Sentinel Surveillance for Marburg Virus and other Bat borne Pathogens in Wildlife in Uganda and its Implications to Public Health

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By

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Introduction

- The diversity and abundance of wildlife in Uganda is of ecological, economic and socio-cultural importance

- Some of the species are both vulnerable to various high-consequence infectious diseases yet also serve as natural reservoir of other pathogens known to cause severe disease in humans

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Rosettus aegytiacus BATS

- Marburg virus is one of the pathogens that in 2007 and 2008 infected tourists after visiting Python Cave in Queen Elizabeth National Park (QENP), one of Uganda's top tourist destinations.

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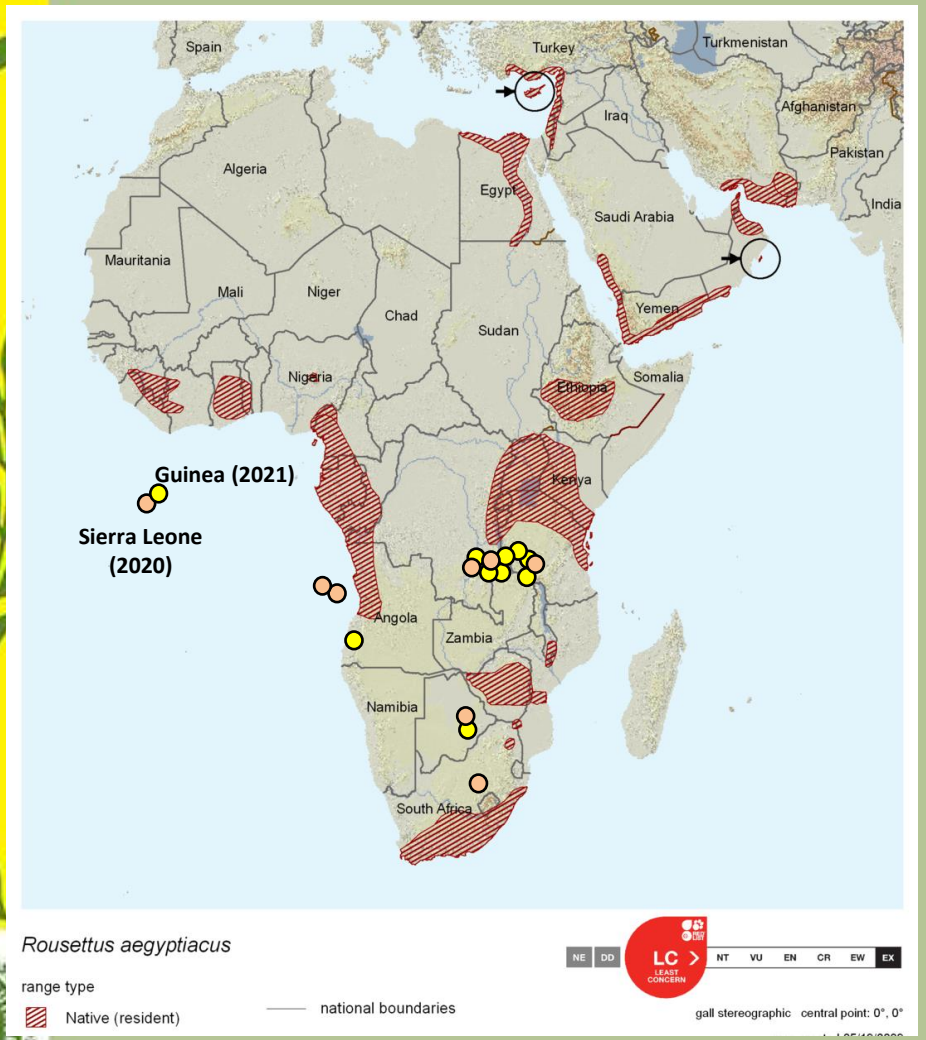
Marburg virus and *R. aegyptiacus* distribution



- Location of all known Marburg outbreaks
- Reproductive capacity combined with large colony sizes (>100,000) predicts large meta-populations
- Reproduces twice a year- 80% of adult females pregnant
  - ~Birthing: Feb and Aug
  - ~Breeding: May and Nov
- By 3 months, capable of free flight, at 6 months females birthing again

= outbreaks in humans = detection in bats

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Marburg Virus Disease in Uganda

