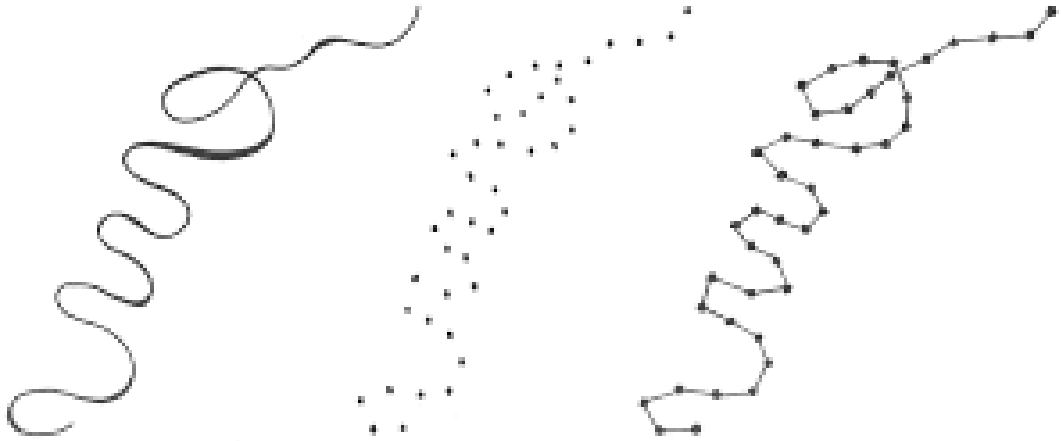
Descriptive Statistics of Movement Data



Johannes Signer

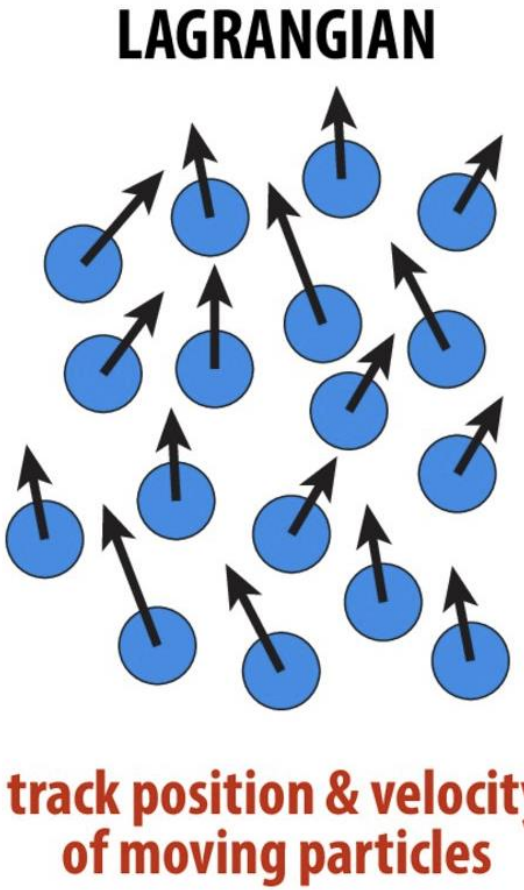
Animal Movement Course 2025

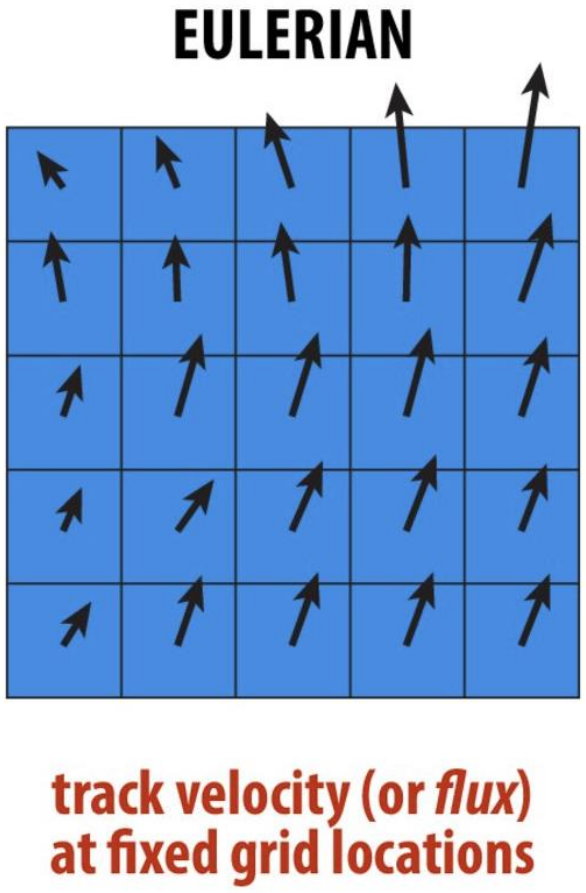
Source image: https://aliceblogs.ch/drawing-the-animals-movement/

Aim for this lecture:

- What is the difference between Lagrangian and Eulerian view on movement data.
- Movement models in discrete and continuous time.
- How to characterize (animal) movement in discrete time.

Eulerian vs. Lagrangian representation





- Lagrangian: tracking individual animals (e.g., with GPS collars). Study at the individual level.
- Eulerian: tracking animals from fixed points (e.g., with camera traps). Study at the population level.

