different stakeholders to see how the activity could be carried forward.

Activity objectives

Overall Objective:

This report presents the community bat monitoring approach and results obtained from the two month bat-human interaction monitoring period in Bundibugyo district.

The specific objectives covered under this reporting period are indicated in Table 1 below.

Table 1: Specific objectives

Objective 1.1. To describe the setup of the bat-human interaction monitoring program in Bundibugyo district.
Objective 1:2. To establish the number of roosts identified and observed bat characteristics at the bat-human interface.
Objective 1:3. To describe the variations in bat numbers within in two month monitoring period.
Objective 1:4. To describe the bat-human interaction points within Bundibugyo district.

Sentinel bat-human interaction monitoring sites

The STOP Spillover Uganda team used an outcome mapping process from which national stakeholders selected the bat-human interface as a priority spillover risk in the country, and Bundibugyo district as a starting point.

Within Bundibugyo district, three regions were selected by stakeholders for research activities and risk reduction interventions around the bat-human interface during a three-day outcome mapping workshop.

The regions considered and reasons for selection are indicated below and in the map in Figure 1.

1. Burondo subcounty (neighbors Semuliki National Park)
2. Harugale subcounty (neighbors Rwenzori Mountains National Park)
3. Ntandi town council (represents areas with bats in homesteads, schools, churches and also has areas where bat hunting is known to occur).