Kitaka Mines, Ibanda district - July 2007

- 3 cases, 1 death
- 2 identified retrospectively
- Epidemiologically linked

- September 2007
  - 1 case
  - Epidemiologically unrelated

Python Cave, Maramagambo Forest, QEPA - 2 cases

- July 2008 Dutch tourist visits cave
- Became ill and died in Netherlands
- The USA case was identified retrospectively
- Visited cave December 2007
- Recovered

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Case investigations 2007 - 2008

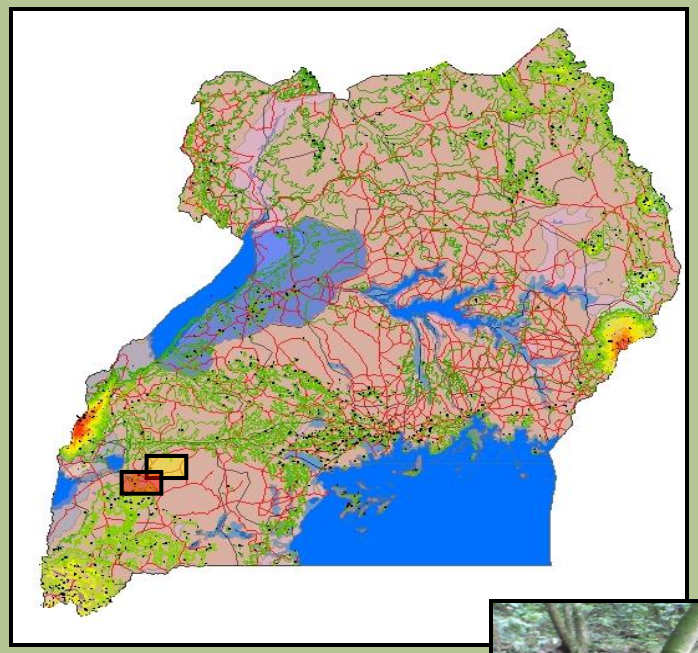
Kitaka Mine - 2007

- 31/611 PCR+
- 5.1% level of active infection
- Bat population estimate in the mines 100,000+

Python Cave 2008/09

- 40/1622 PCR+
- 2.5% level of active infection overall
- Bat population estimate in the cave 20,000

Kitaka Mine & Python Caves



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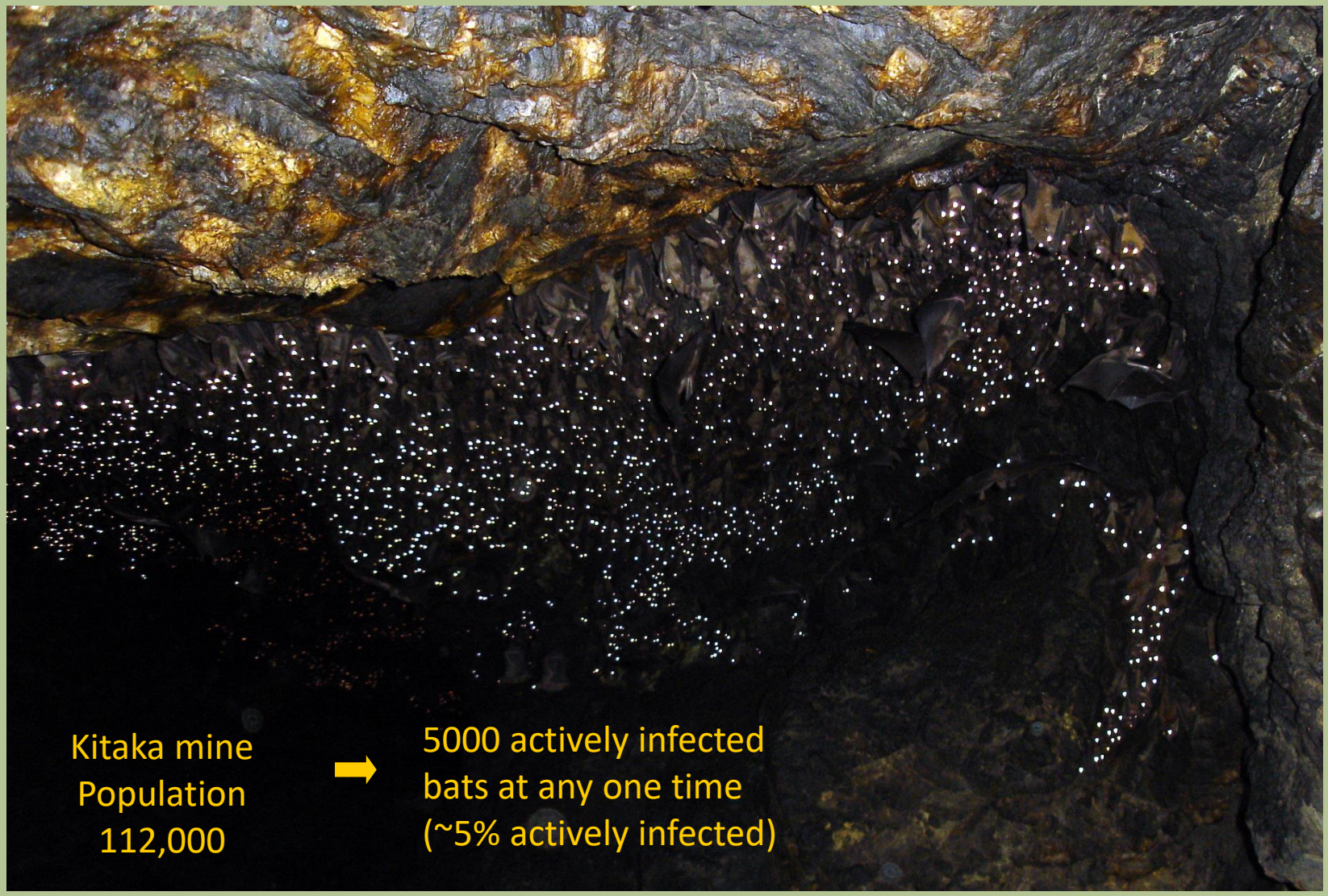
Kitaka mines then..



