Photo: René Steinmann

Footfalls and Vocalization from Wildlife

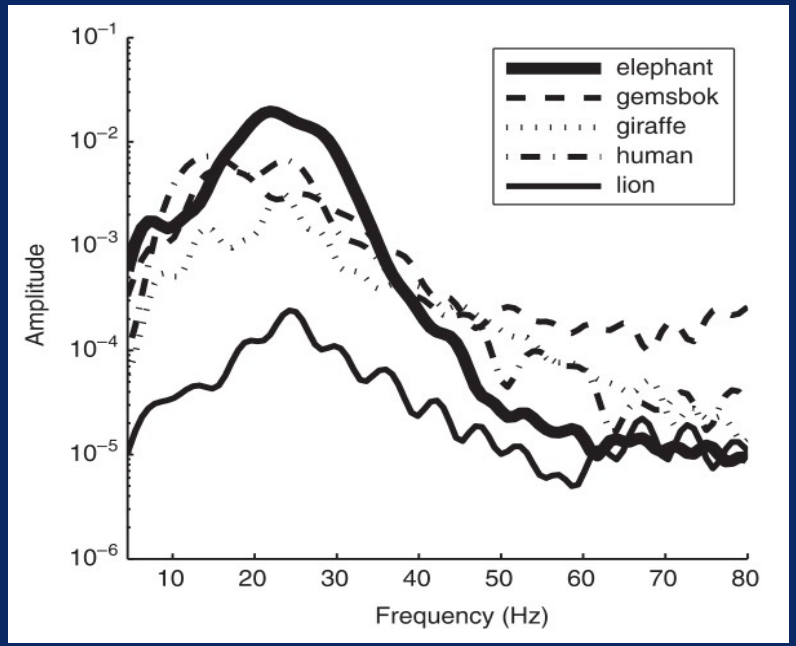
René Steinmann

GFZ Discovery Fellow

AI4Seismology, Leipzig, 7 May 2025

Seismic signals from Wildlife

Footfalls and Vocalization



Wood et al., 2005, first (published) report of footfall signals

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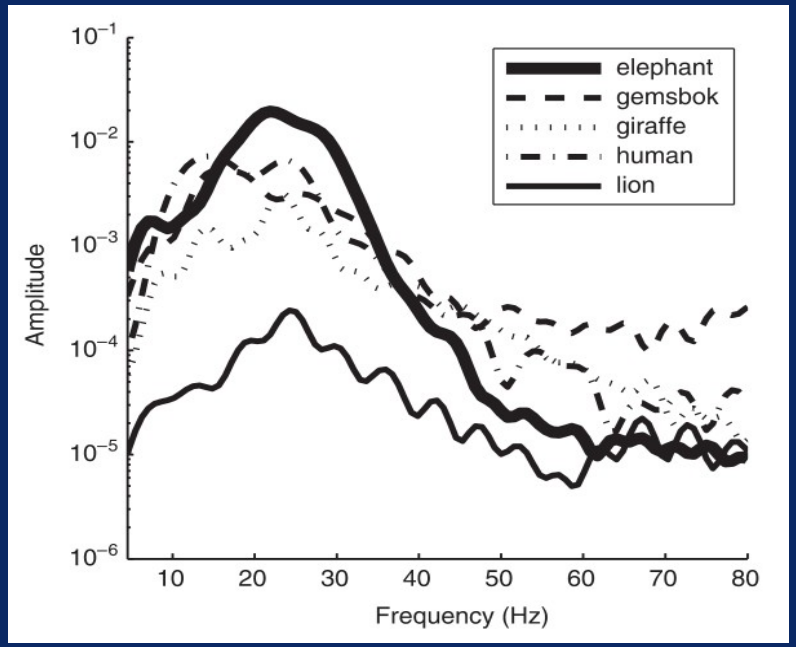

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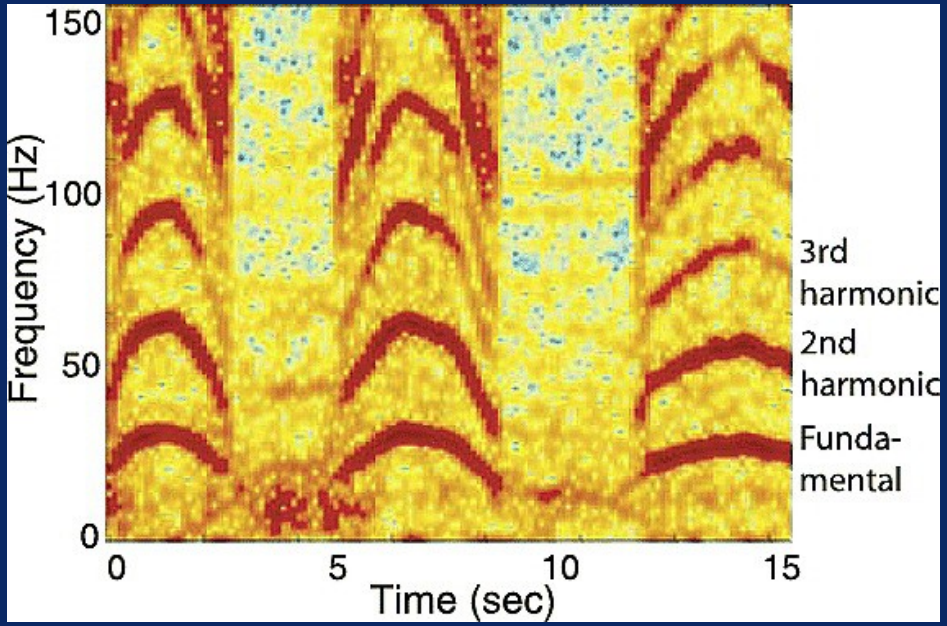


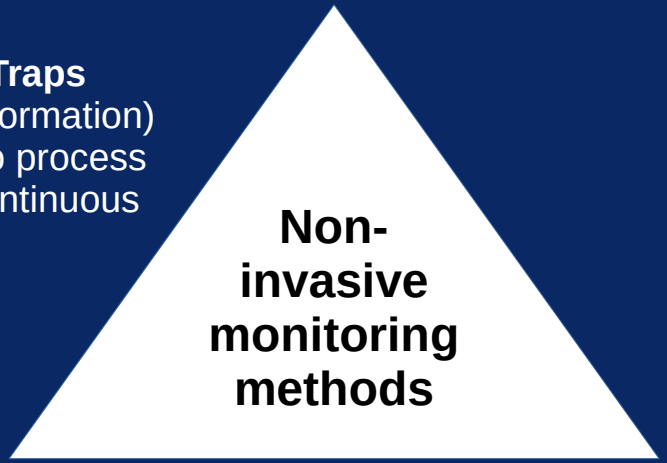
Günther et al., 2004, GRL

What are these signals useful for?

