Calling for conservation:
Bioacoustic monitoring uncovers the breeding phenology of a critically endangered upland rainforest frog *(Taudactylus pleione)*.

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QUEENSLAND PARKS AND WILDLIFE SERVICE

Acknowledgement of Country

I would like to acknowledge the Gurang and Gooreng Gooreng people as the Traditional Custodians of the Country on which my research took place, the Turrbal/Jagera peoples where my thesis was written, and the Bundjalung people upon whose Country we meet today.
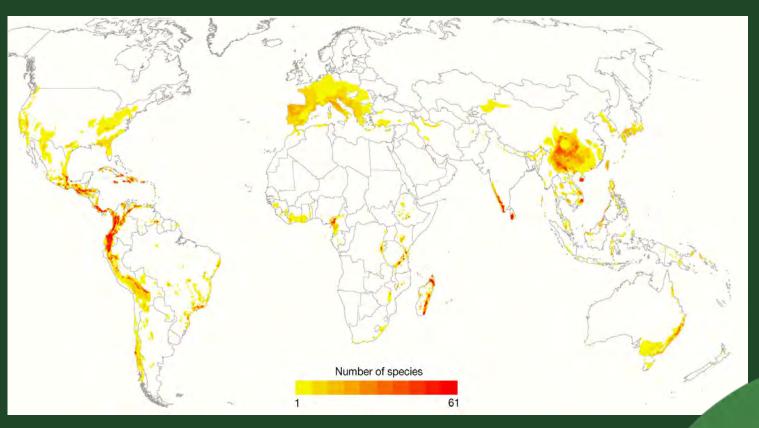
I recognise their continued connection to the land and waters and thank them for caring for its ecosystems for thousands of generations. I pay my respect to the Elders, past and present, and extend that respect to any First Nations people gathered here today.

Artwork: Rachel Williams *'Footprints Across Our Land'*

Introduction

Amphibian extinction crisis

- Amphibians are the most endangered vertebrate class globally[1]

- Disproportionate declines in undisturbed upland rainforests of the Americas and Australia[2, 3]

- Patterns attributed to amphibian chytrid fungus *(Bd)*, shared life-history traits and impacts of climate change
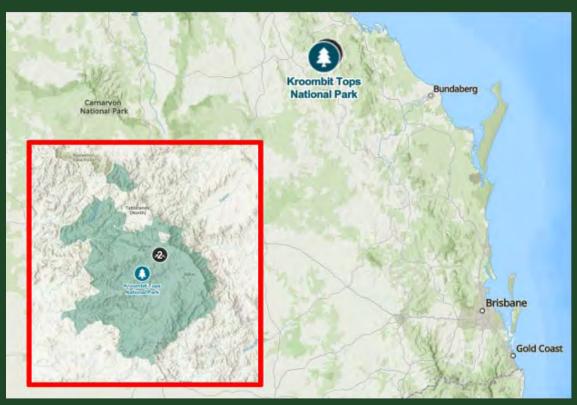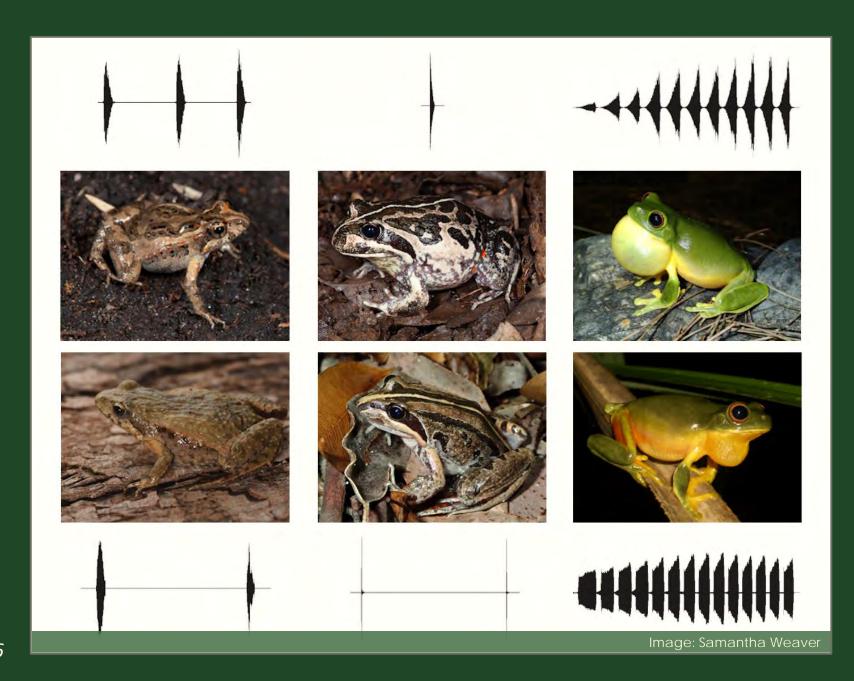

