Movement ecology hackathon: A dingo case-study

Photo by Alexander Babych

Niraj Meisuria

Rhys Cairncross

Sally Burgemeestre

Thomas Newsome

Lily Bentley

Mitchell Cowan

Scott Forrest

Acknowledgement of Traditional Owners

Kaurna people as the Traditional Owner and Custodians of the Adelaide Plains.

Walpiri and Ngarti country where the data was collected.

Organisers and facilitators

- Members of the Movement Ecology Special Interest Network (MoveSIN)


Mitchell Cowan


Niraj Meisuria


Rhys Cairncross


Sally Burgemeestre


Thomas Newsome


Lily Bentley

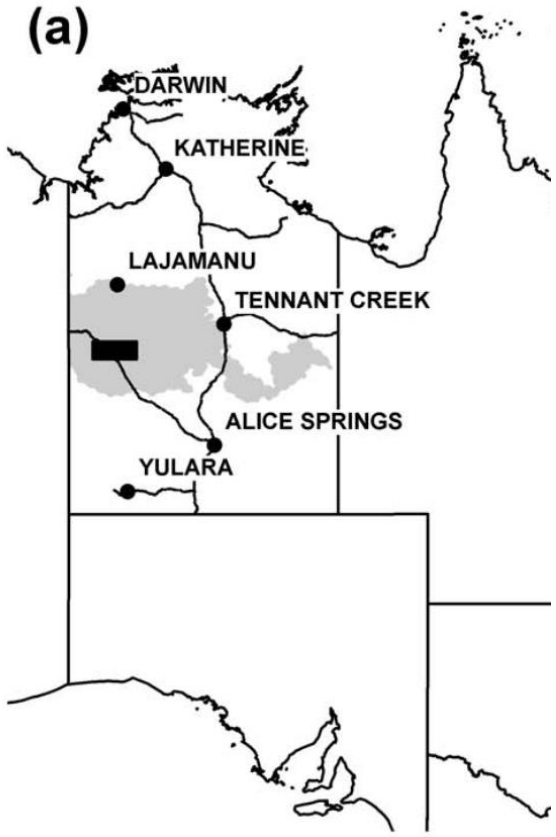

Scott Forrest

Purpose of the workshop

- Hackathon-style workshop
  - self-directed learning to tackle a research question of interest
  - small teams working independently
- Hands-on experience with a new dataset
- Thinking through a research question
- Try out some different movement ecology methods

Time	Duration	Activity
9:00 am	15 mins	Overview of workshop - introductions
9:15 am	15 mins	Introduction to data and study system
09:30 am	15 mins	Brainstorming possible research questions
09:45 am	15 mins	Break into groups
10:00 am	30 mins	Morning tea + coffee
10:30 am	15 mins	Brief introduction to different movement ecology tools
10:45 am	1 hour 15 mins	Working in groups
12:00 pm	1 hour	Lunch
1:00 pm	2 hours	Working in groups
3:00 pm	15 mins	Afternoon tea
3:15 pm	1 hour	Group presentations (5 mins each)
4:15 pm	15 mins	Wrap-up
4:30 pm		Finish (post-workshop food/drink?)

Study system - Tanami Desert



From Newsome et al. (2013)

Tanami mine sites

Tanami mine sites

Mine sites

- food resources are spatially clumped and very rich
- increase interactions with humans and possibly each other

Spatially distant areas (non-mine sites)

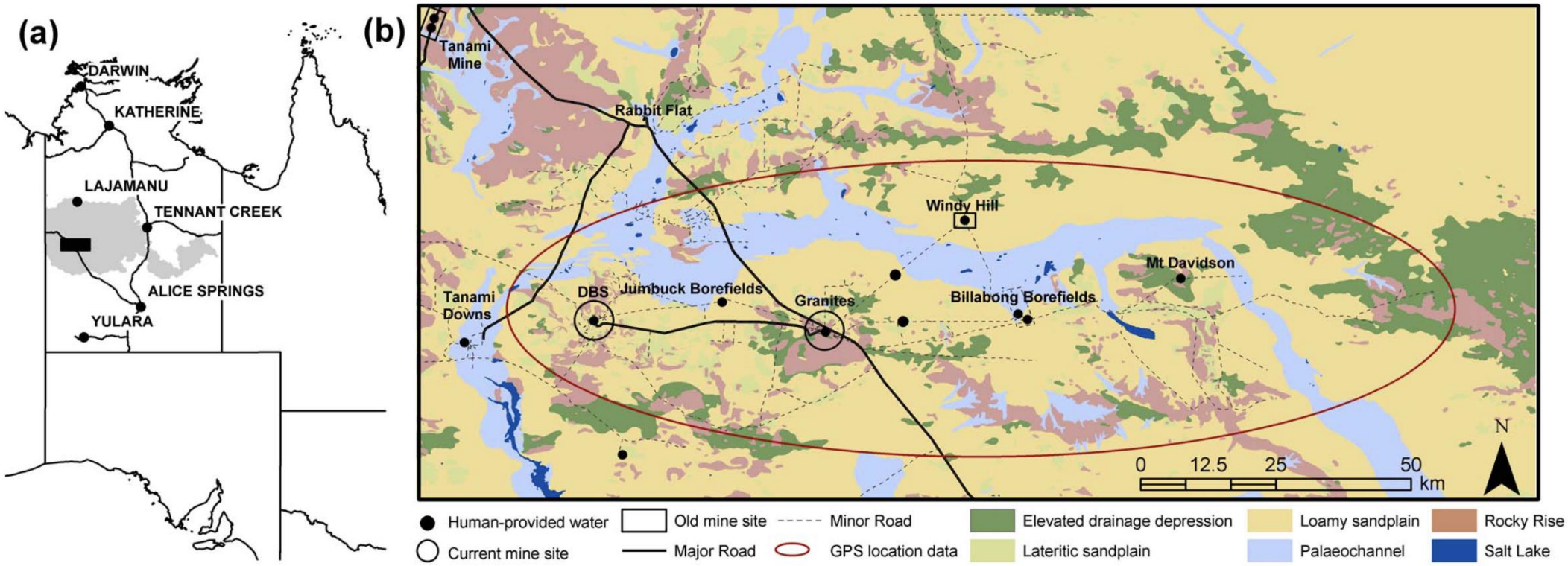
- food resources are naturally dispersed and relatively sparse

Dingo (*Canis lupus dingo*)

- Dingoes introduced to Australia ~4,000 years ago, since naturalised
- Australia's top mammalian predator
- Interact with humans through refuse and artificial water points

Photo by Alexander Babych

Dingo GPS data collection



From Newsome et al. (2013)

Dingo GPS data collection

- 13 dingoes
- Hourly GPS data
- 3 – 9 months

Table 1. Attributes of dingoes studied in the Tanami Desert.

ID	Sex	Category	Date collared	Last GPS fix	Total fixes
60497	male	away	05-Apr-08	07-May-08	713
60498	male	mine	05-Apr-08	20-Nov-08	5167
150301	male	intermediate	28-Aug-08	28-Nov-08	1839
89991	male	intermediate	05-Nov-08	31-Aug-09	6752
89992	female	away	07-Nov-08	31-Aug-09	6495
89994	male	away	08-Nov-08	31-Aug-09	6621
89993	male	intermediate	08-Nov-08	31-Aug-09	6640
105760	male	intermediate	10-Nov-08	09-Mar-09	2559
150302	female	mine	05-Apr-09	08-Aug-09	2254
92380	female	mine	27-Aug-09	29-Apr-10	4065
92491	male	mine	27-Aug-09	29-Apr-10	4172
92492	female	away	30-Aug-09	18-Oct-09	1047
92493	male	intermediate	31-Aug-09	29-Apr-10	5100

Data cleaning

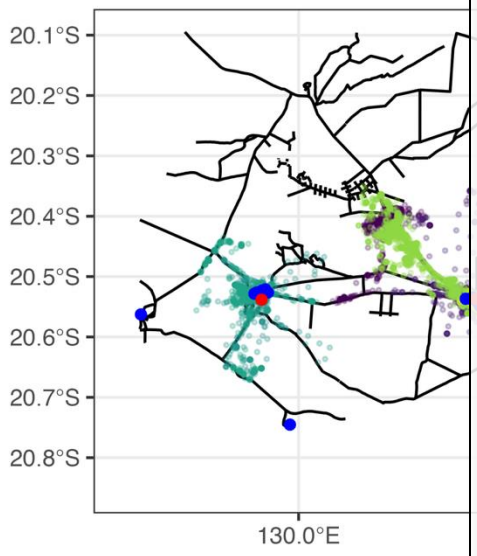
- Spatial data has errors
- Depends on the technology of the device (GPS, Argos, geolocator)
- there are diagnostic metrics (HDOP, number of satellites)