Monitoring wildlife seismically

Monitoring wildlife seismically

Camera Traps
(visual information)
- easy to process
- non-continuous



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Monitoring wildlife seismically

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Non-invasive monitoring methods

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(auditorial information)
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Seismic Monitoring at Mpala Research Centre, Kenya

Savanna Biome with high diversity of large land mammals

Photo: René Steinmann

Photo: Mpala.org

Photo: René Steinmann

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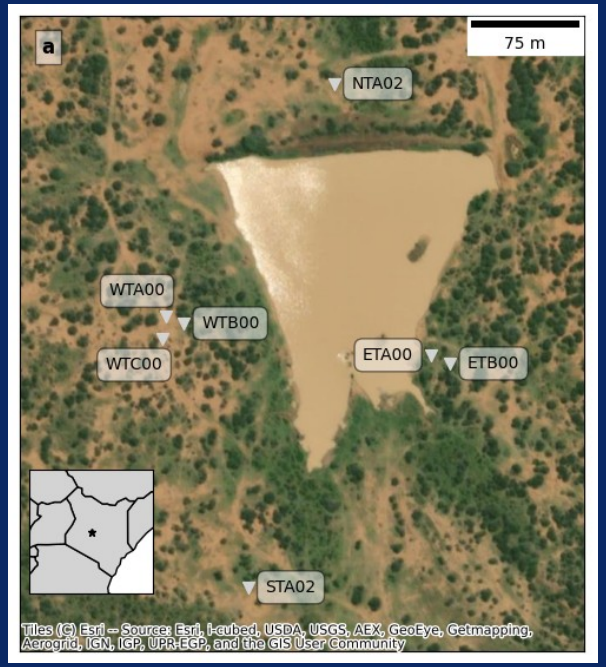
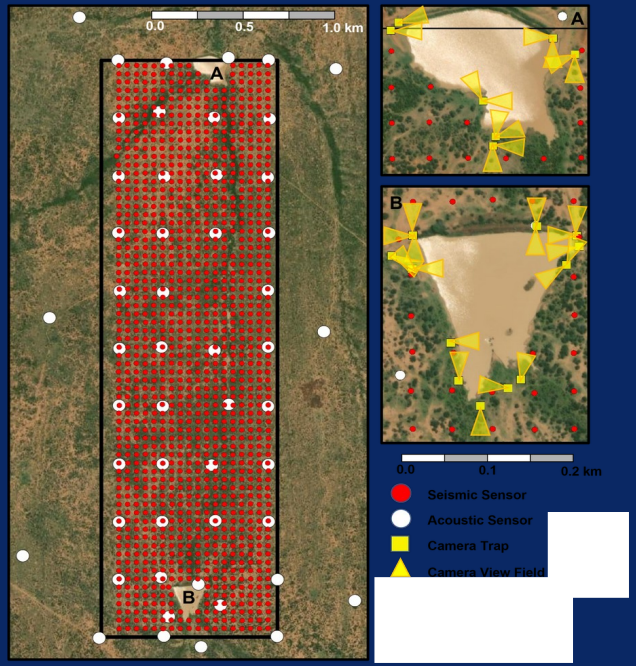
Working at and with Mpala for many years now

2019: first small-scale deployment



2023: large-scale deployment



2025: video and observation

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René Steinmann

Frederik Tilmann

Fabrice Cotton

University of Exeter

Tarje Nissen-Meyer

MPALA

Samuel Kiuna

Esther Ngondo

Eunitah Makokha

James Koech

Gabriel Meitiaki

UNIVERSITY OF OXFORD ANIMAL VIBRATION LAB

Beth Mortimer

Alice Morrell

Tom Mulder

Lara Boudinot

Amy Lovewell

Ellen Morley

Fritz Vollrath

Thomas Miller

Daniel Hending

Taylor Bi

Ayse Gorbon

Alex McDermott-Roberts

Michael Reinwald

Graham Taylor

James Walker

UNIVERSITY OF OXFORD DEPARTMENT OF COMPUTER SCIENCE

Andrew Markham

Atılım Baydin

Yiyuan Yang

OXFORD EARTHSCIENCES

Paula Koelemeijer

Ben Moseley

William Rees

Alexandre Szenicer

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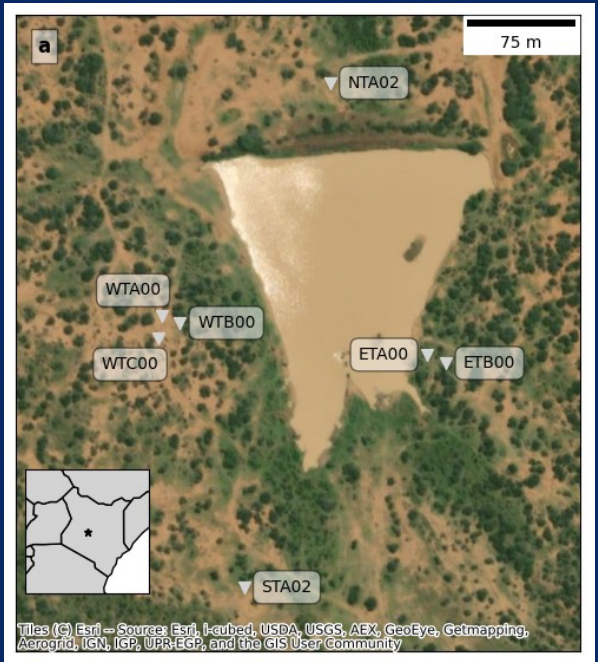
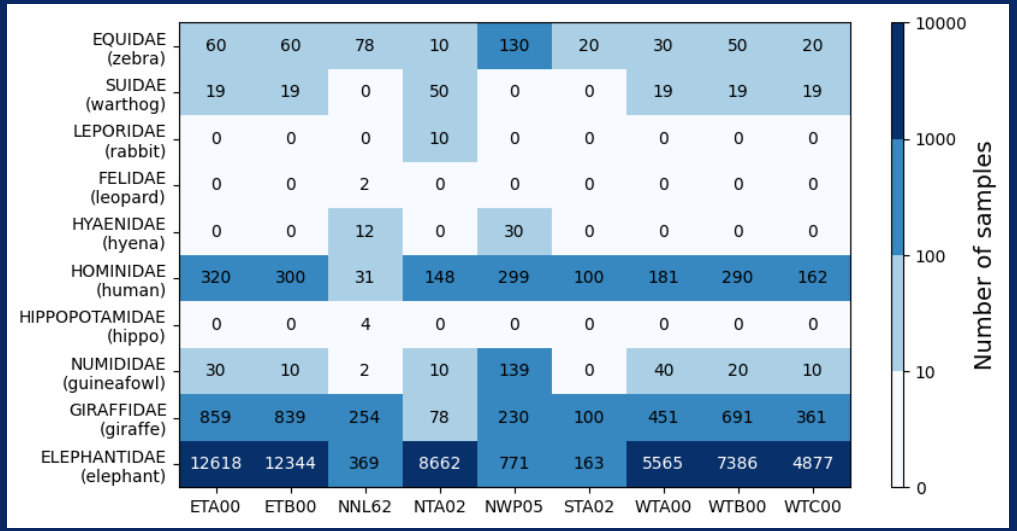
Seissavanna experiment 2019, Mpala, Kenya

