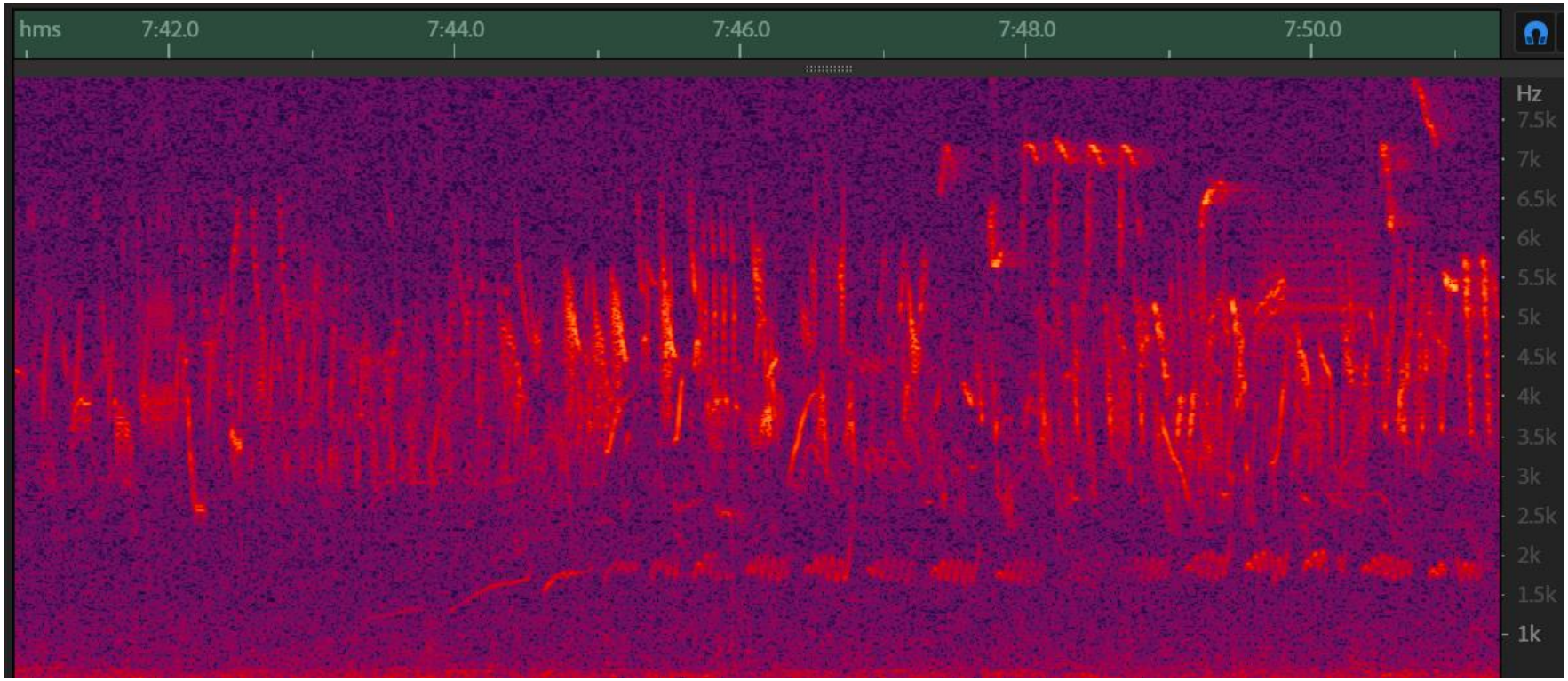
Soundscape Ecology at Audible Frequencies

Oliver Metcalf

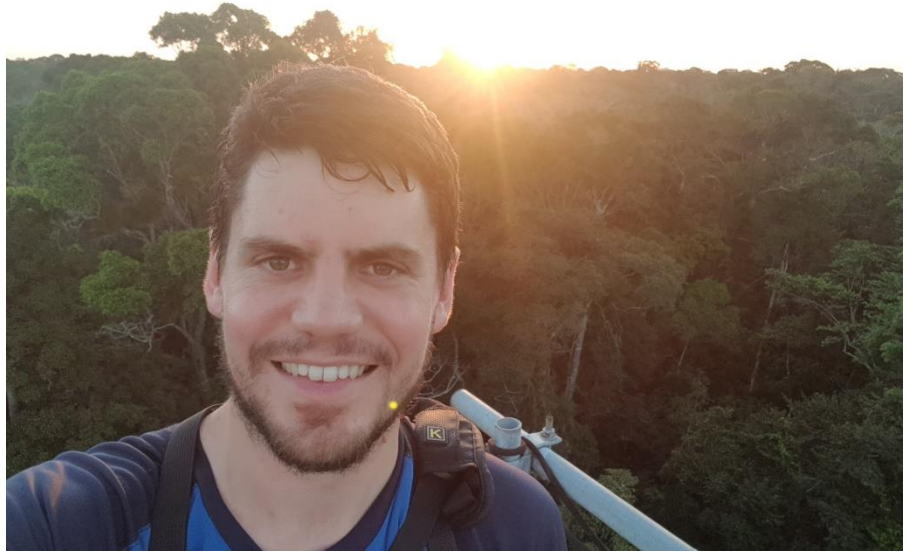


Manchester Metropolitan University

RAS
Rede Amazônia Sustentável

Understanding the impacts of fire and logging on Amazonian wildlife using acoustic monitoring

About me:



Passive Acoustic Monitoring:

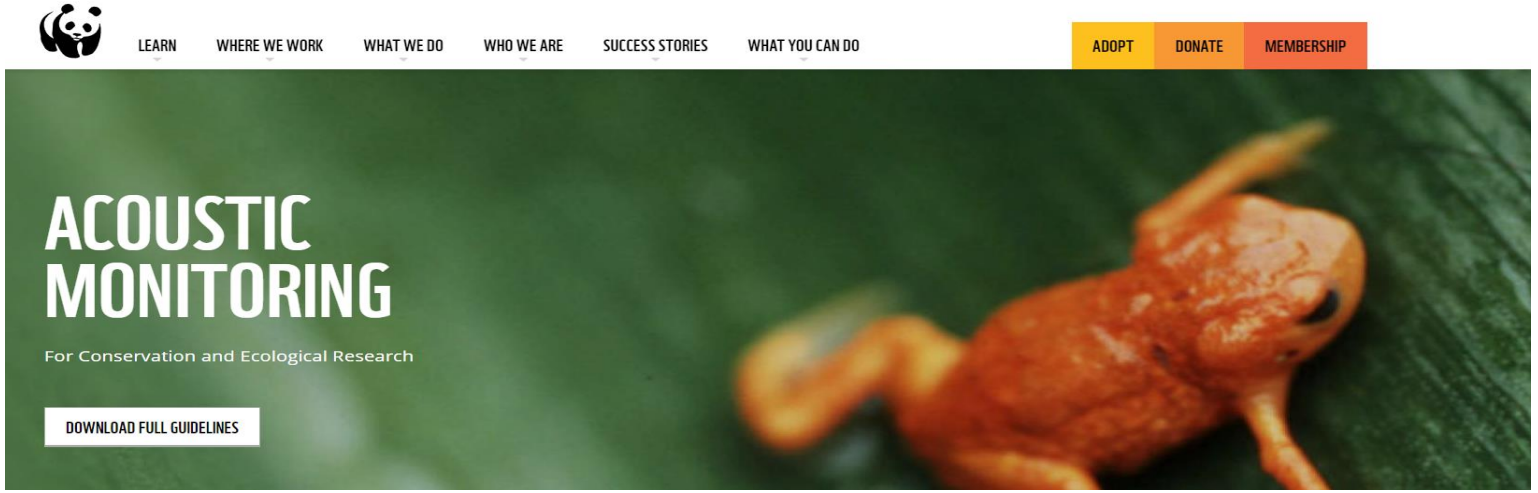
- Record for long periods
- Record for short periods many times
- Reduce number of field visits
- Reduce impact of observer
- Data can be checked by multiple analysts to reduce bias
- Data can be analysed multiple times

Passive Acoustic Monitoring: the downsides

- Data loss
- Bias against non-soniferous species
- No ‘rulebook’ to follow –

…although see Carlos Abraham’s guidelines for CIEEM and WWF’s guidelines for acoustic monitoring