- Terrestrial
  - removing errors using using diagnostic metrics
  - behavioural filters (impossible, unlikely speeds)

- Marine / ARGOS data
  - state-space modelling (aniMotum)

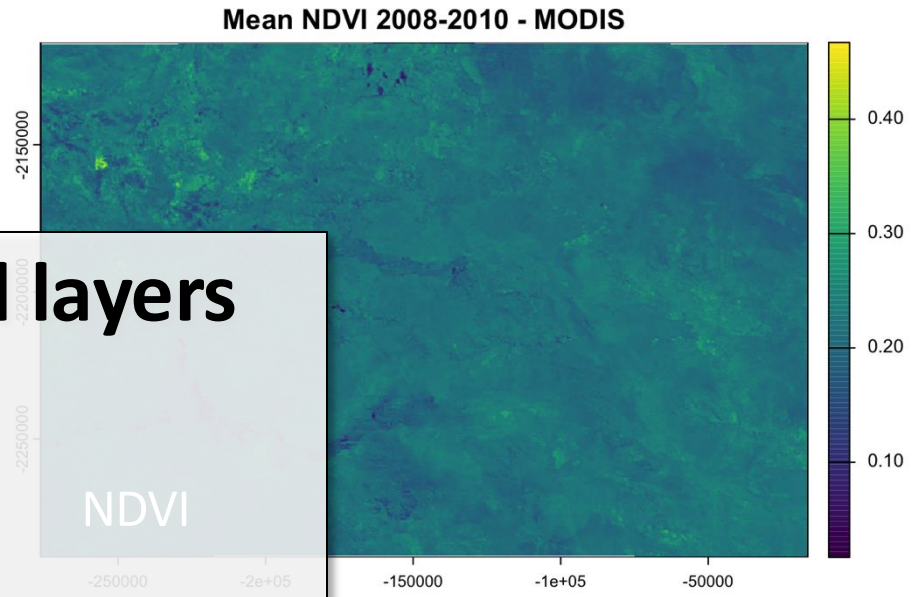
- Dingo data cleaning

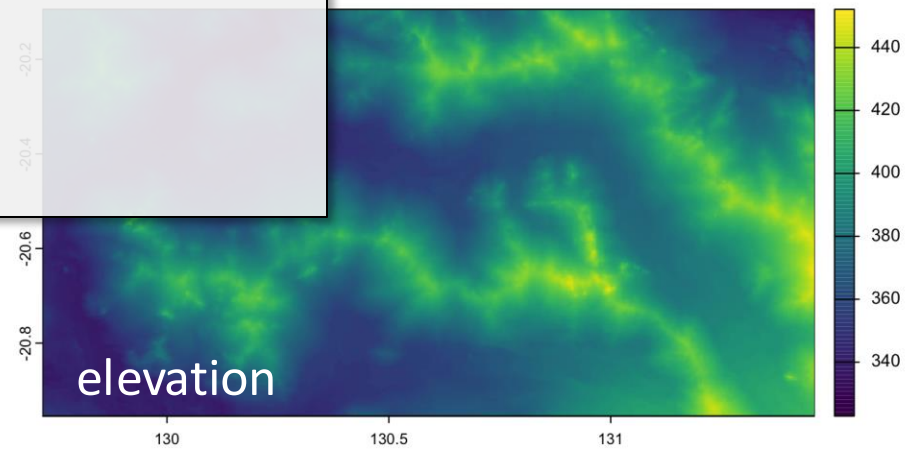
Spatial layers



other possible spatial layers

- vegetation classes
- terrain/soil classes
- climate/weather
  - temperature
  - rainfall





roads

- artificial food locations
- artificial water locations

Previous research with this dataset

- Newsome, T. M., Ballard, G.-A., Dickman, C. R., Fleming, P. J. S., & van de Ven, R. (2013). **Home range, activity and sociality of a top predator, the dingo: a test of the Resource Dispersion Hypothesis.** *Ecography*, *36*(8), 914–925. https://doi.org/10.1111/j.1600-0587.2013.00056.x

- Newsome, T. M., Ballard, G.-A., Dickman, C. R., Fleming, P. J. S., & Howden, C. (2013). **Anthropogenic resource subsidies determine space use by Australian arid zone dingoes: an improved resource selection modelling approach.** *PloS One*, *8*(5), e63931. https://doi.org/10.1371/journal.pone.0063931

Home ranges, activity and sociality

home range estimates

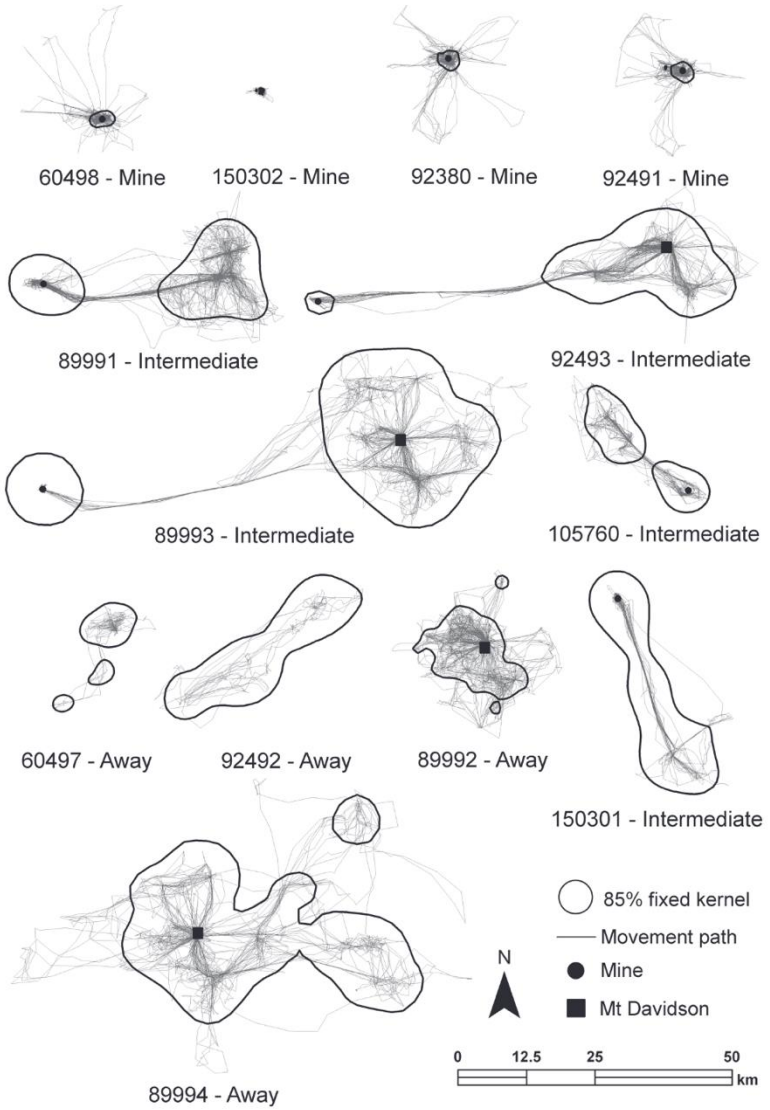


Figure 4. Fixed kernel home range estimates (85%) and movement paths of thirteen adult dingoes fitted with GPS collars in the Tanami Desert.