Broadband Sensors and Camera Traps



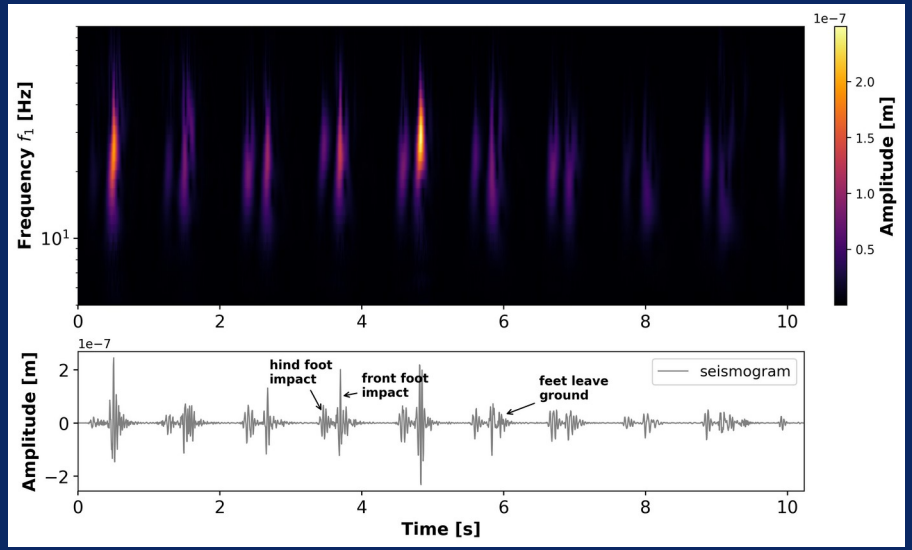


The Seissavanna dataset (>70.000 labeled seismograms)

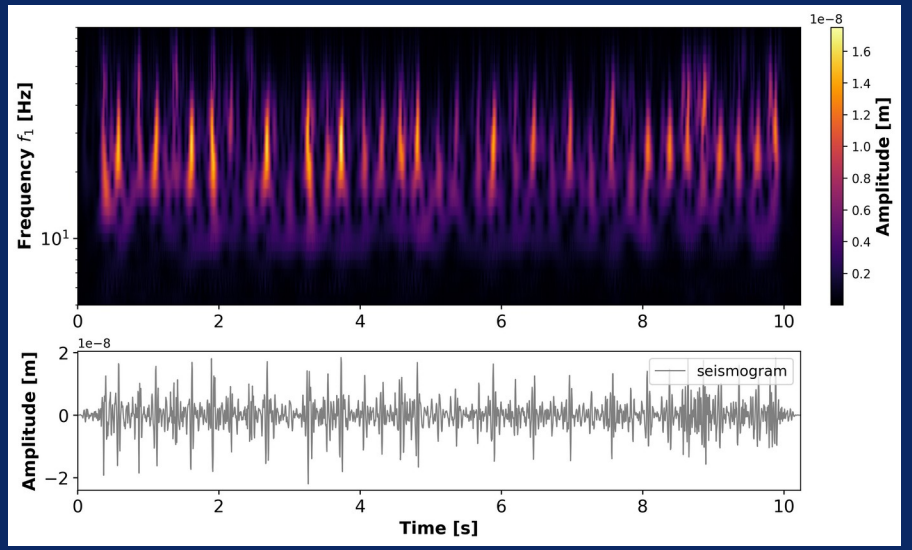
Szenicer et al., 2022 and Steinmann et al., 2025