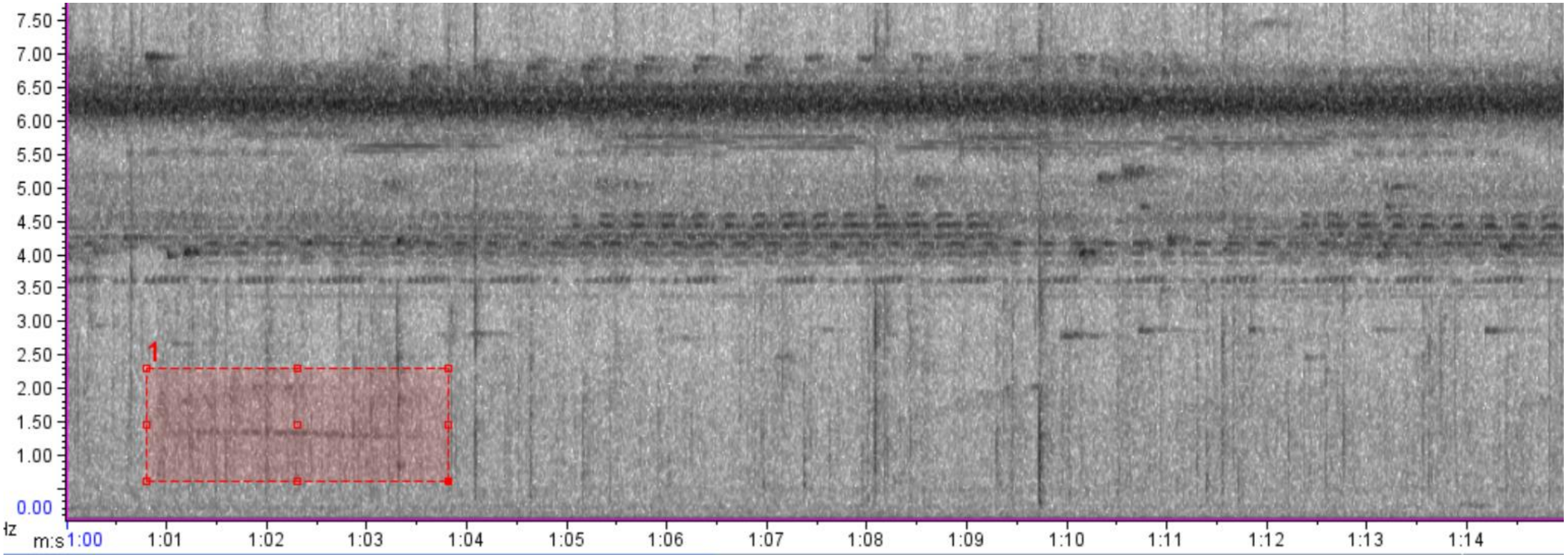
- Huge amounts of data collected



How to analyse sound data?

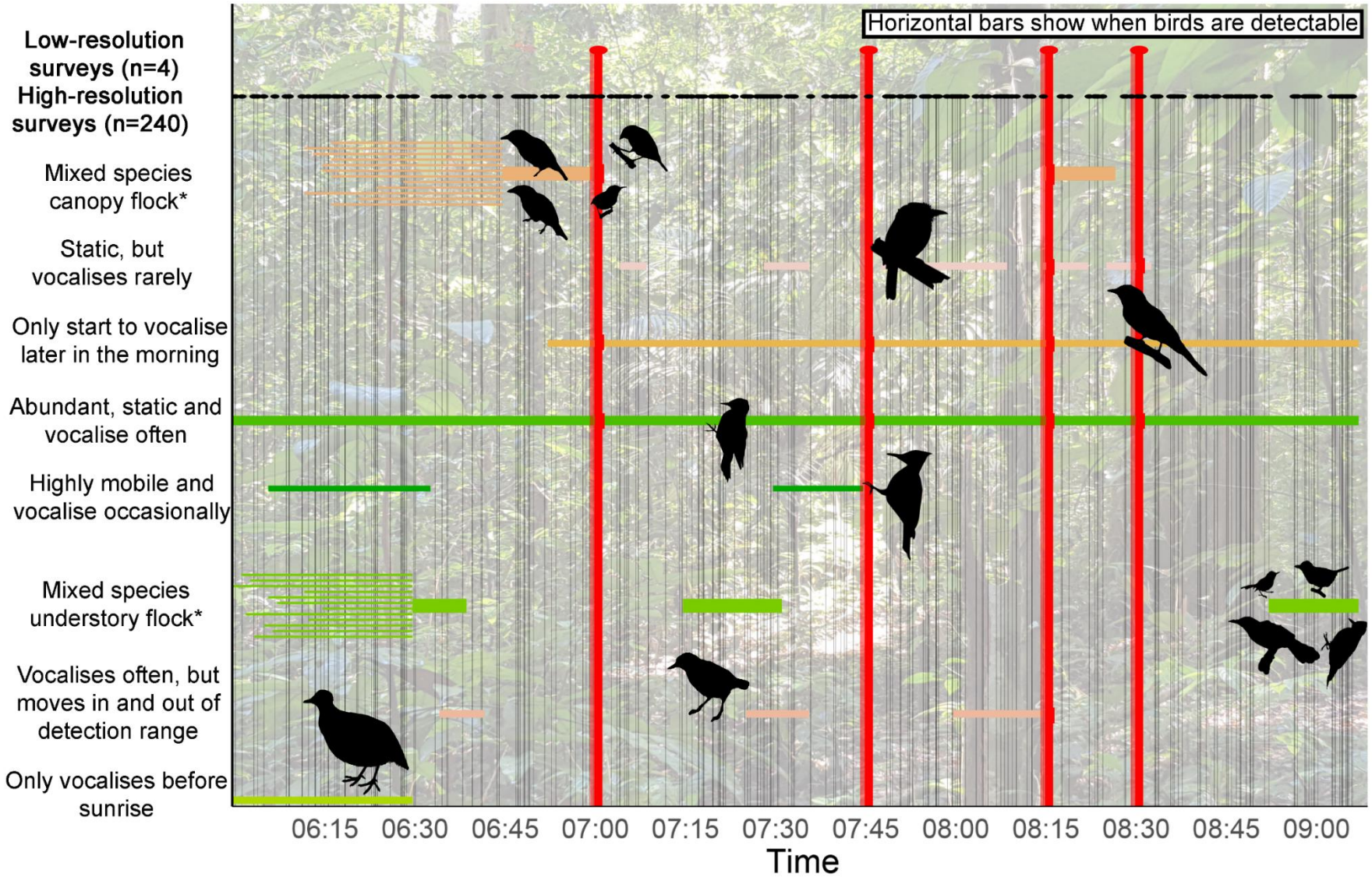
1.Manual analysis

"Autonomous sound recording outperforms human observation for sampling birds" Darras et al., (2019) Ecol.App.

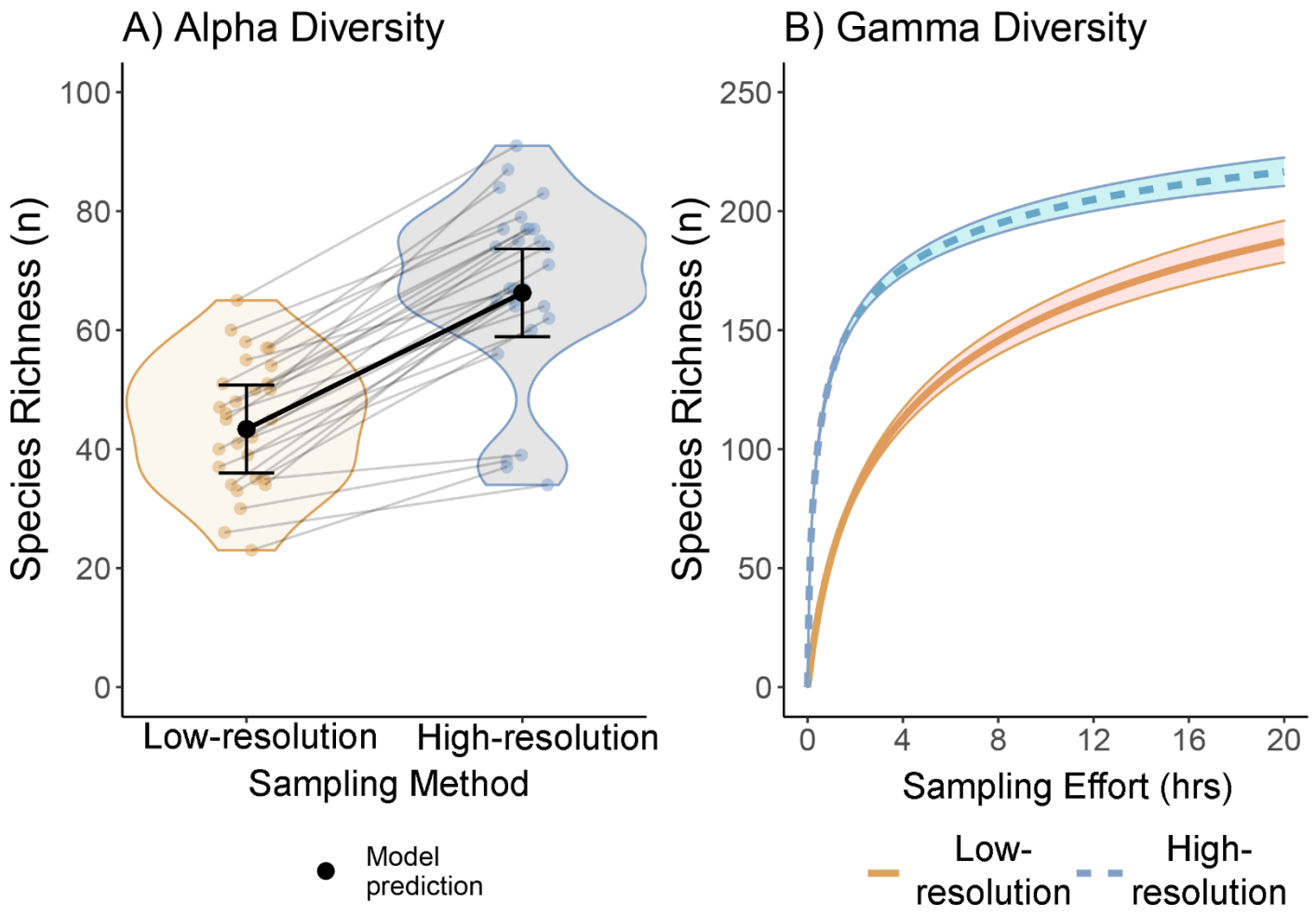


Case study:

High temporal-resolution surveys for bird diversity



Results:



Optimising tropical forest bird surveys using passive acoustic monitoring and repeated short-duration point counts
Oliver C. Metcalf, Jos Barlow, Stuart Marsden, Nárgila Gomes de Moura, Erika Berenguer, Joice Ferreira, Alexander C. Lees
bioRxiv; doi: https://doi.org/10.1101/2020.08.24.263301

Manual listening:

Case study:
Nocturnal scoter migration

- Citizen-science project
- Birdwatchers recorded scoter over there gardens between 31st March-3rd April
- Entered sighting in to online Google Sheet
- Mapped sightings by time and location

- Clear flight lines emerged

How to analyse sound data?

2.Automated classification

- Machine-learning or deep-learning models to detect and classify sound
- Widely used in bat analysis – but lower frequencies have more noise!
- Can accurately detect species presence in large amounts of data

Reality:

- Fully-automated models rarely used in ecological studies
- Tend to be for low numbers of species
- In order to avoid false detections, often miss many true positives
- Relies on large amounts of (manually) labelled training data

- Limited user-friendly options – Kaleidoscope Pro, Arbimon, Tadarida

-but none of these use the latest and best AI methods

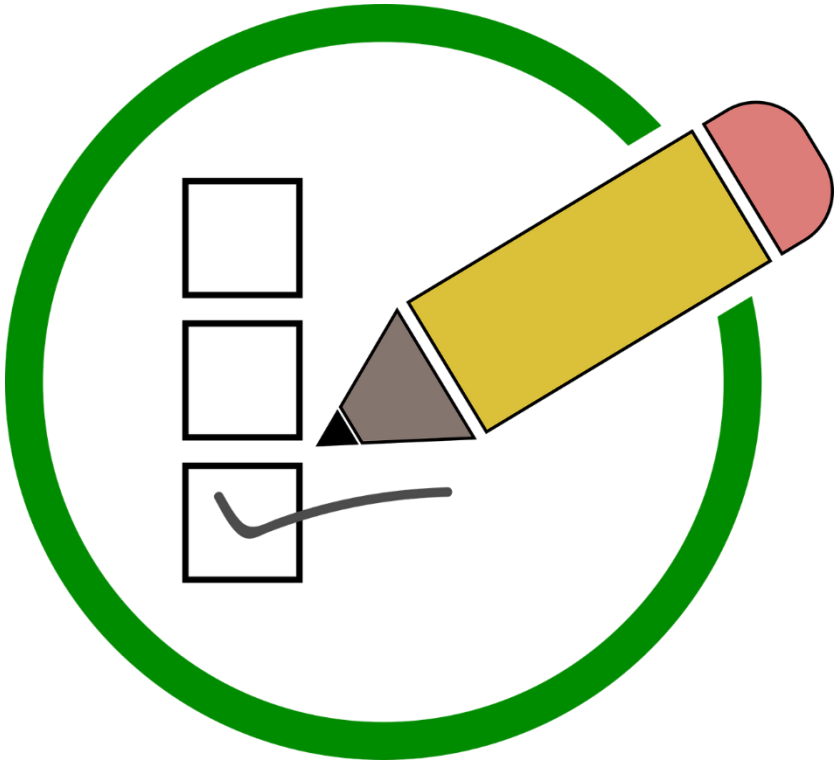
Species	Balanced Accuracy	False detection rate
Silky-tailed nightjar	91%	<1%
Amazonian pygmy-owl	92%	3.9%
Crested owl	91%	3.1%
S. Tawny-bellied screech owl	92%	<1%
White-winged potoo	84%	7.1%

In the meantime –
1A: **Semi-automated classification**

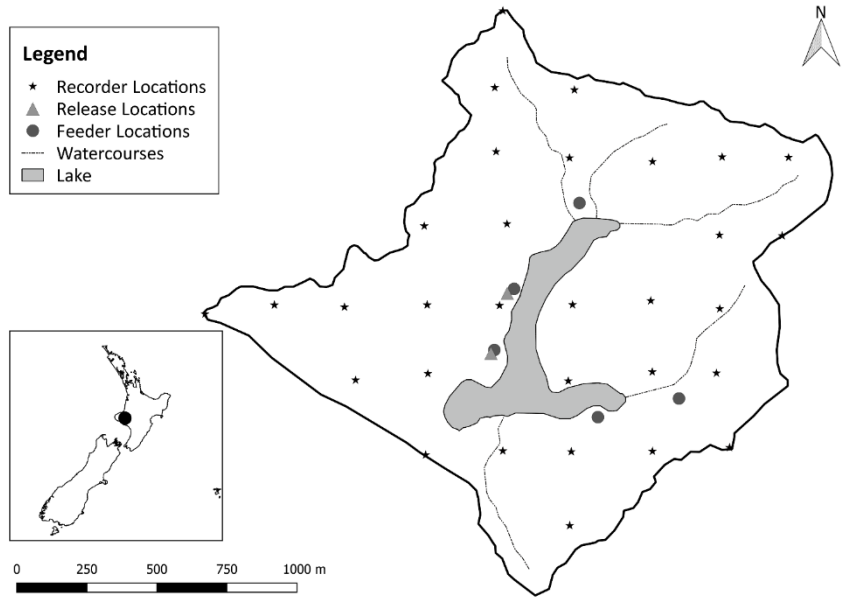
AI models detect vocalisations, human observers confirm presence

Uses

- Occupancy models
- Species distribution models
- Abundance (in special cases)
- Behavioural studies