Source: https://15462.courses.cs.cmu.edu/fall2018/lecture/pdes/slide_023

An example

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ARTICLE

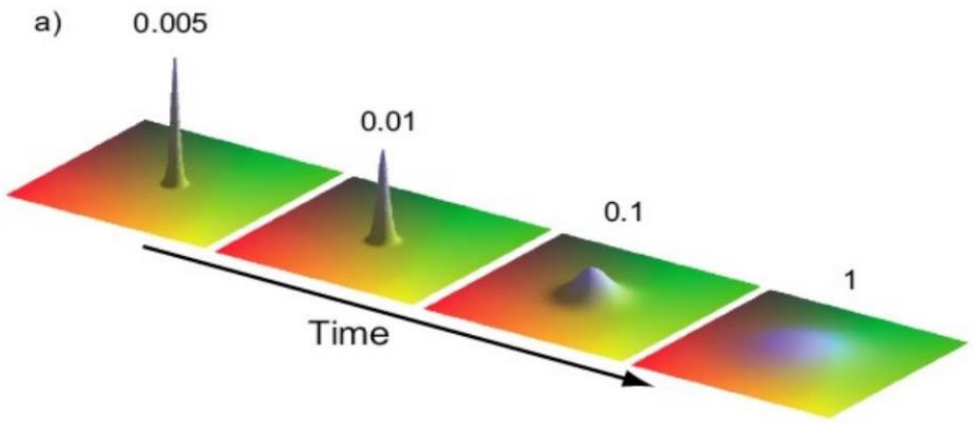
ECOLOGICAL APPLICATIONS
ECOLOGICAL SOCIETY OF AMERICA

Are we telling the same story? Comparing inferences made from camera trap and telemetry data for wildlife monitoring

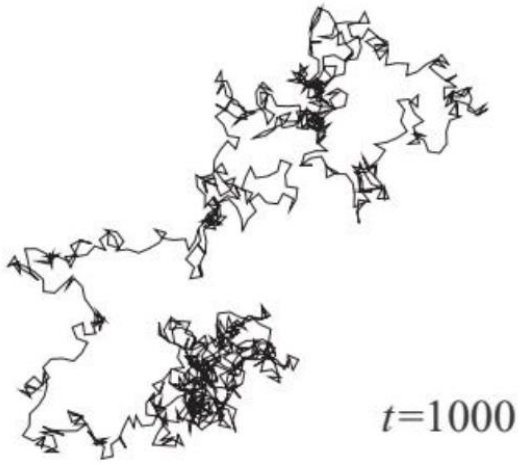
Sarah B. Bassing[1] | Melia DeVivo[2] | Taylor R. Ganz[1] | Brian N. Kertson[3] | Laura R. Prugh[1] | Trent Roussin[1,4] | Lauren Satterfield[1] | Rebecca M. Windell[1] | Aaron J. Wirsing[1] | Beth Gardner[1]

	Lagrangian	Eulerian
Scale	Individual	Population
Data collection	GPS telemetry	Camera traps
Analysis	Resource selection functions (RSF)	Occupancy models

Continuous vs. discrete time stochastic process



Models for velocity in continuous time:
e.g., CRAWL and ctmm.

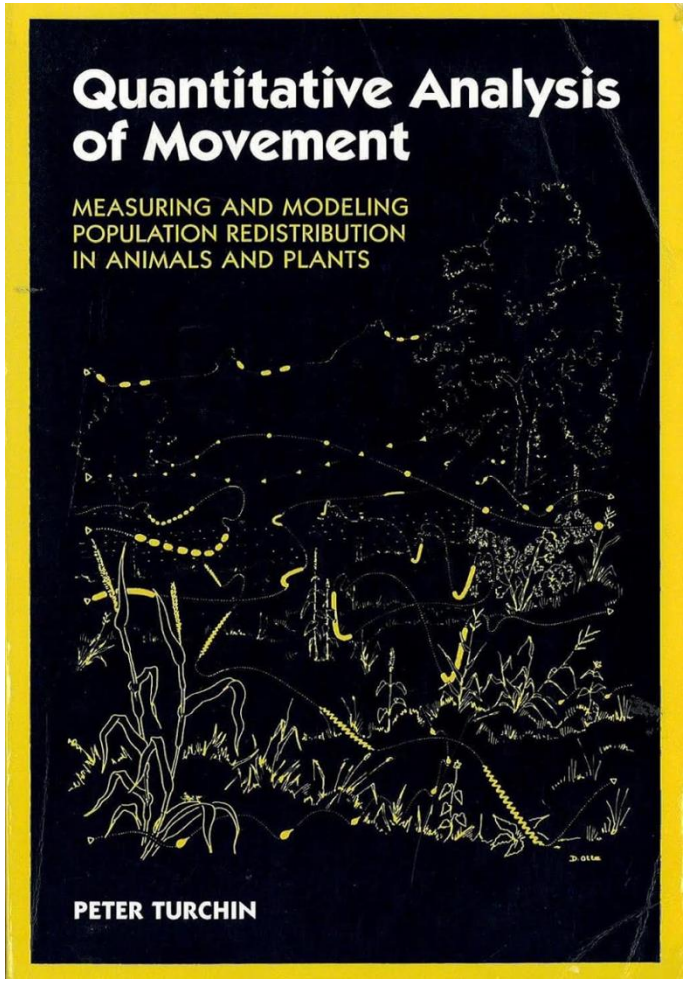


Models for step length in discrete time:
e.g., moveHMM and amt.