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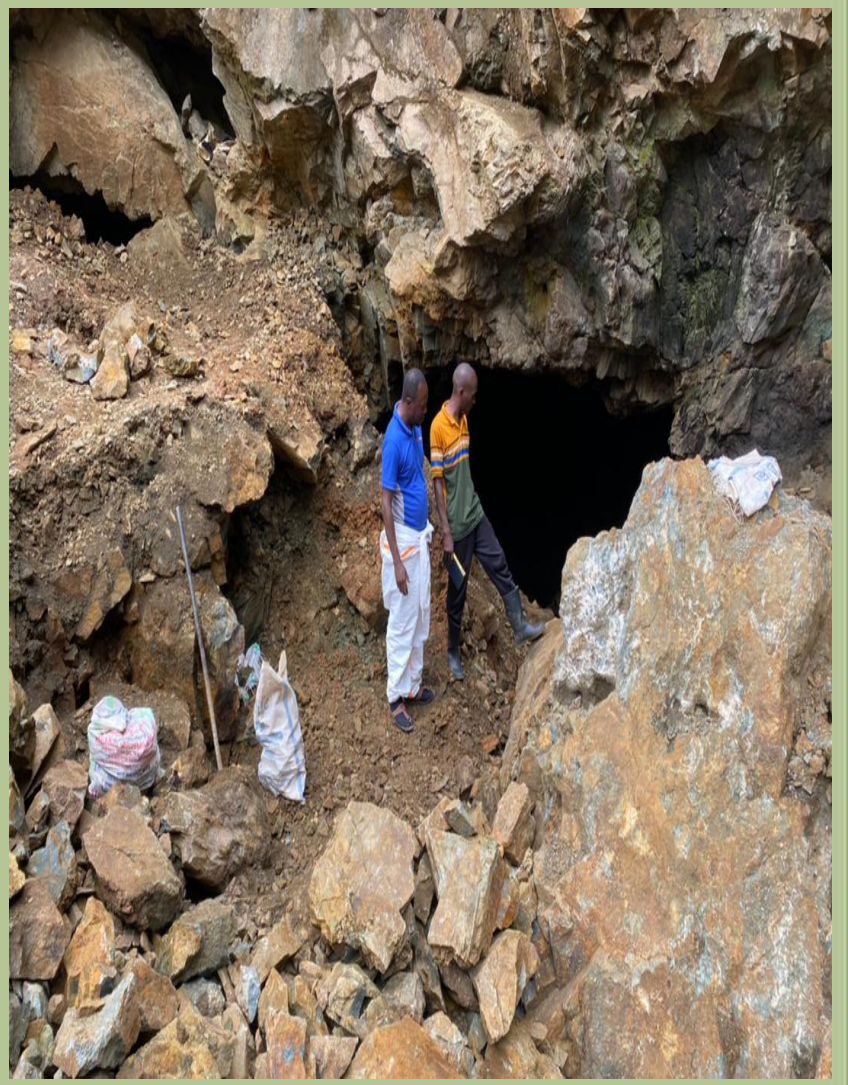
Kitaka mines now