Case study:
Reintroduction monitoring

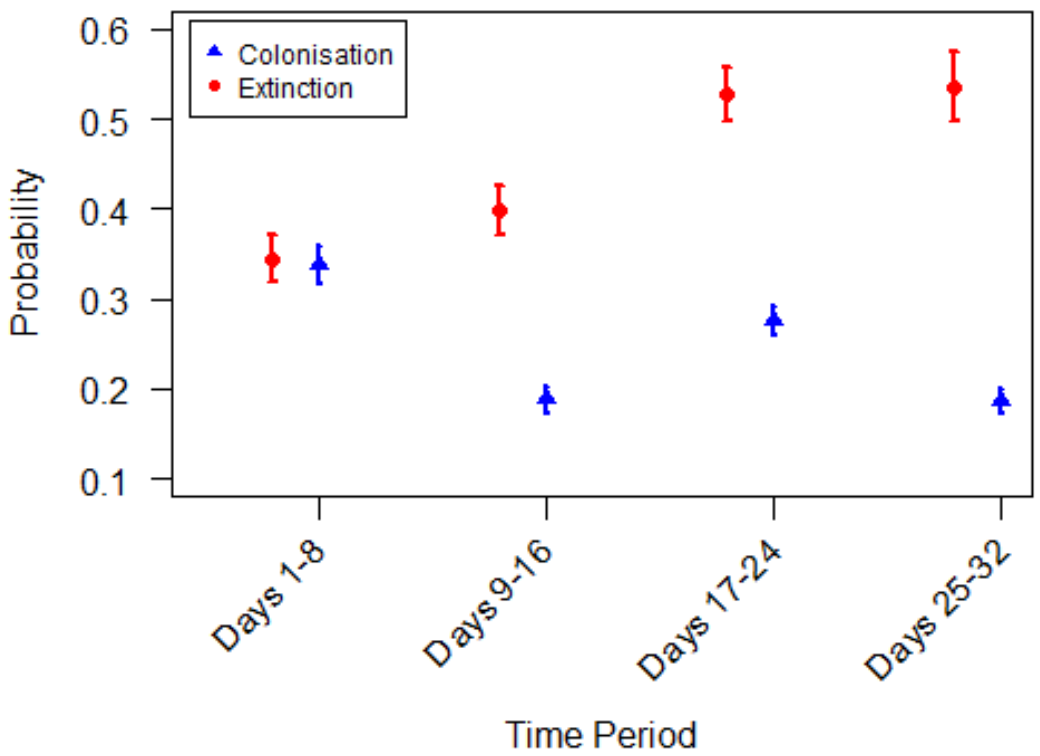


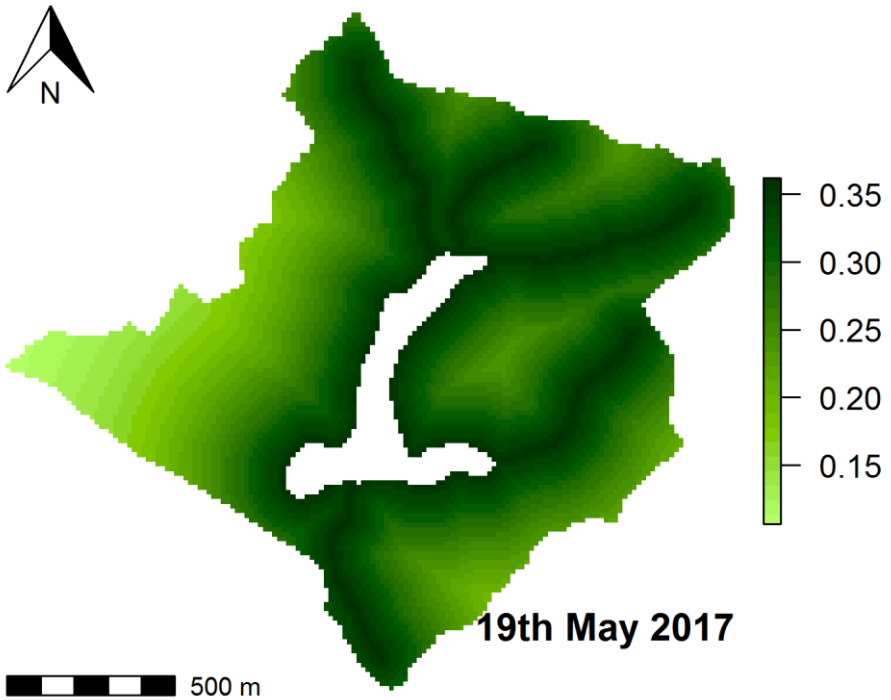
RESEARCH ARTICLE

Methods in Ecology and Evolution | BRITISH ECOLOGICAL SOCIETY

A novel method for using ecoacoustics to monitor post-translocation behaviour in an endangered passerine

Oliver C. Metcalf[1,2] | John G. Ewen[3] | Mhairi McCready[3,4] | Emma M. Williams[5,6] | J. Marcus Rowcliffe[3]

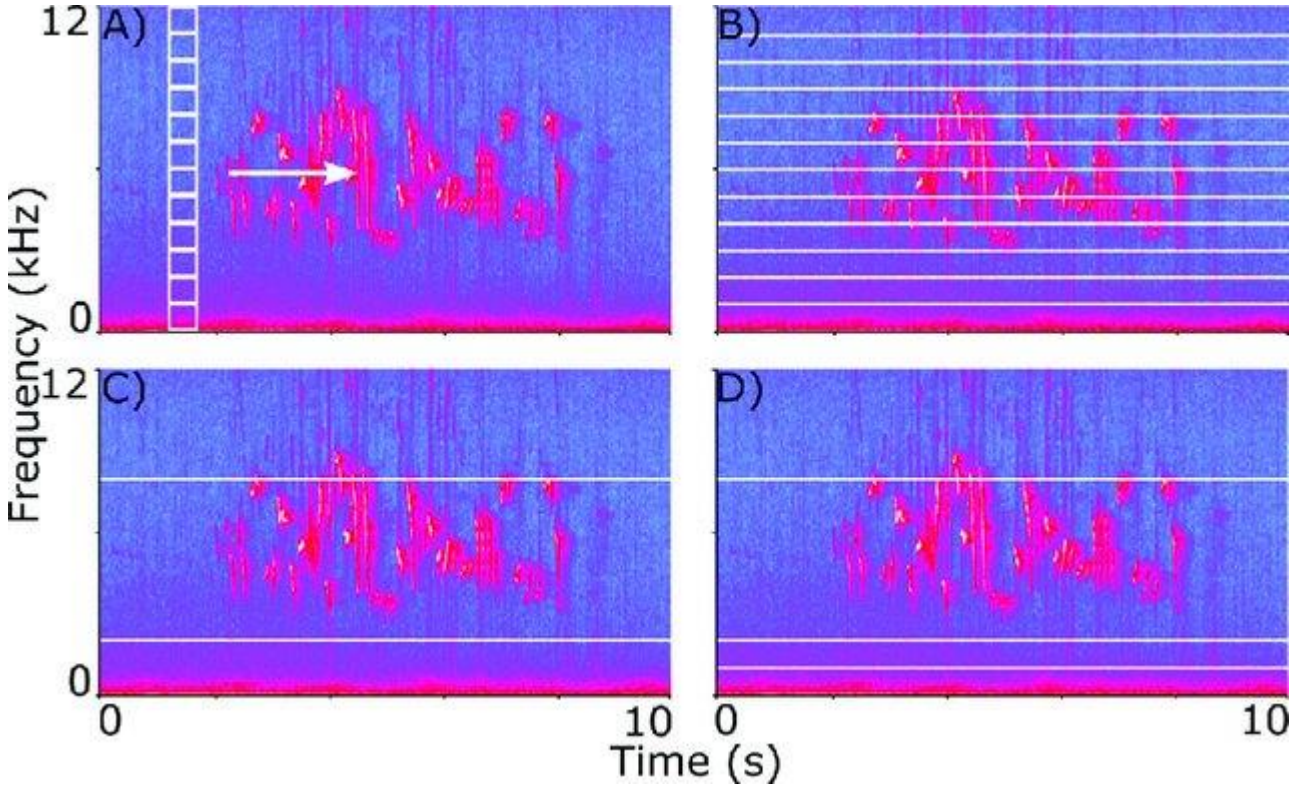




How to analyse sound data?

3: Acoustic Indices

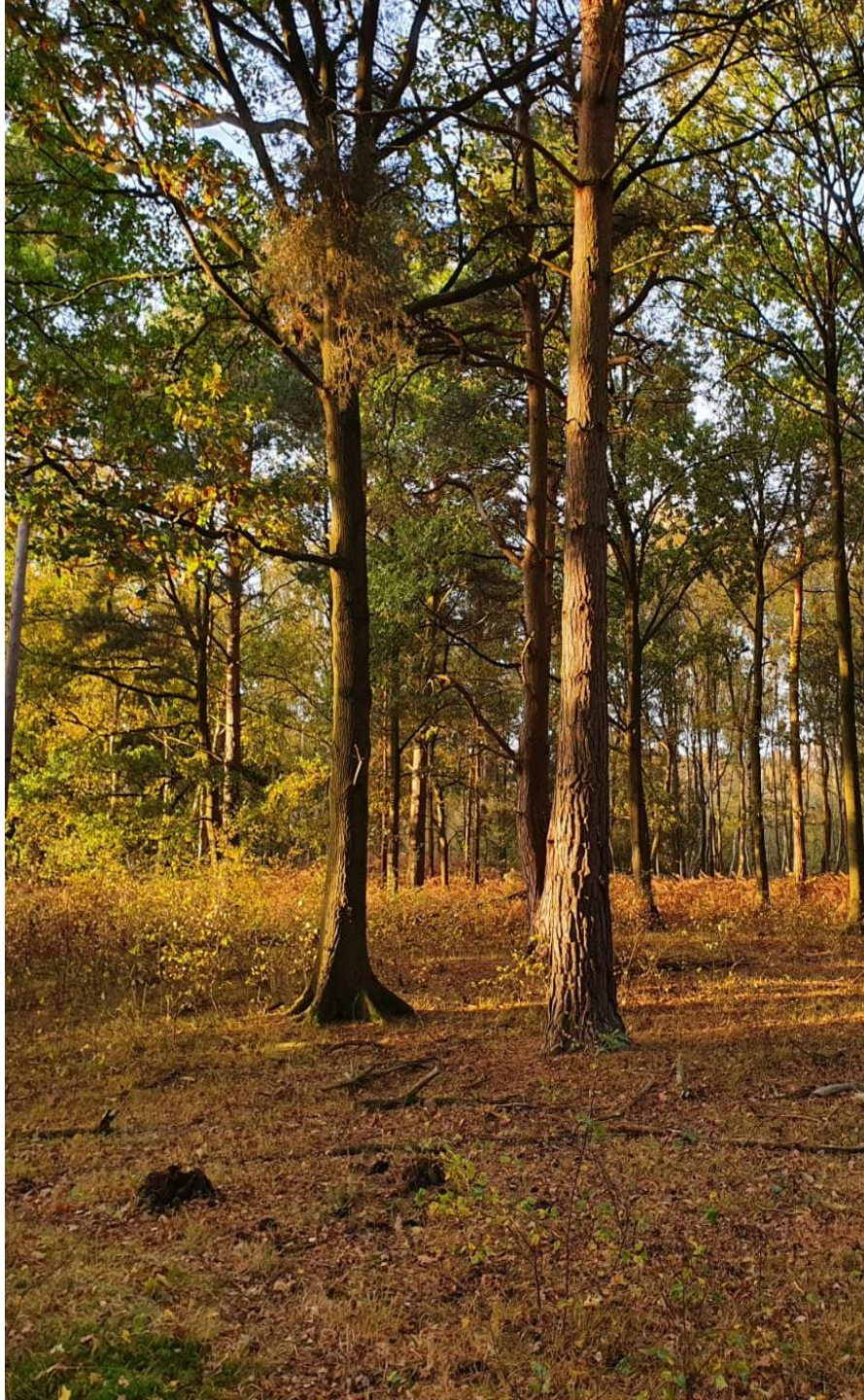
- Automated analysis – very quick!
- No information at species level.
- Statistical measures of power in a spectrogram
- Huge number of different indices available (Bradfer-Lawrence et al 2019, Methods. Ecol.Evol for good summary)
- Have been used in terrestrial and aquatic environments



