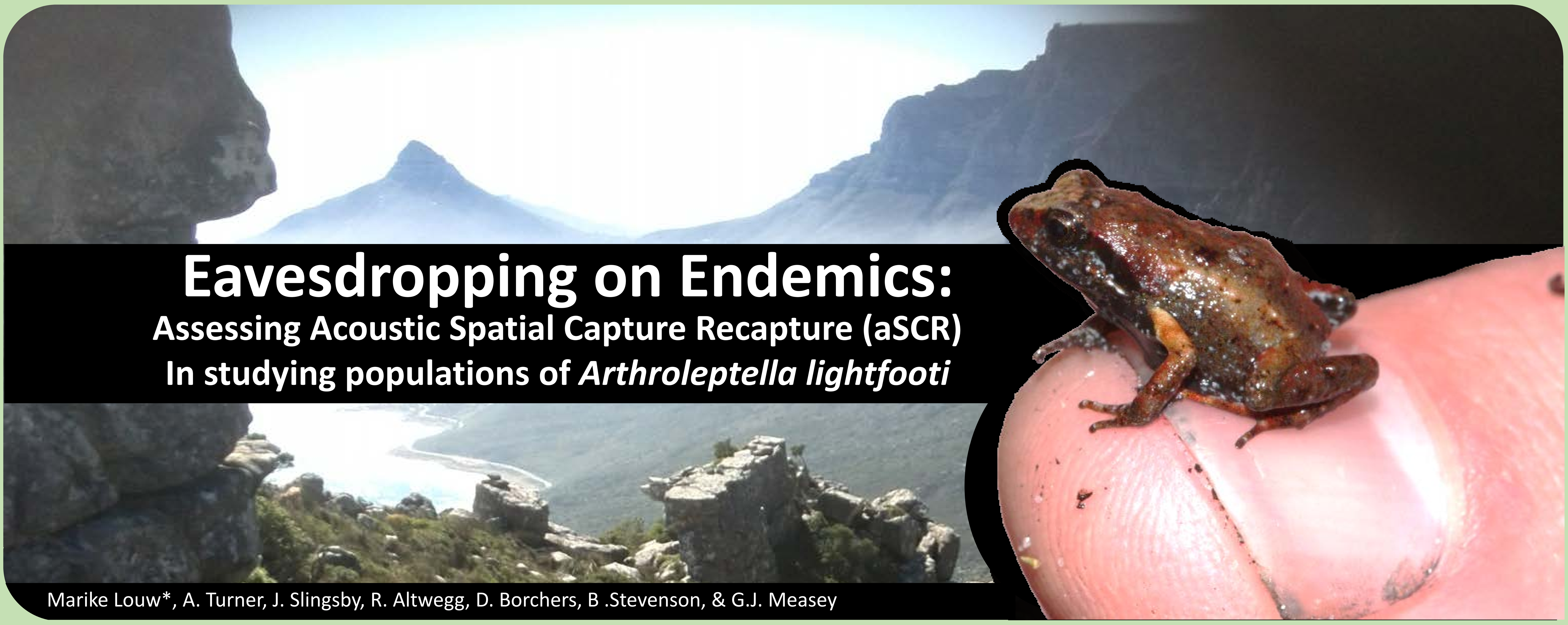

Eavesdropping on Endemics:
Assessing Acoustic Spatial Capture Recapture (aSCR) In studying populations of *Arthroleptella lightfooti*