The seismic signatures of footfalls

Giraffe



Zebra



Different Wildlife = Different Signatures

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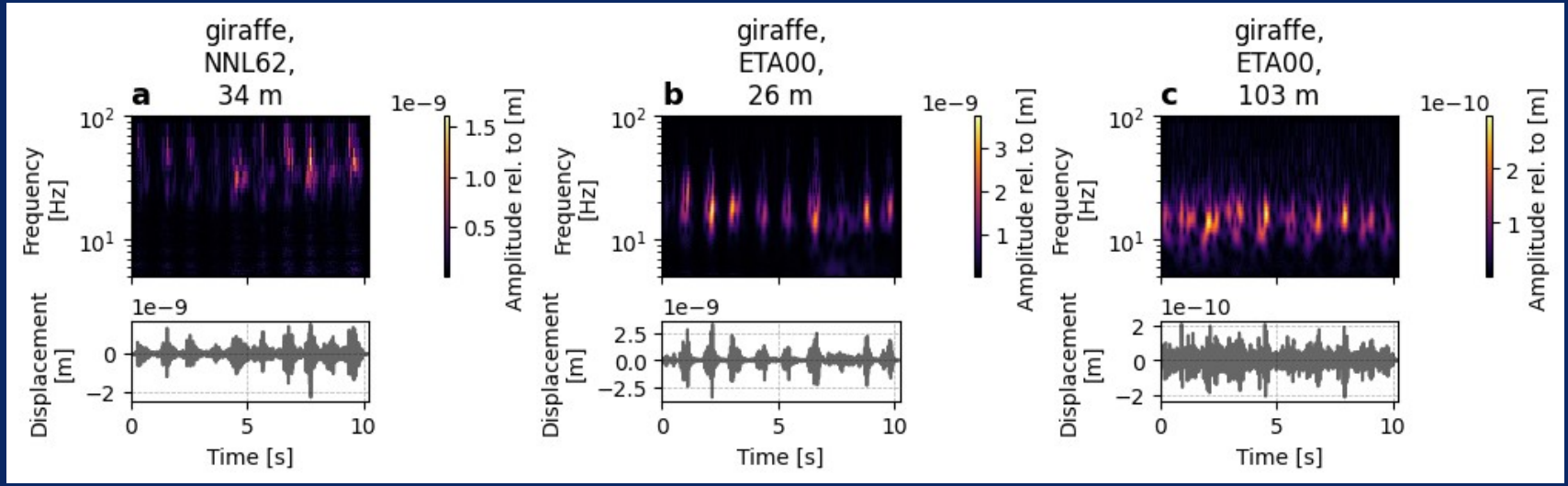
Steinmann et al., 2025

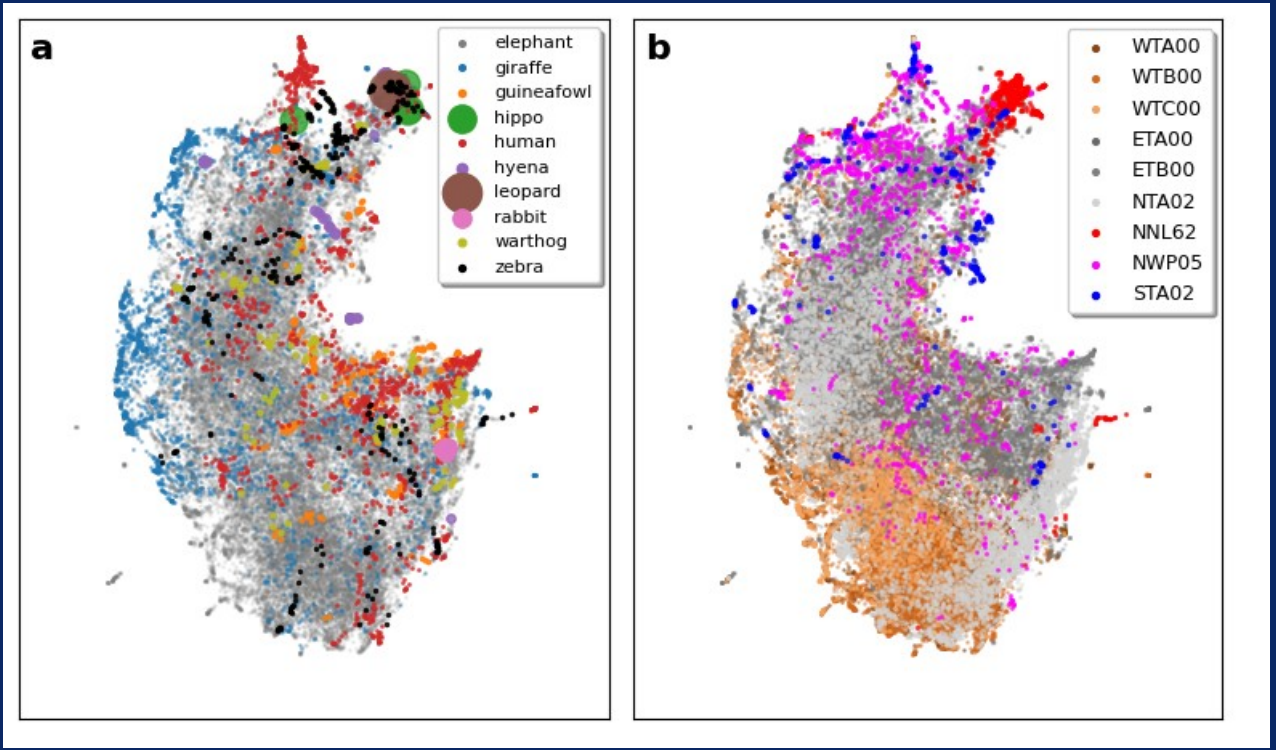
Signals are subject to path and site effects

hard-rock site | **close to water hole** | **distant giraffe at water hole**



Steinmann et al., 2025

Exploring the data with UMAP



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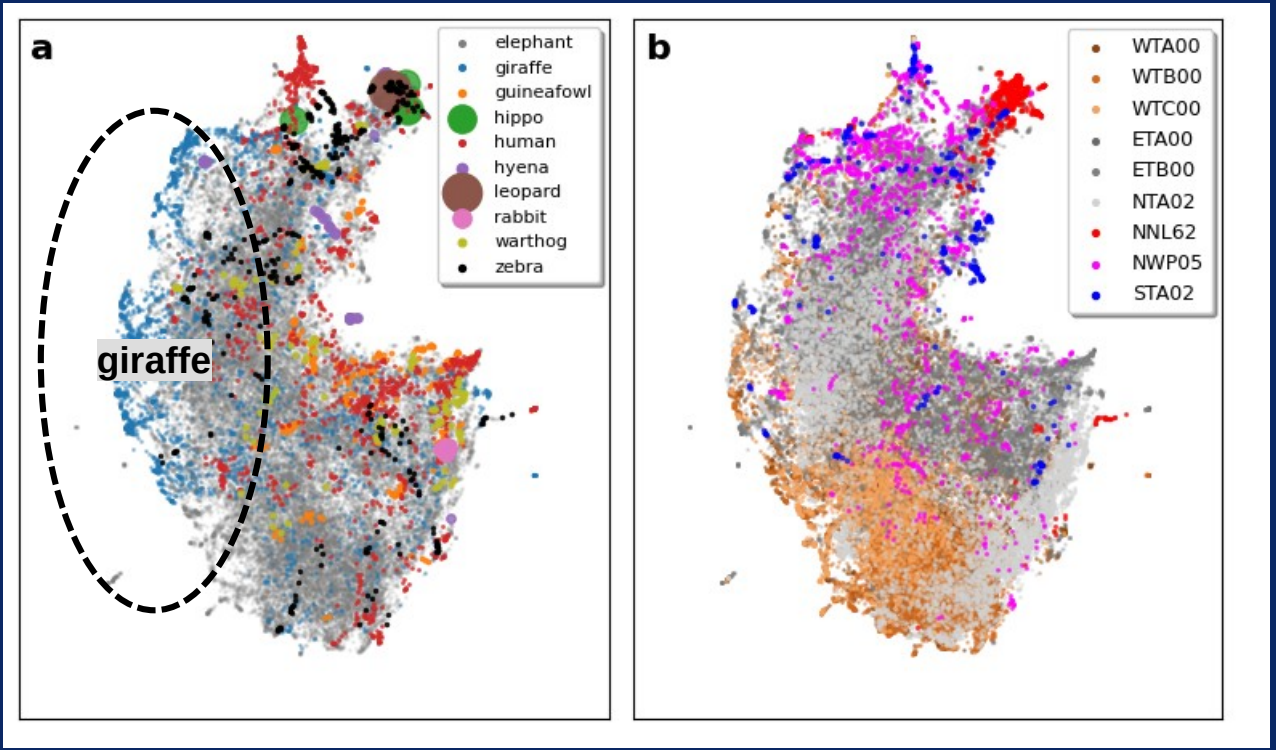

