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

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Awarded a PSGB Conservation grant (Cyril Rosen award) in May 2018

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, 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 ape conservation to maintain populations at viable levels. To do so, we 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.

Aims of the project

The project had three main objectives: (1) test and validate passive acoustic monitoring (PAM) system as a way to collect capture-recapture data for chimpanzees; (2) validate spatially explicit capture-recapture (SECR) methods for estimating chimpanzee density from PAM data; (3) compare the efficacy of PAM to data collected from camera traps to estimate chimpanzee density.

Methods

I conducted my study between March and December 2018, in the Issa Valley, western Tanzania (Figure 1). 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.

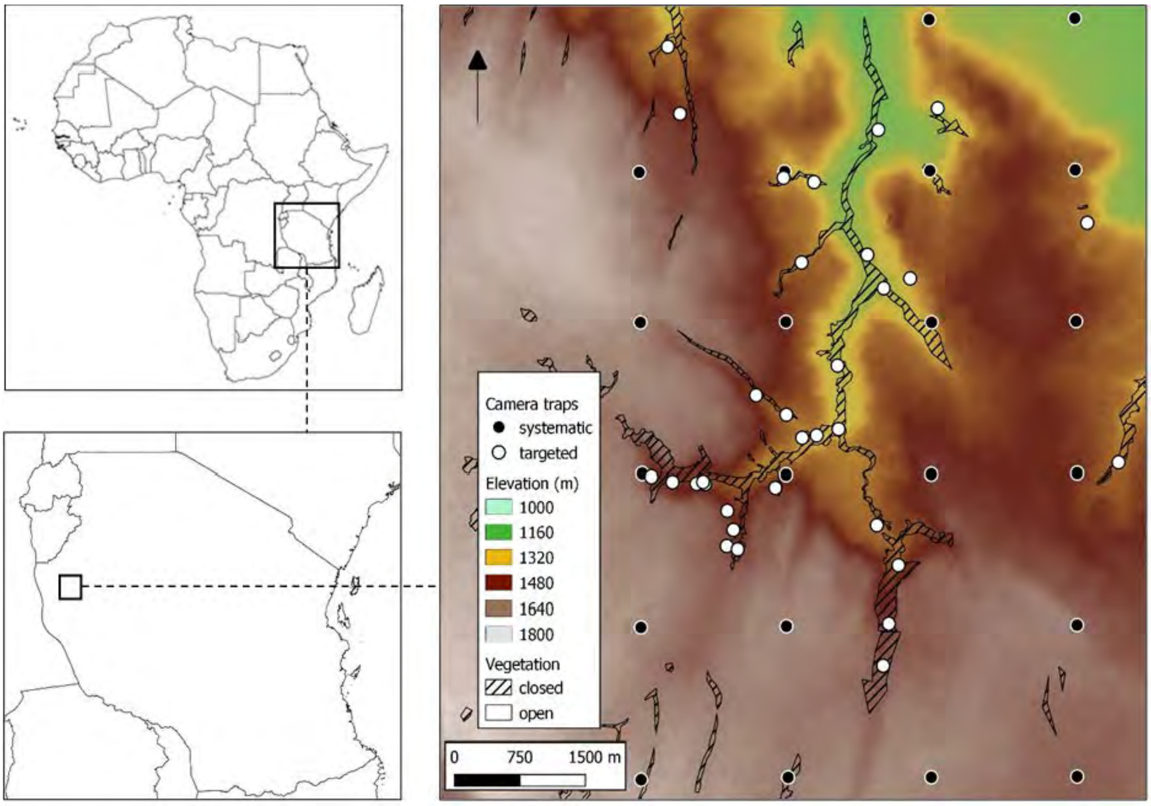

Figure 1: Study site and camera trap locations (targeted and systematic placements) in Issa Valley, Western Tanzania.

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 16kHz 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 (Fig. 2), with inter-sensor distance ~500m to allow for later sound localization. I rotated the clusters to new locations within the study area every two weeks (four arrays, Fig. 2). I manually processed acoustic recordings by visualizing spectrograms and aurally confirming any detection, with the aid of the acoustic software Raven (Bioacoustics Research Program, 2014).