(Luedtke J. A., et al. 2023)

1. Luedtke J. A., et al. (2023) Ongoing declines for the world's amphibians in the face of emerging threats. Nature 622, 308-14.
2. Hero J.-M., et al. (2005) Ecological traits of declining amphibians in upland areas of eastern Australia. Journal of Zoology 267, 221-32.
3. Scheele B. C., et al. (2019) Amphibian fungal panzootic causes catastrophic and ongoing loss of biodiversity. Science 363, 1459-63.

Species on the brink: *Taudactylus pleione*

Image: Harry Hines

- All six species in genus *Taudactylus* are highly threatened (two presumed extinct) by *Bd* and climate change[4]

- *Taudactylus pleione* most recently described member[5]

- Critically endangered under *NCA 1992* and *EPBC Act 1999*
  - Extremely restricted and fragmented distribution, < 70 ha total
  - Low number of animals left in the wild

- Occurs only along headwater streams and seepages of Kroombit Tops NP

- Small and cryptic frog thar shelters under leaf litter and rocks

4. Gillepsie et al. 2020 Gillespie G. R., et al. (2020) Status and priority conservation actions for Australian frog species. Biological Conservation 247, 108543 .
5. Czechura G. (1986b) Kroombit Tops Torrent Frog Taudactylus pleione, with a key to the species of Taudactylus. Queensland Naturalist 27, 68-71.