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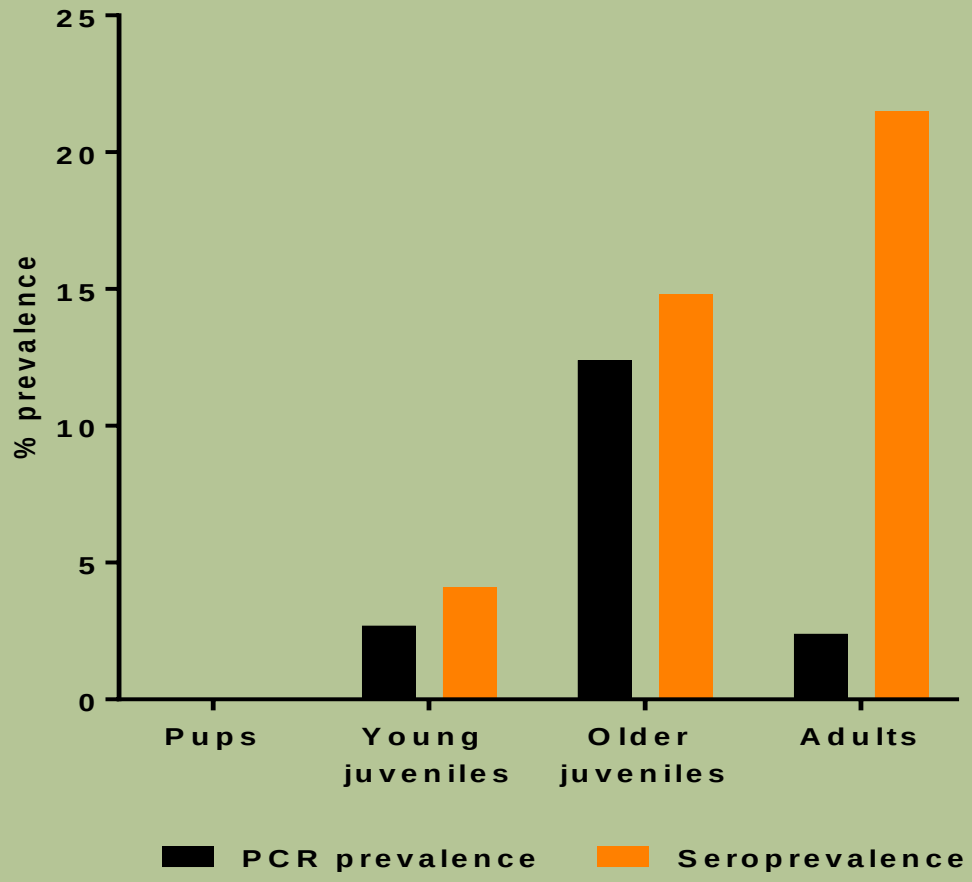
Case findings

- Isolated Marburg virus (MARV) in bats
- Established *Rousettus aegyptiacus* as the natural reservoir of MARV
- Established bat movement between Python Cave and Kitaka Mine established approx 50km distance. Tagged bat in Kitaka mine was found in the python
- A strong age bias was Identified among bats