How to represent movement

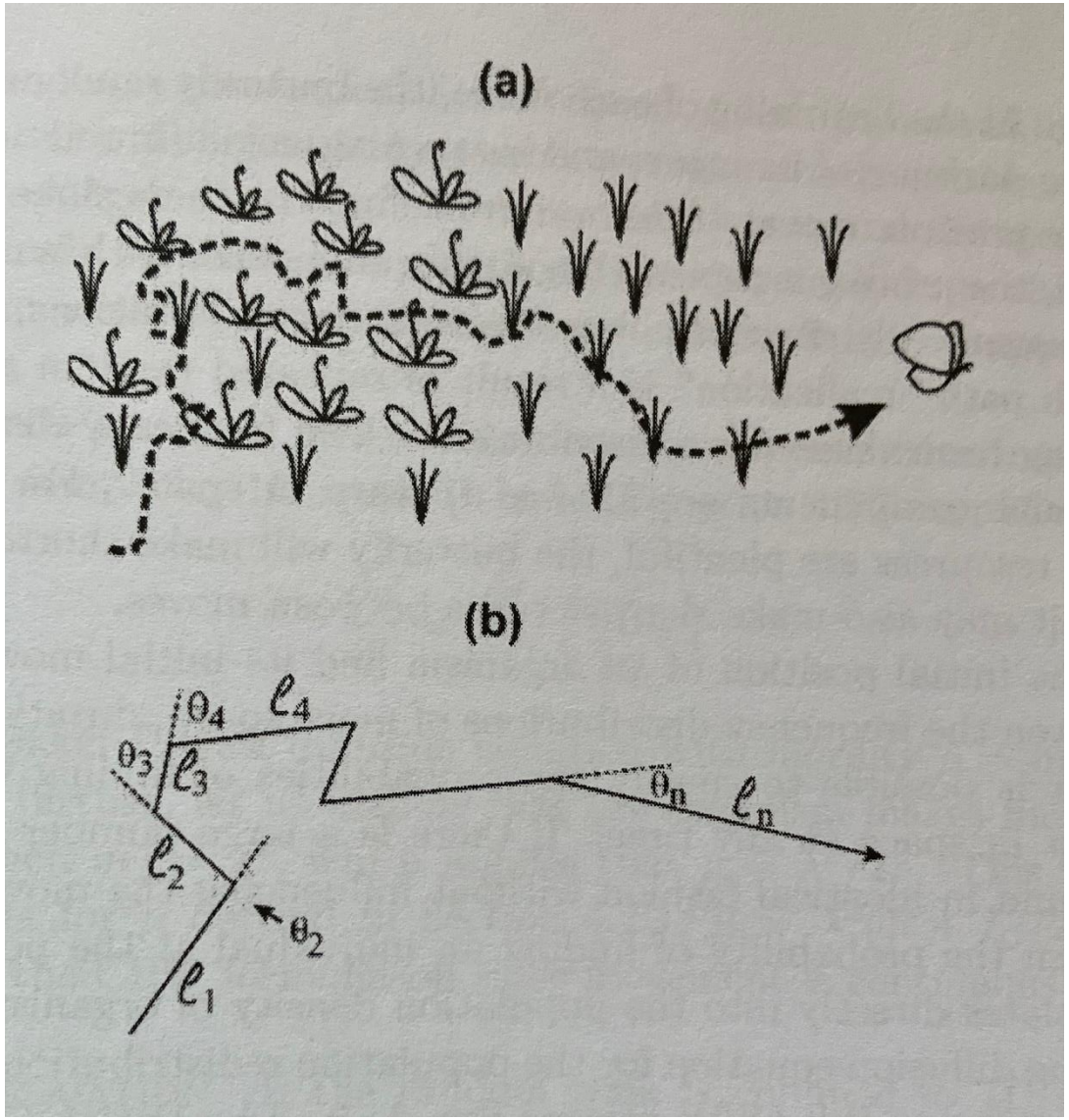
- **Path:** continuous trace of an animal moving through space from the beginning to the end of observation.
- **Move:** Each *path* is represented as a series of straight-line *moves*. Each move is defined as the displacement between two consecutive stopping points.
- **Steps:** Breakpoints of a path at regular time intervals.