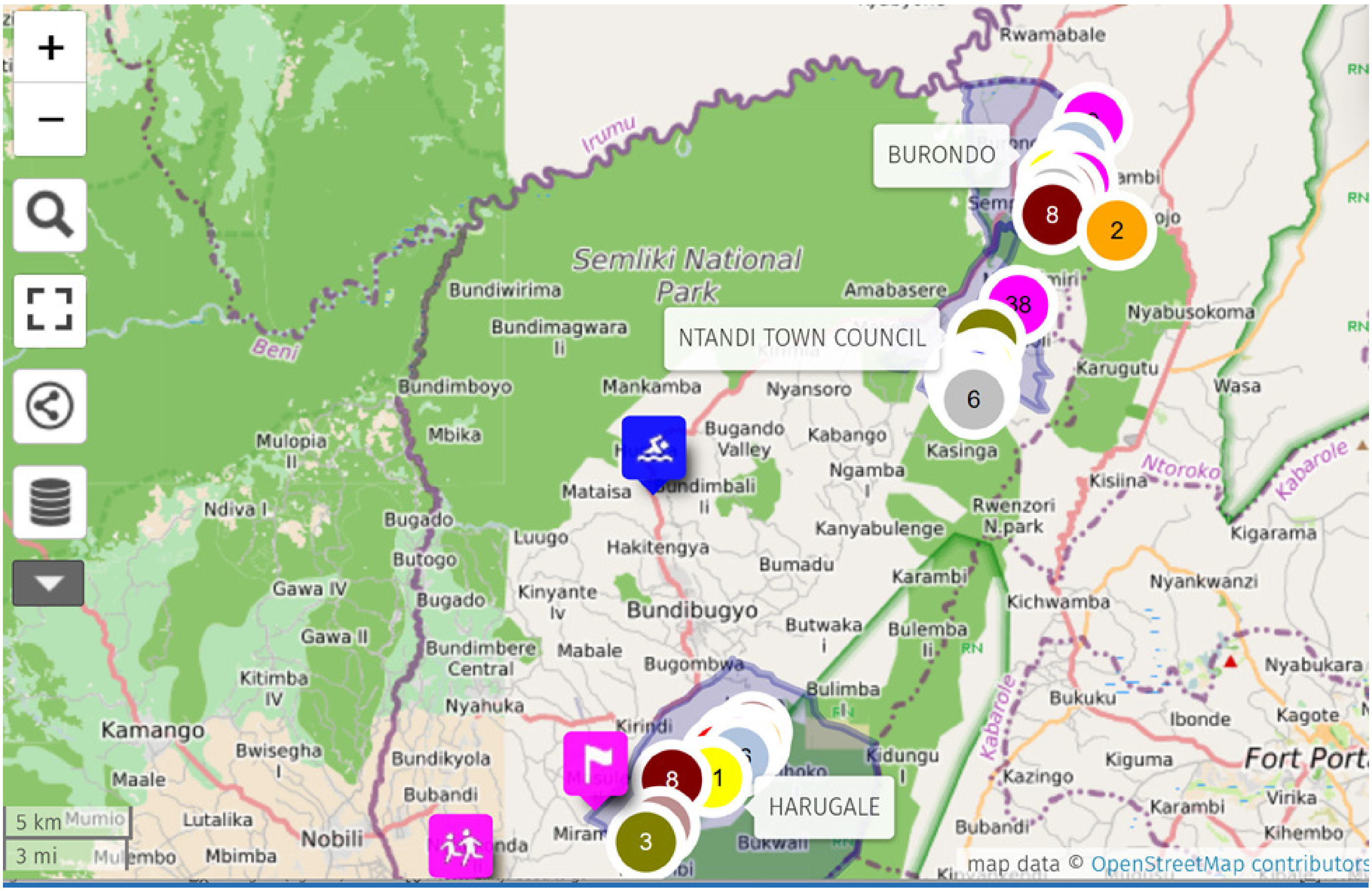

Figure 1. Map of Bundibugyo showing the 3 bat-human interface project areas of Burondo and Harugale subcounty and Ntandi Town Council.

OBJECTIVE 1.1. ESTABLISHING THE BAT-HUMAN INTERACTION MONITORING PROGRAM

In order to standardise the monitoring process, we developed a framework to guide participatory community-based bat-human interaction monitoring in Bundibugyo district. The framework provided a detailed description of the planned community-based program for monitoring bat human interactions.

The project team held participatory community meetings from which it was agreed that within each of the three sub-counties, five parishes were selected for monitoring making a total of fifteen parishes in the district.

Each parish was provided with one (1) bat monitoring agent (see Annex 1 for list of bat monitoring agents), making a total of fifteen (15) agents across the bat-human interface sites (Figure 2 summarizes the structure of the monitoring framework).

The bat-human interaction data was collected using an Open Data Kit (ODK) tool using android mobile devices through direct observation, opportunistic encounters and purposeful searches or surveys (Figure 3 demonstrates agents while in the field).

The data capture tool is indicated under Annex II. A given place was identified as a bat roost based on the criteria that it had hosted bats for a considerable amount of time (as observed by the community). Annex III summarizes the approaches that were used at given roosts/sentinel sites during bat population monitoring.

Monitoring of bat roosts was done twice a month, that is during the first week of the month (1st – 5th day of the month) and in the middle of the month (15th – 20th day of the month).

