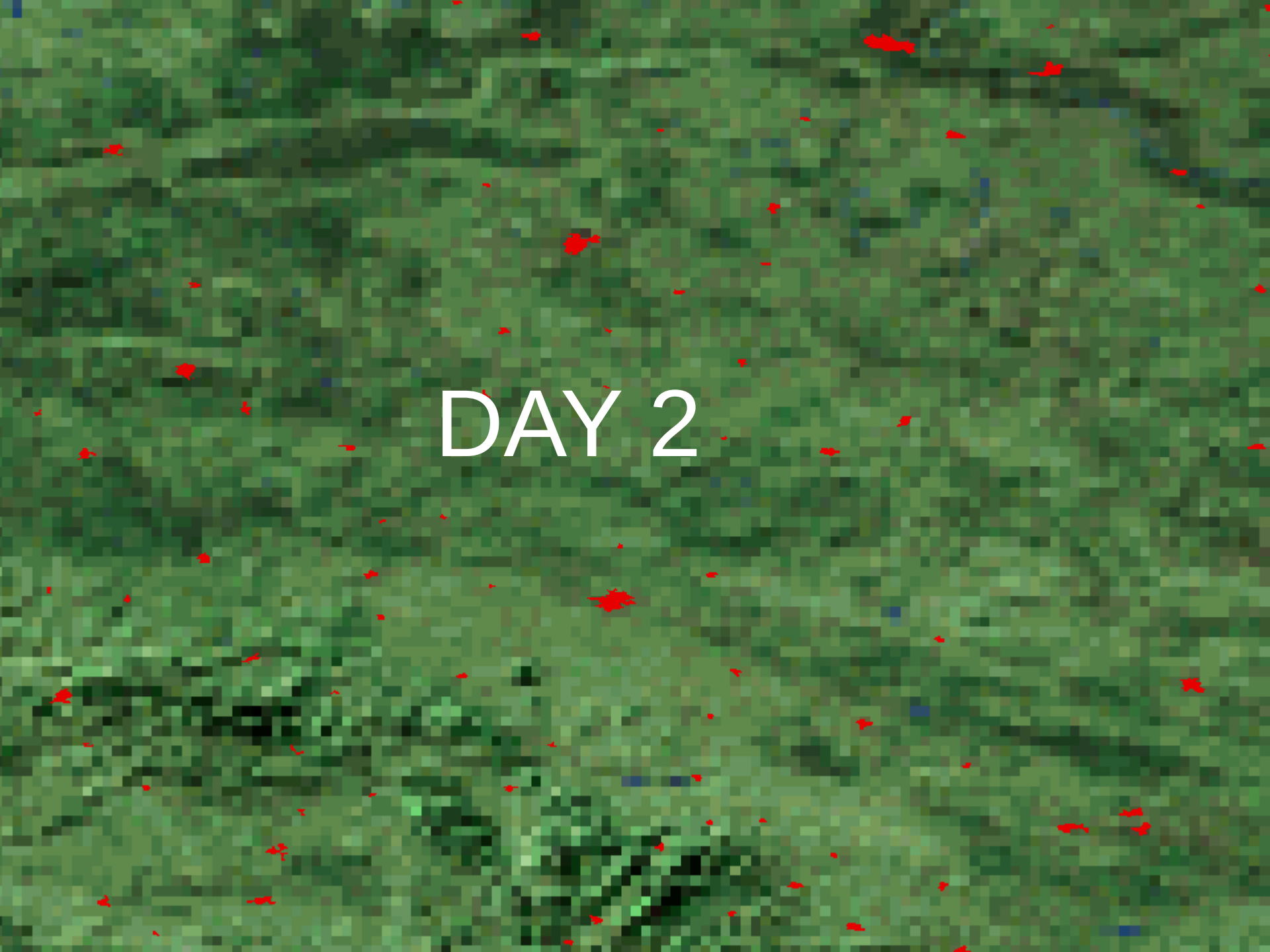
A roller coaster introduction to spatial analysis using R