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Introduction

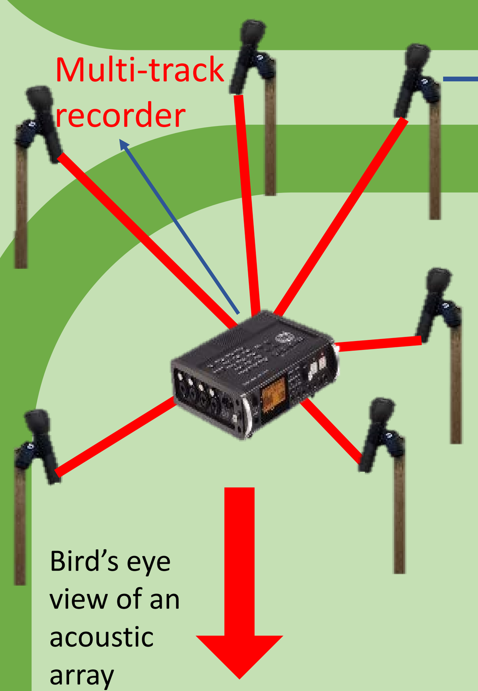
Acoustic Spatial Capture Recapture (aSCR) provides a means to estimate population densities of highly elusive, yet vocally active species[1].

This technique combines traditional capture-recapture and distance sampling methods. A major advantage is the implicit estimation of the effective sampling area using the spatial information provided by knowing the locations of detectors[2,3].

The Cape Peninsula Moss frog, *Arthroleptella lightfooti,* a visually cryptic species, is endemic to the Cape peninsula, South Africa[4]. Quantitative population information of this species across its range did not exist before aSCR, due to the cryptic nature of the frog.

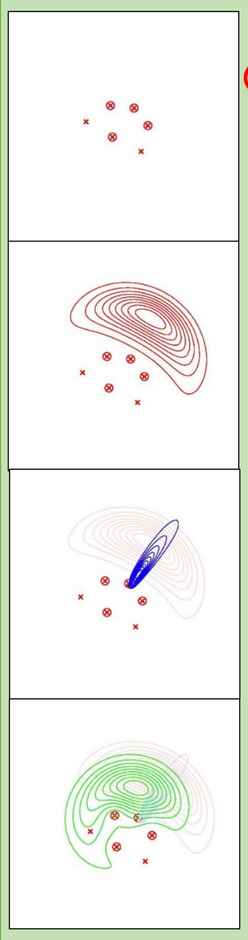
The efficacy of using aSCR under varying sampling conditions has not been evaluated, and understanding factors which lead to decreasing accuracy can streamline data collection and analyses. **Our aim is to determine optimal performance of aSCR with respect to minimizing error in estimates of call densities.**

In addition, we want to identify factors that may render use of aSCR inappropriate for density estimation.



Results

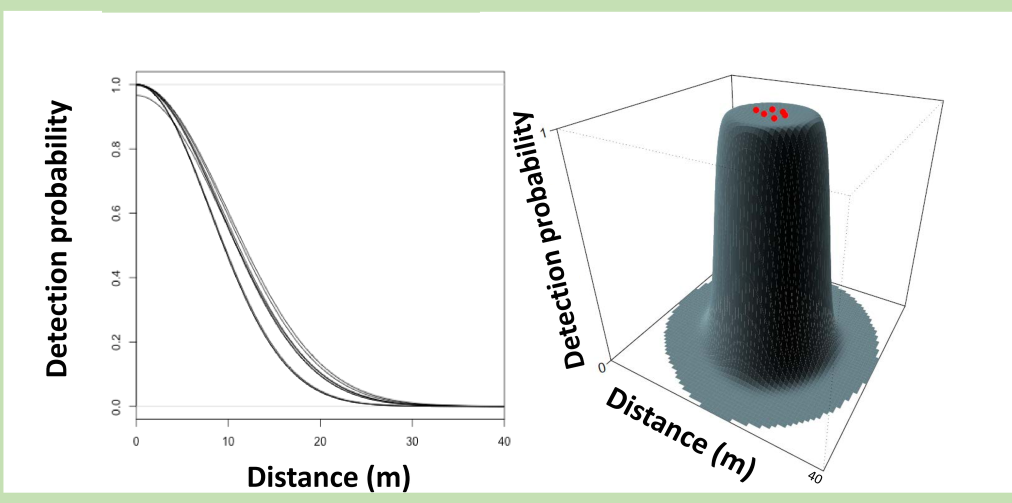
An acoustic array consisted of detectors of known locations, which "captured" the calls of animals. PAMGUARD was used to extract Frog calls from the recorded soundscape. Capture histories were constructed for each unique call and consisted of detectors which did and did not detect a call.