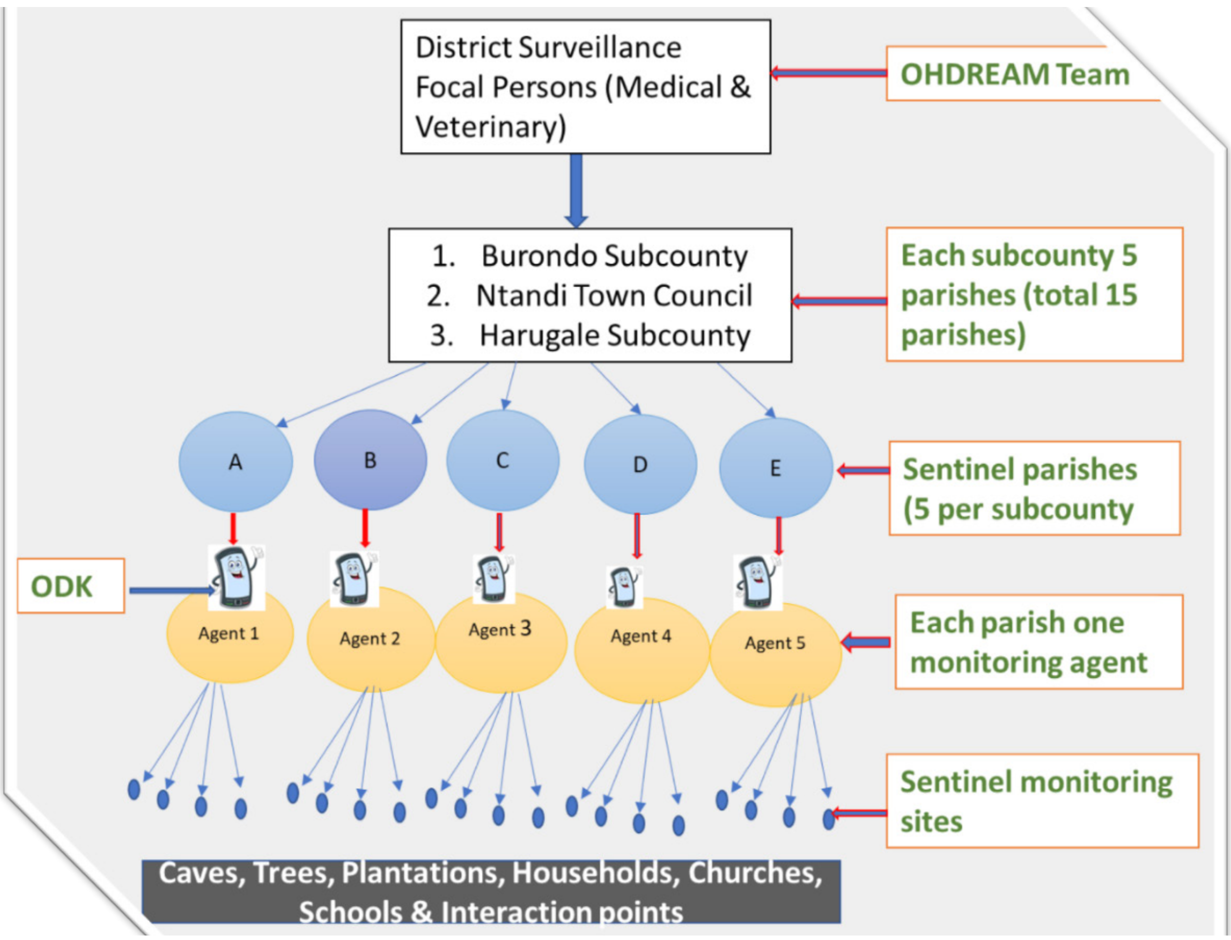

Figure 2. Graphic description of the bat monitoring plan

Figure 3. Monitoring agents collecting bat-human interaction data using Kobo Collect mobile app

OBJECTIVE 1:2. OBSERVING BAT ROOSTS AND CHARACTERISTICS

Number of identified bat roosts

The bat monitoring activity was carried out in three selected subcounties in Bundibugyo district from February to March 2023. Initially, at the start of February (baseline month), 58 roosts were identified and mapped (Figure 4). At the end of February, monitoring was done on 73 roosts, which demonstrated an increase of 17 new roosts (Figure 5). The number of identified new roosts increased from 17 to 24 between end of February and start of March, however, it reduced at the end of March to only 9 new roosts. The monitoring agents associated the reduction in bat roosts during the month of March to the hot weather that led to the migration of bats. Bat characteristics observed and reported by monitoring agents are summarised in Table 1.