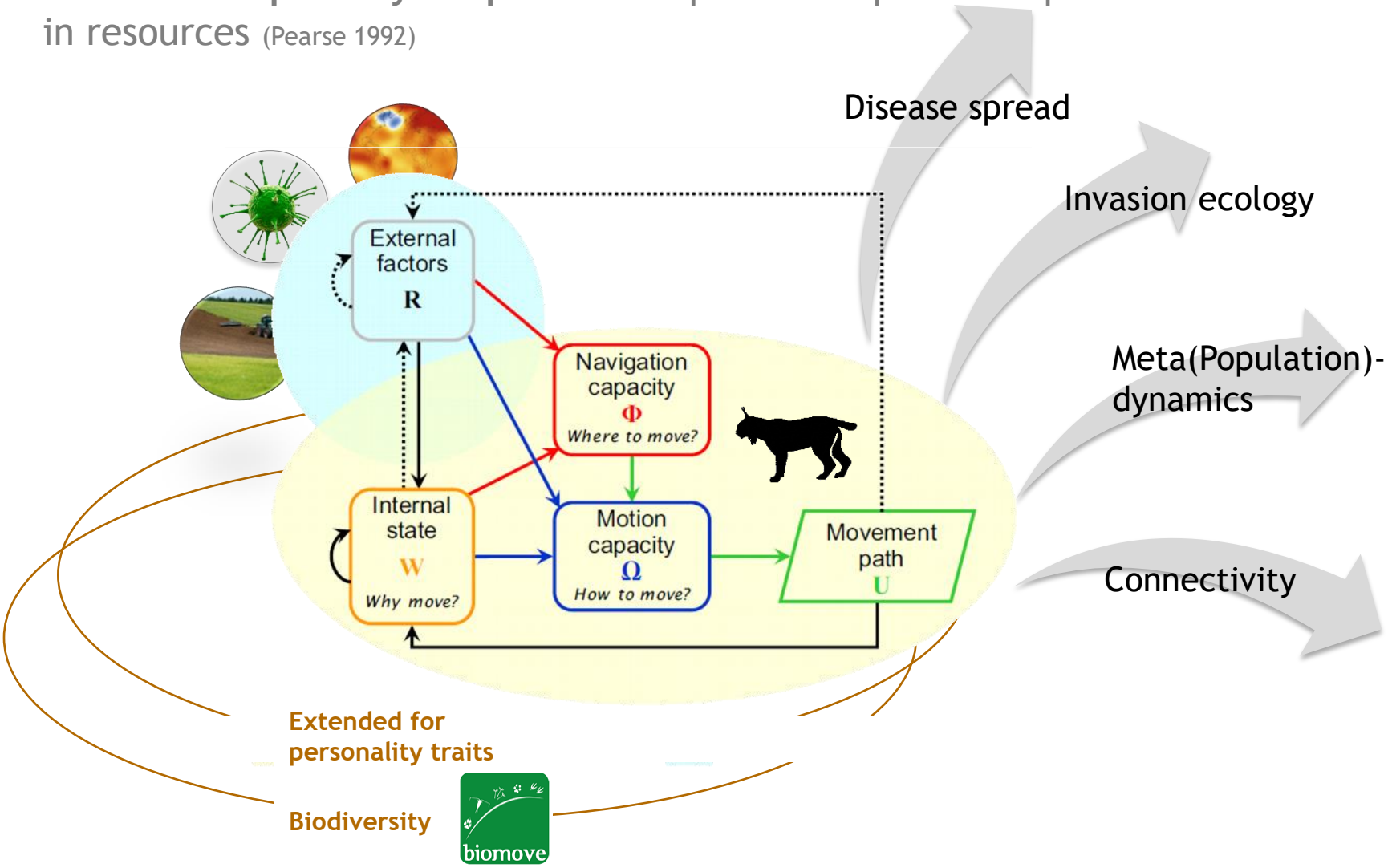
Photo by Mark Asthoff on Unsplash

Stephanie Kramer-Schadt (IZW)


DAY 2

Movement analysis

Movement is **primary adaptation** of species to spatio-temporal variation in resources (Pearse 1992)

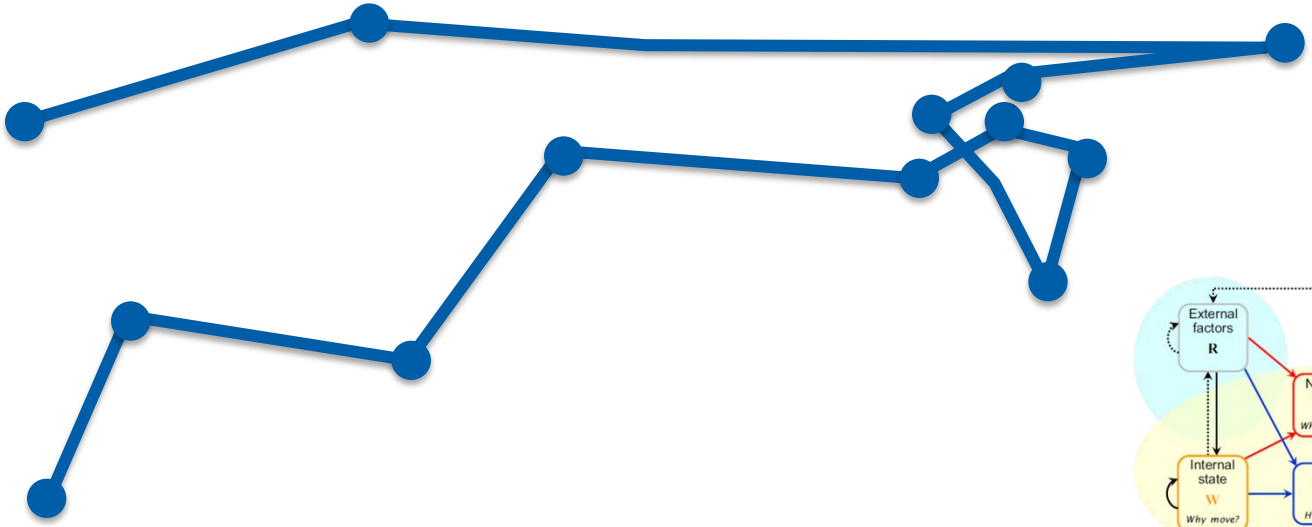


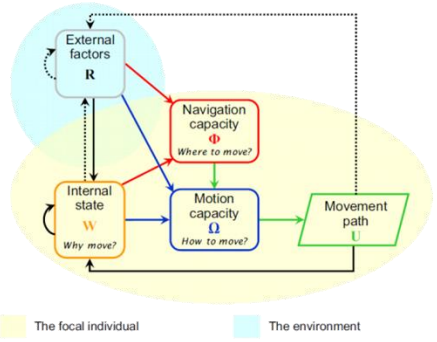
Based on frameworks by Nathan et al. 2008 PNAS, Spiegel et al. 2017 EcolLet, Jeltsch et al. 2013 Basic Appl Ecol

Movement analysis

How can we deduce from a line on internal states, motion capacity,

or effects of habitat etc?





Two frameworks

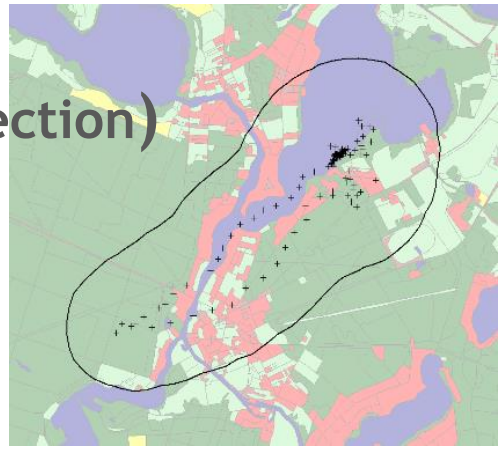
- Analysis of the **ranging area (& habitat selection)**

  MCP

  UD kernel

  aKDE, ….

R-packages
adehabitatHR
ctmm



Two frameworks

- Analysis of the **ranging area (& habitat selection)**

  MCP
  UD kernel
  aKDE, ….