Calling for conservation: *Taudactylus pleione*

Image: Samantha Weaver

Male advertisement calls

- Circadian and circannual rhythms
- Environmental cues

Convey fitness

- Female partners
- Male competitors

Ecological information

- Breeding activity
- Population status

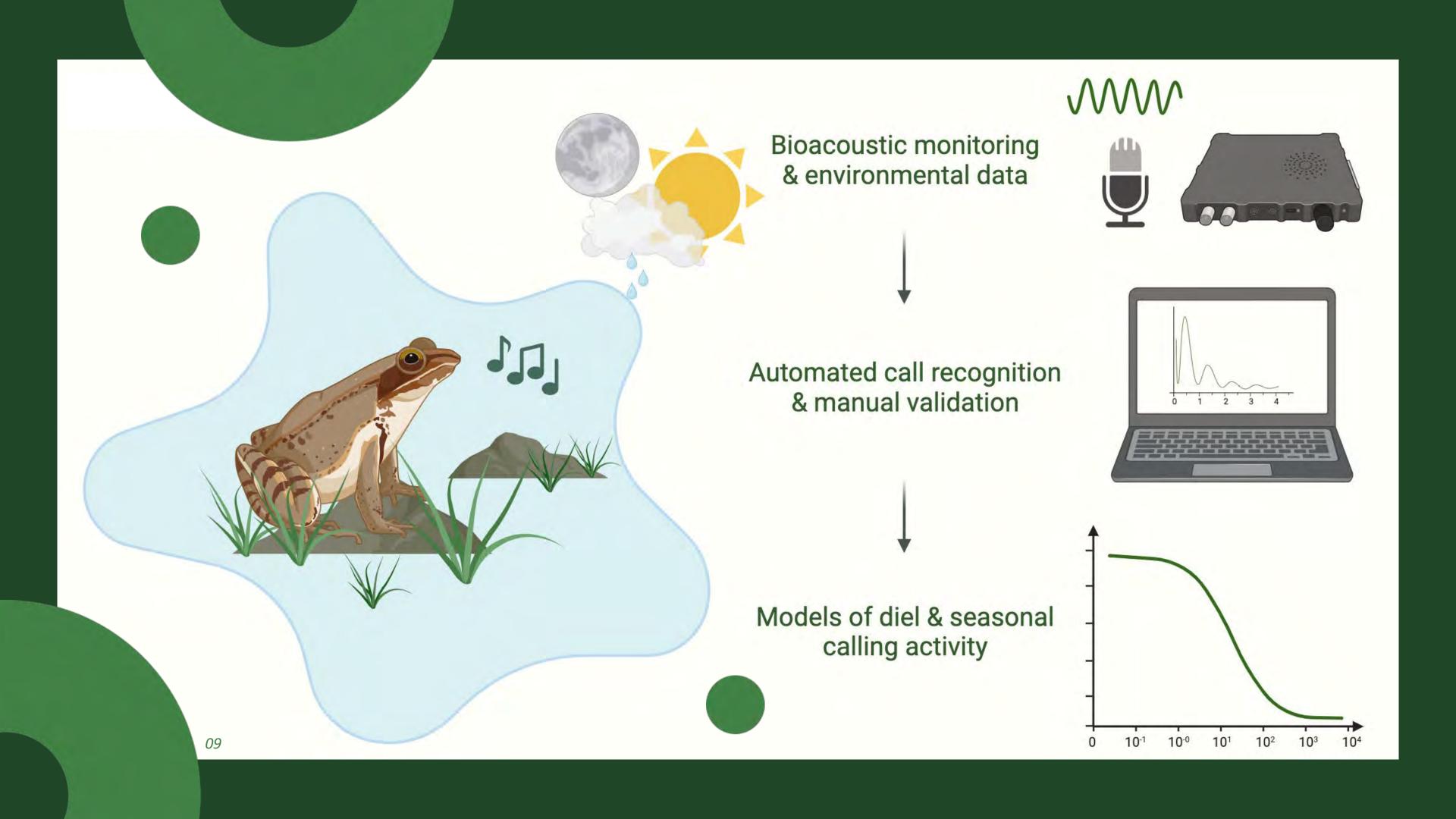**Species management**

- Visual and aural surveys
- Bioacoustics

Aims and research questions

My research aimed to improve our understanding of the breeding phenology and detectability of a critically endangered upland rainforest frog, *Taudactylus pleione*, to contribute to their conservation.

My research questions:

1. Can an automated call recogniser be applied with a high-level of confidence?
2. What are the diel and seasonal patterns of calling activity?
3. How do abiotic environmental factors, such as temperature, humidity and rainfall, influence these patterns?
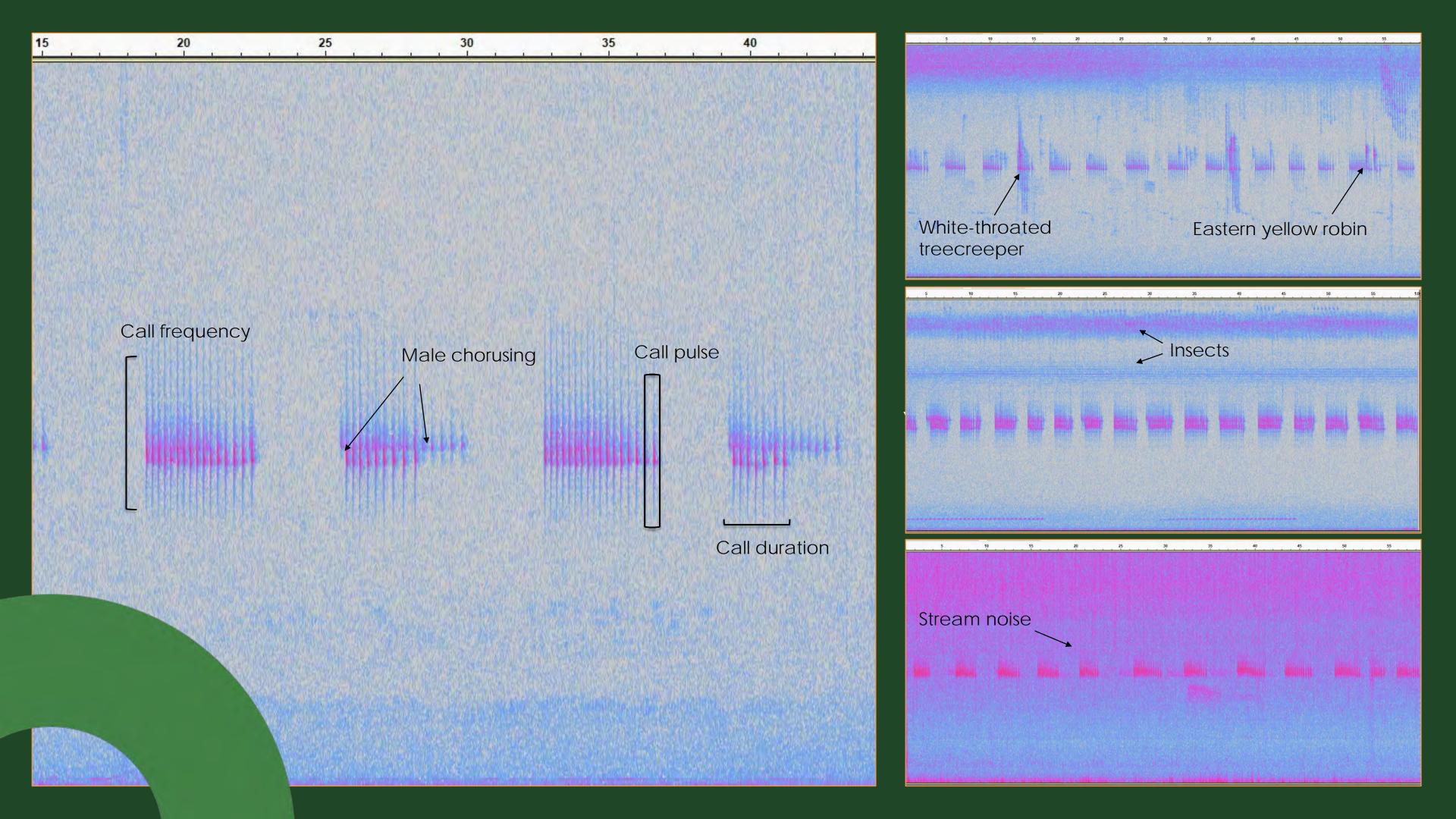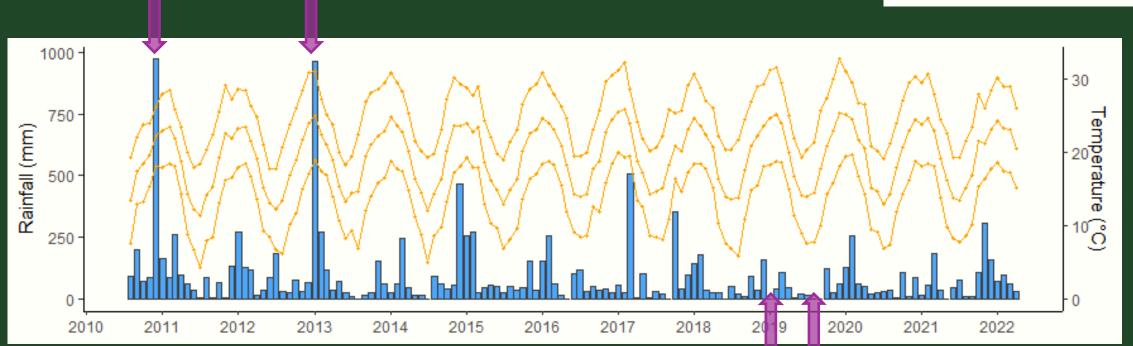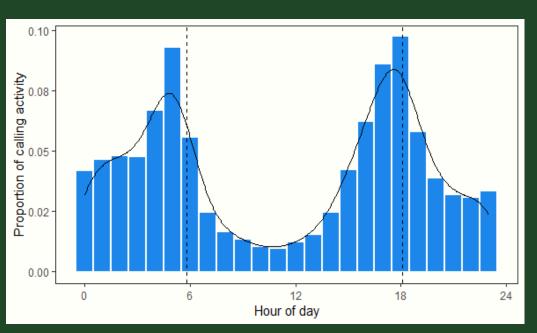
Methods