Moves != steps



From path to steps

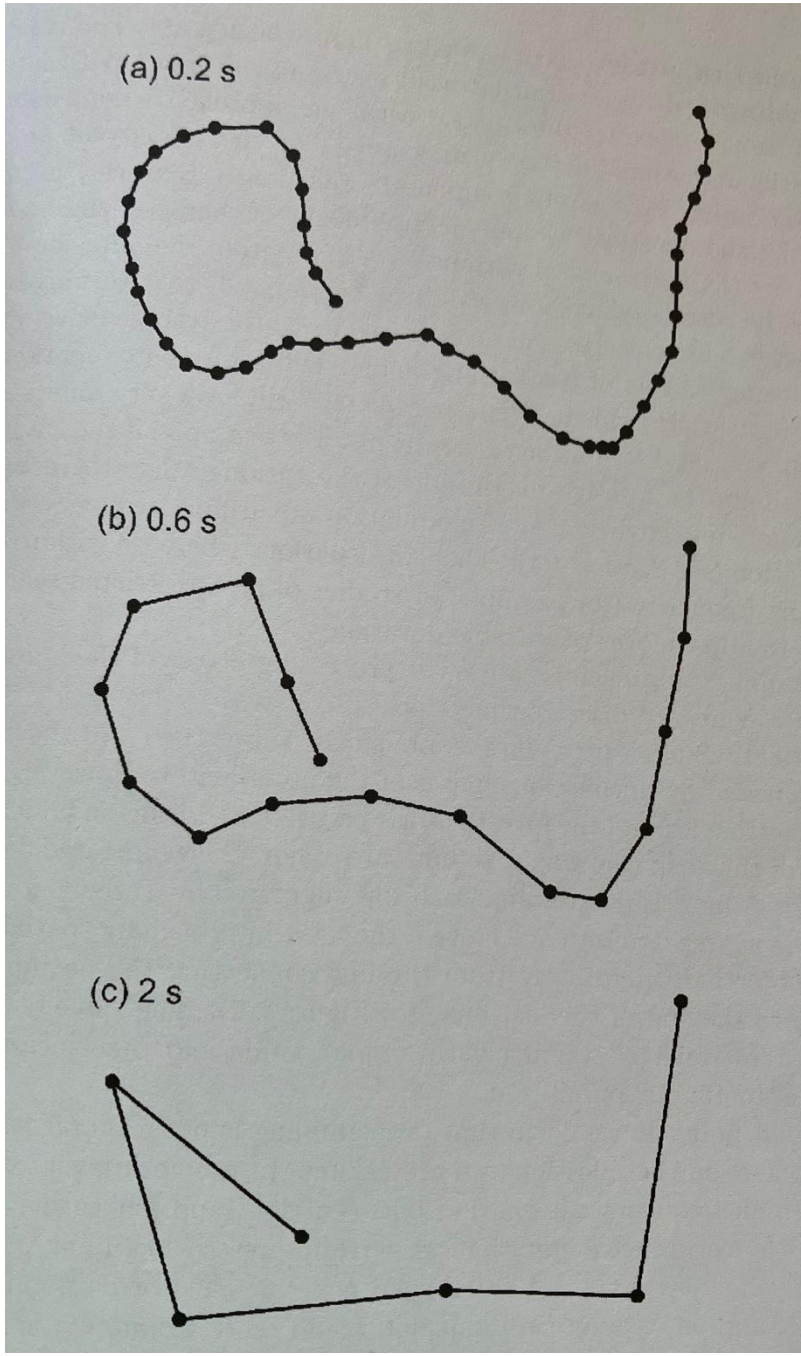
- The actual path (that how the animal actually moved through the landscape; panel a)
- Discrete representation of the steps.
- The sampling rate (i.e., how often the position is tracked) is often dictated by practical consideration (such as battery life time).



Source: Turchin 1998; p 99

Oversampling and under sampling

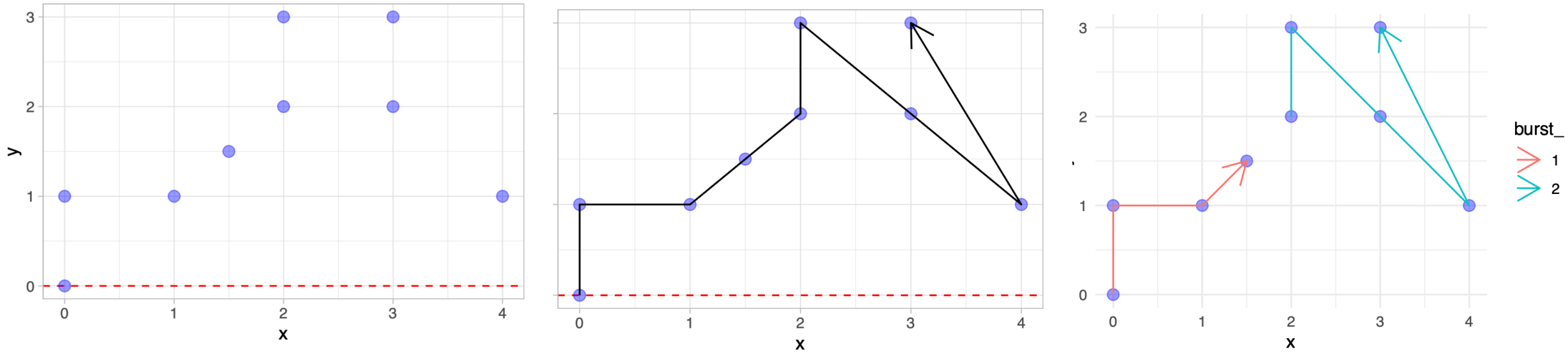
- What is the right sampling rate?
- 0.2s seem to be to fine and 2s probably to coarse.
- It all depends on what you want to know.
- Better to fine than to coarse.



Source: Turchin 1998; p131

Bursts

- Often we have missing data (i.e., dt between two relocations is not constant).
- **Burst:** parts of track with constant sampling rate.