Acute Marburgvirus infection levels peak in older juveniles



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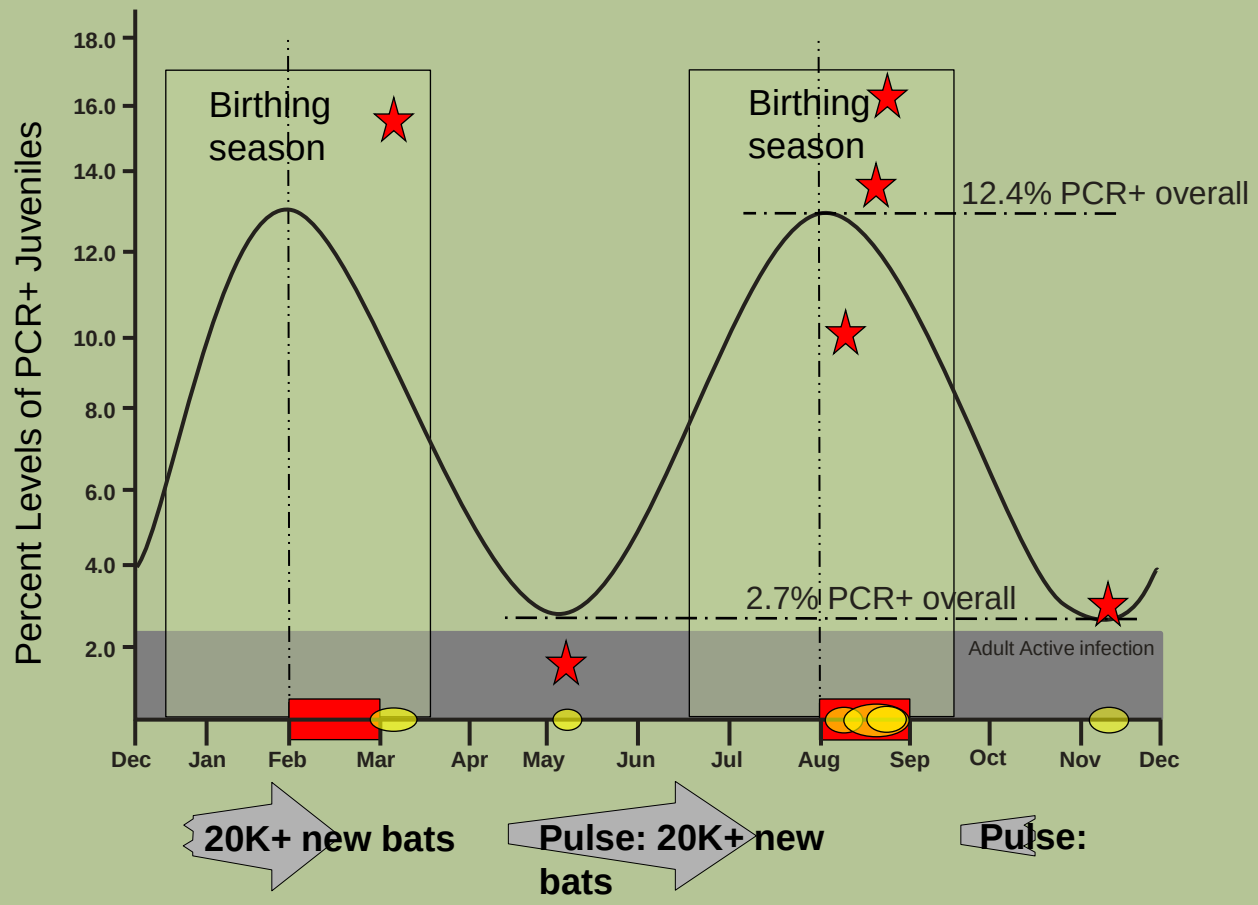
Seasons of Increased Human Risk



Collection period

Level of active infection (PCR+)

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What are we doing now?

- Telemetry
  - -50 GPS unit fitted on bats to understand nightly travel of potentially infected Rousettus bats
  - -Data downloaded to base station at the opening of the cave
- Passive Integrated Transponder (PIT) tagging
  - -508 bats were PIT tagged to determine colony size
  - -Tag also help determine bat dispersal from sentinel to other roosting sites

GPS

Telemetry Solutions

- Nano GPS
  - -Fitted using veterinary surgical adhesive
  - -≤ 7g weight
  - -7:00pm-5:00am interval
  - -Battery level failsafe
- Repeater antenna
  - -Brings satellite signal into cave
- Base station
  - -Long and short-range antenna
- 2 km wireless download

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Biosurveillance

- Bat capture done by MIST netting & sweep netting
- Destructive sampling
- Non destructive sampling for GPS and Pit tagged bats

