Acoustically assessing apes: estimating wild chimpanzee (*Pan troglodytes schweinfurthii*) densities in a savanna-mosaic landscape

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Project background

In western Tanzania, most chimpanzees (~75%) live outside of national parks and at low population densities (~ 1/25th) compared to those in tropical forests. Combined with a large home range, their low numbers mean that they can easily elude researchers trying to find and study them. Given rapid expanses of human settlement across great ape distribution, there is an urgent need to prioritize areas for conservation to maintain populations at viable levels. We thus need to systematically, reliably and affordably monitor large landscapes as well as ape population status and threat levels. Developing an accurate and cost-effective method of surveying animals in remote areas is critical to understanding population dynamics. Recent studies have demonstrated the application of bioacoustics to estimate animal density, yet few studies have employed this remote approach with terrestrial species, and never with chimpanzees.

Project aim

The aim of this study was to assess a method to acoustically estimate chimpanzee density using passive acoustic monitoring (PAM) and spatial capture-recapture (aSCR). The goal was to validate our method by comparing acoustically derived estimates with those from two more common methods, i.e. spatially explicit capture-recapture (SECR) and distance sampling (DS) from camera trap footage.

Methods

I collected data between March and December 2018, in the Issa Valley, western Tanzania. The area is comprised of a series of valleys separated by steep mountains and flat plateaus, with an altitudinal gradient ranging from 1050 to 1650 m above sea level. Vegetation is dominated by miombo woodland and also includes grassland, swamp and riparian forest. It hosts eight primate and four large carnivore species (spotted hyena, lion, leopard, wild dog), and over 260 species of birds. The study site covers the territory of at least one chimpanzee community that was fully habituated in September 2018.

I deployed twelve acoustic sensors (SM2, Wildlife Acoustics) for a nine-month period that were secured on trees at a height of approximately 1.65 m, at the top of the valleys to maximize the chance of recording calls. I recorded sounds at a 16 kHz sample rate and 16 bit/s in uncompressed .wav format. I scheduled the sensors to record for 30 minutes of every hour from 06:00 to 19:30 (7h/day) to maximize capturing calls when chimpanzees are the most vocally active. I deployed the sensors in three clusters of four sensors/cluster, two sensors on each side of a valley with inter-sensor distance ~500 m to allow for sound localization. I rotated the clusters to new locations within the study area every two weeks (four arrays). I manually processed acoustic recordings by visualizing spectrograms and aurally confirming any detection, with the aid of the acoustic software Raven. I also deployed twenty-one camera traps (Bushnell Trophy Cam) in a systematic layout (henceforth 'systematic' cameras), in grid cells of 1.67 km x 1.67 km. I deployed thirty-two additional camera traps (Bushnell Trophy Cam) at targeted locations where chimpanzees were known to pass, i.e. animal paths or termite mounds (henceforth 'targeted' cameras). To transform acoustic data into chimpanzee density estimation, call rate (number of calls per hour) is necessary. Focal follows were subsequently conducted, where I documented each loud call produced by a focal individual, as well as data on behavioural context, party size, etc. Considering that seasonality is likely to influence the call rate, we estimated the call rate for the same season (late dry season) than the one we analysed the acoustic data from PAM.

To estimate chimpanzee density, I conducted DS and SECR analyses from the CT footage within the software Distance 7.3 and the package 'secr' in R. Calling chimpanzee density has been estimated within the package 'ascr' in R. For more details on the methods, see Crunchant et al., *in preparation*.

Results

For the duration of the study, the cameras were functional for 11,342 camera days across 21 systematic CT and 32 targeted CT. This resulted in 3342 chimpanzee videos. 125 videos were recorded on 12 systematic cameras and 3217 on 32 targeted cameras. The acoustic sensors recorded for 5316 cluster hours (15344 sensors hours). Of the 62120min of audio recordings analysed, I identified 2036 calls. Chimpanzees had a mean call rate of 1.96 ± 0.24 calls per hour for the subadult and adult males and 0.86 ± 0.16 calls per hour for the subadult and adult females. The aSCR model estimated a density of 0.24 chimpanzees per km^2, while SECR estimated a density of 0.49 chimpanzees per km^2 and DS a density of 0.32 chimpanzees per km^2.

Conclusion and perspectives

With this study, I have demonstrated that passive acoustic monitoring is a powerful tool for species monitoring and conservation, and results are promising. Its applicability in evaluating presence/absence, but also providing population density estimates, especially but not exclusively for loud calling species, such as elephants, lions, gibbons or chimpanzees provides an efficient way of monitoring populations and inform conservation plans to mediate species-loss. Currently, I am working with collaborators to use machine learning to automate species detection and expedite call identification. Results have bearing on how we remotely study wildlife distribution, specifically by improving survey design, identify hotspots and prioritize patrol areas, and monitor wildlife response to ever-increasing anthropogenic disturbance.