home range overlap

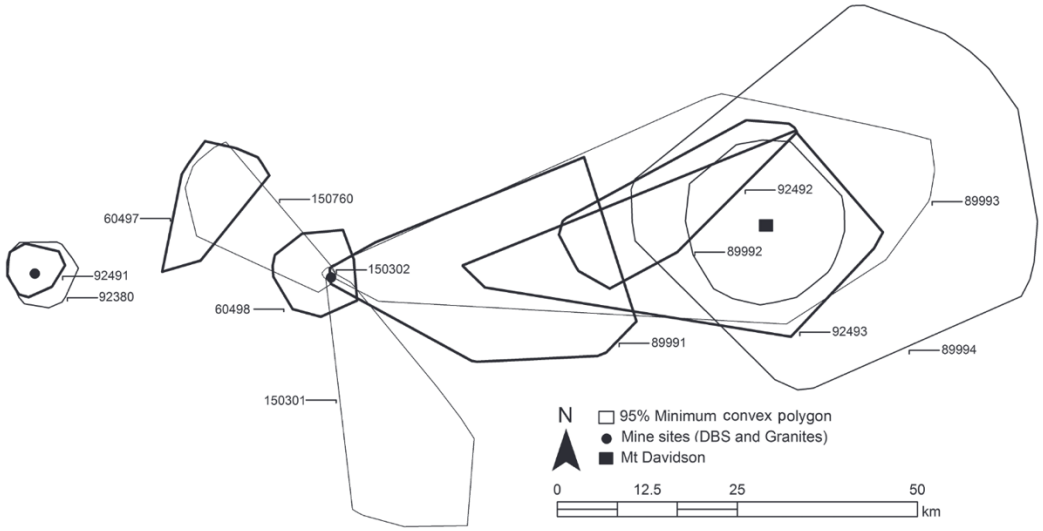


Figure 5. Overlapping minimum convex polygon (95%) home ranges for 13 adult dingoes fitted with GPS collars in the Tanami Desert.

Resource selection modelling

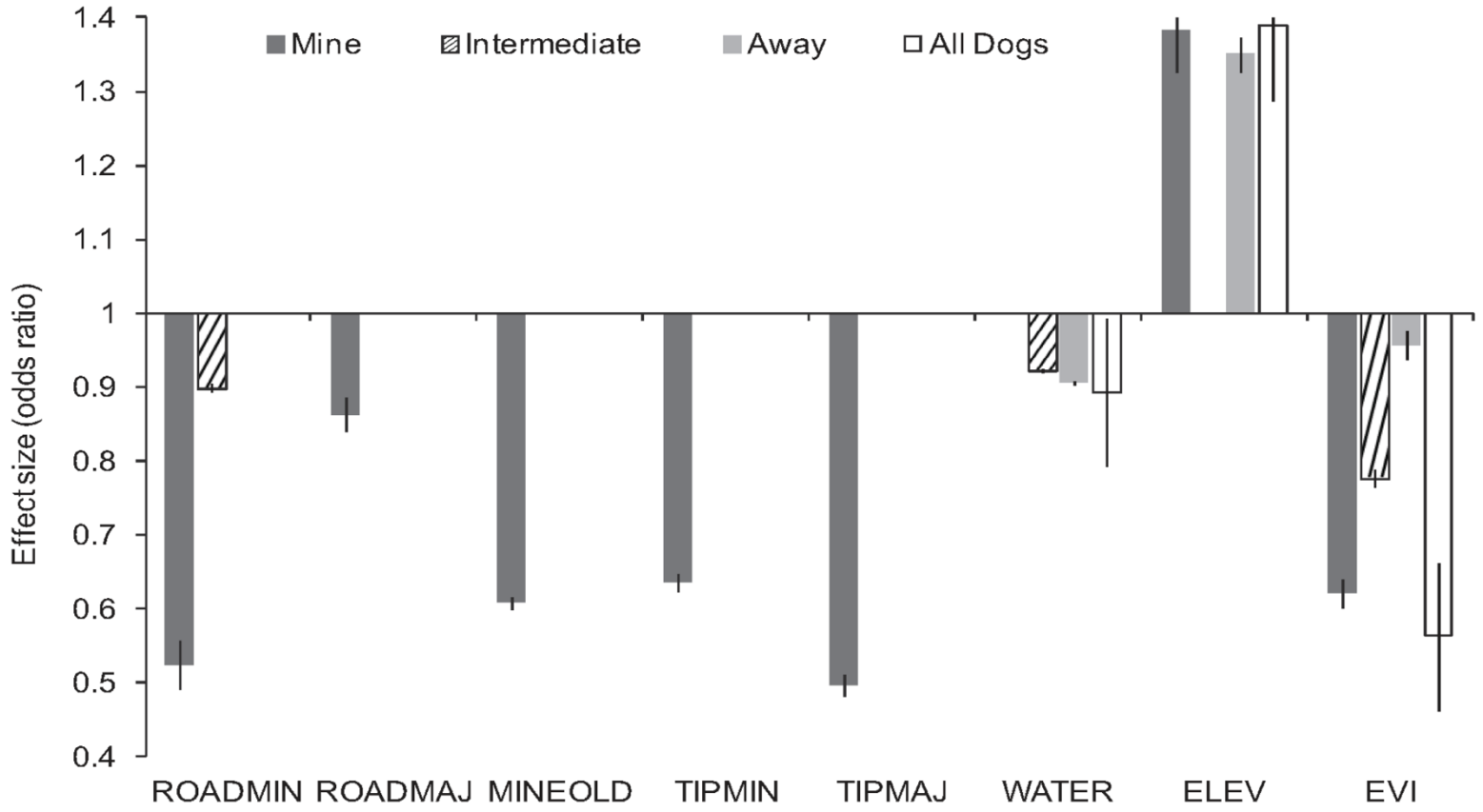


Figure 2. Effect size of continuous predictors on occurrence of dingoes in the Tanami Desert based on the results from the final generalized linear mixed model. Odds ratios are provided ±95% confidence intervals (CI). See Table 1 for X-axis acronyms.
doi:10.1371/journal.pone.0063931.g002

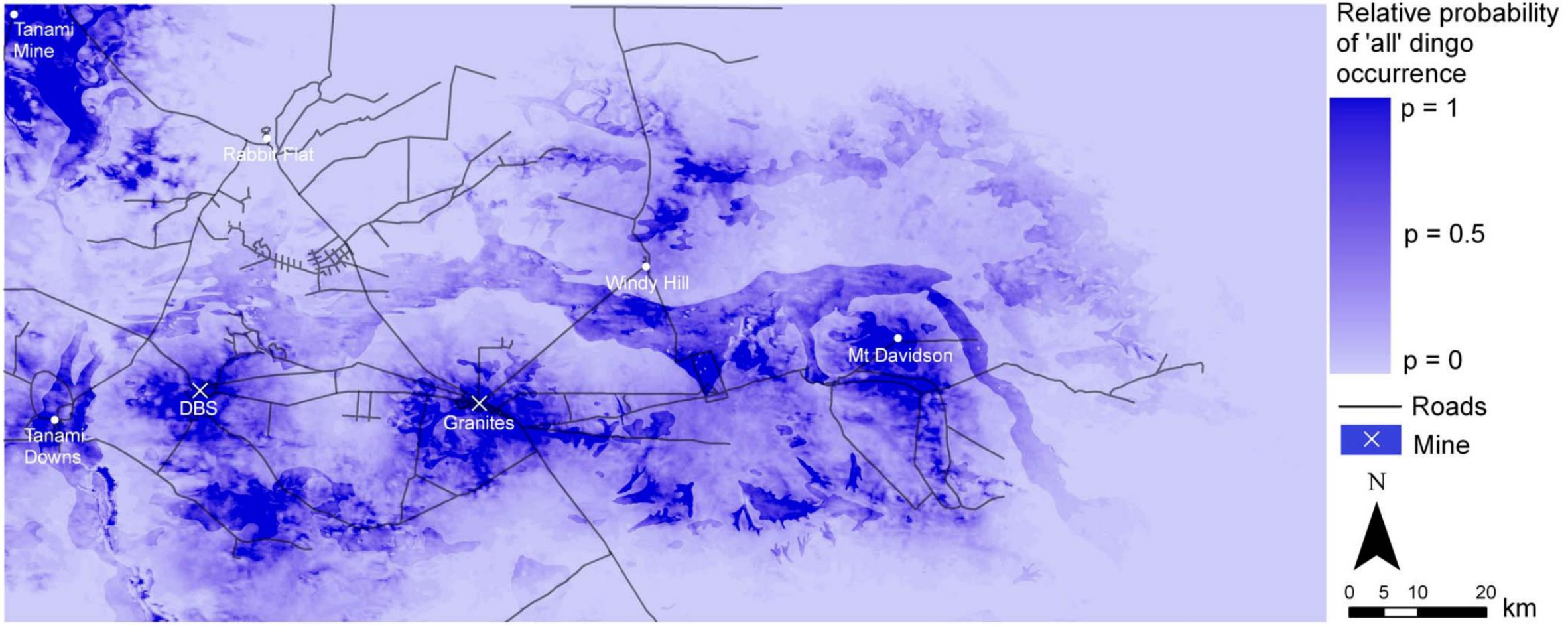


Figure 6. Predicted resource selection by 'all' dingoes in the Tanami Desert at a scale of 1 km for distance predictors and 10 m for elevation.

doi:10.1371/journal.pone.0063931.g006

Brainstorm!