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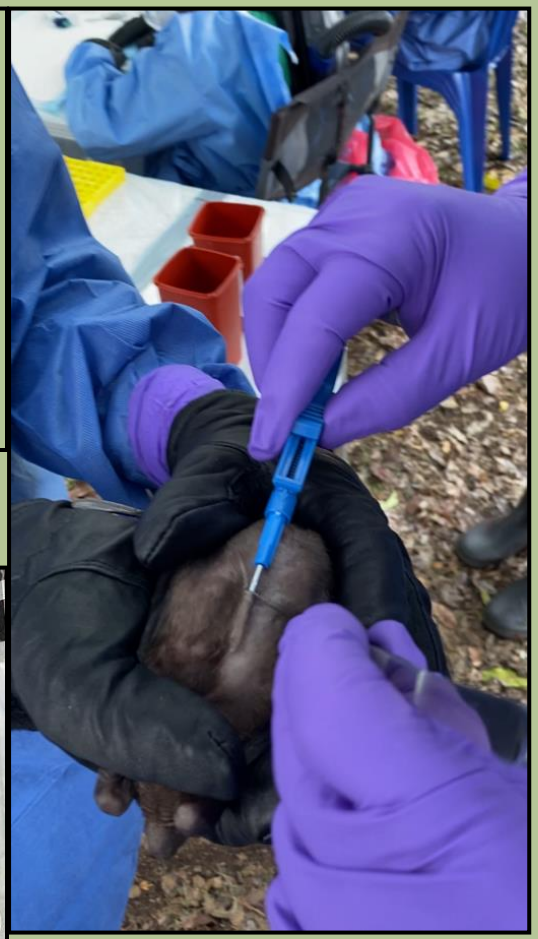
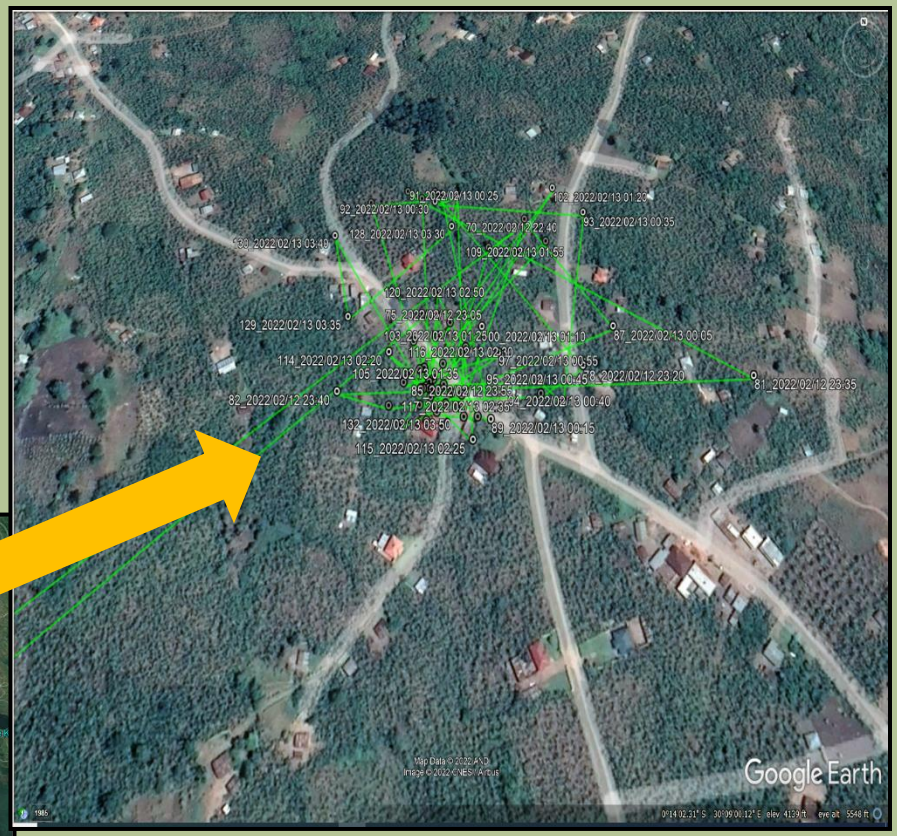
PIT Tags Passive Integrated Transponder

Biomark

- Pre-loaded sterile
  - 12.5 mm 143.2 KHz
- Mark/Recapture
- Estimates population size
- Estimates dispersal (long term)
  - -Remote sensing
  - -60’ litz cord antenna
  - -Reader