Step lengths and turn angles

Ecology and Evolution

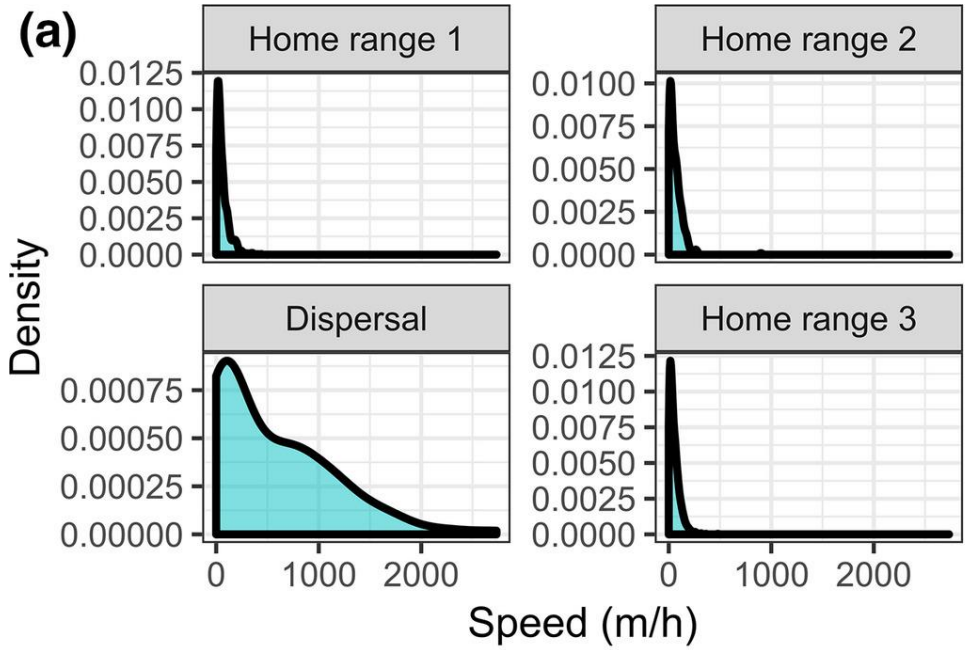
Forward Series

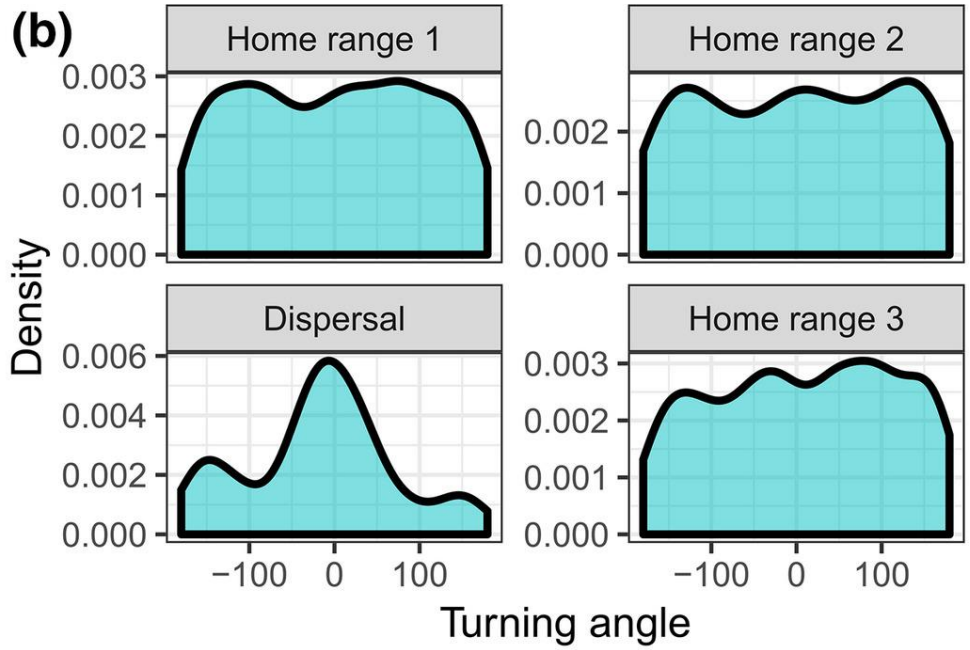
NATURE NOTES | Open Access

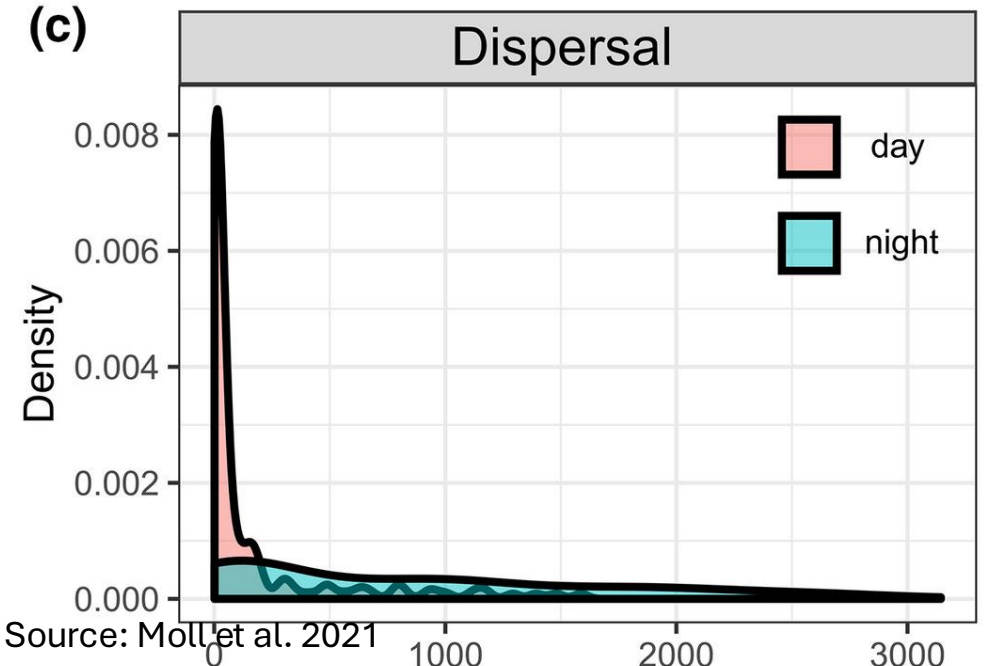
A rare 300 kilometer dispersal by an adult male white-tailed deer