- What are some research questions you can think of?

Some possible research questions

- How do dingo behaviours differ between individuals at mine sites and those elsewhere?
- What is the influence of the surrounding environment on the dingoes' movement?
- How do dingoes' behaviours change across the day?
- How do dingoes connect through the landscape?
- Do dingoes near mines have a higher probability of disease transmission?

Morning tea

- At the end of the break
  - find a group
  - define your ecological question

Thinking through the problem

- What is the question?
- What is the quantity that you need to address your research question?
- What data do you need?
  - is the dingo data appropriate?
- What will you be comparing/analysing?
  - what is the time-scale?
  - what covariates might you need?

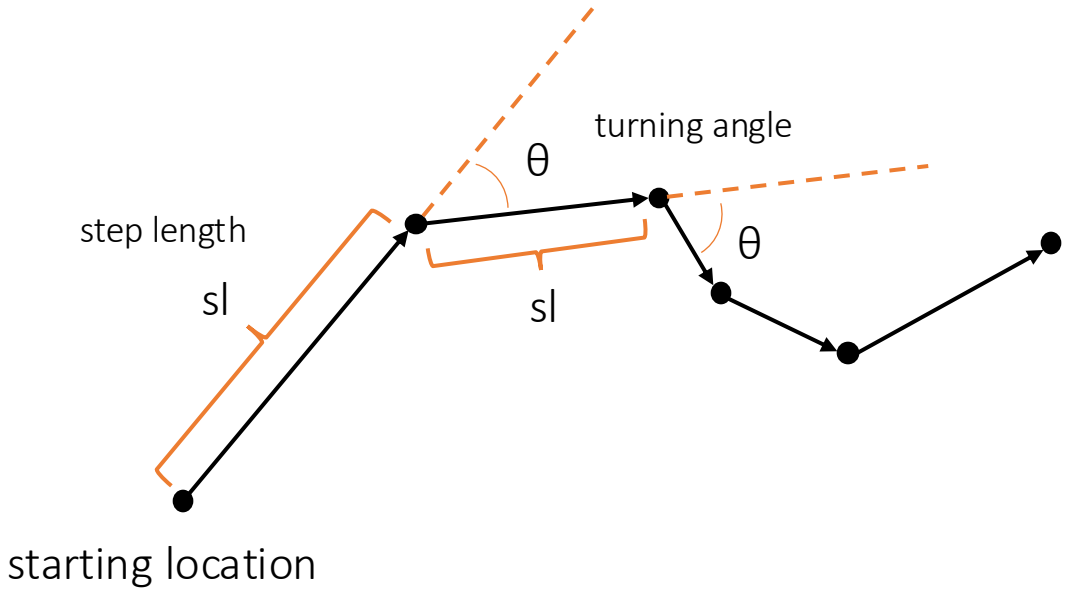
Movement ecology approaches

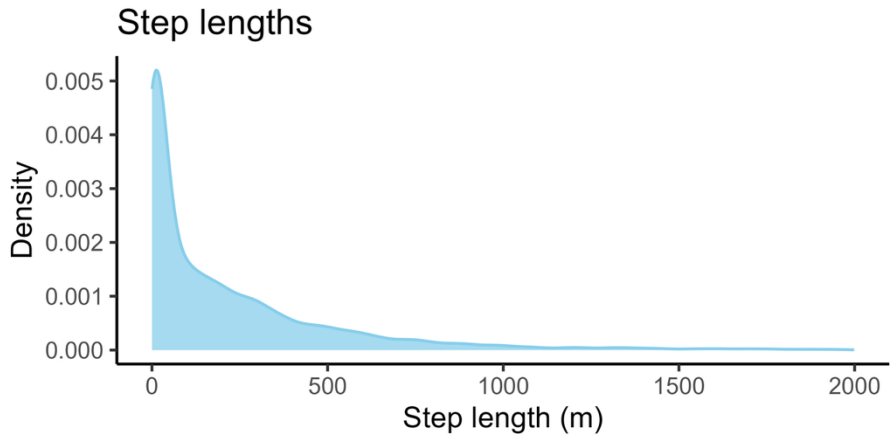
- Movement summaries
- Home range analyses (KDE, AKDE)
- Behavioural classification (HMM, BCPA)
- Resource and step selection functions (RSF, SSF)
- Revisitation analysis
- Social network analysis

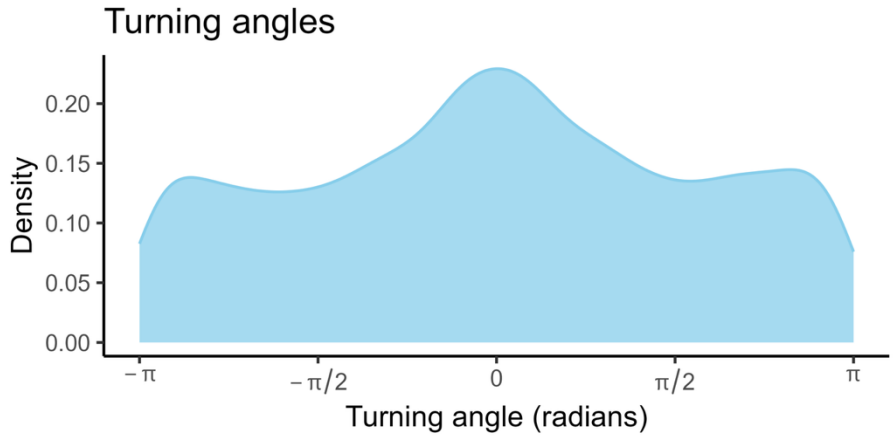
Movement summaries

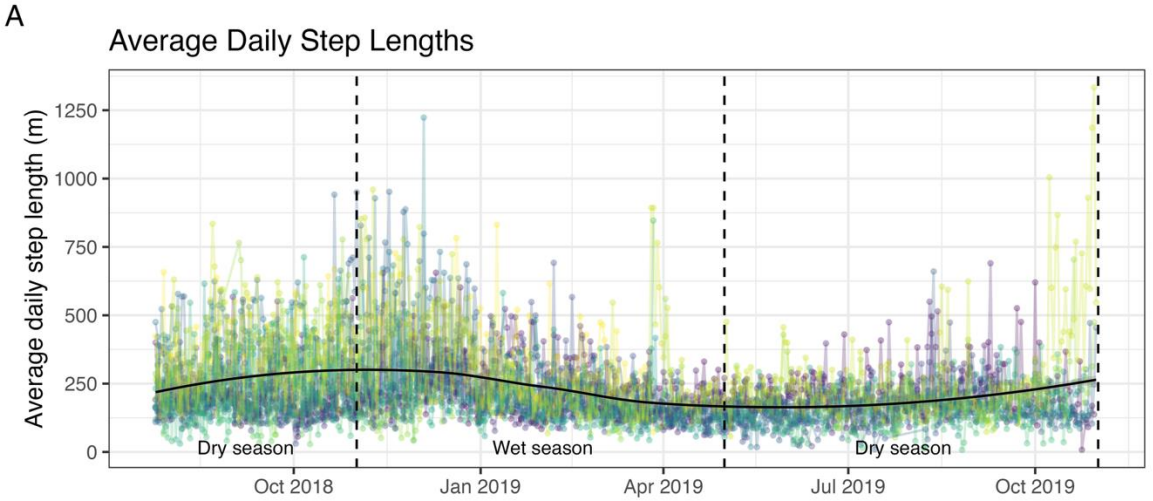
- E.g., did the animal show different movement behaviour in different areas, times?
  - movement speeds, directionality
- May be exploratory or used for inference
- Can be used to guide model development