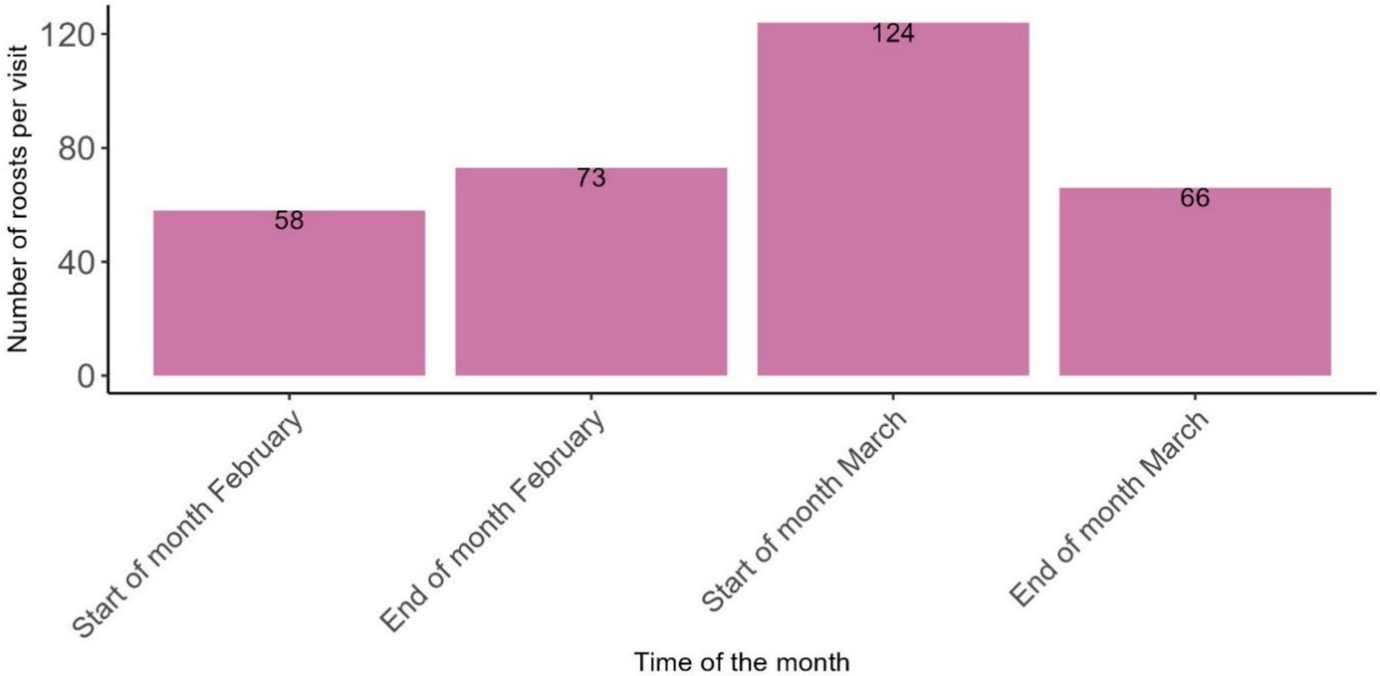

Figure 4. Total number of monitored roosts per month.

Table 2. Bat characteristics

Characteristic monitored	Monitored parameter	% Frequency
Type of bat seen (local name)		
	Emilima (big bats)	37 (51%)
	Keribo/Kakolokombe (small bats)	34 (47%)
Number of Emilima (big bats) seen	< 5 Bats	1 (2.7%)
	>100 <500 Bats	2 (5.4%)
	>15 <100 Bats	17 (46%)
	>5 <15 Bats	17 (46%)
Number of Keribo/Kakolokombe seen	< 5 Bats	19 (59%)
	>15 <100 Bats	6 (19%)
	>5 <15 Bats	7 (22%)
Colour of Emilima (big bats) seen	Black	2 (13%)
	Black, Brown	5 (33%)
	Brown	8 (53%)
Colour of Keribo/Kakolokombe (small bats) seen	Black	11 (73%)
	Brown	2 (13%)
	Grey	2 (13%)
Bat Activity of Emilima – big bats (i.e., what are the bats doing?)	Resting	14 (93%)
	Sleeping	5 (33%)
	Grooming/socializing	5 (33%)
	Flying	6 (40%)

Bat Activity of Keribo/Kakolokombe seen (i.e., what are the bats doing?)	Resting	10 (67%)
	Sleeping	6 (40%)
	Grooming/socializing	1 (6.7%)
	Flying	6 (40%)

OBJECTIVE 1:3. VARIATIONS IN BAT NUMBERS

The bat numbers were stratified as big bats (Emirima) and small bats (Keribo), and their numbers were classified as <5, between 5 and 15, between 15 and 100, between 100 and 500, then more than 500. The number of observed bats increased from the start of February up to start of March (Figure 6 and Figure 7). This was mainly observed in roosts reported to have few observed bats (<5) at the time of roost mapping. However, the bat numbers started reducing from start to end of March. Roosts with many bats reduced significantly during this time, some to even zero bats being observed.