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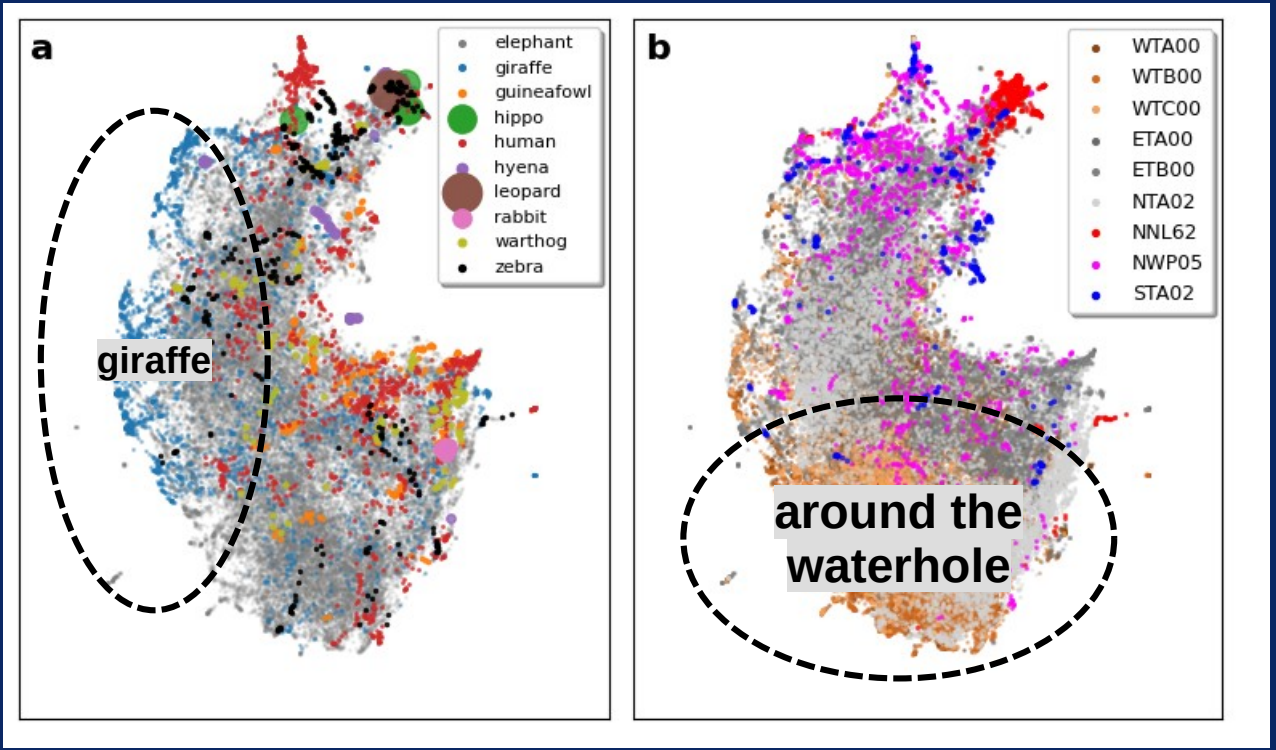

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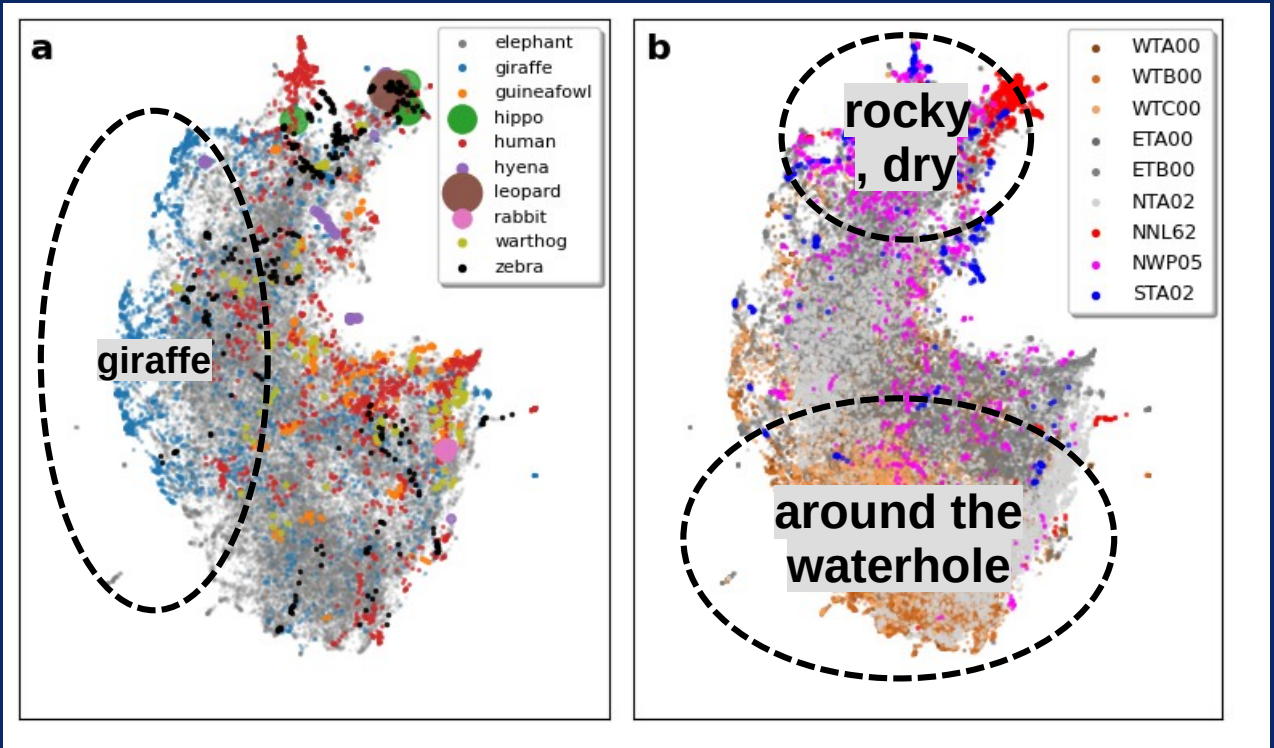