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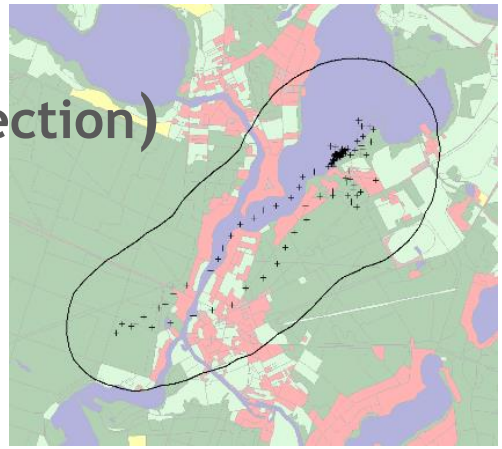
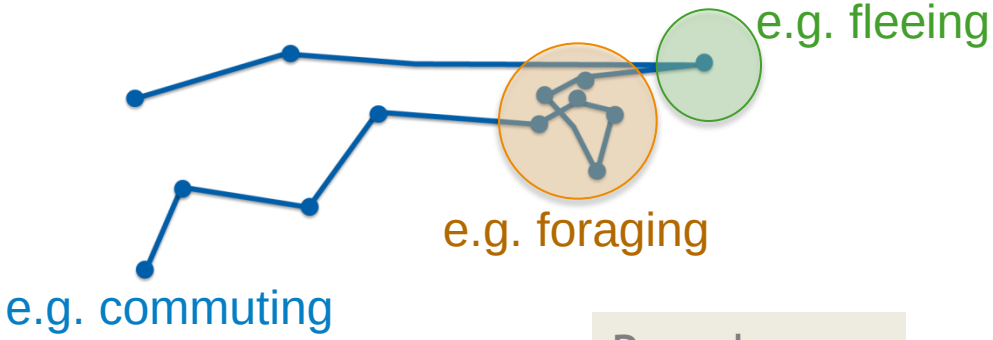
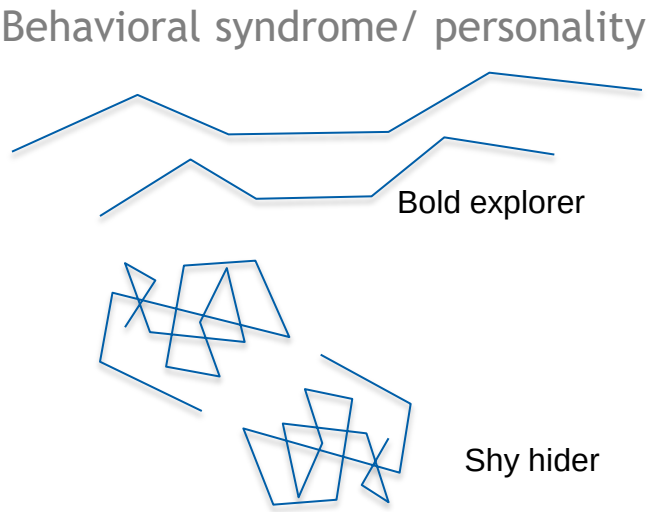


- Analysis of the **trajectory**

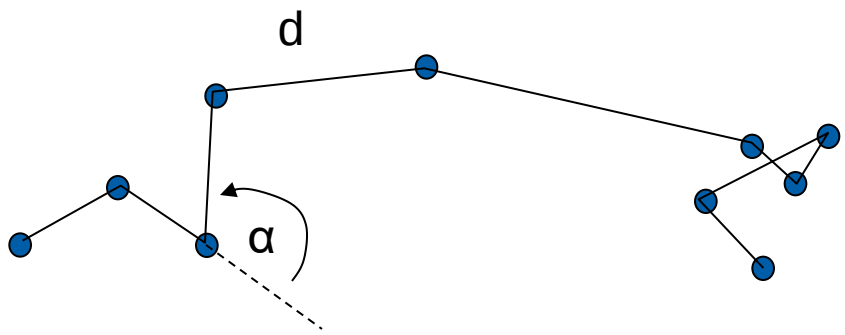
  Step length and turning angle distinguish movement types



R-packages
HMM
moveHMM

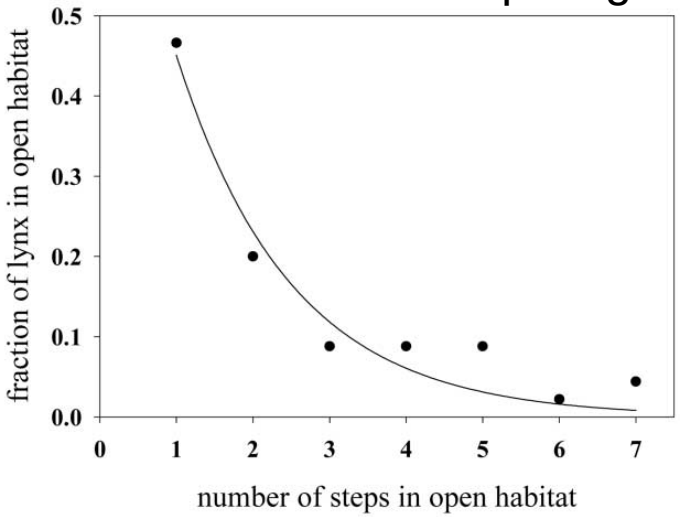


Movement pattern from trajectory

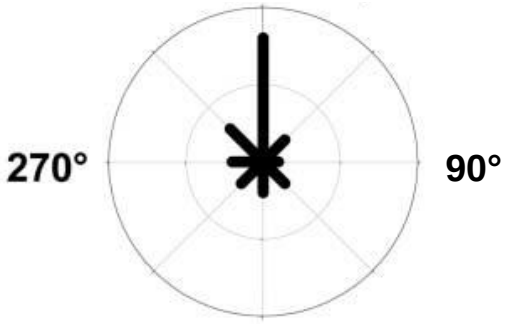


d – Step length
α – Turning Angle

Distribution of step length



Distribution of turning angles



Revilla et al. 2004, American Naturalist 164 (5) → Analysis-Protocol

Where to move from here? Two inspiring papers (for BioMove data)