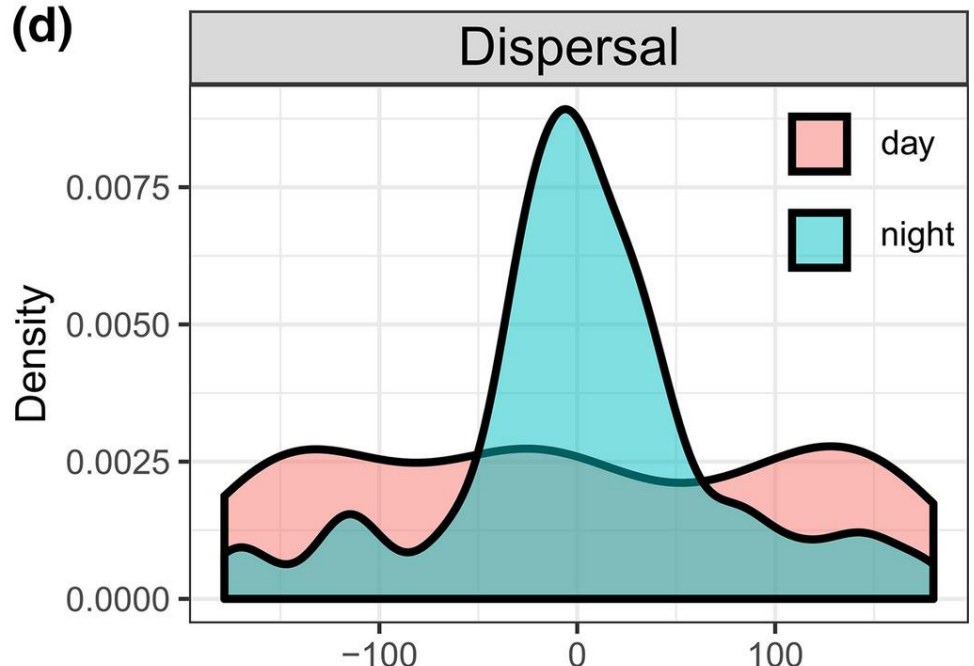
Remington J. Moll, Jon T. McRoberts, Joshua J. Millspaugh, Kevyn H. Wiskirchen, Jason A. Sumners, Jason L. Isabelle, Barbara J. Keller, Robert A. Montgomery

First published: 09 March 2021 | https://doi.org/10.1002/ece3.7354 | Citations: 10





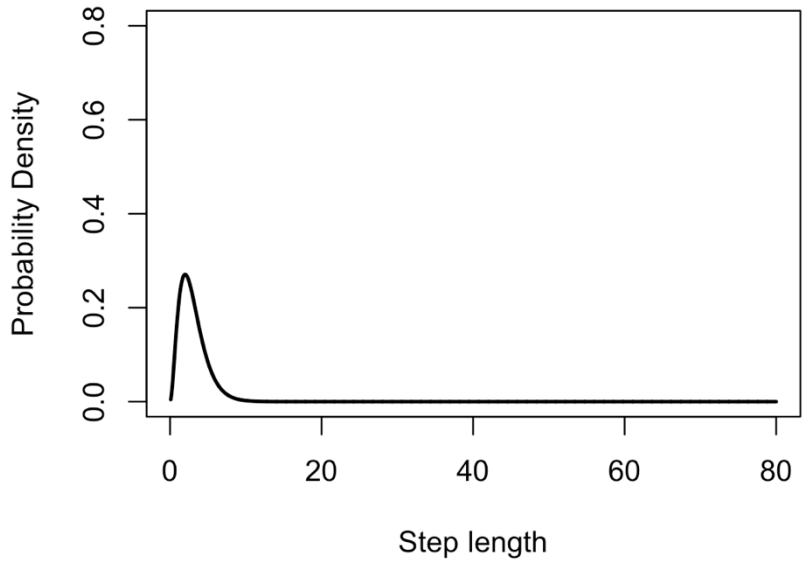


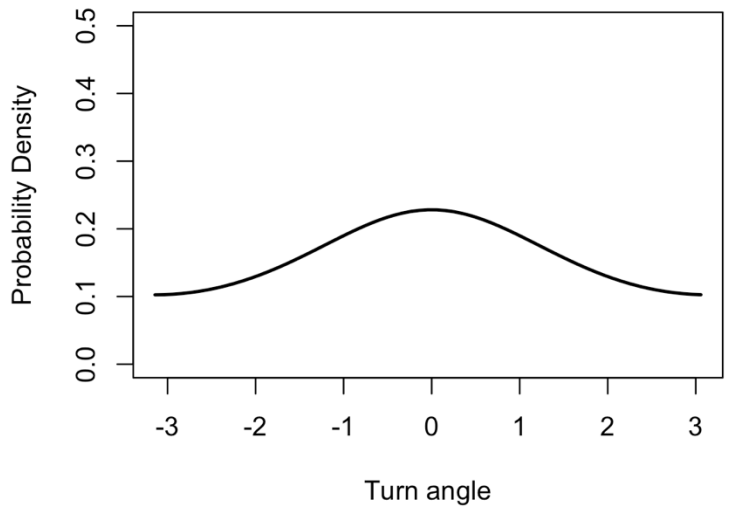


Source: Moll et al. 2021

How to represent animal movement?