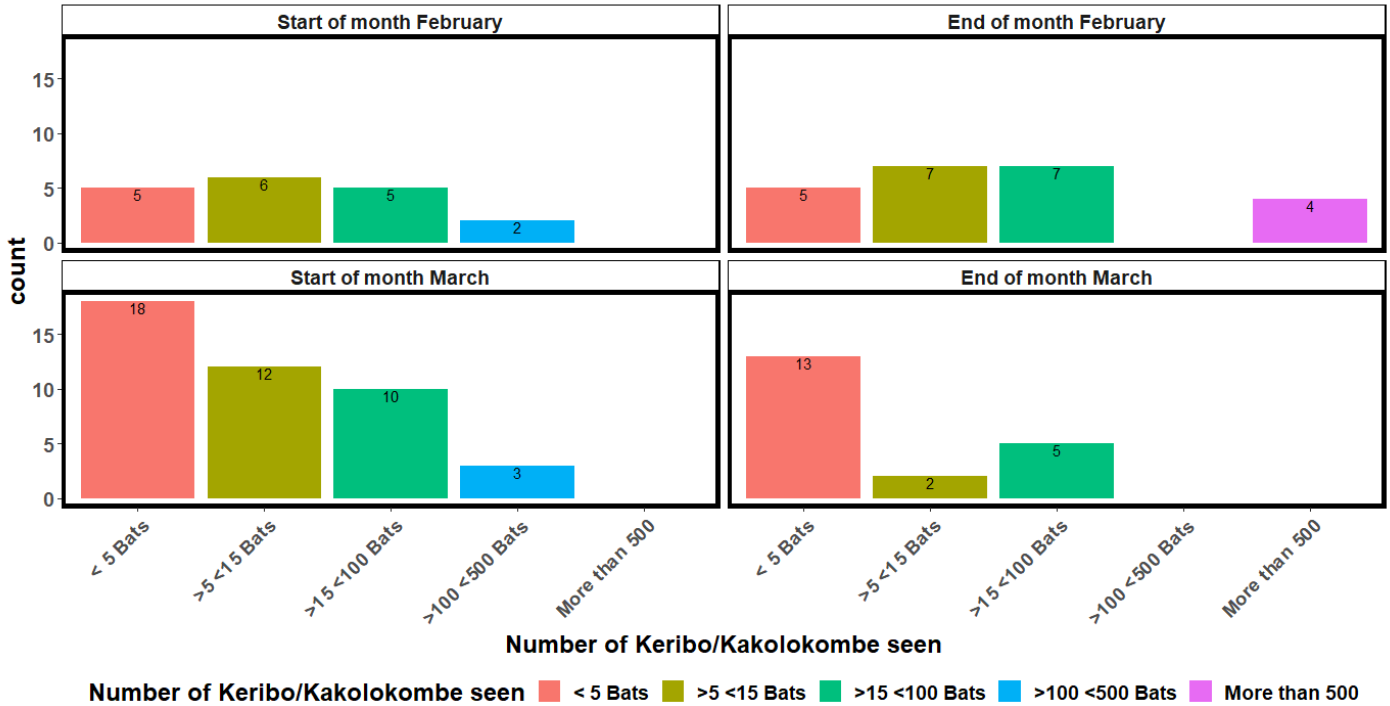

Figure 6. Variation in small (Keribo) bat numbers over the monitoring period.

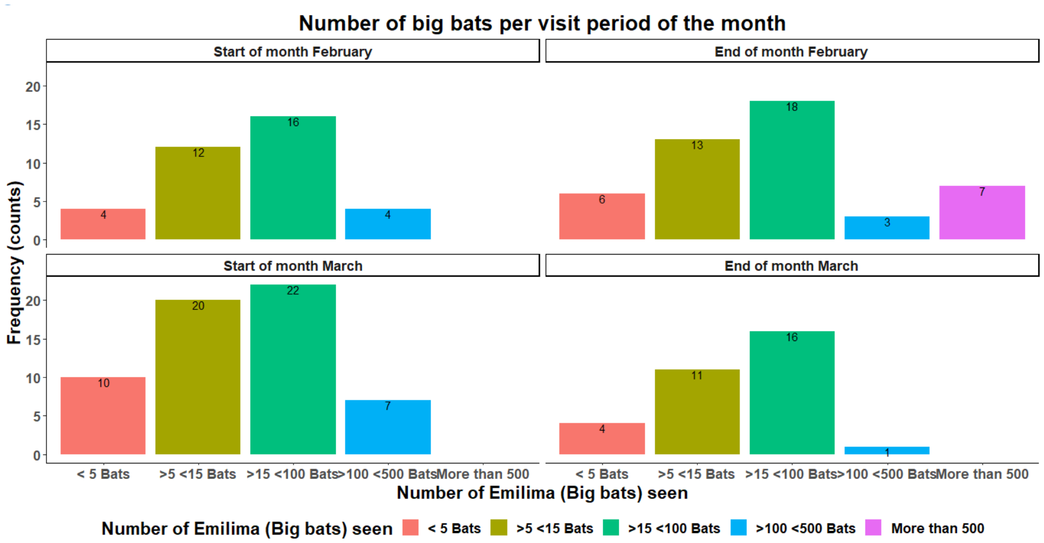

Figure 7. Variation in big bats (Emilima) over the monitoring period.

