# World's biggest bat colony gathers in Zambia every year. Researchers used artificial intelligence to count them

September 30 2023, by Dina Dechmann, Benjamin Koger and Roland Kays

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Everybody who visits Kasanka National Park in Zambia during "bat

season" agrees that the evening emergence of African straw-colored fruit bats from their roost site is one of the wildlife wonders of the world. The bats (Eidolon helvum) arrive at Kasanka every year around October. The numbers swell rapidly until they peak in November. By January they are gone again.

Once they recover from the shock of the breathtaking spectacle, everyone also converges on the same question—how many bats are there? So many fly out so fast, it seems impossible to count them. Past estimates based on visual counts have ranged from 1 million to 10 million, a sign of how difficult the task is.

To crack the problem we clearly needed a new approach. Using an array of small video cameras, we filmed the bats leaving their roost and then developed artificial intelligence to count them. This offers an inexpensive, fast and repeatable way to count large numbers of moving animals.

Our average estimate for the Kasanka colony for five days in November 2019 was 857,233 bats. This makes it one of the biggest bat colonies in the world, and the most important in Africa.

The next question is why we wanted to count them.

## Why counting is important

Past work on this species has shown that the ecosystem services they provide are unparalleled. They disperse seeds every night over distances of 75km and more—three times further than the African elephant. Larger colonies disperse more seeds and are thus more valuable in ecosystems. Unfortunately, decreases in bat numbers are being observed in places. Standardized counts are critical to distinguish between colony shifts due to disturbance by people and population-level declines that

require conservation management.

Counting the Kasanka colony is important for another reason too. The African straw-colored fruit bat is the only long-distance migrant fruit bat on the continent. We don't know the details of these migration routes yet, but each year we see them converging in temporary colonies, such as the one in Kasanka, and then moving on to parts unknown. Their time at these stop-over sites seems to be synchronized with peaks in local food availability, and larger colonies are better at matching their timing with the best food availability.

So large colonies indicate a healthier, more food-rich landscape, and are also key to maintaining the collective behavior of migration.

The technology needed to track the bats and understand their migration paths is still being developed. Only a few individuals have been studied. The results were nevertheless striking. The bats flew off to many places across the continent, including one all the way to South Sudan. It seems that bats from several other colonies meet at Kasanka during a short time of the year, probably to take advantage of the abundant fruit in the region.

## The counting

For our new counting approach, we decided to film the bat emergence in a standard way, count the bats in each video, and then extrapolate a total number.

The key was collecting data from all sides of the colony. So we surrounded the bat forest with nine GoPro cameras, aimed straight upwards. These small "helmet cameras" are more typically used to film extreme sports, but were also suitable to record the dark bats flying beneath the pale evening sky. Our team of scientists and rangers would

race around the park to start the cameras just before the bats started flying, take a break to marvel at the bat swarm, then return after dark to fetch the cameras, while dodging the hippos and crocodiles that share the swamp forest with the bats.

Back at the lodge there was just time to recharge the batteries and download the footage to prepare for filming the next day.

We got about 45 hours of footage over five days of filming. But we still had to actually count the bats.

Manually counting bats in these videos was not realistic—there were just too many of them. Instead, our team developed an artificial intelligence (AI) program to recognize the bats against the evening sky, track them from frame to frame as they flew across the screen, and count them whenever they crossed the center line.

The AI takes 1.25 minutes to process one minute of video. This means 40 hours of footage takes 50 hours to run on the computer. If a human took two minutes to count all the bats in a single video frame, it would take over 13 years to complete the job.

We checked the accuracy of the AI method by manually counting some short clips and found it was detecting 95% of the bats.

We then used a bit of trigonometry to figure out what portion of the total colony was flying past our cameras and extrapolated a total colony size. The highest number on one day was 987,114 bats.

We might not have caught the colony at peak size during our five days of counting, so we can say there are about a million bats in Kasanka at peak season in November.

There are caves in Texas with more bats, but they are much smaller. The Kasanka colony of straw colored fruit bats is the largest (by weight) in the world by at least an order of magnitude.

## Future monitoring

The use of cheap GoPro cameras and the innovative automatic analyses allowed us to establish an easy method (weather permitting) to count this and other colonies of animals over successive years. We hope this will allow us to identify changes in numbers to inform conservation efforts. These are important because protecting the Kasanka colony helps protect bats from the entire sub-continent.

Agricultural developments are encroaching on Kasanka National Park and a wind farm is planned in the area. This could have negative effects on the numbers of bats aggregating here. Monitoring will be crucial to reveal and prevent these effects wherever the species provides ecosystem services.

Hopefully the bats will continue to darken the evening sky of Kasanka for many years to come, continuing their services as the secret gardeners of Africa.



Provided by The Conversation