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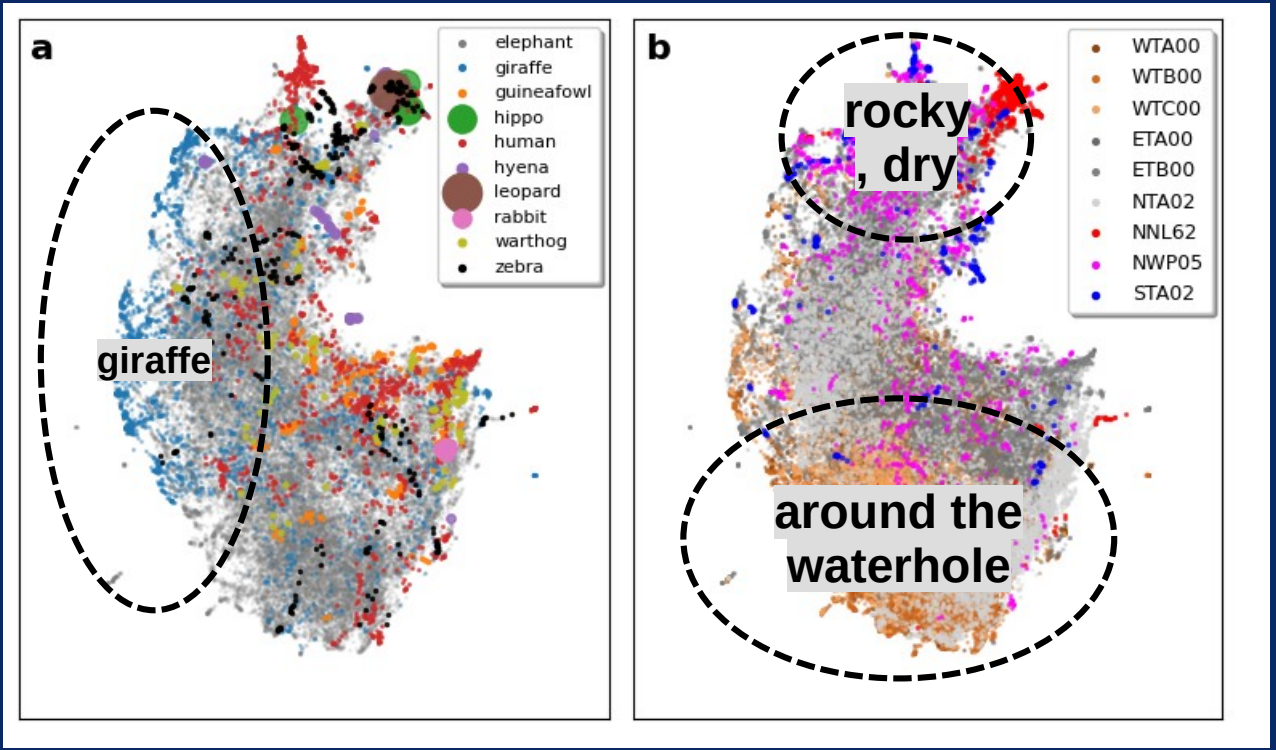

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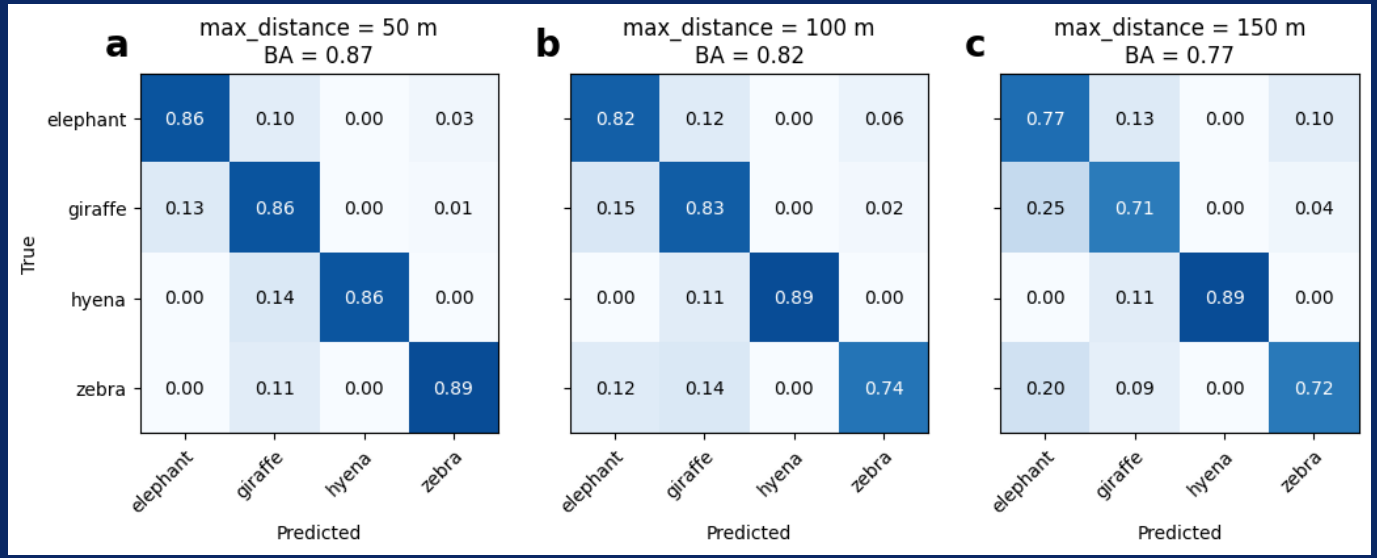
Wildlife classification needs to take into account the site effect!