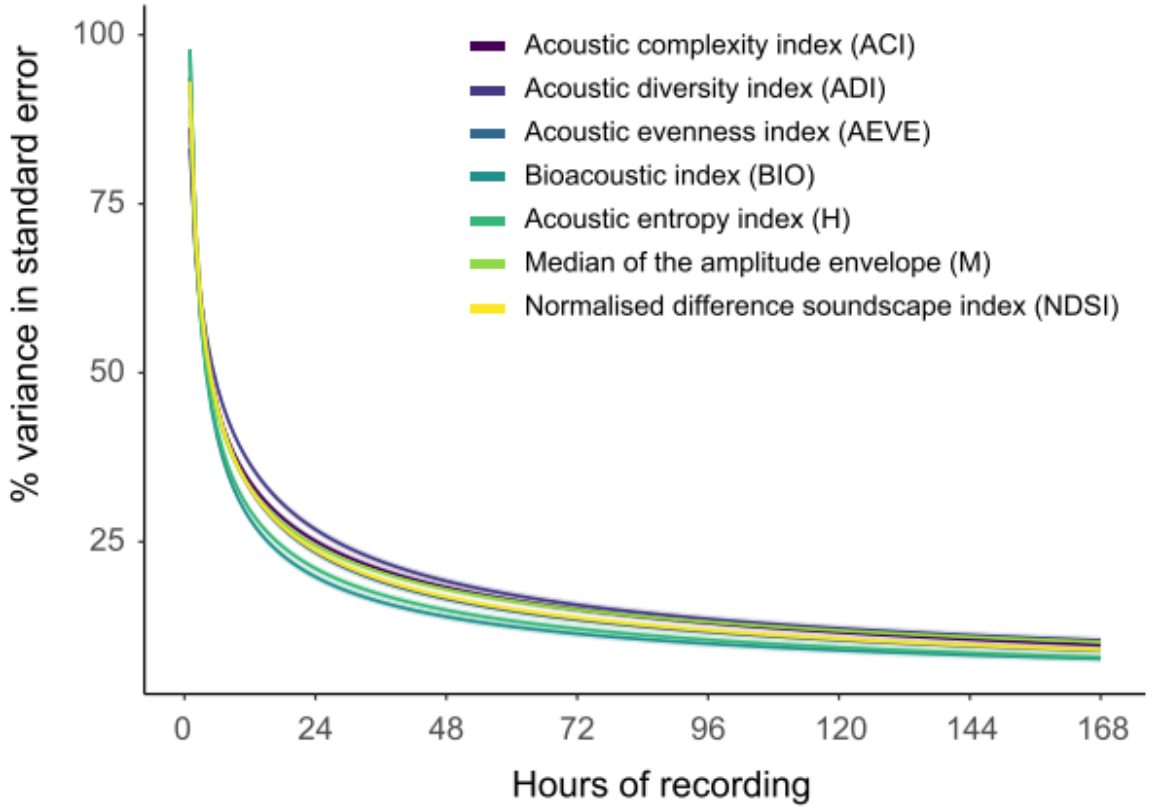
Fairbrass et al ., (2017) Ecol.Ind.

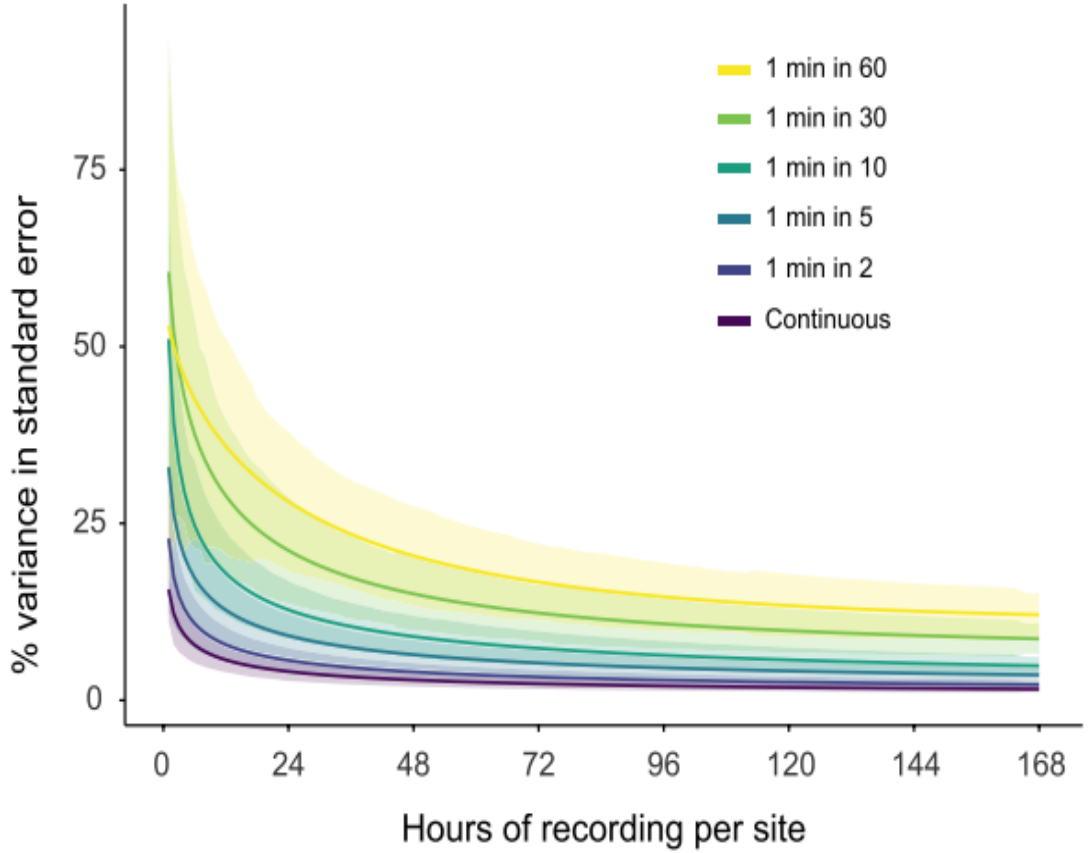
Uses of Acoustic Indices

- Correlating with species richness – many examples, including coral reefs and UK landscape
- Prediction of habitat types at macro and fine scale
    - Including predicting human perceptions of ‘wilderness’ in the UK (Carruthers-Jones et al., 2019. Sci.Tot.Env)
- Detection of temporal trends – e.g. ‘winter chorusing’ (Farina & Ceraulo, 2017. Wiley)
- Features in classification
- Data reduction and production of long-duration false colour spectrograms (Towsey et al., 2014. Ecol. Inf)