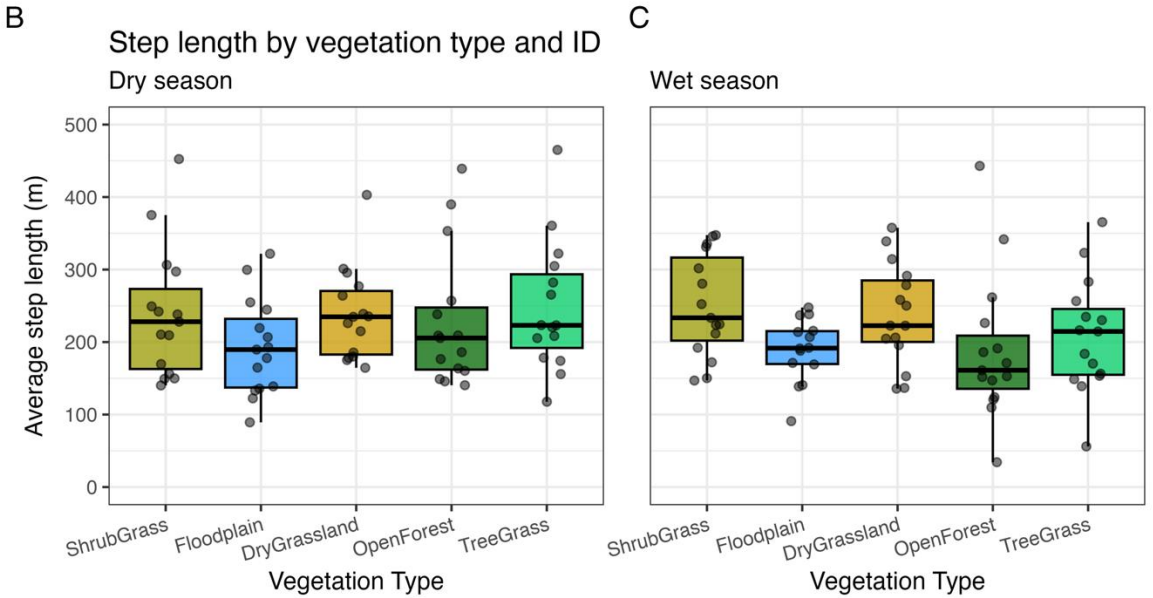
Movement data as ‘steps’







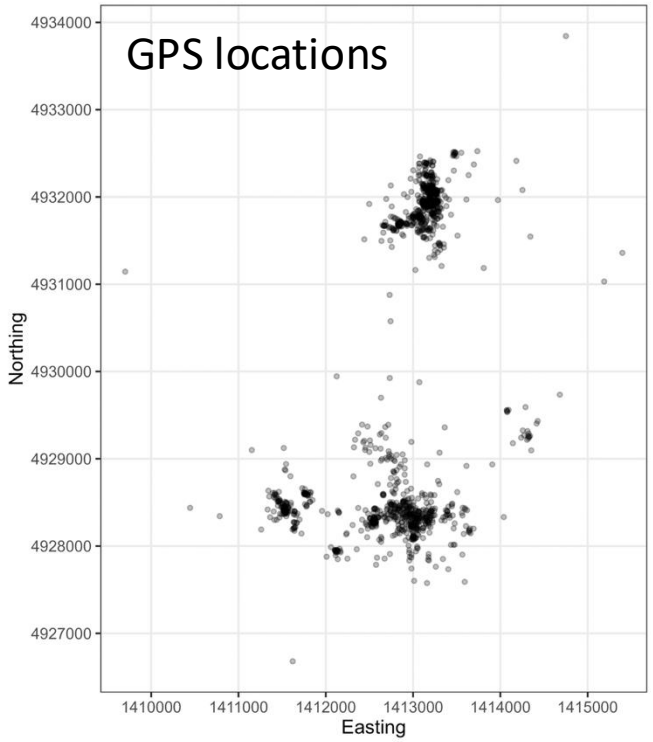


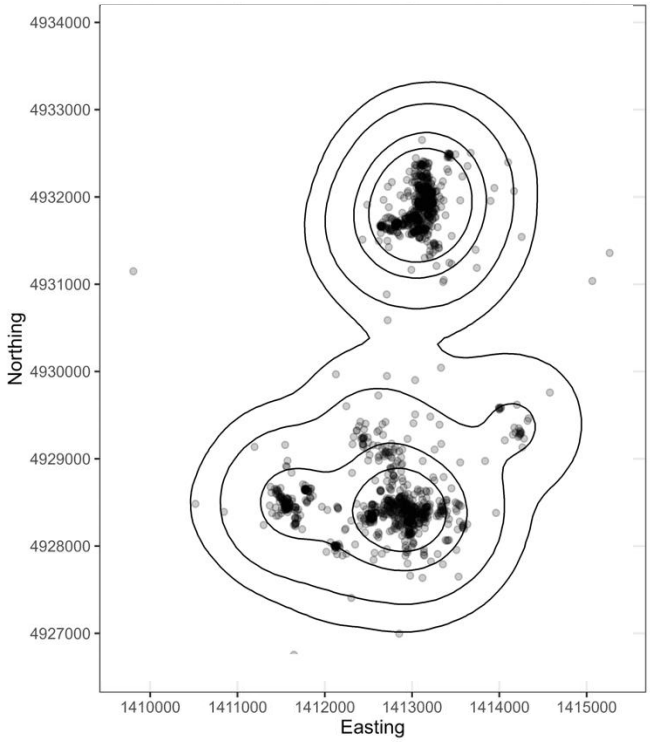


water buffalo
(*Bubalus bubalis*)

Home range analysis

- What is the animal's 'home range' or space use?





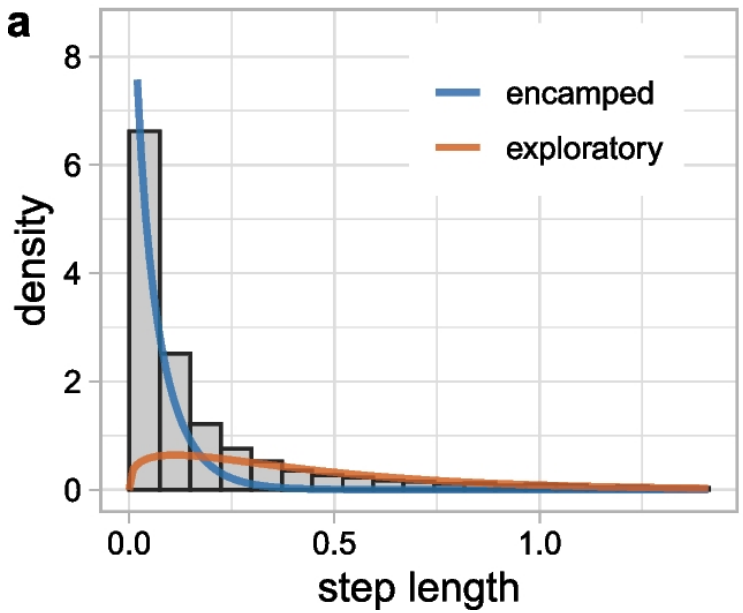
Kākā
(Nestor meridionalis)