- Use of a simple model with statistical distributions for step length and turn angles.
- **step lengths** (e.g., gamma or exponential distribution) and
- **turn angles** (e.g., von Mises distribution)





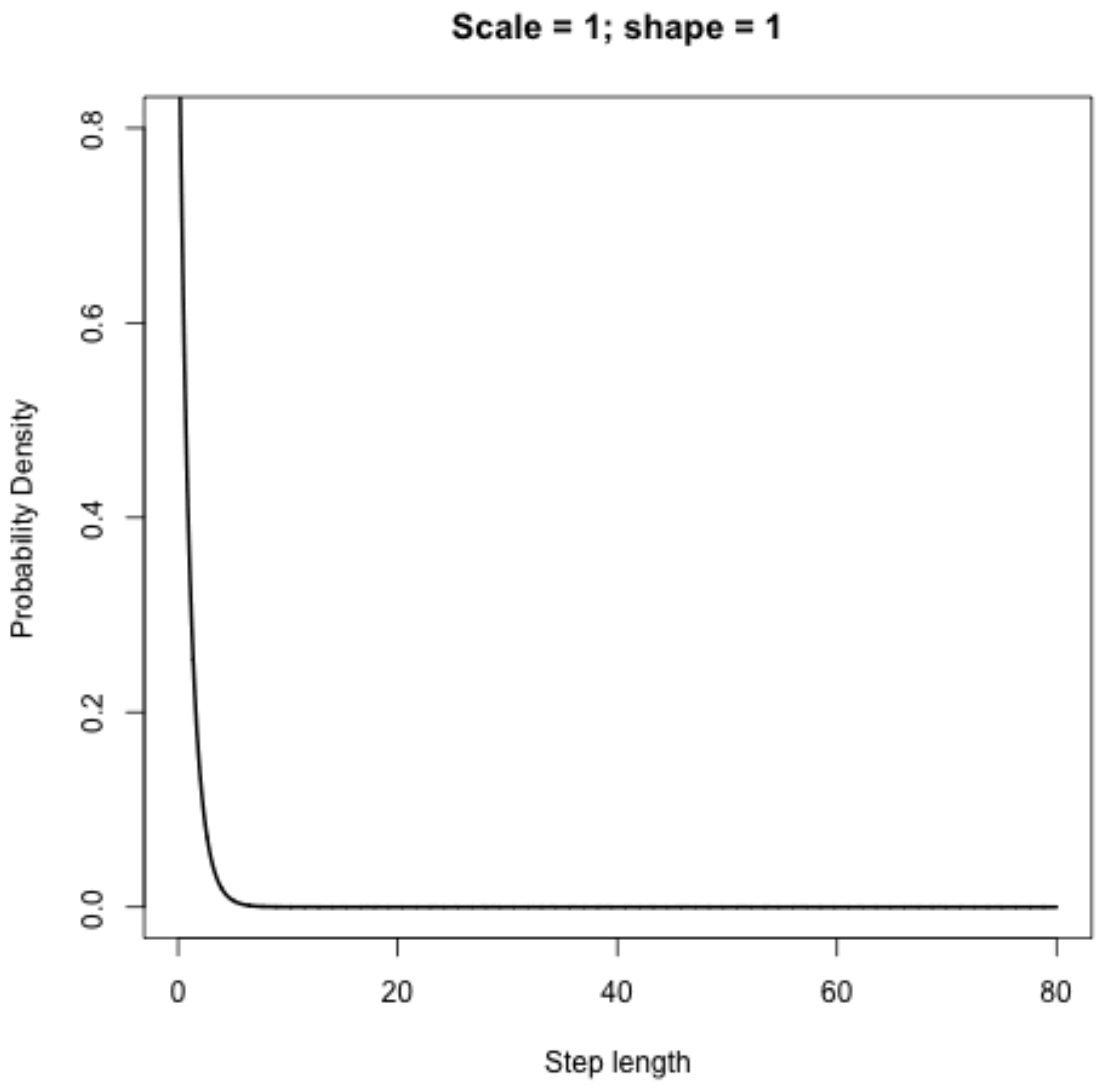
Step-length distributions

- Gamma distribution with two parameters: **shape** and **scale.**

Your turn:
Open R and try different parametrization of a gamma distribution:

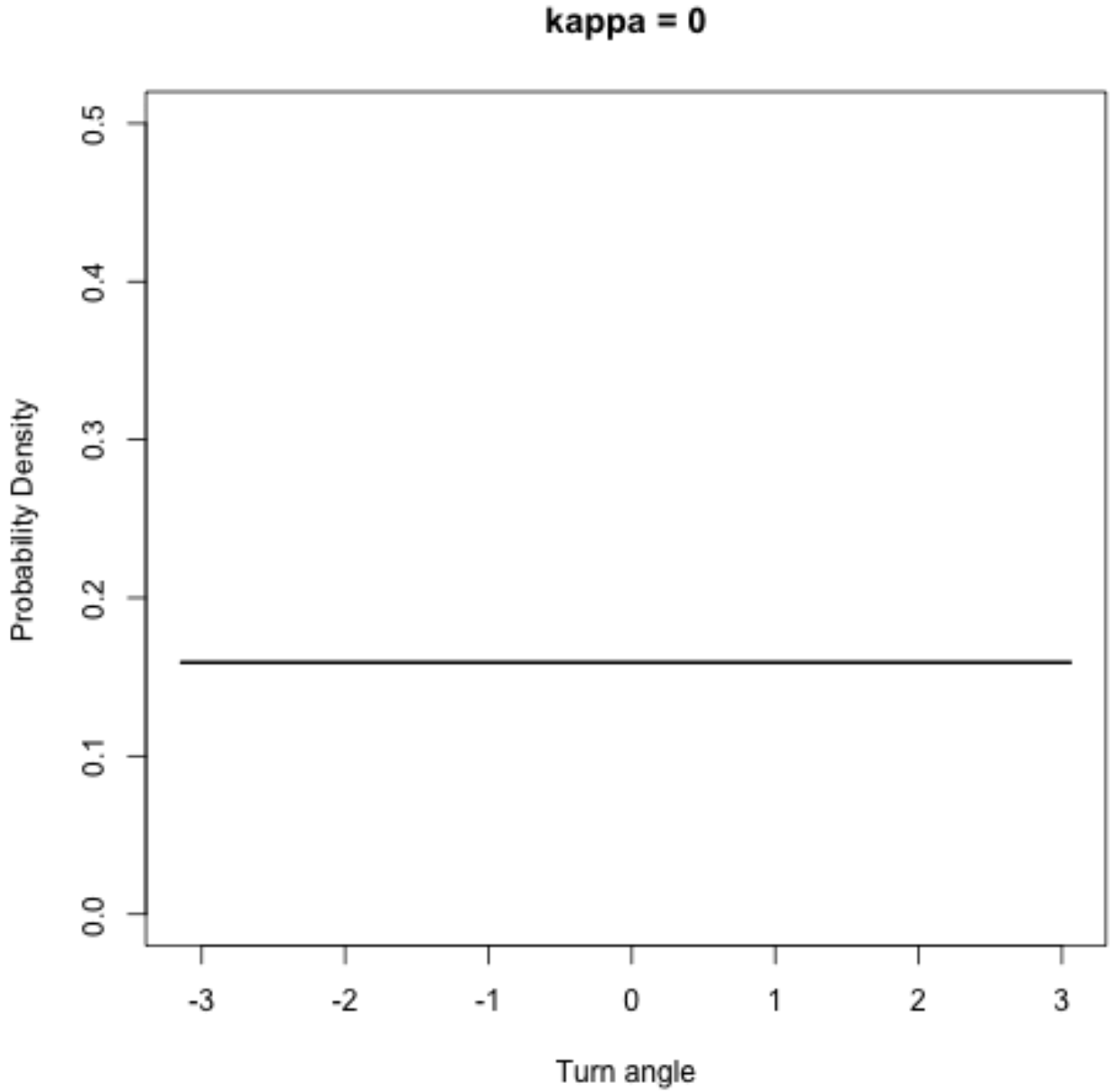
x <- seq(0, 80, 0.01)
plot(x, dgamma(x, scale = 1, shape = 2), type = ”l”)

Try different values for shape and scale. What happens if you fix the shape at 1?



Turn-angle distribution

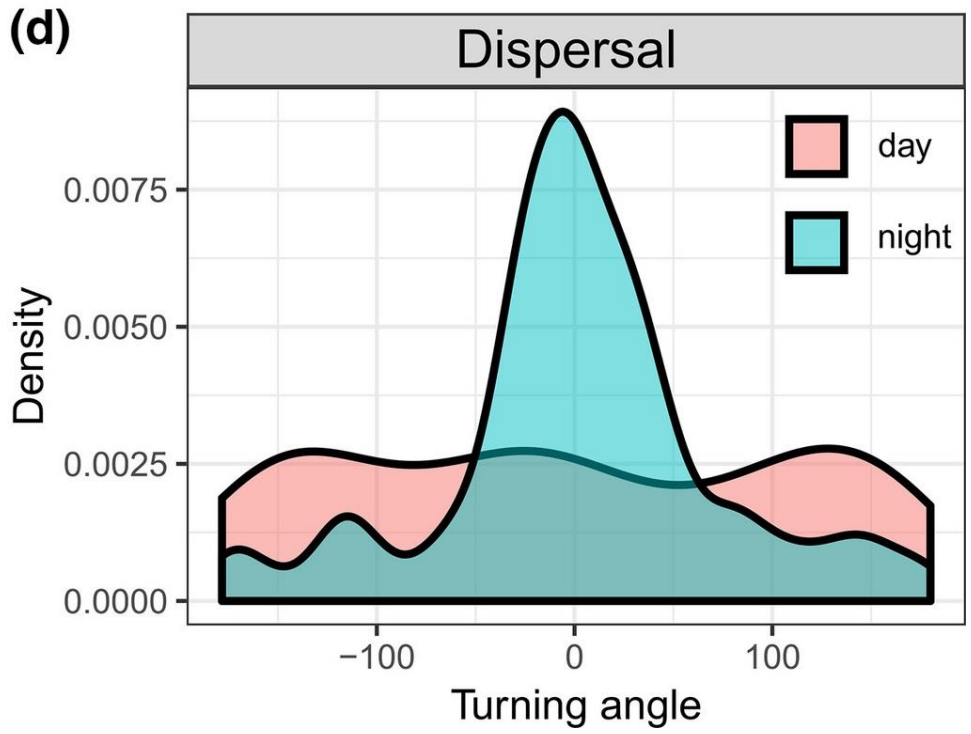
- Uniform distribution needed.
- Typically von Mises distribution used.
- Two parameters:
  - location (set to 0)
  - concentration (0 = uniform distribution; the larger the more concentrated).
- In R: von Mises distribution is implemented in the **circular** package



Your turn:

What if we had fitted a von Mises distribution to these observed turn angles?

Do you think we would observe a larger **kappa** value (the concentration parameter) during the *day* or at *night*?



Exercise (approx. 60 min)

- How to read movement data in R and to resample it.
- How to deal with multiple animals.