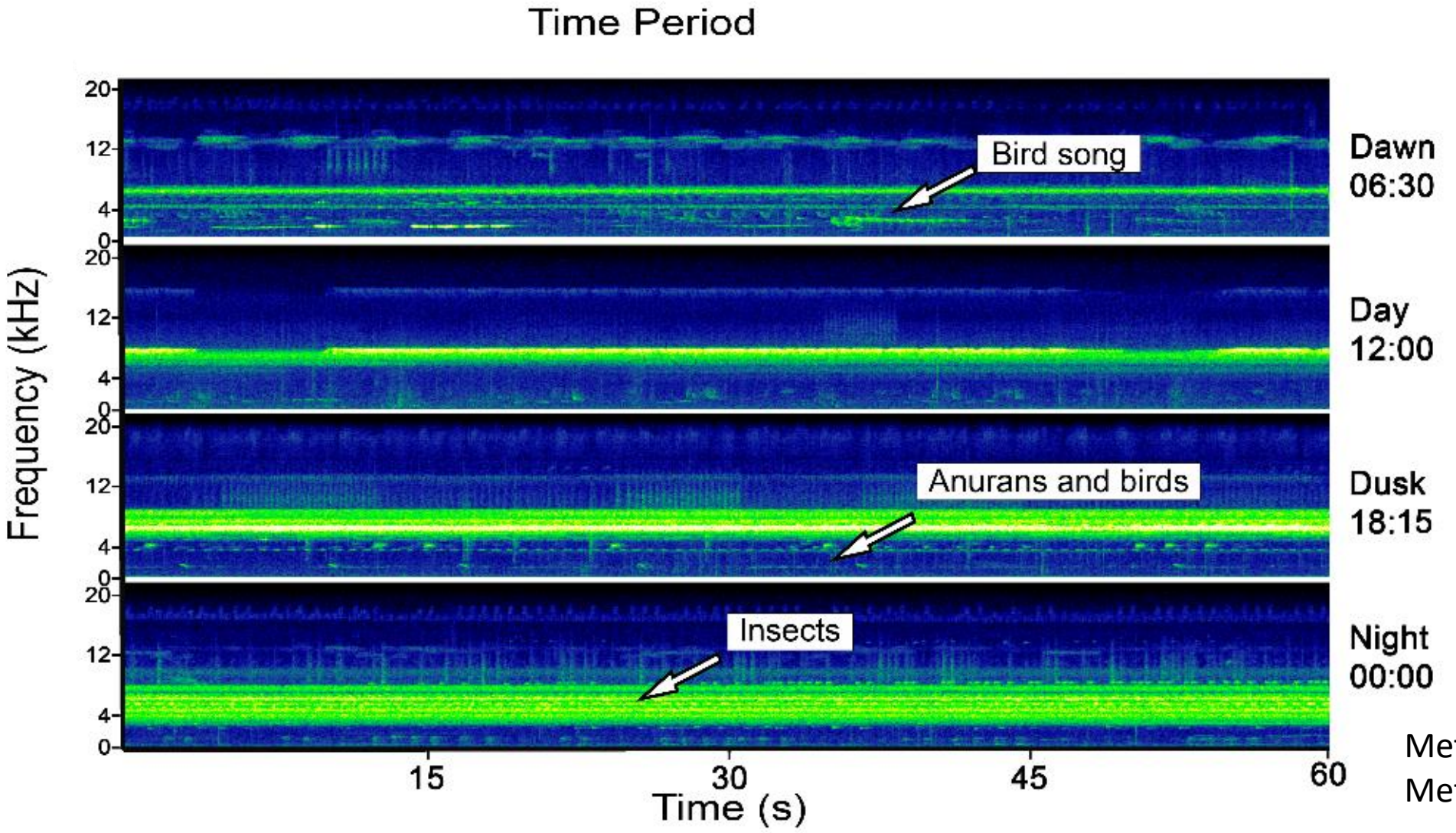
Appropriate study design: Use lots of data





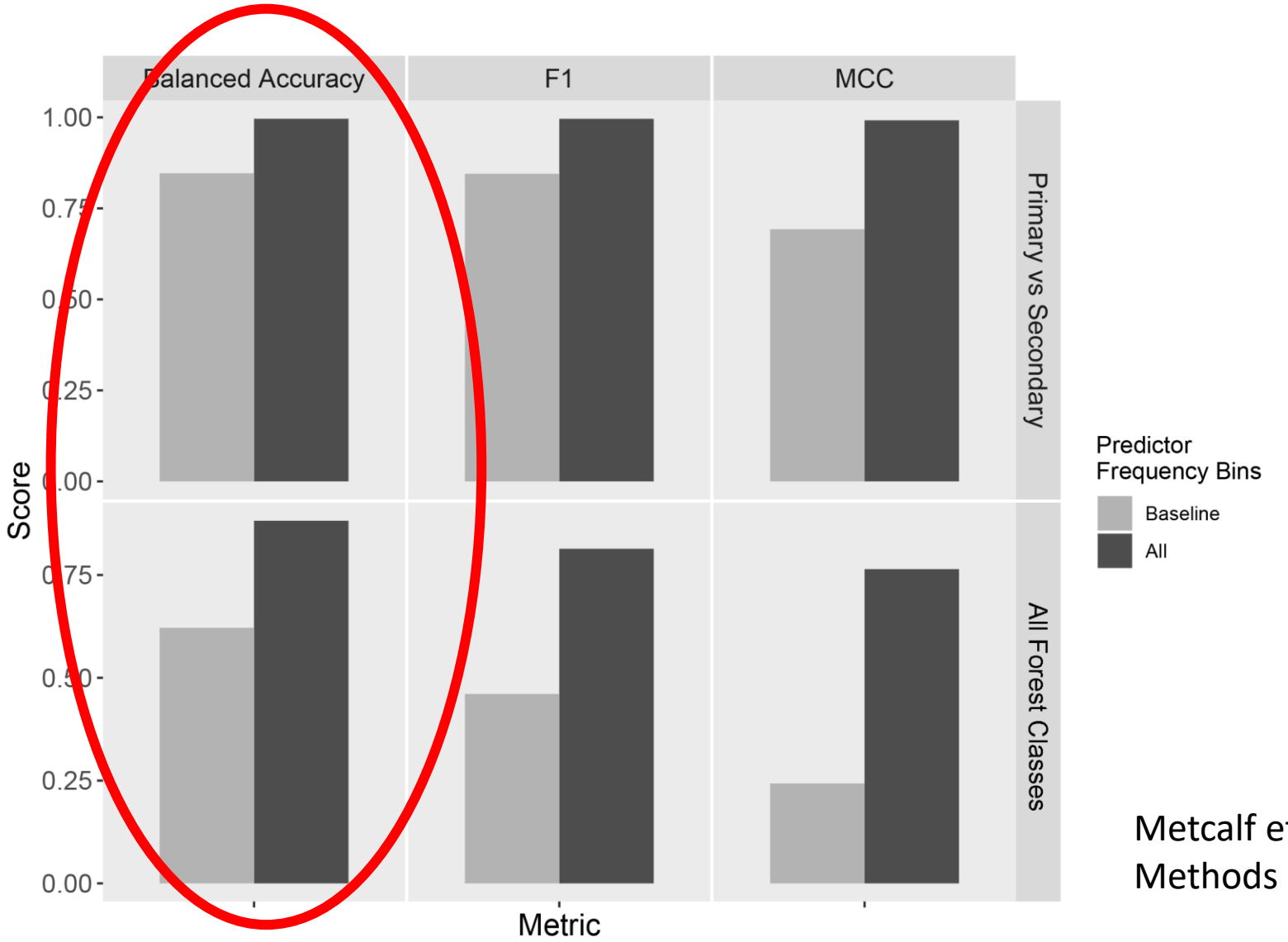
Bradfer-Lawrence et al., (2019) Methods in Ecol.Evol.

Appropriate study design: Apply at appropriate times and frequency bands



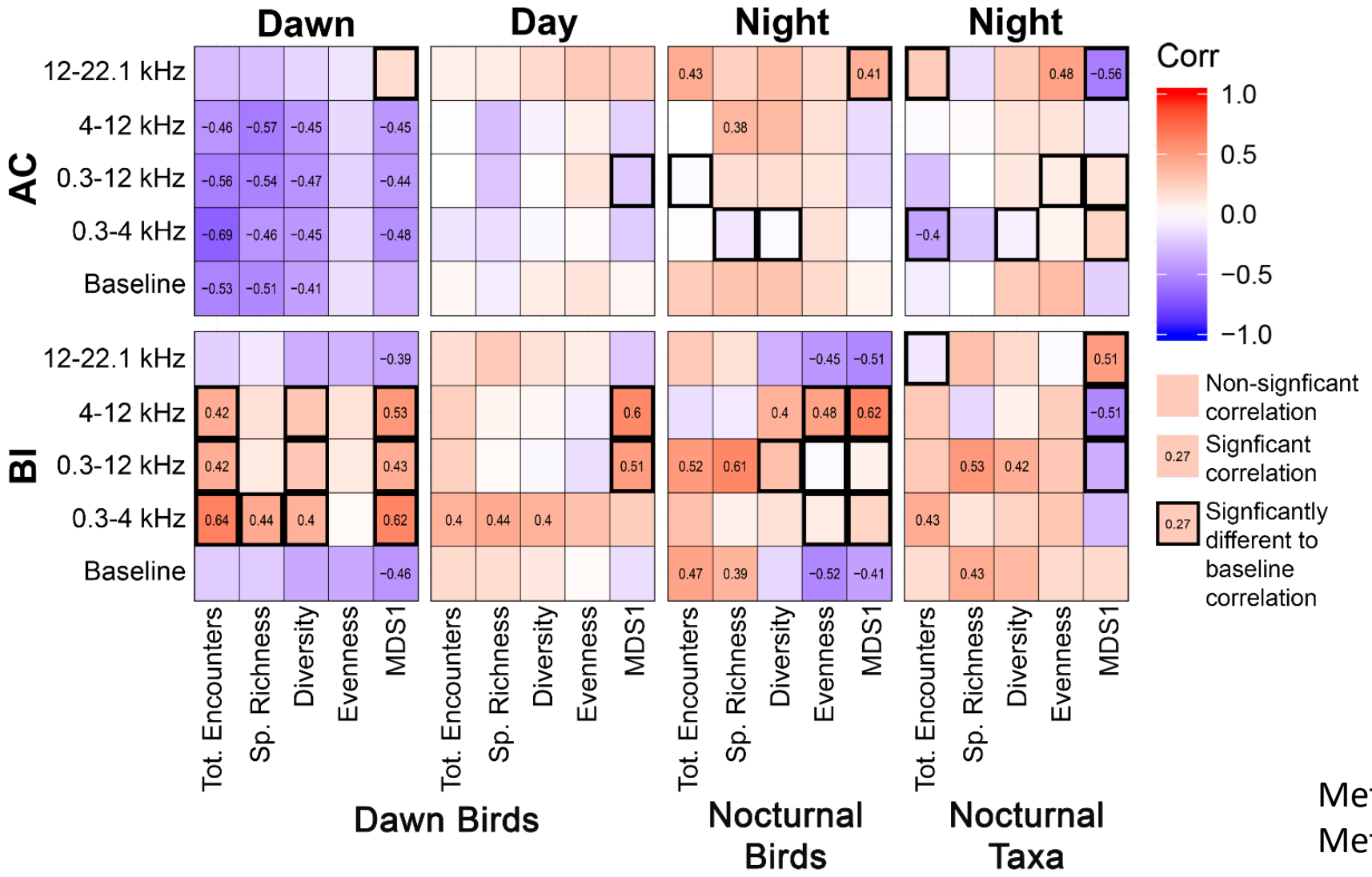
Metcalf et al., (2020)
Methods in Ecol.Evol