DOI: 10.1111/1365-2656.13406

RESEARCH ARTICLE

Journal of Animal Ecology

Biologging reveals individual variation in behavioural predictability in the wild

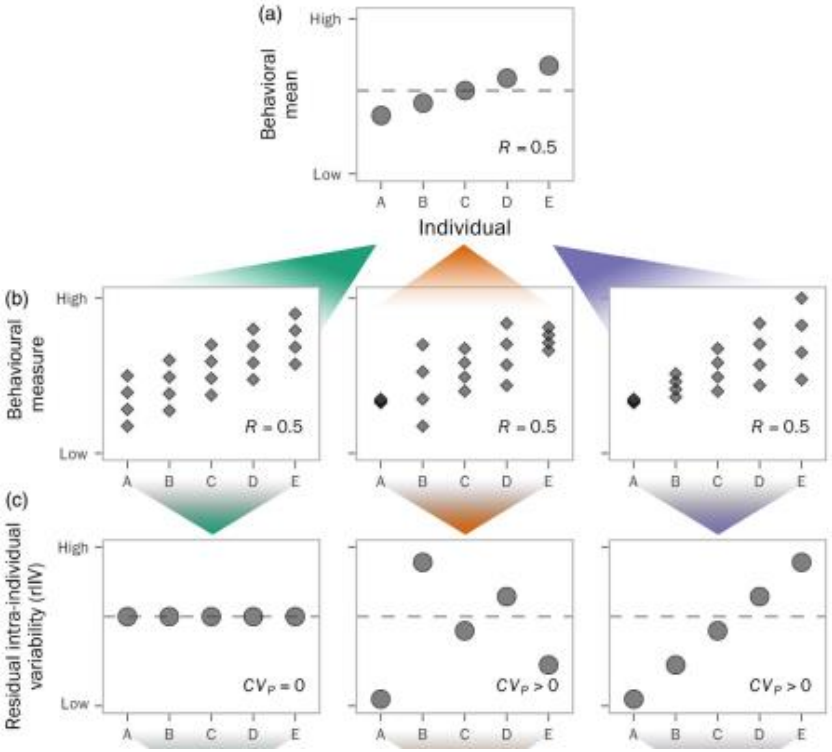
Anne G. Hertel[1,2] | Raphaël Royauté[3] | Andreas Zedrosser[2,4] | Thomas Mueller[1,5]

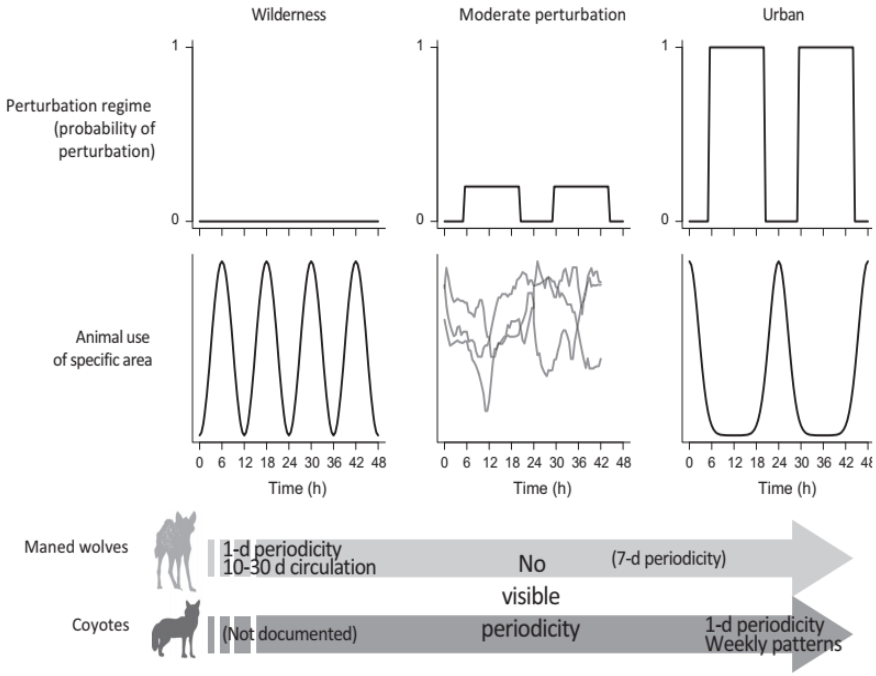
Ecological Monographs, 87(3), 2017, pp. 442–456
© 2017 by the Ecological Society of America

Periodic continuous-time movement models uncover behavioral changes of wild canids along anthropization gradients

Guillaume Péron,[1,2,7] Christen H. Fleming,[1,3] Rogerio C. de Paula,[4] Numi Mitchell,[5] Michael Strohbach,[6] Peter Leimgruber,[1] and Justin M. Calabrese[1,2]

predictability

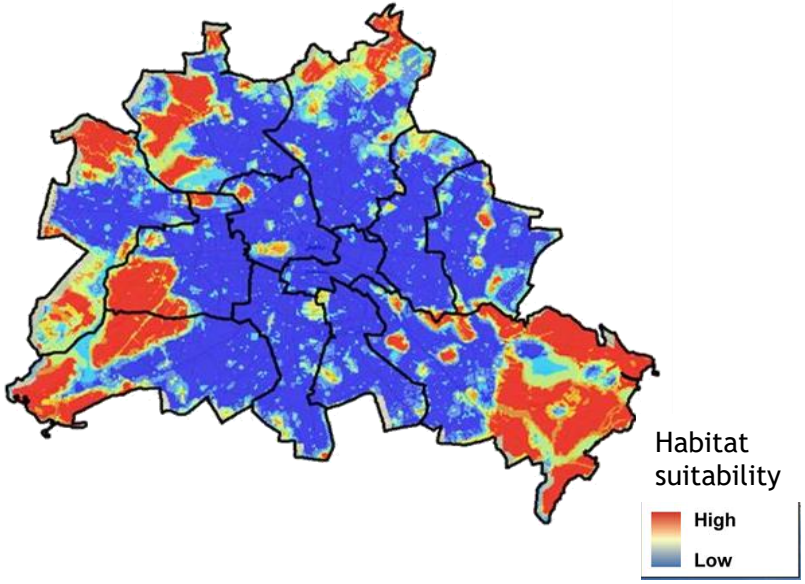




Behavioral adjustment in habitat use

Important landscape variables (urban green space)

