Exploring Movement Characteristics

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Questions

Large-scale movement patterns:

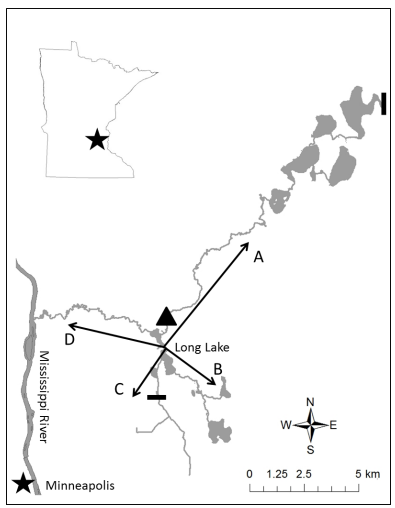
- Nomadism, home range, migratory
- Do all individuals migrate and in all years?

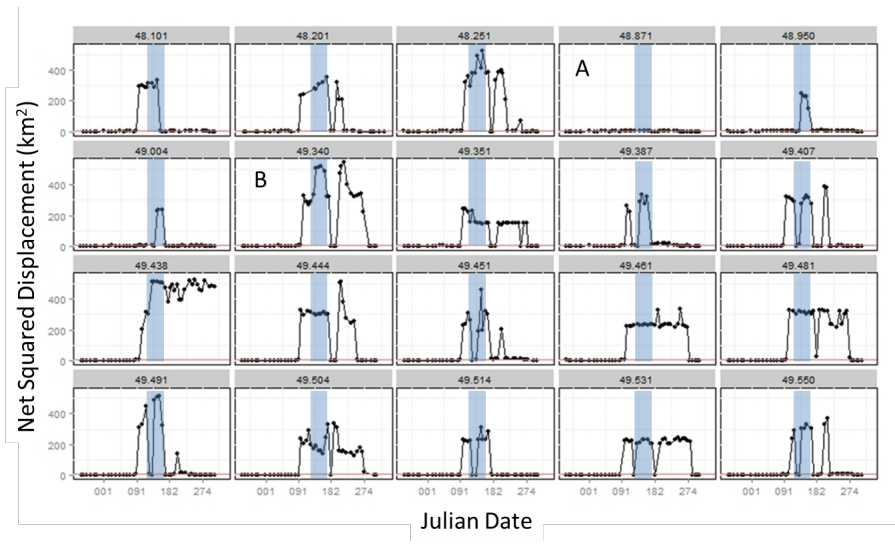
Fine-scale movement patterns:

- Do animals move more/less during the middle part of the day?
- Do animals display different movement strategies in different habitat types?

General movement strategies

Net Squared Displacement = squared distance from a starting location (x_0, y_0)





Shaded areas = spawning

Semivariance

Describe “closeness” in space as a function of “closeness” in time.

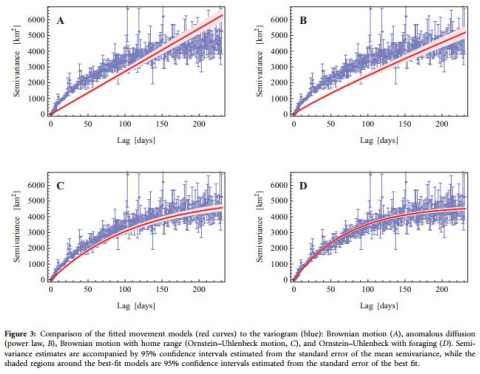


Figure 3: Comparison of the fitted movement models (red curves) to the variogram (blue): Brownian motion (*A*), anomalous diffusion (power law, *B*), Brownian motion with home range (Ornstein–Uhlenbeck motion, *C*), and Ornstein–Uhlenbeck with foraging (*D*). Semivariance estimates are accompanied by 95% confidence intervals estimated from the standard error of the mean semivariance, while the shaded regions around the best-fit models are 95% confidence intervals estimated from the standard error of the best fit.

Fleming, C.H., Calabrese, J.M., Mueller, T., Olson, K.A., Leimgruber, P. and Fagan, W.F., 2014. From fine-scale foraging to home ranges: a semivariance approach to identifying movement modes across spatiotemporal scales. The American Naturalist, 183(5), pp.E154-E167.