Bioacoustic monitoring & environmental data

Automated call recognition & manual validation

Models of diel & seasonal calling activity

Fieldwork

Results
&
Discussion

Recogniser performance

Detection threshold increased post-processing from 1 to 21 matches per one-minute recording

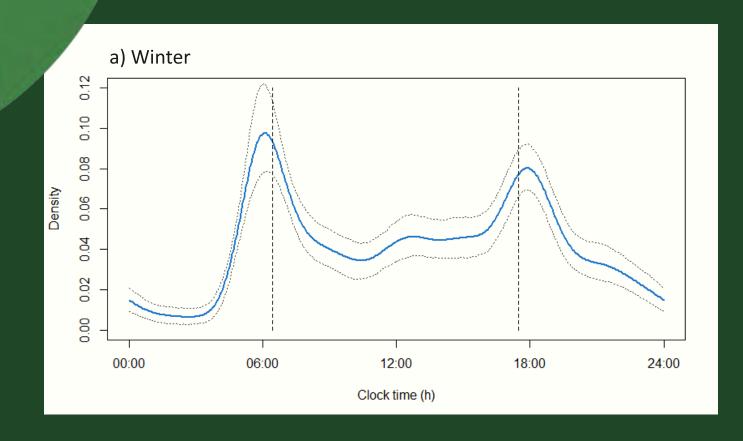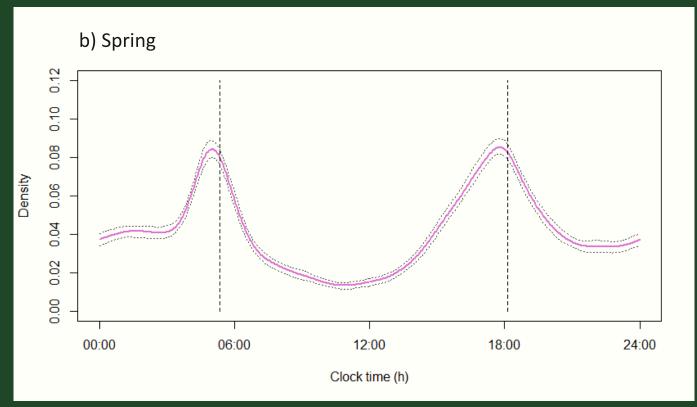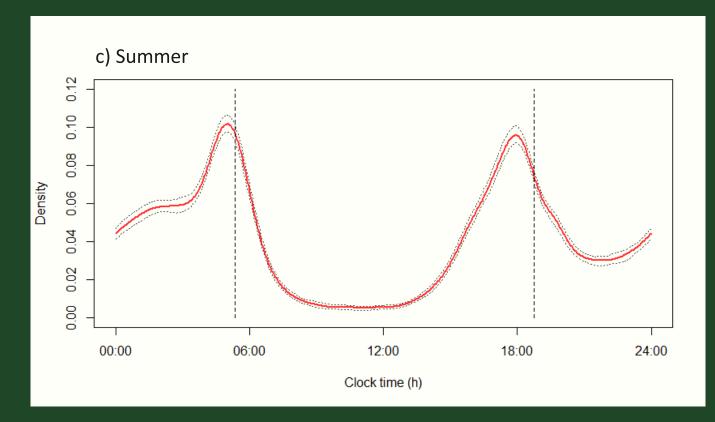|	Performance metric	Value (0–1)
Threshold 1 (≥ 1 matches/per min)	Accuracy (TP + TN) / (TP +TN + FP + FN)	0.85
	Precision (TP / TP + FP)	0.55
	Recall (TP / TP + FN)	0.60
Threshold 2 (≥ 21 matches/per min)	Accuracy (TP + TN) / (TP +TN + FP + FN)	0.89
	Precision (TP / TP + FP)	0.84
	Recall (TP / TP + FN)	0.43