- In the urban matrix wild boar select natural, undisturbed places and natural food
- use landscape of risk (alleys, parks, vicinity to streets and houses) to find food when human disturbance is low



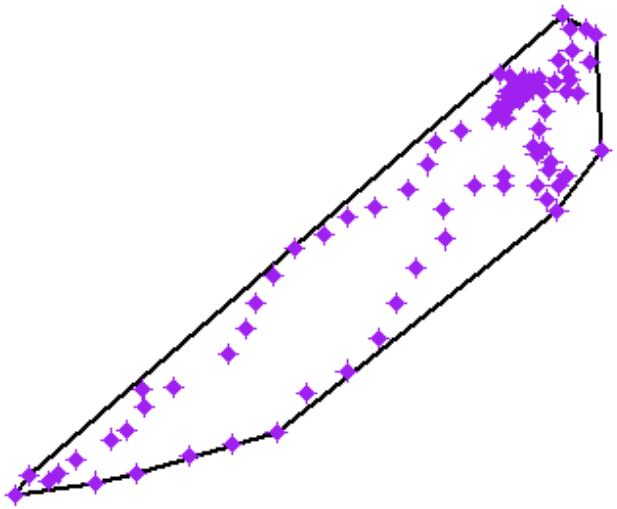
11 collared wild boar, ~ 80 000 locations, 30 min interval
Use vs availability design with correlated random walks (CRW)

Generalized linear mixed models
Binomial response: Wild boar vs. CRW / day vs. night
Predictor variables: Landscape, Origin rural vs urban, Season
AIC based model selection of candidate models

2 - Space use

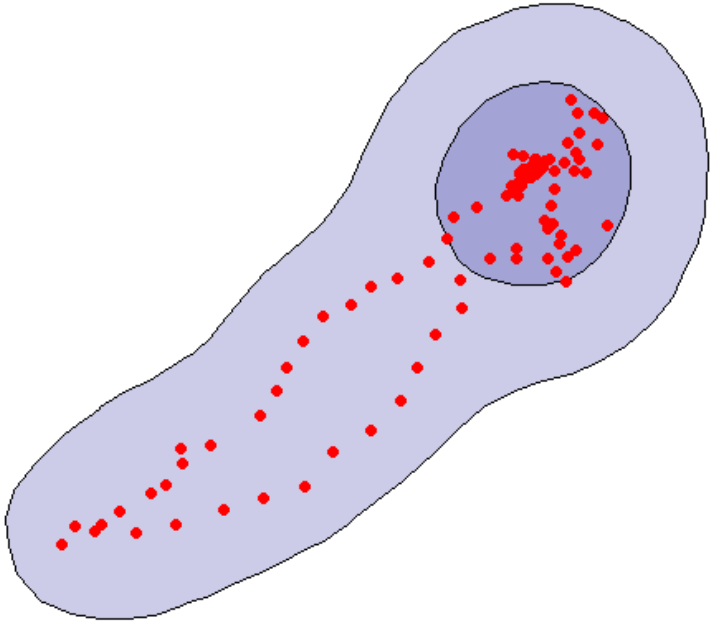
MCP:

Minimum convex polygon



KDE:

Area with estimated density



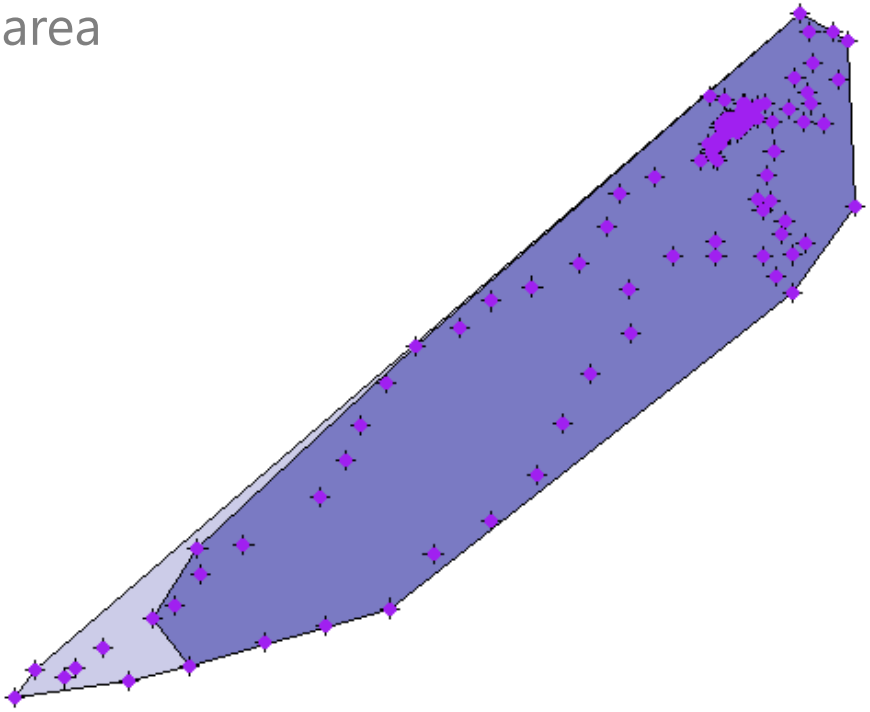
@Manuel Röleke

Space use
-> Minimum Convex Polygon MCP

Connect the outer points

Normally 95% closest to the gravity center to remove outliers

Encapsulates area

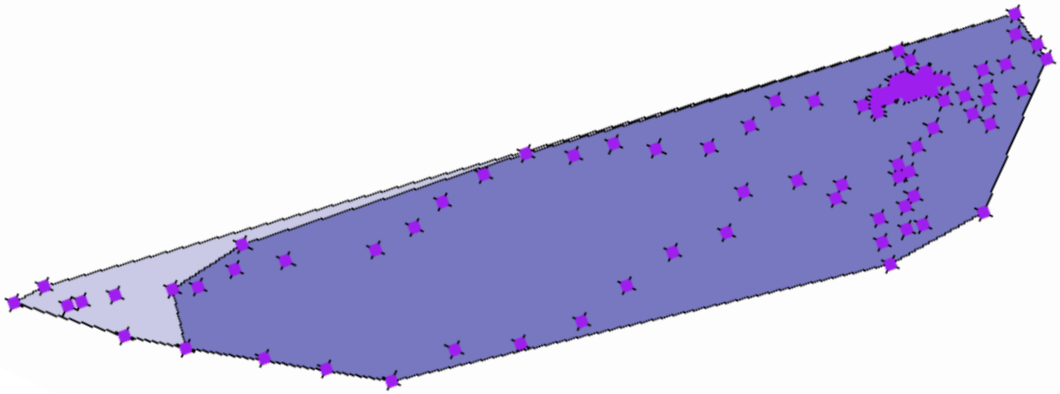


@Manuel Röleke

Space use
-> Minimum Convex Polygon MCP

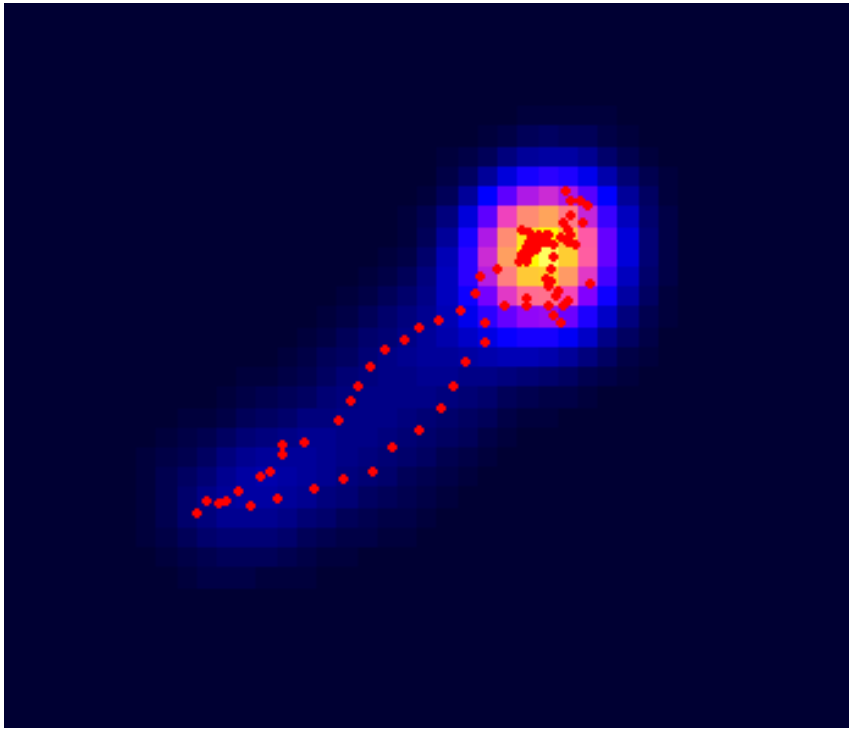
Drawbacks:

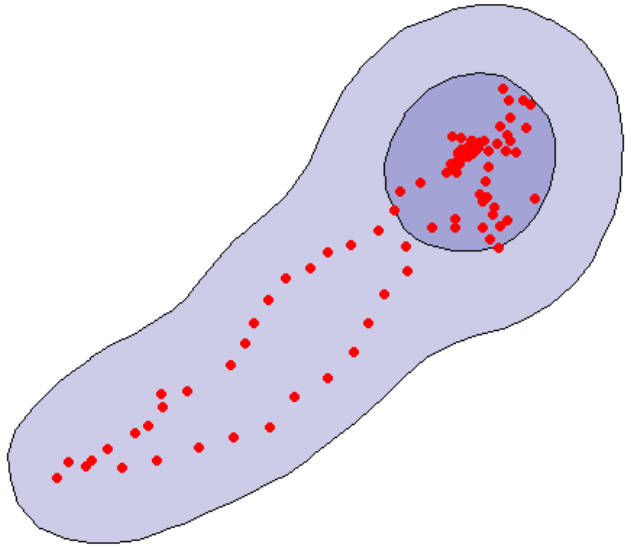
- Unused areas have same importance as used ones
- 95% method might exclude important areas far away
- Areas outside the MCP are not considered