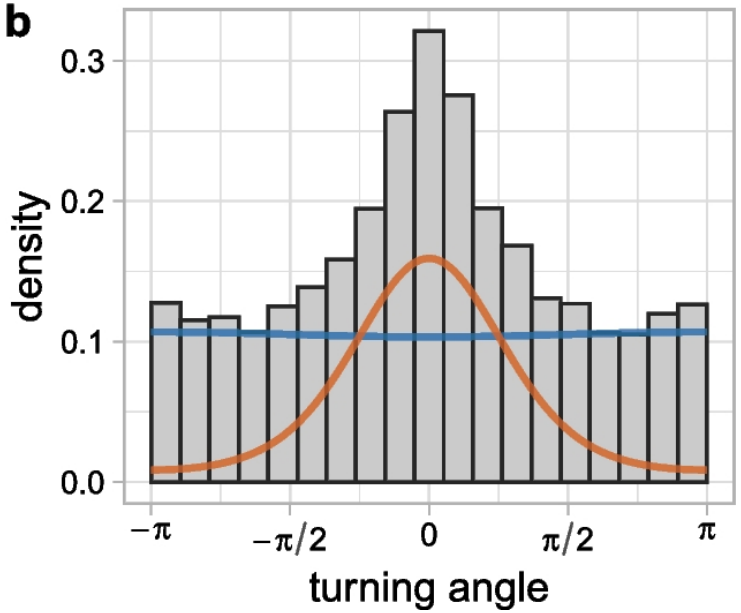
Tag ID: 45505

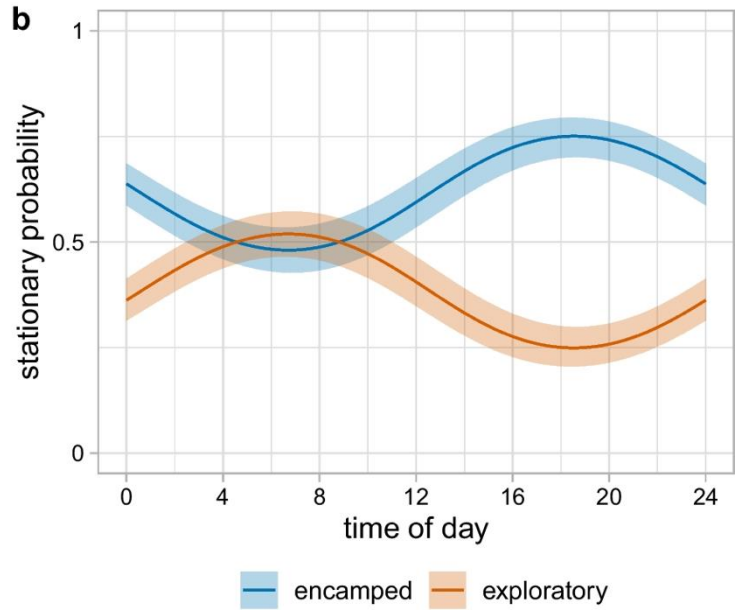
Behavioural classification

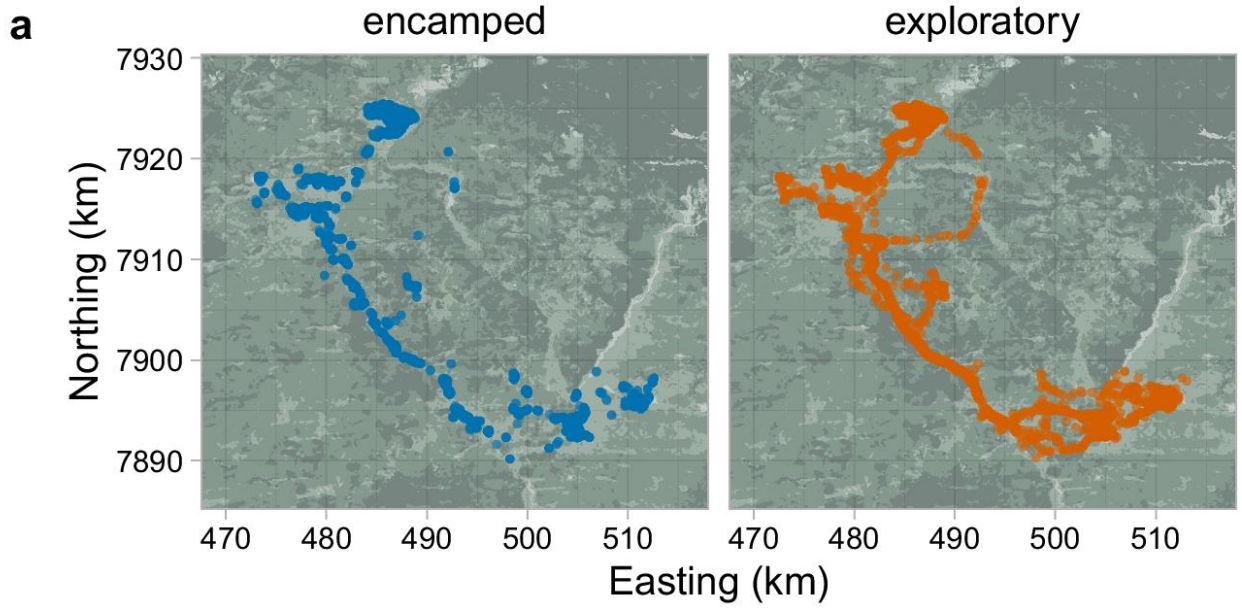
Figures from Klappstein et. al (2023)

- What behaviours was the animal displaying?
- Does this relate to any covariates (time of day, spatial layers)?



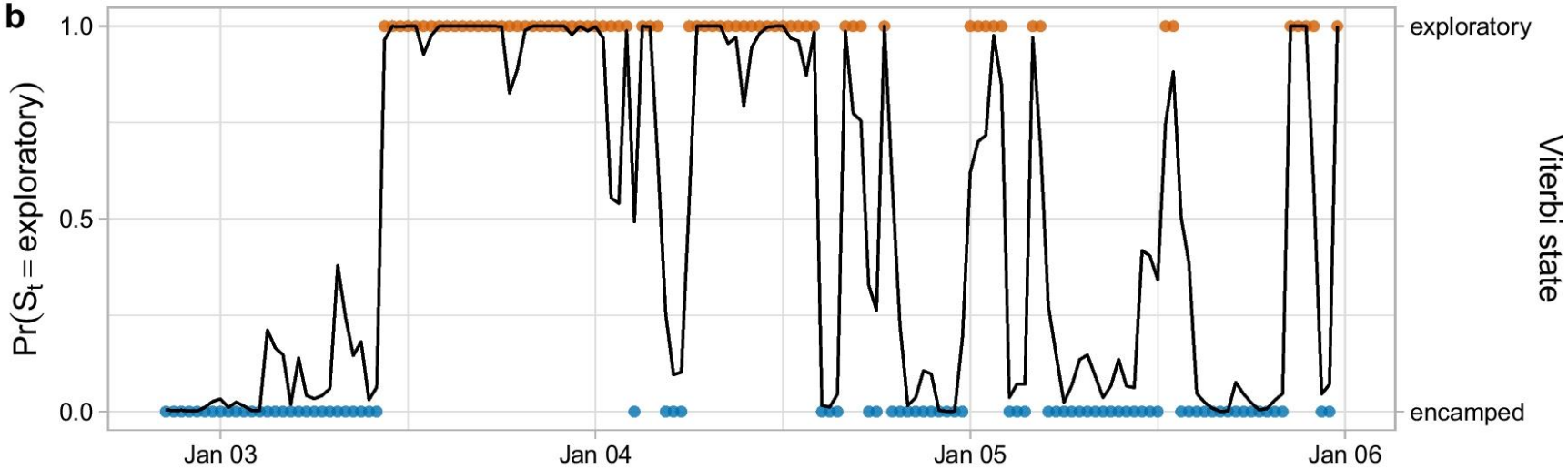






Figures from Klappstein et. al (2023)

