Optimizing **animal movement studies**

Developing an application to evaluate **study design**

Inês Maria Simões Silva
i.simoes-silva@hzdr.de
Scientists have been systematically tracking individual animal movements since the **1800s**, employing ever-evolving technologies.
Scientists have been systematically tracking individual animal movements since the 1800s, employing ever-evolving technologies.

Large-scale data collection is revolutionizing our understanding of animal movement, opening new frontiers for research and conservation.

Locations (in billions)

Movebank.org
Define research questions

Identify spatiotemporal scales

Choose sampling design

Collect animal tracking data

Analyze data, mitigate biases

Assess conclusions

How does this application work?

- Click here for a guided tutorial
- Use fixed seed for tutorials only

What is your workflow?

Data source:
- Upload
- Select
- Simulate

Research question:
- Home range
- Speed & distance
Identify spatiotemporal scales

Choose sampling design

Define research questions

Collect animal tracking data

Analyze data, mitigate biases

Assess conclusions

Compromise between

Battery life

Fix rate

SAMPLING DURATION
How long is an animal tracked for?

SAMPLING INTERVAL
How much time between new locations?

Users can also currently test:
Data loss,
Location error,
Device storage limitations,
Resolution/battery trade-off,
All can constrain study design.
Researchers design their projects without knowing how much data is **sufficient** for potential research targets....

“**what do I do with the data I’ve already collected?**”

Collecting data first and setting goals later introduces a risk of **aimless exploration** during data analyses.
Animal movement paths are realizations of continuous stochastic processes,

1. Summarize behavior using characteristic timescales,

- Position autocorrelation timescale: $\tau_p$
- Velocity autocorrelation timescale: $\tau_v$

2. Choose sampling design

3. Collect animal tracking data

4. Analyze data, mitigate biases

5. Define research questions

6. Identify spatiotemporal scales

ctmm R package
Calabrese et al. (2016)
1. Animal movement paths are realizations of continuous stochastic processes,

2. Summarize behavior using characteristic timescales,

   \( \tau_p \) Position autocorrelation timescale
   \( \tau_v \) Velocity autocorrelation timescale

3. These timescales impose constraints on sampling design that must be met for sufficiently large (effective) sample sizes.

Identify spatiotemporal scales

Assess conclusions

Choose sampling design

Collect animal tracking data

Analyze data, mitigate biases

Define research questions

ctmm R package
Calabrese et al. (2016)
Position autocorrelation timescale

- $\tau_p = 1$ hour
- $\tau_p = 1$ day
- $\tau_p = 5$ days
- $\tau_p = 10$ days

**Sampling Duration**
How long is an animal tracked for?

**Space-use**
- HOME RANGE

**Movement Behavior**
- SPEED & DISTANCE

6 out of 9
Velocity autocorrelation timescale

- $\tau_v = 1$ minute
- $\tau_v = 1$ hour
- $\tau_v = 12$ hours
- $\tau_v = 1$ day

**SAMPLING INTERVAL**

How much time between new locations?

**SPACE-USE**
- HOME RANGE

**MOVEMENT BEHAVIOR**
- SPEED & DISTANCE

7 out of 9
Position autocorrelation

10.3 days
8.2 – 12.8 (τₚ)

These parameters are fairly conservative at the species- and population-level.

African buffalo
( Syncerus caffer )
Future goals:
Explore new use cases and test other movement metrics,
Address more challenging sample design questions (e.g., optimal number of tracked individuals).
Thank you for your attention!

Special thanks to:

CASUS
Dr. Justin Calabrese
Dr. Jorge Menezes
Dr. Eduardo Colombo

External collaborators
Dr. Chris Fleming
Dr. Michael Noonan
Dr. William Fagan
Dr. Jesse Alston

Check the first paper here!