Space use
-> Kernel Density Estimator KDE

Calculates probability of presence based on spatial distribution of points





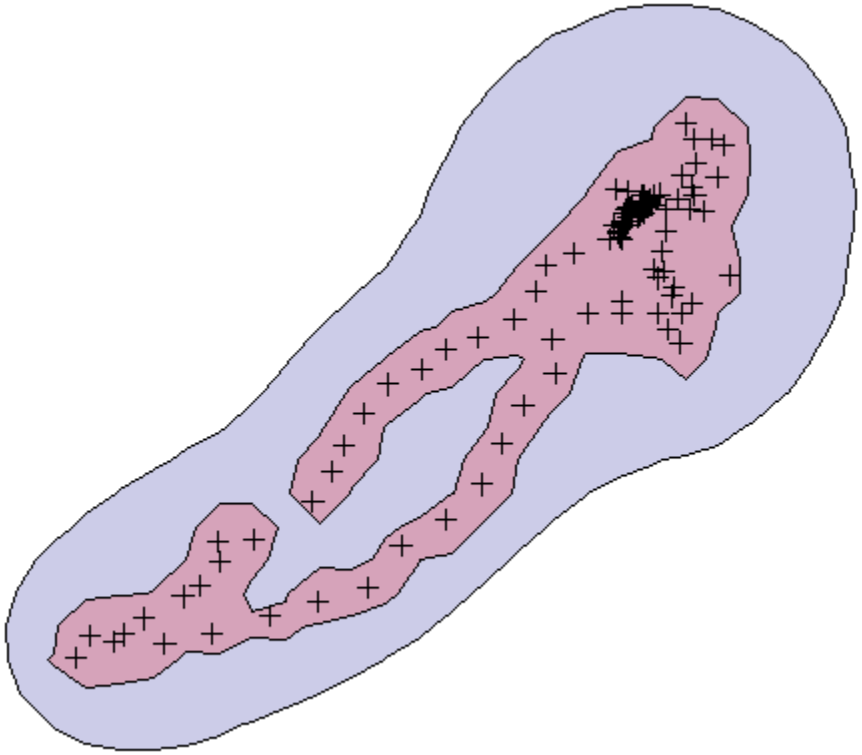
95% home range, 50% core area

@Manuel Röleke

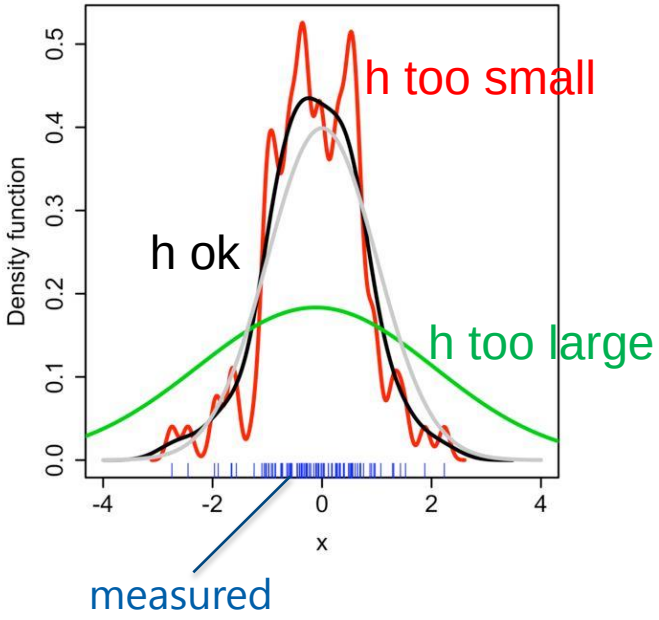
Space use
-> Kernel Density Estimator KDE

h-Factor is a smoothing function for the density probability

-> the larger h, the wider the smoothing function, the larger the area



@Manuel Röleke

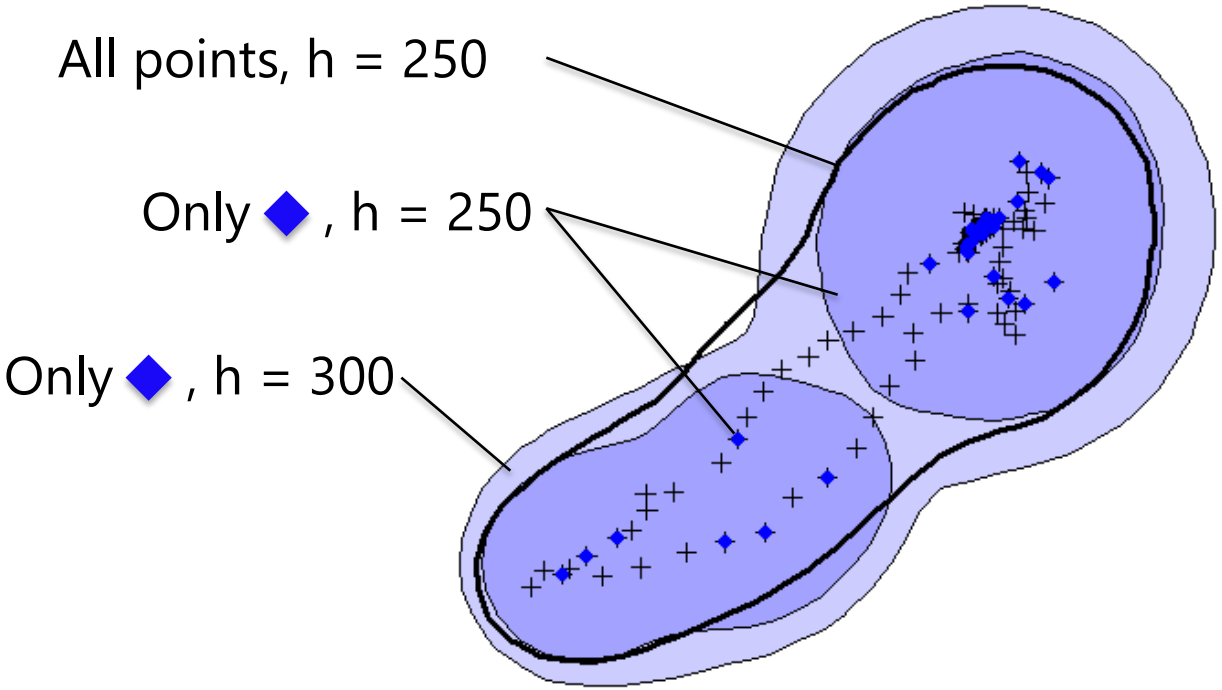


https://en.wikipedia.org/wiki/Kernel_density_estimation

Space use
-> Kernel Density Estimator KDE

What is the 'correct' h-factor??

None, it depends on the quality of the points…



Space use
-> Kernel Density Estimator KDE

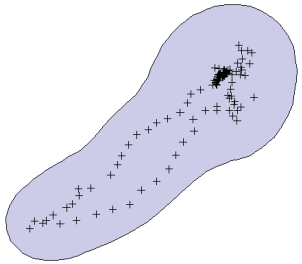
What is the 'correct' h-factor??

It depends on the question…

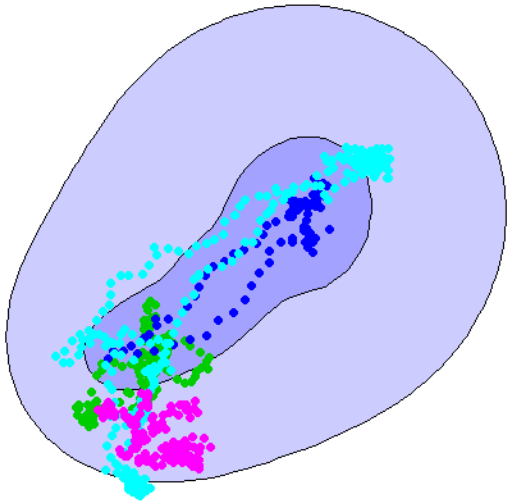
→Space use of bat 16. Juli?