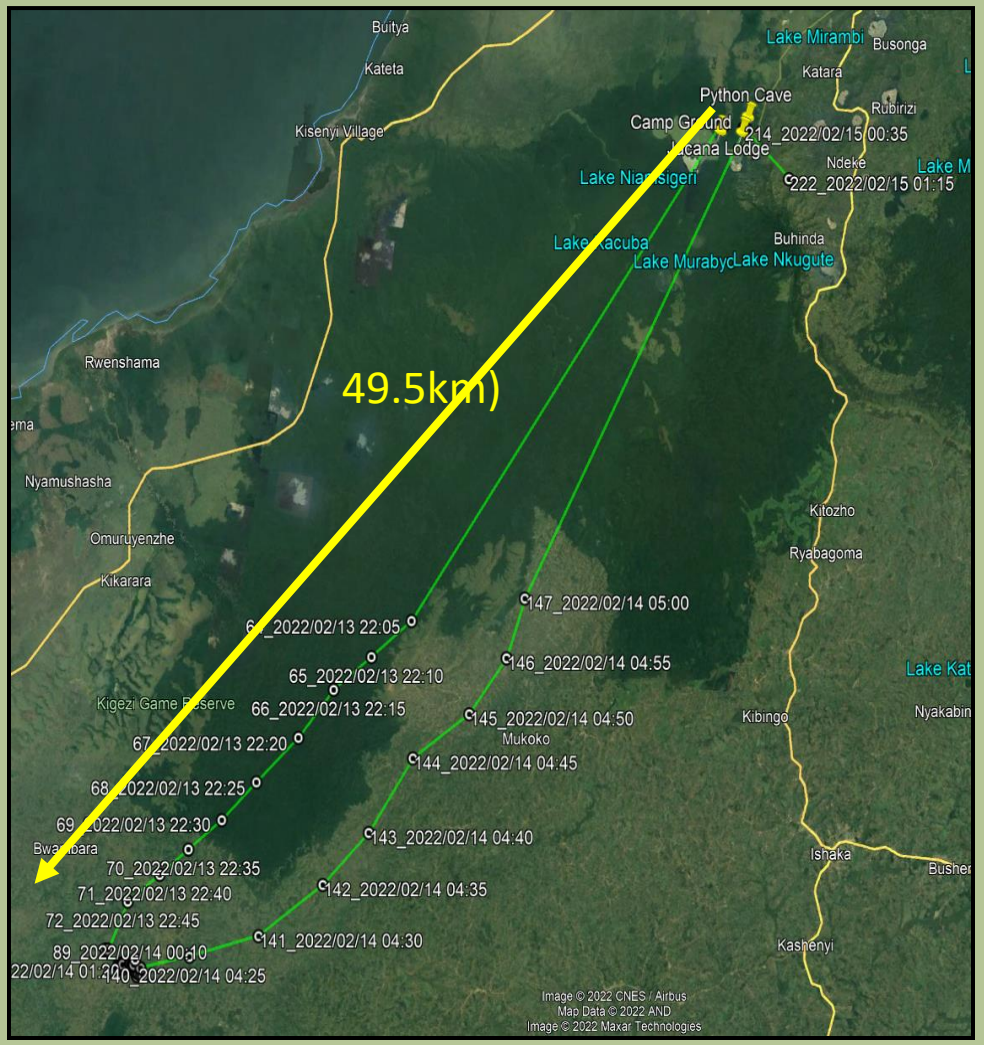
MV19
Adult male 149g
12 Feb - Tagged
13 Feb @ 05:00 - Last download
75 GPS positions – 1 day



Many houses in Uganda have mango trees in yard or near home

MV48
Deployed 13 Feb 2022
Last data point 15 Feb 2022, 01:15 am
Distance from cave to foraging = 49.5km (30.7 miles) – **99.0 km round trip (>60 miles)**

- Significant nightly dispersal
  - Dispersal of MARV, SOSV, KASV
- Significant potential contact with human food sources
- Increased risk of spillover



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Findings

- Males displayed foraging activity typically of selection of nearby abundant fruit.
- These males were recorded flying distances of 50 km or more nightly to specific fruiting trees.
- Females are known to be more selective in their foraging, often seeking out better quality fruits
- They fly even greater distances in search of better forage
- Bats were found to forage on fruit trees near human dwellings
- Also forage in cultivated crop areas preferring Banana plantations