General calling patterns

Diel calling activity

a) Winter

b) Spring

c) Summer

d) Autumn
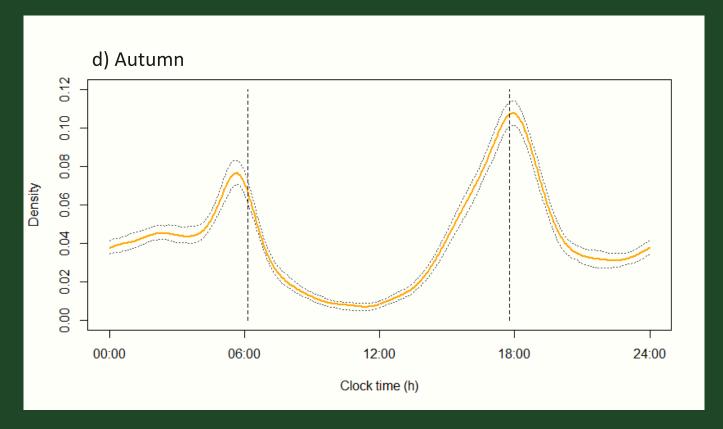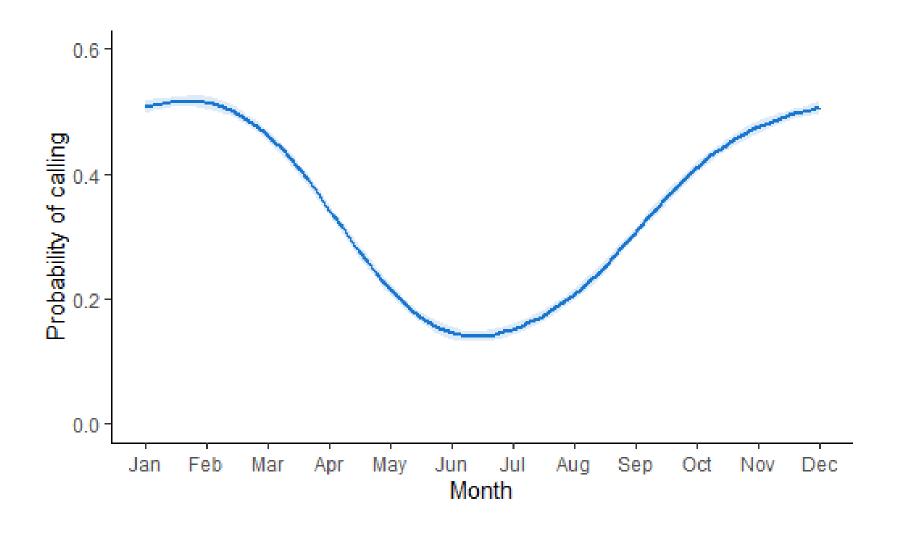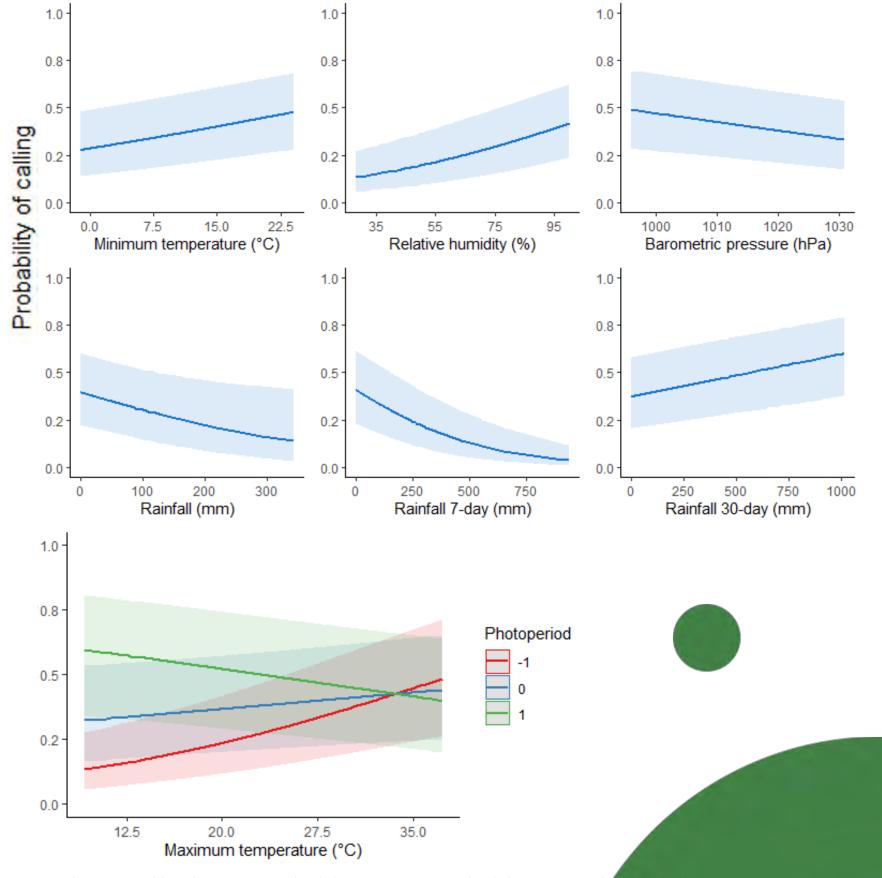
Seasonal calling activity