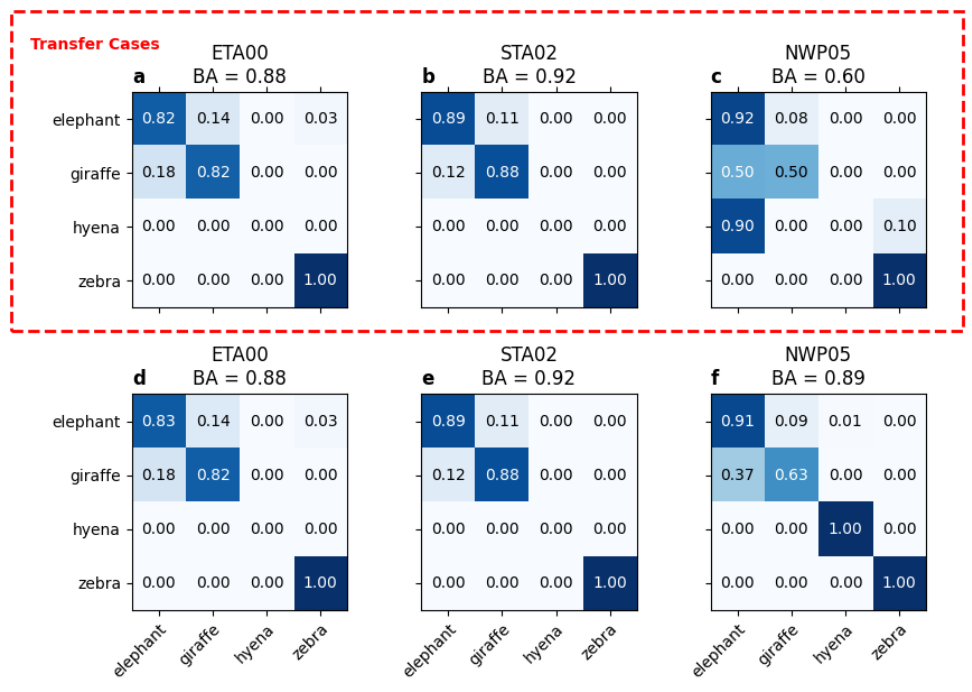
Support Vector Classifier exposed to all sites