behavioural state of each GPS location

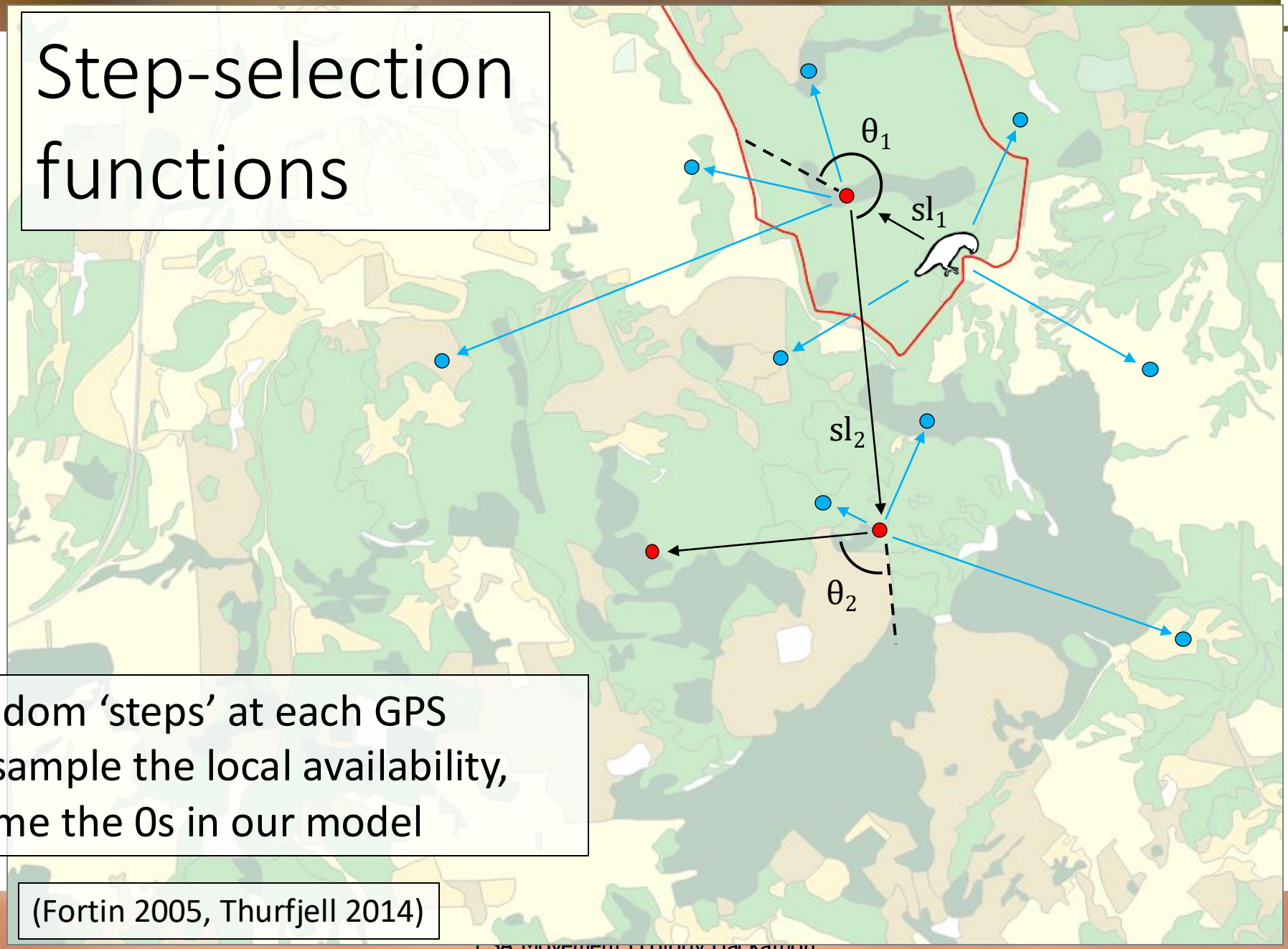


Plains zebra
(*Equus quagga*)

Resource and step selection functions

- What habitat was the animal using?
- How was the habitat affecting its movement behaviour?

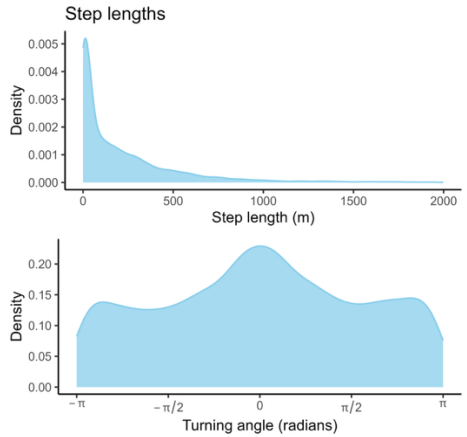
Step-selection functions

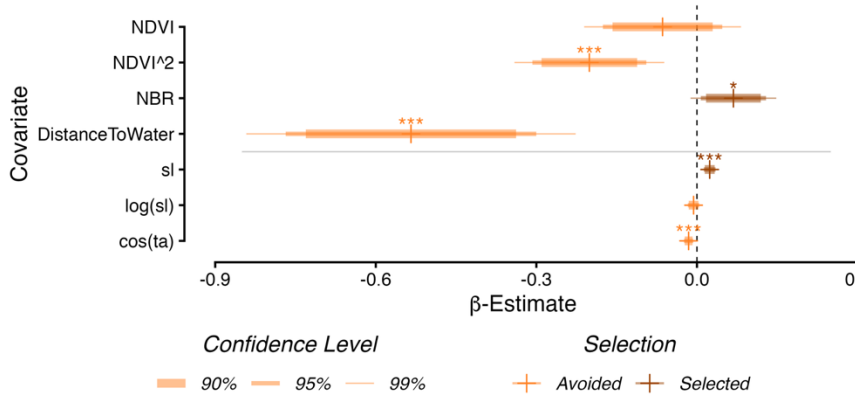


We take random ‘steps’ at each GPS location to sample the local availability, which become the 0s in our model

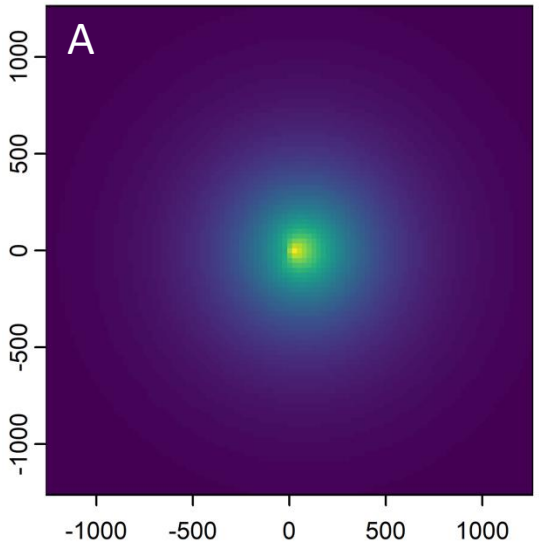
(Fortin 2005, Thurfjell 2014)