The average number of calls received by an array was determined from the capture histories.

Call features, i.e. time of arrival and signal strength (loudness), at different detectors aided in animal location estimates.

This spatial information associated with each detected call is used to create detection functions associated with the array and to determine the effective sampling area of the array.



We used acoustic arrays (n=85) to obtain recordings of calling males during their austral winter breeding season in 2016 and 2017; we employed aSCR to obtain density estimates across the population range.

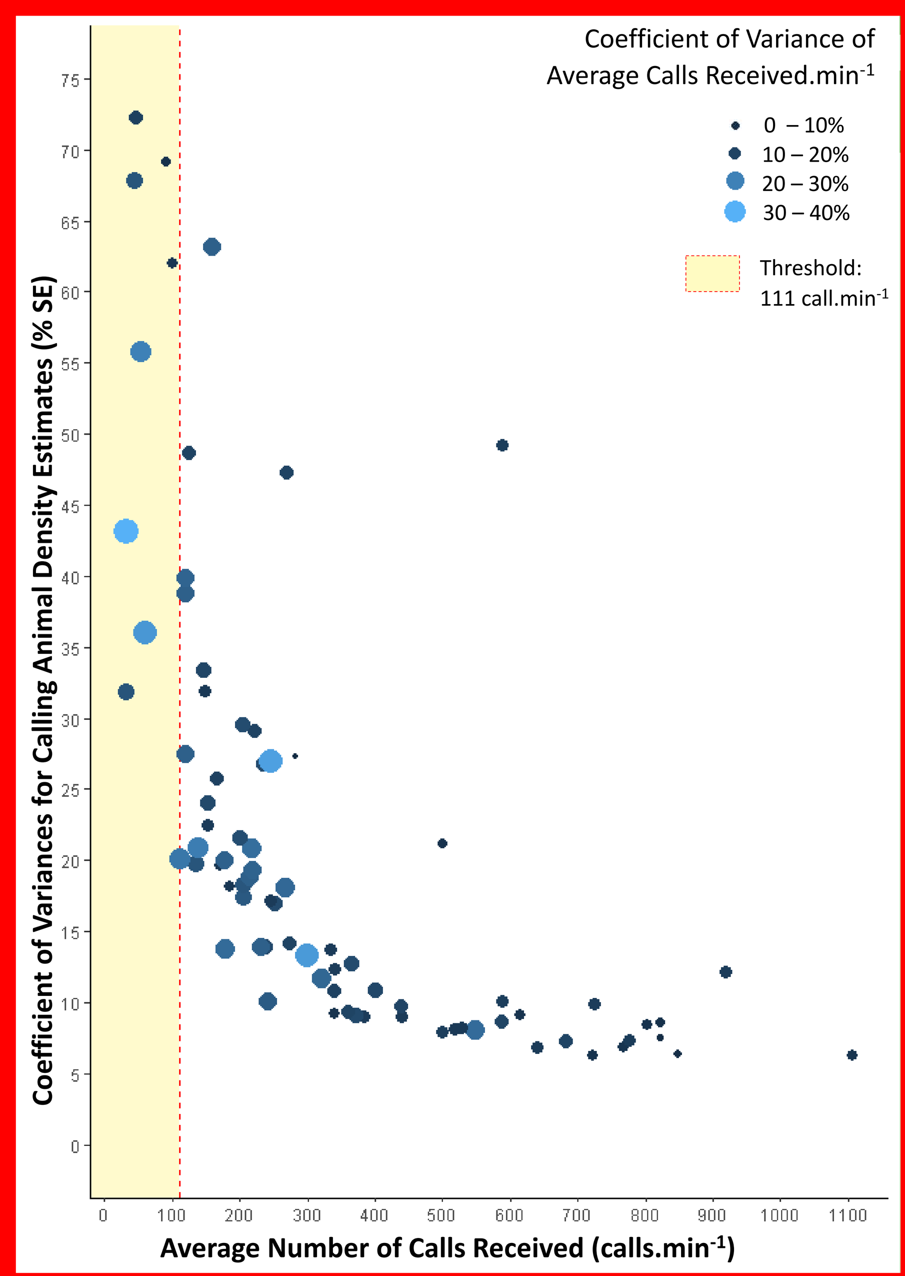
Each calling animal density estimate had an associated standard error which was used to calculate a coefficient of variance (CV).