increasing animal-sensor distance

Steinmann et al., 2025

Exposing the model to unseen station



Model has not seen test station

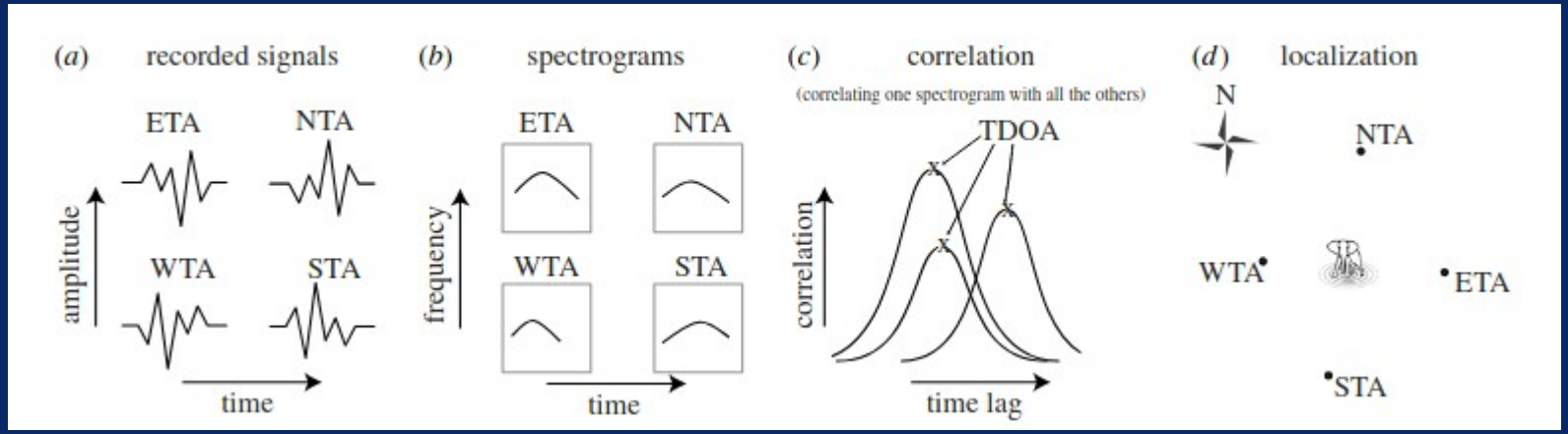
Model has seen test station

other stations nearby

other stations far, similar site

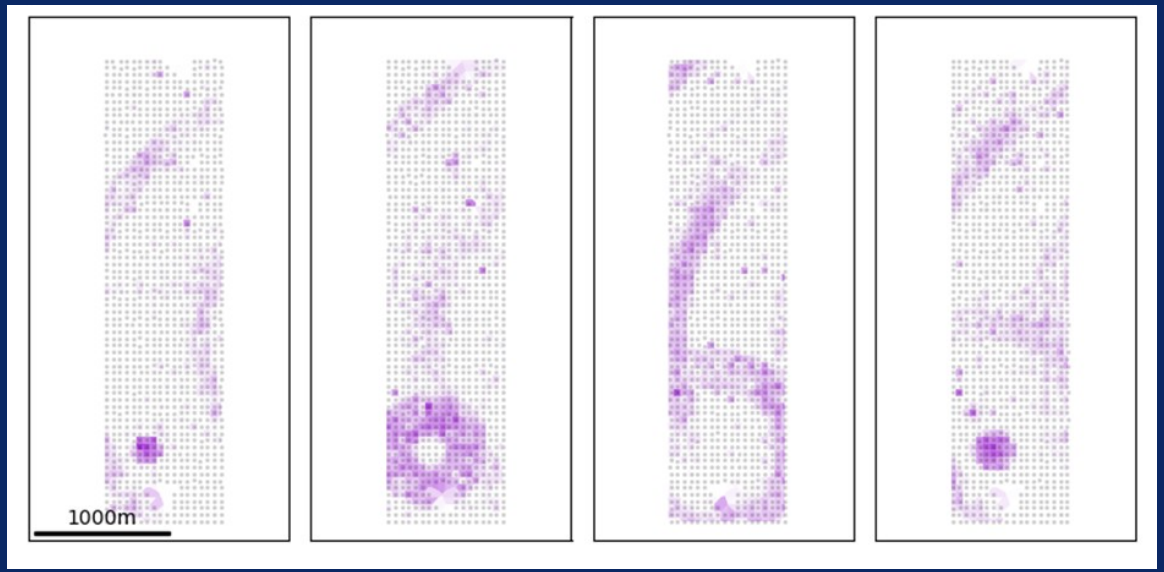
isolated station, different site

This is about footfalls, what about vocalizations?



Reinwald et al., 2021

Recording vocalization with large n-arrays



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Hending et al., in prep.

Recording vocalization with large n-arrays

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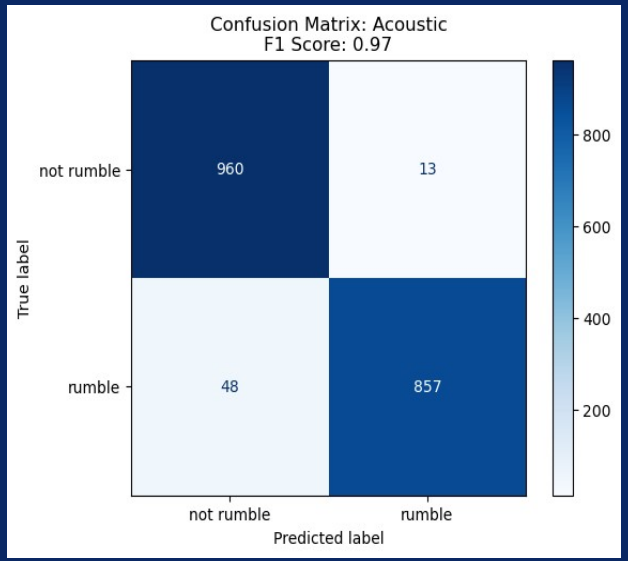
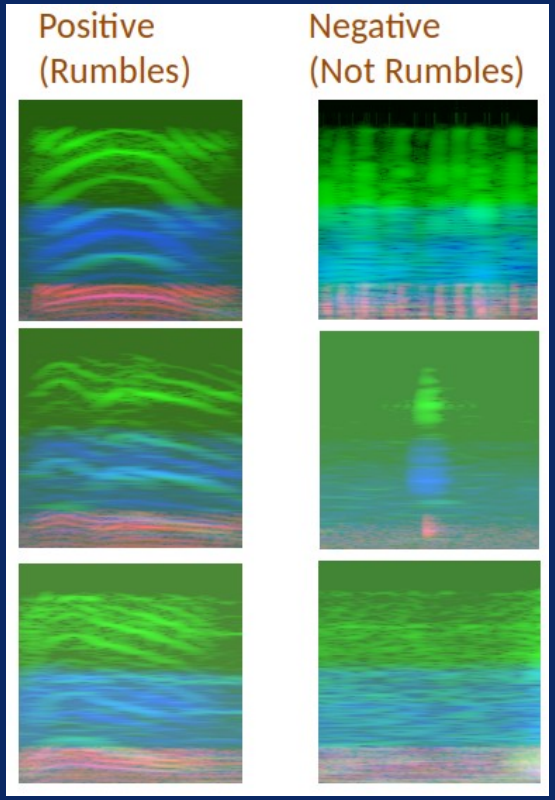
Hending et al., in prep.

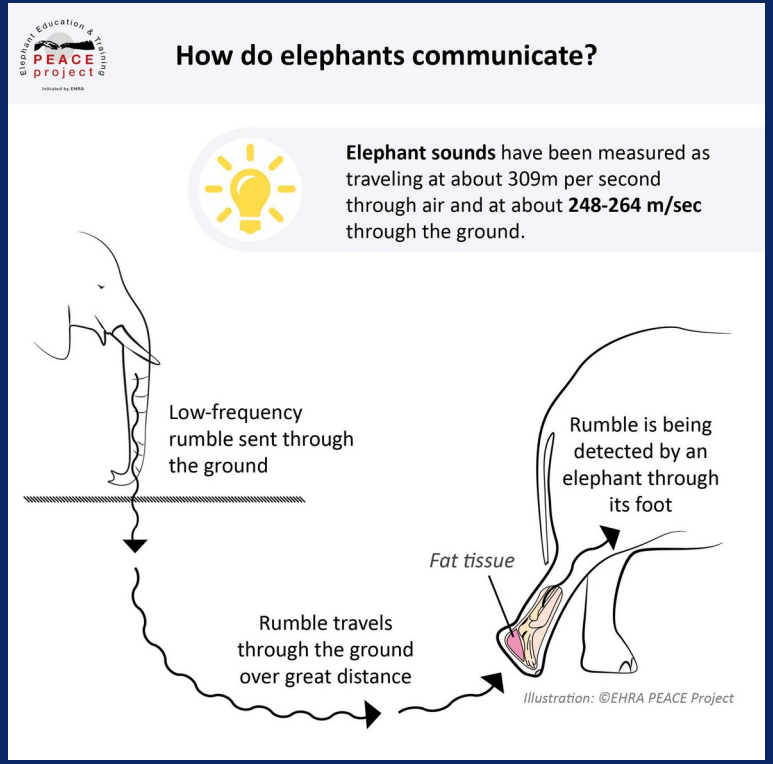
Identifying elephant rumbles with pre-trained ResNet18





Morrell et al., in prep.

Vibration as a source of information?



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Three Key Messages

- Seismic sensors record footfalls and vocalization

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- Useful to monitor and study wildlife, but first we need to turn signals into information
- Implications for biology and conservation?