To improve sensitivity:



Metcalf et al., (2020) Methods in Ecol.Evol

And fidelity:



Metcalf et al., (2020) Methods in Ecol.Evol

Sunart Fields: a case study

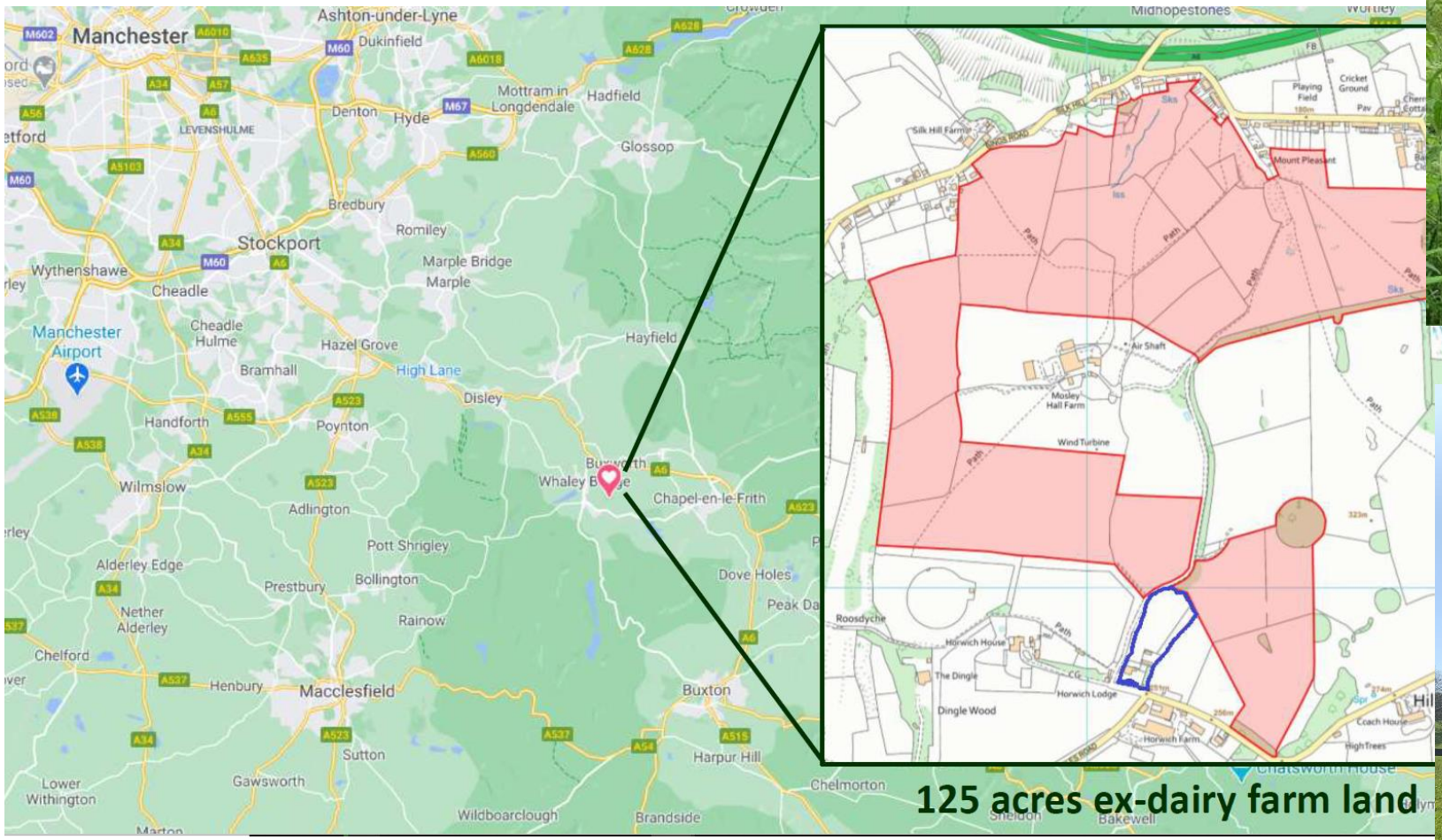
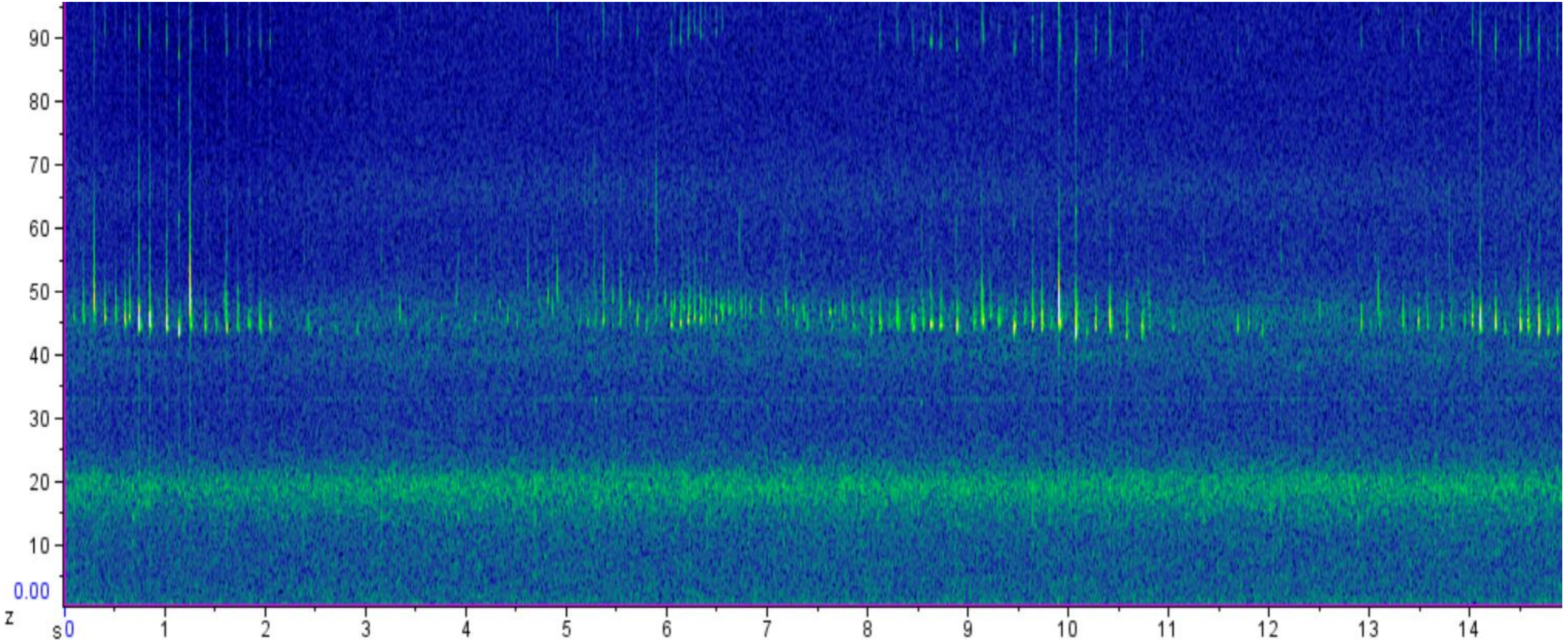
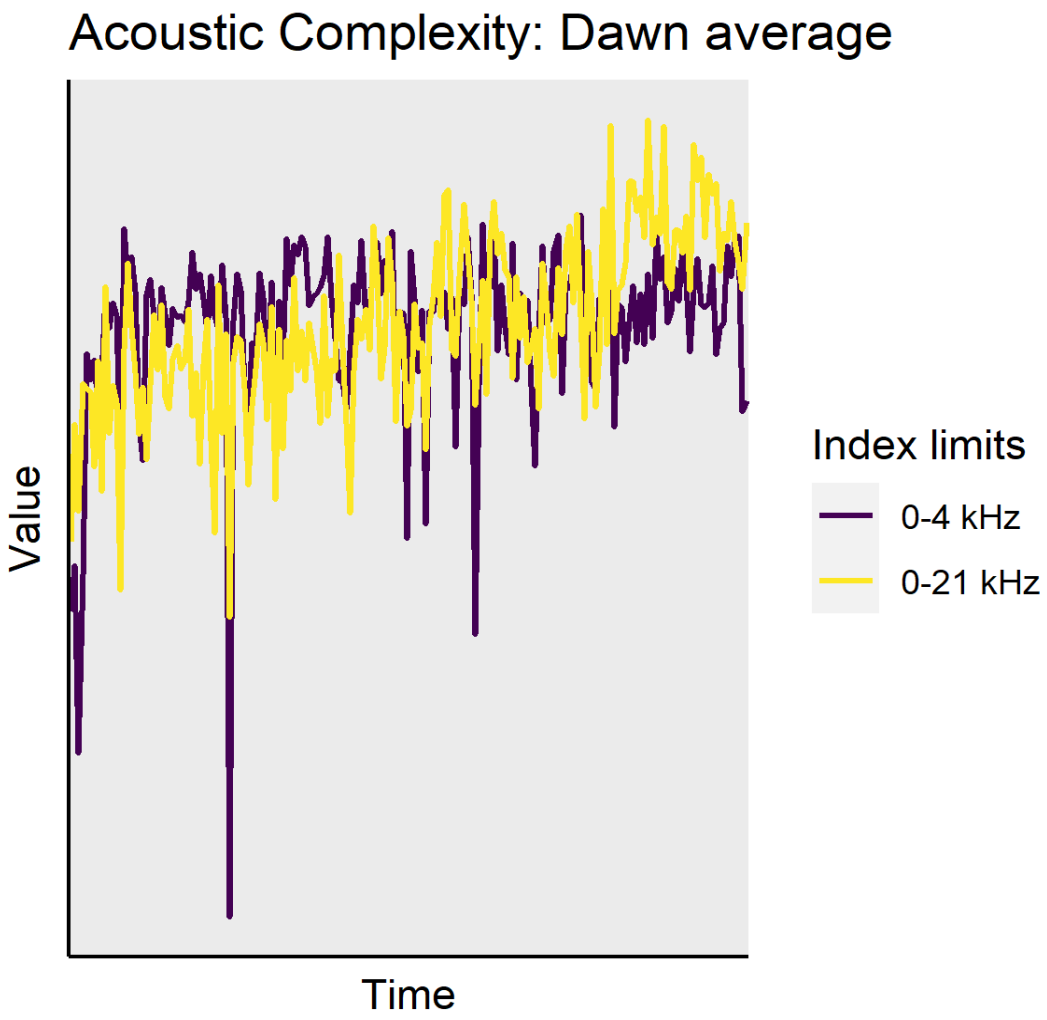