Results

The CVs of calling animal density estimates decreased as more calls were received across an acoustic array. When < 100 calls.min^{-1} were received, which are approximately 5-6 calling frogs, the CVs of the calling animal density estimates were above 30%. However, when more than 5 frogs were calling, 91% of the recordings had CVs below 30%.

There was more variation, indicated by the size and colour of the points representing a site at which recordings took place, in the number of calls received when fewer calls were received per minute.

We could not find an upper-threshold of standard error values.

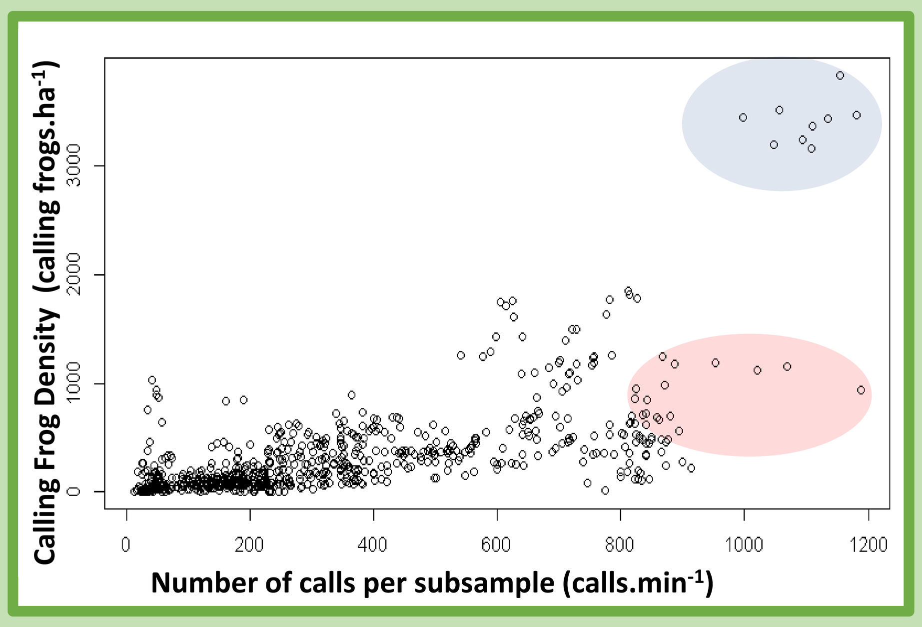


Discussion

aSCR performs optimally when the average number of calls received is >100 calls.min^{-1}. Lower densities may exhibit some density-dependent calling behaviour as variation in calls received is much higher: when there are fewer males advertising, the call rate is not constant. When more males are present, calling has greater consistency.

There could be a limit to effective estimation of calling animal densities when a very high abundance of calls is received across the array. Correctly allocating detections to the appropriate call capture history depends on determining whether a detection across microphones is the same call, or a different call that could become more difficult when there are more calling males.

The figure (right) depicts the relationship between the number of calls received and the resulting calling animal density estimates.



The distribution of the calling males relative to each other and the detectors could be important in differentiating between calling males at high densities. For example, the graph (above) shows two different sets of densities (highlighted blue and red) for sites which received similar numbers of calls. This could be due to how the frogs were distributed: if more dispersed, the ToA is more effective, or if clumped, the ToA is less effective.

Conclusion

When less than 5-6 frogs were recorded, not enough information was available for aSCR to create detection functions and, therefore, to provide accurate density estimates.

It is possible to estimate small numbers of frogs accurately without deploying an array. Arrays should only be deployed when more than 5 frogs are heard. No upper limit was detected.

This study has implications for efficiently monitoring this enigmatic frog species using aSCR. It also provides insight in designing studies using aSCR for other acoustically active taxa.

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