Resource and step selection functions

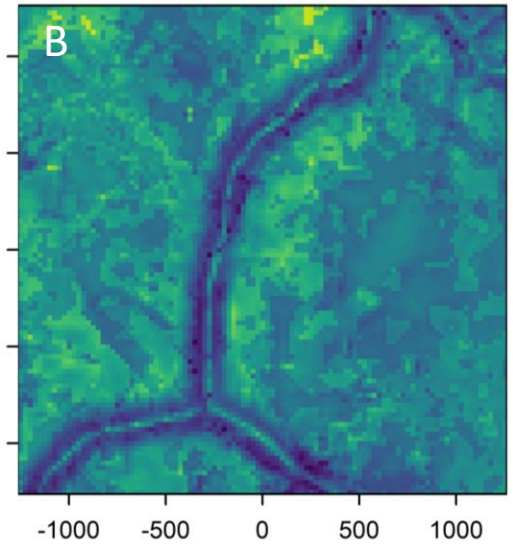


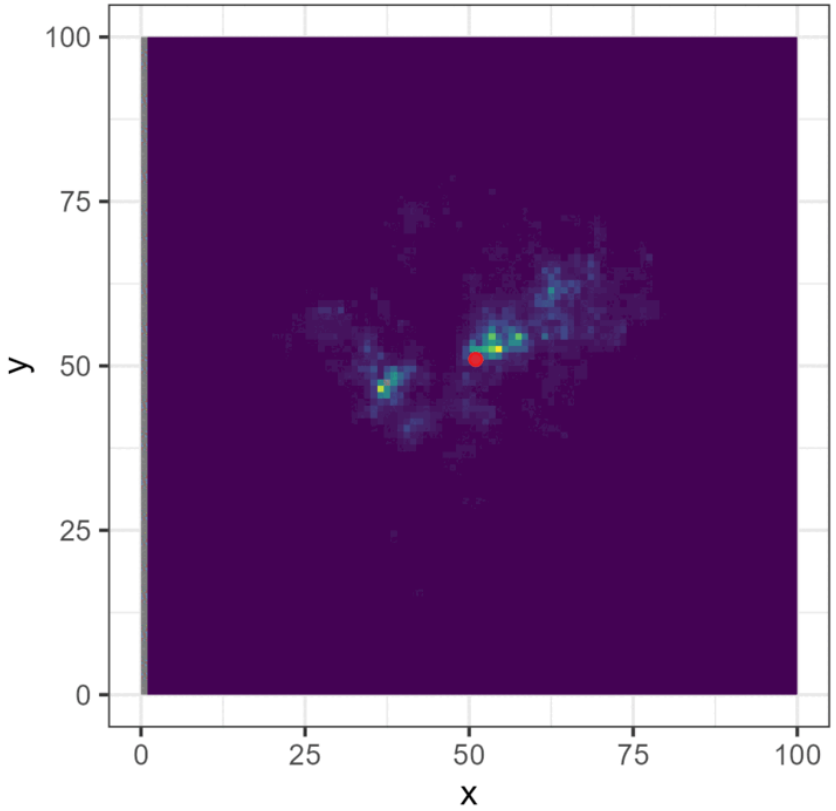


Movement



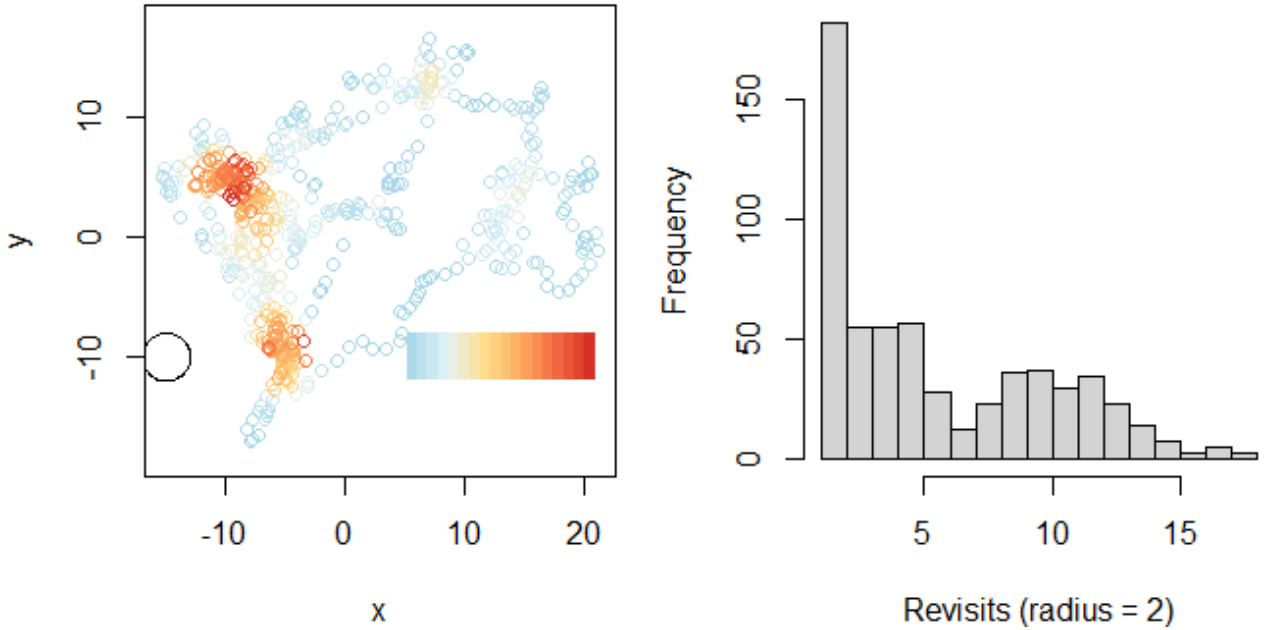
Habitat selection



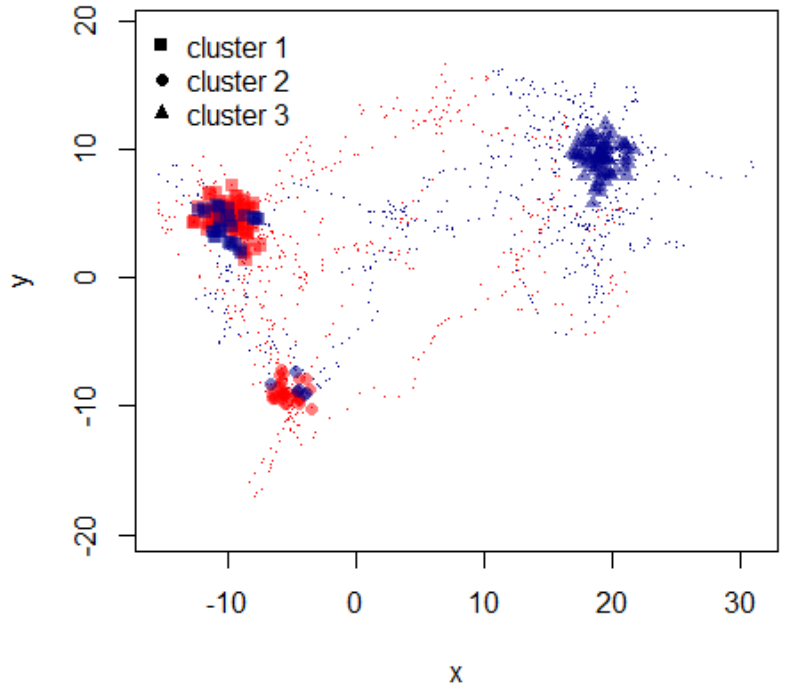


Revisitation analysis

- Where did the animal 'revisit'?



clusters of locations to identify important areas



Figures from: https://cran.r-project.org/web/packages/recurse/vignettes/recurse.html

Social network analysis

- Assessing connections between individuals based on proximity (in space and time)

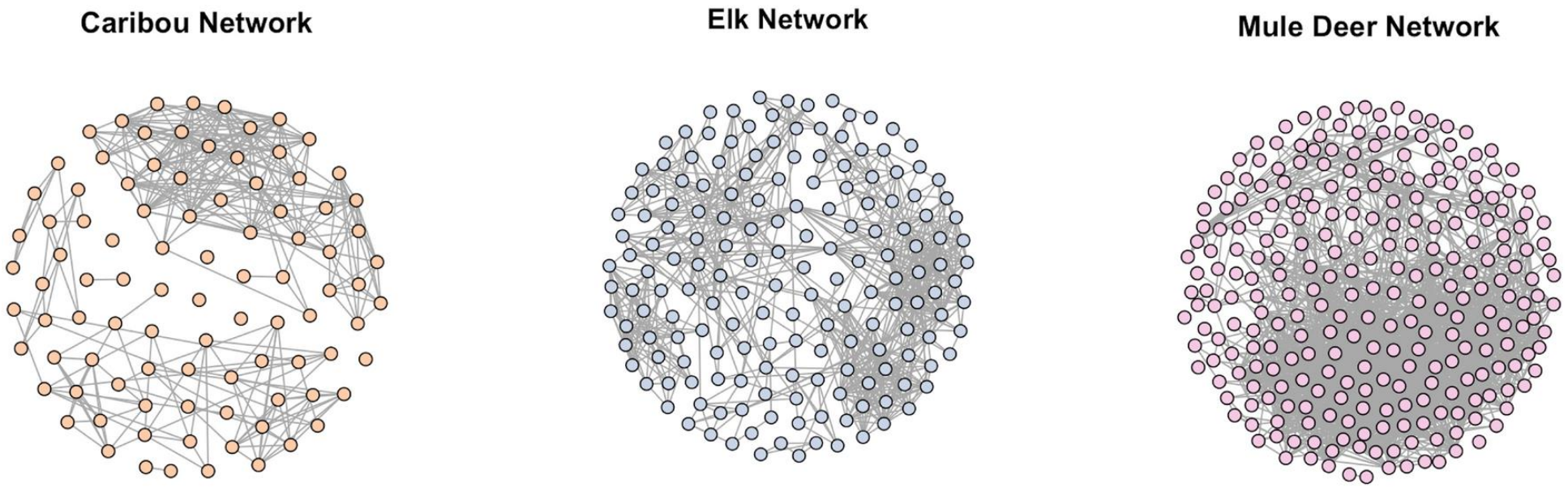


Figure from Kaur et al. (2024)

Suggested workflow and delegation of tasks

- Develop your research question
- Determine what quantity you need to answer that question
- Use the resources on the website, and look for packages, papers, tutorials online
- Divide tasks
  - Looking for resources/tutorials
  - Getting data into appropriate format
  - Running analyses
  - Creating figures
  - Documenting methods
- Feel free to move between groups if you want
- Remember – not a competition – the aim is to learn!

Note on the use of generative AI – go for it but make sure you understand the code!

- good for understanding general approaches and generating basic code
- does not always capture specifics of animal movement

Collaborative journal article

- How can we get the most out of movement datasets?
- Showcasing outputs from each team
- Outlining the process of the workshop
- Everyone can be a co-author
- Would require follow-up for tidying analyses, figures etc, and for putting the paper together

EOI and feedback form
(fill out to be co-author)

Looking forward

- What workshops would you like to see in the future?
- MoveSIN - https://movesin.github.io/website/

MoveSIN