Laboratory analysis

Sample types

- Destructive sampling
  - Cardiac puncture (blood)
  - Spleen and liver
  - Kidney, lung, heart
  - Axillary lymph node
  - Salivary gland
  - Rectum / colon
  - Oral swabs
- Non destructive sampling
  - Wing bleed
  - Oral swab
  - Rectal swab

Laboratory Analysis

- Marburg virus
- Kasokero virus
- Sosuga virus

Results/findings

Targets	No. of positive bats	Total no. of bats
Kasekero virus	9	50
Marburg virus	2	50
Sosuga virus	2	50

Filovirus transmission to other animals and Humans

- Competition for fruit between chiropterans (bats) and non-human primates leads to potential contacts
- Masticated fruit spats – children nibbling on such fruits
- Fecal material (guano) or urine containing infectious virus
- Birthing fluids (blood, placental tissues etc)
- Knowledge of the routes are of Public Health Importance

Contribution To Public Health

- Develop a dynamic and evidence-based risk map highlighting human-bat interface zones that are at increased risk for virus spillover events
- Together with MoH use the risk map to institute appropriate mitigation measures at locations of most likely MARV virus spillover at-risk communities.
- Develop easy-to-understand brochures to facilitate education of at-risk communities on how to live safely with bats and avoid infection with MARV & other bat borne pathogens
- Work with MoH and partners to disseminate educational materials
  - Brochures, risk maps, exclusion information
- Promote conservation instead of destruction of bats due to their ecological role in the ecosystem

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Clean up after bats inside the house

- **Step 1:** Spray urine and droppings with disinfectant (Jeek and water) until very wet. Soak for 5 minutes

- **Step 2:** Use towel to wipe up the urine or droppings

- **Step 3:** Throw away soiled towels

- **Step 4**: Mop or sponge area with disinfectant

- **Step 5**: Wash hands with soap and water

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Contact a healthcare provider in your community to learn more about preventing illnesses spread by bats

Logos? Text attribution? Contact info?

LIVING SAFELY WITH BATS

Learn how to protect your family from diseases spread by bats

Bats play an important role in our community.

- They spread seeds
- They pollinate plants which is necessary for fruit to grow
- They eat insects that spread disease, like mosquitos that spread malaria

Sick bats can spread illnesses to people and other animals, primarily through a bite or scratch or through handling or eating infected bats or contaminated food.

Picture of fruit with virus on it on the ground and child picking it up and eating it

Picture of a sick child

Once a person is infected, some illnesses can spread to other people through direct contact with their infected body fluids (or through objects or surfaces contaminated with their infected body fluids). These illnesses can be severe, and sometimes fatal.

Bats live and roost in trees, caves, rock crevices, abandoned buildings or barns, occupied buildings (bars, attics), and under corrugated or thatched roofing.

Not all bats are diseased, but it is impossible to tell just by looking at them. Treat all bats as potentially infectious. Even healthy people can become sick if exposed to an infected bat.

Protect your family. Protect your community.

Avoid direct contact with bats. Teach children to appreciate bats and to NEVER touch them.

[Show someone covering water]

- Cover water and food

[Show washing fruit]

- Always wash fresh fruit

[Show hunting bats with line through it]

- Do not hunt, kill, or eat bats

[Use earlier photo, add line through it.]

- Avoid touching and consuming fallen fruit on the ground – family members and livestock

[Add image of ?? With line through it]

- Do not eat or drink anything that has come in contact with a bat or its urine or feces or feed it to your animals

[Picture of the inside of a local house. Include: 1) holes near the roof, eves, and overhangs 2) smudges, or dirty spots, next to holes 3) small black, rice grain size feces 4) urine running down the wall 5) brownish liquid splats. Add circles/targets around each of these to highlight what people should look for.]

Recognize if you have bats in your home.

- Look for holes near the roof, eves and overhangs where bats tend to enter the home
- Look for smudges or dirty spots next to the holes near the roof line
- Look for feces. Bat feces can be small, black, rice grain size or brownish liquid splats
- Look for urine, which can be running down the wall
- Look for discarded insect parts – wings, shells, etc.

[Here we can include information on how to fix or reduce the size of holes using local materials]

Step 1

Step 2

Step 3

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