OBJECTIVE 1:4. BAT-HUMAN INTERACTION POINTS

The majority (43%) of bat roosts were inside buildings, whereas the least number (9.7%) of bat roosts were observed in gardens (Table 2). Presence of bats in households presented the greatest spillover risk as most structures were devoid of ceilings and thus household dwellers were directly exposed to bat guano. Majority (79%) of the roosts were reported within a 2 kilometres radius from the national parks. This is a possible indication that the bats could have migrated from the national parks and might come to human settlements due to park encroachment and lumbering.

Table 3. Bat human interaction points

Characteristics	Monitored parameter	% Frequency
Proximity to human settlement (i.e., Location of the roost in relation to human settlement)	Cave/tourist site	11 (15%)
	Compound	23 (32%)
	Garden	7 (9.7%)
	Inside building	31 (43%)
Proximity to national park or forest reserve	< Half a kilometer	14 (19%)
	1 Kilometer	21 (29%)
	2 Kilometers	22 (31%)
	> 2 Kilometers	15 (21%)
Which of the following comes with direct contact with bat excreta?	Humans (Droppings on skin)	55 (76%)
	Food (House and garden)	22 (31%)
	Water (House and collection point)	19 (26%)
	Bat excreta Smell	52 (72%)
Bat hunting in the previous months	Yes	19 (26%)
For bats in house structures, is there a ceiling?	Yes	17 (55%)
For bats in house structures, what bat excreta do you commonly encounter?	Faecal matter	29 (94%)
	Urine	20 (65%)
What is the average number of people accessing the roost per month?	< 5 individuals	15 (21%)
	6-15 individuals	29 (40%)
	>15 individuals	28 (39%)

CONCLUSION AND RECOMMENDATIONS

Conclusions

- Although the reported data did not span the entire climate season within Bundibugyo to facilitate comparison of bat numbers across seasons, our partial results indicate that bat numbers started to reduce in the month of March, and this reduction might have been due to increasing temperatures. Indeed, in some roosts, no bats were observed during this period as bats had migrated. However, the actual course for this variation in bat numbers could not be investigated due to the short monitoring period.
- Bats in house ceilings presented the greatest spillover risk as the majority of bats were recorded in house structures. Moreover, most of these house structures were without ceilings which meant that house occupants were directly in contact with bat guano which could also contaminate food and water in the household. This was also common in schools and places of worship and these, according to our data, represented sites with the highest number of individuals interacting with bat excreta and thus increased spillover risk.
- Most of the observed bat roosts were in close proximity to national parks, indicating that bats could possibly be migrating to human settlements as a result of park encroachment and human activities like lumbering that destroy their natural habitats. Moreover, at some instances during the monitoring period, established bat roosts were reported to have zero bats due to bat migrations back to the national parks.

Recommendations and future plans

- We reported data for only two months of monitoring which does not span the entire climate season and thus we could not ascertain the effect of seasonality on bat numbers or bat-human interactions. Therefore future studies should look at the complete picture across the dry and wet seasons. This would provide conclusive results to predict which months or season that could have the highest spillover risk so as to target interventions that reduce human contact with bats during the most high- risk season.
- The greatest spillover risk was observed in household structures where household dwellers come in direct contact with guano, including their drinking water and food, especially those devoid of ceilings. Therefore, interventions to reduce the bat human interactions in households and protecting household drinking water and food are key to reducing the spillover risk.
- The majority of bat roosts were identified in close proximity to national parks, and in some instances, bats appeared to have migrated back to the national parks. Therefore, interventions targeting park encroachment, illegal tree cutting in parks or planting of trees to attract bats away from homesteads could be beneficial. However, we could not ascertain where the bat migrations had occurred as established roosts devoid of bats during the monitoring period. Therefore, studies tracking bat migrations over a wide distance could be beneficial in characterising the spillover risk.