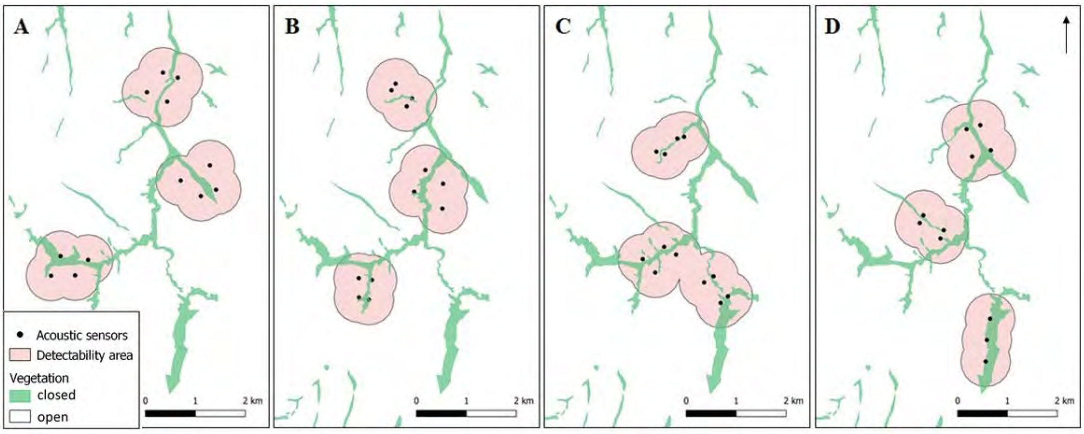

Figure 2: Location of acoustic sensors: each set-up (A, B, C, D) remained two weeks before being rotated to another one. Detectability is the area where a call can reach a sensor, defined as a 500 m buffer around a sensor.

For nine months, 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 32 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, Fig. 2).

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.

Results

For the duration of the study, the cameras were functional for 11,342 camera days across 21 systematic CT and 32 targeted CT (214 ± 49.5 days per camera). This resulted in 3349 chimpanzee videos. Of these, 125 videos were recorded on 12 systematic cameras and 3224 on 32 targeted cameras (Fig. 3).

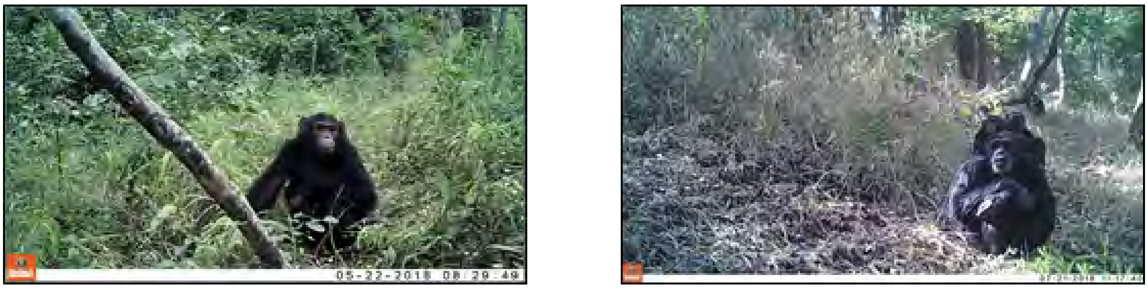

Figure 3: Snapshots from camera trap videos

The acoustic sensors recorded for 5316 cluster hours (15344 sensors hours). Of the 10632 30-min occasions analysed, at least one call has been detected in 1024 occasions (9.6%) and detections have been made on all sites surveyed. Calls have been made at each hour of the day with a higher proportion early morning (06.00 and 07.00 h) (Fig.4).