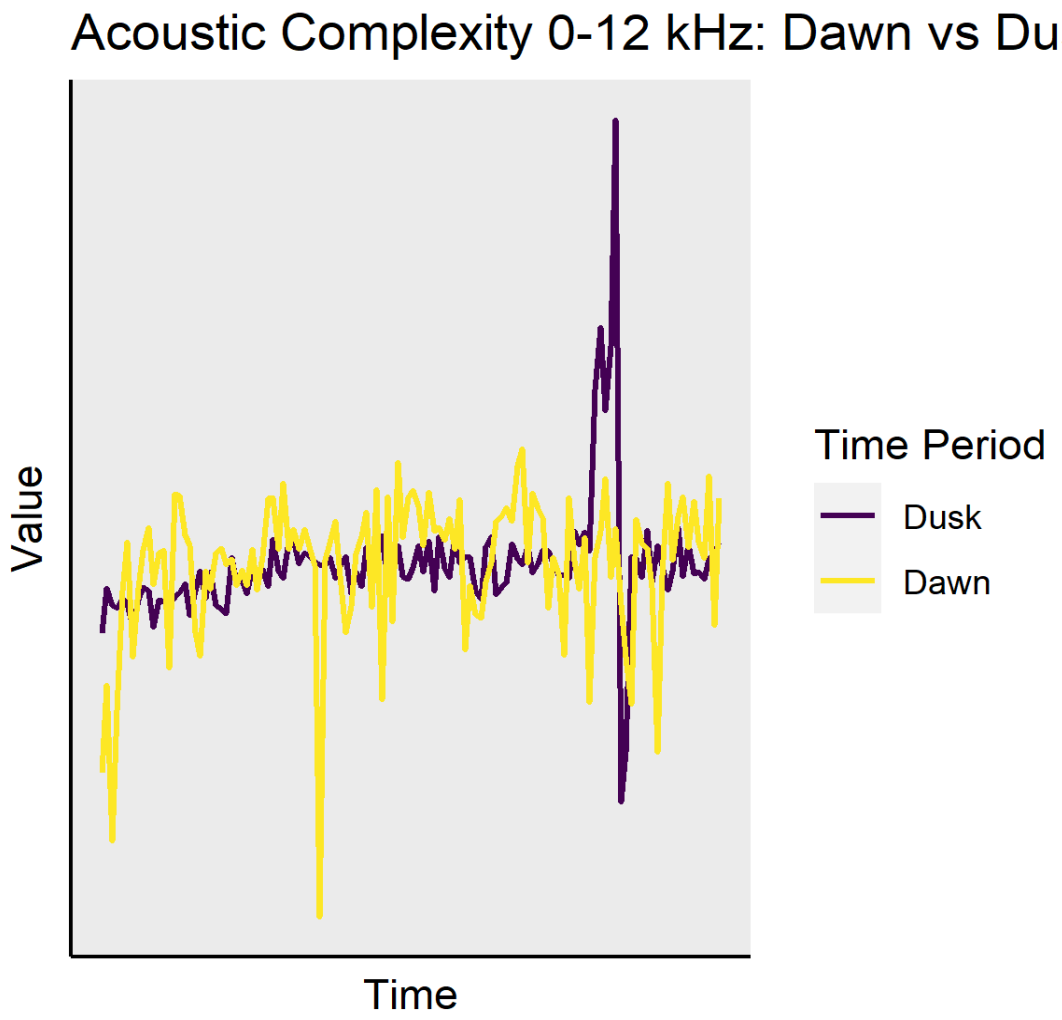
Photo credits: Rachel Evatt

Acoustic Indices – some quick examples from Sunart Fields:



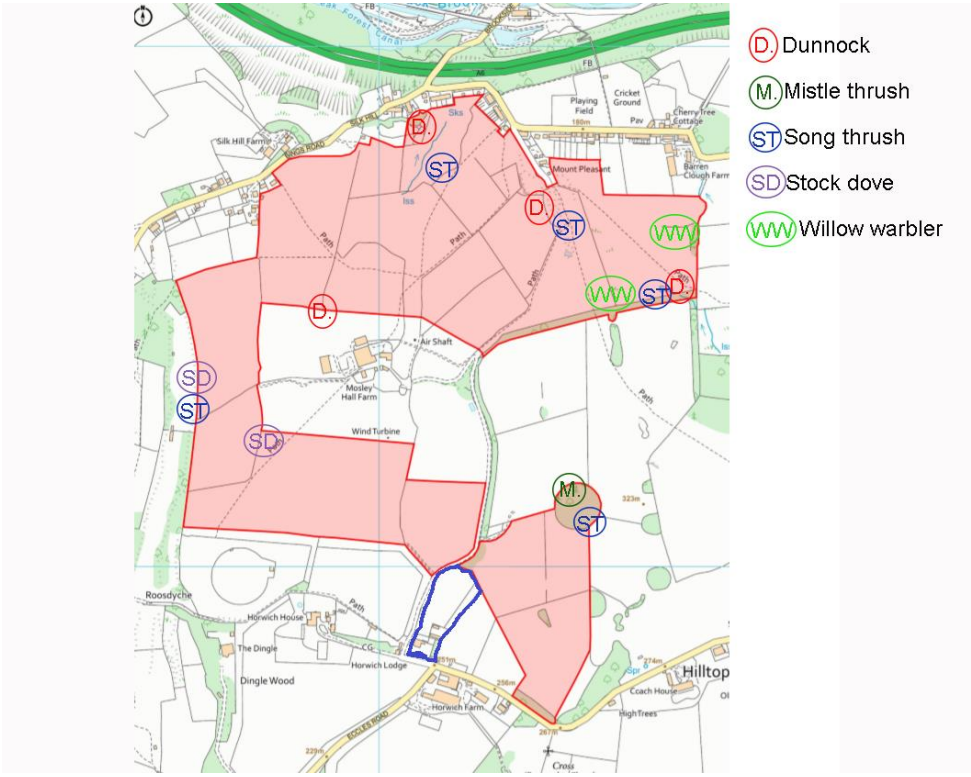
A single index….





Traditional and acoustic surveys:

- BBS surveys and territory mapping
- Vegetation surveys
- Manually checked PAM point-counts
- Local bat group using PAM data for bats
- Acoustic Indices
- Use BTO classification tools?



Oliver Metcalf

PhD Candidate, Manchester Metropolitan University

@ecoacou_ollie o.metcalf@mmu.ac.uk

Supervisors:

Alexander Lees, Jos Barlow and Stuart Marsden

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