- We could not ascertain the true identity of observed bats, as we were unable to record bat sounds nor trap representative bats to aid speciation. We recommend that future studies could explore this gap so as to fully characterize the risk. This data could also be helpful in establishing a library of bat species within the region.
- Similarly, we could not ascertain if the observed bats at the interface harboured spillover priority pathogens, as we were not able to take bat specimens for subsequent laboratory analysis. We recommend that future studies could explore this gap.
- Lastly, our plan was to establish a dashboard that would show real time changes in bat numbers and bat-human interactions, unfortunately this was not possible. The Red Cross is implementing an event-based Community Epidemic and Pandemic Preparedness Program (CP3) surveillance program. The CP3 project looks at events in human health, livestock and wildlife and has already established a dashboard for this. Therefore, the CP3 project could introduce bat monitoring components within its surveillance framework.

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ANNEX ONE: LIST OF BAT MONITORING AGENTS PER SUB-COUNTY

Sub county	Name:	contact	Parish	villages
Harugale Sub County	Masika Justin	0786427942	Bumate	Bimara Village; Bimara Full Gospel Church
	Mbusa Daniel	0789147319	Kihoko	Ngugho Village, Ngugho stone cave
	Mercy Orine	0777538177	Bupomboli	Kihoko II Village; S/C HQ & Kathengu's home
	Masereka Lugard	0778524652	kasulenge	Kasulenge II; Nyalulu stone cave
	Bwambale Josam	0787500507	Kitsolima	Kalhalhu Village; kalhalhu stone cave
Ntandi Town Council	Mbambu Yones	0782283017	Kahumbu	Isura II, kahumbu, Nyambowe, karongoti and Nkisya villages
	Asiimwe Gloria	0774985883	Mpulya	Mpulya I, II and III; Mpulya Central and Mpulya west cells
	Sekalombi Alex	0770863976	Bundimasoli	Bundimasoli central, Bundimasoli, Bundimasoli West, Kapepe, Kabale and Kabale central Cells
	Baluku Edson	0781375732	Ntandi	Ntandi west, Ntandi east, Bumaga I and Bumaga II cells
	Muhindo Sadam	0783974809	Nyabugesera	Bitahura I, Butahura II, Nyabugesera & Kapangu cells
Burondo Sub county	Muhindo Nyahoma Joram	0773086545	Burondo	Kinyambogo
	Thembo Edson	0785735878	Karambi	Karambi I and Kinyanjojo
	Sekalombi David	0785428419	Sempaya	Kinoni III
	Muzima Juliet	0776121712	Karambi	Burangapasi II
	Masika Ellen	0762599548	Burondo	Burondo Central

ANNEX TWO: BAT-HUMAN INTERACTION DATA CAPTURE TOOL FOR MONITORING AGENTS

1. Name of Data collector:………………………………………………………………
2. Date & Time of data collection:…………………………………………………..
3. Subcounty
   - ☐Harugale Subcounty
   - ☐Burondo Subcounty
   - ☐Ntandi Town Council
4. Parish:…………………………………………………………………………………..
5. Village:…………………………………………………………………………………
6. GPS Location:…………………………………………………………………………
7. Type of roost
   - ☐Tree
   - ☐Cave
   - ☐House
   - ☐School
   - ☐Church/mosque
   - ☐Hospital
   - ☐Crevice
8. For bats in house structures, is there a ceiling?
   - ☐Yes
   - ☐No
   - ☐Not applicable
9. For bats in house structures, what bat excreta do you commonly encounter? (Multiple answers)
   - ☐Fecal matter
   - ☐Urine
   - ☐Both
   - ☐Not applicable
10. What is the average number of people accessing the roost per month?
    - ☐< 5 individuals
    - ☐6-15 individuals
    - ☐>15 individuals
11. Type of bat seen (local name) (Multiple answers)
    - ☐Emilima (Big bats)
    - ☐Keribo/Kakolokombe (small bats)
    - ☐Both types
12. Number of bats seen

13. Colour of the bat (Multiple answers)
    - ☐Black
    - ☐Brown
    - ☐Grey
    - ☐Unknown
14. Bat Activity (i.e., what are the bats doing?) (multiple answers)
    - ☐Resting
    - ☐Sleeping
    - ☐Grooming/socializing
    - ☐Flying
15. Proximity to human settlement (i.e. location of the roost in relation to human settlement)
    - ☐Inside building
    - ☐Garden
    - ☐Compound
    - ☐Cave/tourist site
16. Number of dead bats seen
    - ☐0 individuals
    - ☐1-5 individuals
    - ☐6-10 individuals
    - ☐>10individuals