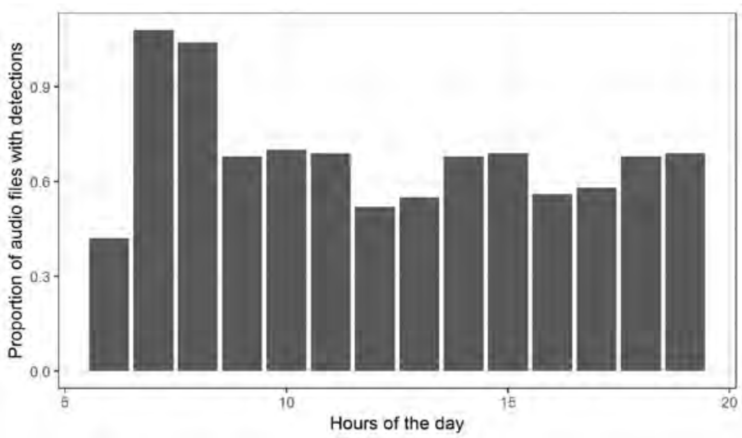

Figure 4: Histogram representing the proportion of audio files with at least one call per hour of the day

In progress:

- Additional data on call rate are currently being collected
- Chimpanzees from camera trap videos are currently being individually identified
- Analyses on chimpanzee densities are in progress

Conclusion and perspectives

Analyses on chimpanzee densities from PAM and CT monitoring are currently in progress. However, with occupancy modelling I evaluated the efficacy of each method to detect chimpanzees, using the estimated number of sampling days needed to establish chimpanzee absence with 95% probability, as the measure of efficacy. Passive acoustic monitoring was more efficient than camera trapping in detecting wild chimpanzees (Fig. 5). Detectability varied over seasons, likely due to social and ecological factors that influence party size and vocalization rate. The acoustic method confirmed chimpanzee absence with less than ten days of recordings during the late dry season, the period of highest detectability, which was five times faster than camera traps.

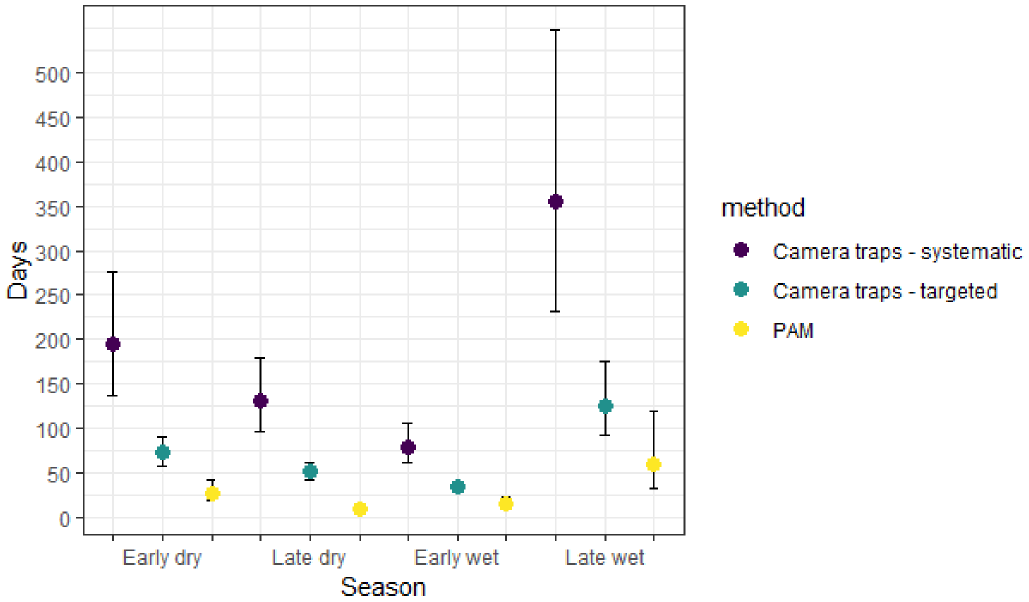

Figure 5: Number of trap days necessary to infer chimpanzee absence at a confidence level of 95% in function of seasons and methods. Error bars represent upper and lower bounds.

Despite some technical limitations, I have demonstrated that passive acoustic monitoring is a powerful tool for species monitoring, and results are promising. Its applicability in evaluating presence/absence, but also densities, especially but not exclusively for loud call species, such as cetaceans, elephants, lions, gibbons or chimpanzees, provides a more efficient way of monitoring populations and inform conservation plans to mediate species-loss. The next step would be the development of algorithms to automate species detection in order to speed-up how we remotely study wildlife distribution by helping to plan surveys, identify hotspots and prioritize patrols, and how we monitor the wildlife response to ever-increasing anthropogenic disturbance to their environments