Fine-scale Movement

Discrete time (steps connecting regularly spaced observations)

- step length
- turn angles

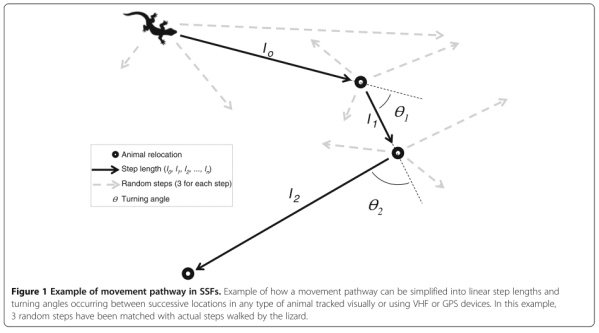


Figure 1 Example of movement pathway in SSFs. Example of how a movement pathway can be simplified into linear step lengths and turning angles occurring between successive locations in any type of animal tracked visually or using VHF or GPS devices. In this example, 3 random steps have been matched with actual steps walked by the lizard.

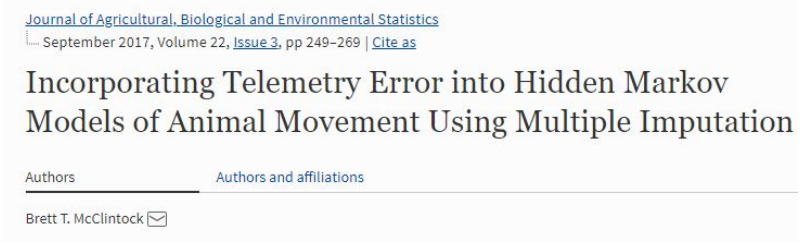
Thurfjell et al. 2014. Applications of step-selection functions in ecology and conservation. Movement Ecology 2:4

Fine-scale Movement

Continuous time (can handle irregularly spaced observations)

- See: https://github.com/ctmm-initiative/ctmmweb
- https://ctmm.shinyapps.io/ctmmweb/

Can also use to create regular trajectories:


Journal of Agricultural, Biological and Environmental Statistics
September 2017, Volume 22, Issue 3, pp 249–269 | Cite as

Incorporating Telemetry Error into Hidden Markov Models of Animal Movement Using Multiple Imputation

Authors | Authors and affiliations

Brett T. McClintock

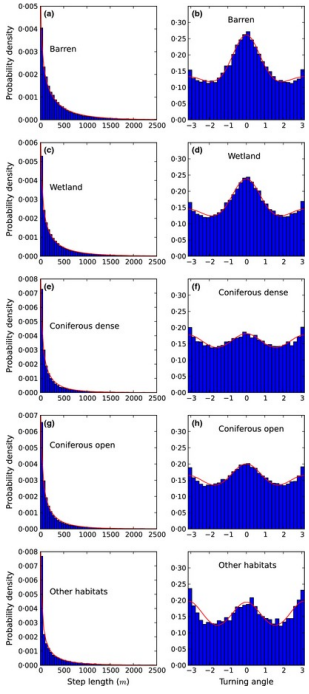
Movement Statistics

Quantify differences in the distribution of step lengths and turn angles as a function:

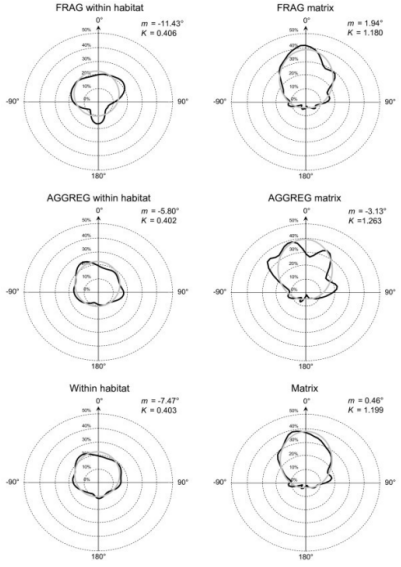
- Habitat type
- Time of day/season
- Individual characteristics: sex, age, weight

How?

- Descriptive statistics (using `amt`)
- Hidden Markov Models (using `momentuHMM`) that infer latent (unobserved) behavioral states
- Integrated step-selection models (using `amt`): include interactions between step-length or turn angle and habitat characteristics.



Potts et al. 2014. Predicting local and non-local effects of resources on animal space use using a mechanistic step selection model. Methods in Ecology and Evolution 5:253-262



Quantitative analysis of changes in movement behavior within and outside habitat in a specialist butterfly. Schtickzelle N, Joiris A, Van Dyck H, Baguette M - BMC Evol. Biol. (2007)

- Movements were straighter (smaller turning angles) in the matrix than in habitat.
- Black: observed (kernel density estimate; Grey curve: fitted von Mises (i.e. circular normal) distribution with mean m and concentration K.