ANNEX THREE: APPROACHES USED AT A GIVEN ROOST/ SENTINEL SITE DURING BAT POPULATION MONITORING

Sentinel site/ Roost Type Description	Method of Counting / estimating bats	Data element (s)	Timing	Duration	Frequency
Cave Roost (caves are permanent roosts but not found everywhere)	Total roost counts	•Bat species/ type •Estimated number of bats in the roost	Any time convenient for the monitoring agent but preferably between (09:00hrs and 14:00hrs)	Variable (depending on nature of cave roost and number of bats and or species in the roost)	Twice (02) a month. (At beginning and middle of the month)
	Roost-exit counts	• Bat species/ type • Estimated number of bats flying out of the roost	Either early morning (06:00hrs to 07:00hrs) or evening time (18:00hrs to 20:00hrs)	Range between one to two hours	Twice (02) a month. (At beginning and middle of the month)
	Acoustic surveillance	• Number of Bat passes per minute analysed from echolocation bat call data	Either early morning (06:00hrs to 07:00hrs) or evening time (18:00hrs to 20:00hrs)	One hour	Twice (02) a month. (at beginning and middle of the month)
Tree Roost (tree roots are usually for fruit bats	Total roost count	•Estimated number of bats at tree roost	Any time convenient for the monitoring agent but preferably between (09:00hrs and 14:00hrs)	Variable (depending on nature of tree roots and number of bats or species at the roost)	Twice (02) a month. (At beginning and middle of the month)
	Roost-exit counts	• Bat species/ type • Estimated number of bats flying out of the roost	Either early morning (06:00hrs to 07:00hrs) or Evening time (18:00hrs to 20:00hrs)	Range between one to two hours	Twice (02) a month. (At beginning and middle of the month)

Crevice Roost (these are crevices in rocks or walls of infrastructures were bats live). Humans usually cannot enter these	Roost-exit counts	• Bat species/ type • Estimated number of bats flying out of the roost	Either early morning (06:00hrs to 07:00hrs) or Evening time (18:00hrs to 20:00hrs)	Range between one to two hours	Twice (02) a month. (At beginning and middle of the month)
	Acoustic surveillance	• Number of bat passes per minute analysed from echolocation bat call data	Either early morning (06:00hrs to 07:00hrs) or Evening time (18:00hrs to 20:00hrs)	One hour	Twice (02) a month. (At beginning and middle of the month)
Man-made structurer (house, bridges, church, school etc.) bats here would be expected to hang in the roofing structures	Total roost count (for structures with normal roofs)	•Bat species/ type •Estimated number of bats in the roost	Any time convenient for the monitoring agent but preferably between (09:00hrs and 14:00hrs)	Variable (depending on nature of cave roost and number of bats and or species in the roost)	Twice (02) a month. (At beginning and middle of the month)
	Roost-exit counts	• Bat species/ type • Estimated number of bats flying out of the roost	Either early morning (06:00hrs to 07:00hrs) or Evening time (18:00hrs to 20:00hrs)	Range between one to two hours	Twice (02) a month. (At beginning and middle of the month)
	Acoustic surveillance	• Number of bat passes per minute analysed from echolocation bat call data	Either early morning (06:00hrs to 07:00hrs) or Evening time (18:00hrs to 20:00hrs)	One hour	Twice (02) a month. (At beginning and middle of the month)

Foraging grounds, places where bats go to look for food. Bats may also occasionally roost there. Eg: cocoa gardens, banana plantations, coffee gardens or bush land	Tally counts	• The number of bats observed f ying(foraging) at a given site. • Type/species of bats encountered	Either early morning (06:00hr to 07:00hrs) or evening time (18:00hrs to 20:00hrs)	One hour	Twice (02) a month. (At beginning and middle of the month)
	Acoustic surveillance	• Number of bat passes per minute analysed from echolocation bat call data	Either early morning (06:00hrs to 07:00hrs) or evening time (18:00hrs to 20:00hrs)	One hour	Twice a day (morning and evening), twice (02) a month. (At beginning and middle of the month)