MaxT	MinT	Hum	BarP	Rain	Rain7	Rain30	Moon	Photo	MaxT×P	AICc	ΔAICc	w
✓	✓	✓	✓	✓	✓	✓	X	✓	✓	16,582.7	0.00	0.60

Fixed effects	Estimate	SE
Intercept	-0.86	0.42
Maximum temperature	0.08	0.04
Minimum temperature	0.17	0.04
Relative humidity	0.20	0.02
Barometric pressure	-0.10	0.03
Rainfall	-0.05	0.02
Rainfall 7-day	-0.16	0.03
Rainfall 30-day	0.11	0.02
Photoperiod	0.37	0.18
Max temperature × photoperiod	-0.21	0.04
Random effects	σ^2	
Site	0.65	
Frog season	0.16	
AR(1)	0.24	
Marginal / Conditional R^2	0.16 / 0.33	

Probability of calling

Minimum temperature (°C)

Relative humidity (%)

Barometric pressure (hPa)

Rainfall (mm)

Rainfall 7-day (mm)

Rainfall 30-day (mm)

Photoperiod
-1
0
1

Maximum temperature (°C)

* Photoperiod levels are -1 standard deviation, +1 standard deviation and 0 equals the mean

Key findings
&
Future research

Summary

01

Can the call recogniser be applied with confidence?

The recogniser had high accuracy and precision, but a low recall rate may have influenced results

02

What are the diel and seasonal patterns of calling activity?

Calling was most likely in the summer from late-November to early-March at dawn and dusk

03

How do environmental factors influence these patterns?

Calling was associated with cloudy, warm and humid conditions and high monthly rainfall

Image: Mik Vella

Implications and future research

- Baseline data on calling, and thus detectability and breeding activity

- Optimal timing and conditions for active search surveys

- Bioacoustics better targeted to reduce costs and improve efficiency

- Sensitivity to accelerating climate change – shift timing of calling and result in reduced breeding opportunities

Image: Harry Hines

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