Space use of bat some days later?

h = 250

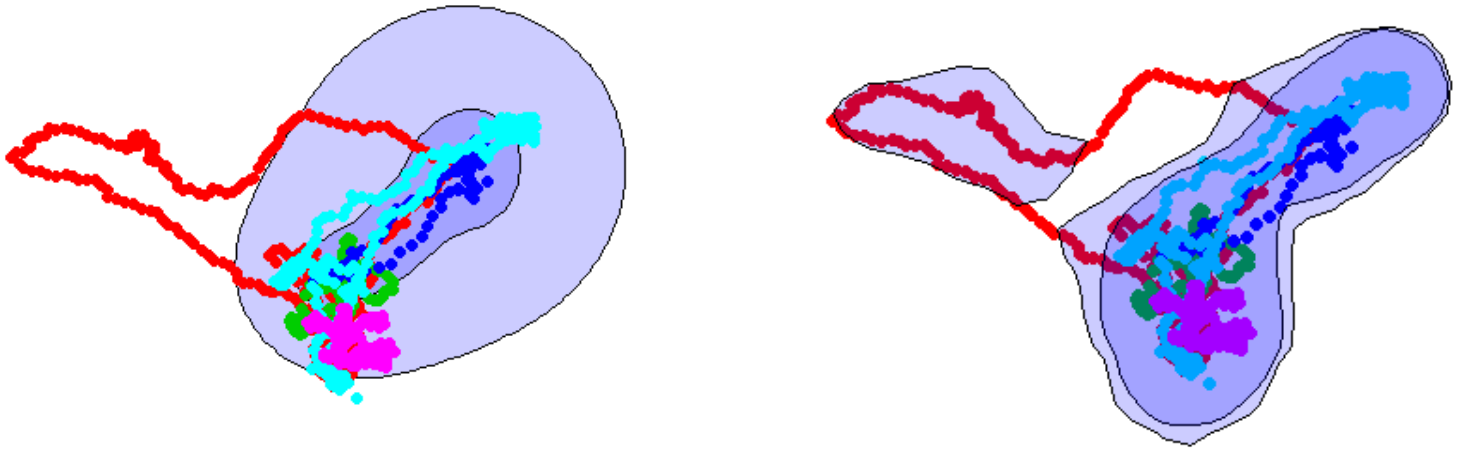


h = 850



Space use
-> Kernel Density Estimator KDE

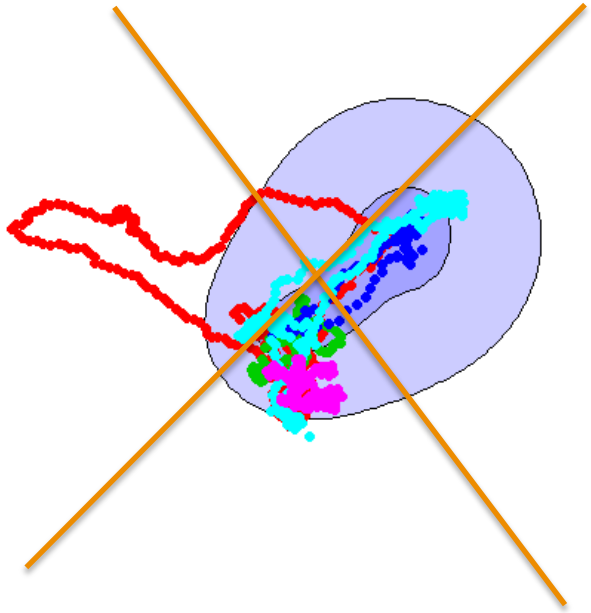
…and you need a lot of data across larger time spans!



PS In many programs, the ‚data best fitting' h-factor is automatically calculated

Space use -> aKDE

- Statistical issues with KDE have led to the development of aKDE: irregular data (e.g. biased towards a certain area) lead to wrong density estimations (narrow density distributions) and underestimation of the true home range area/ size
- Development of a method that uses an correlated random walk model (called OU for Ornstein-Uhlenbeck process) that best fits the trajectory (and which therefore can fill data gaps or estimate the true area where the animal could have been)



Methods in Ecology and Evolution

Methods in Ecology and Evolution 2016, **7**, 1124–1132 doi: 10.1111/2041-210X.12559

APPLICATION

ctmm: an R package for analyzing animal relocation data as a continuous-time stochastic process

Justin M. Calabrese[1,2]*, Chris H. Fleming[1,2] and Eliezer Gurarie[2]

Received: 21 January 2018 | Accepted: 26 April 2018
DOI: 10.1111/2041-210X.13027

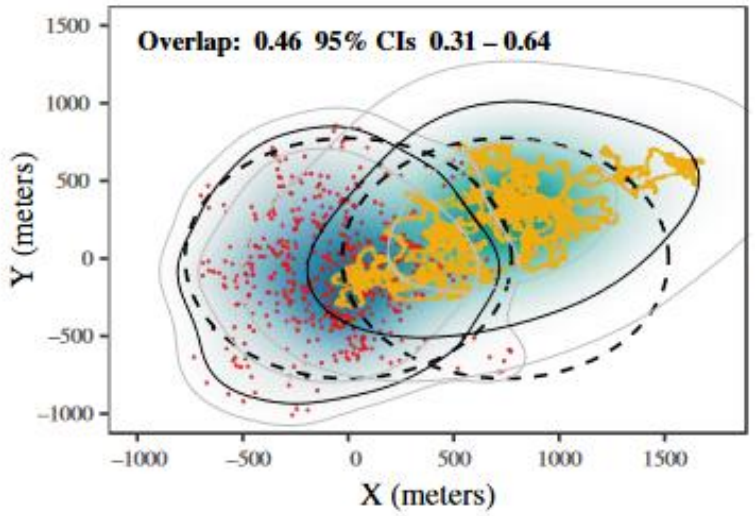
RESEARCH ARTICLE

Methods in Ecology and Evolution | BRITISH ECOLOGICAL SOCIETY

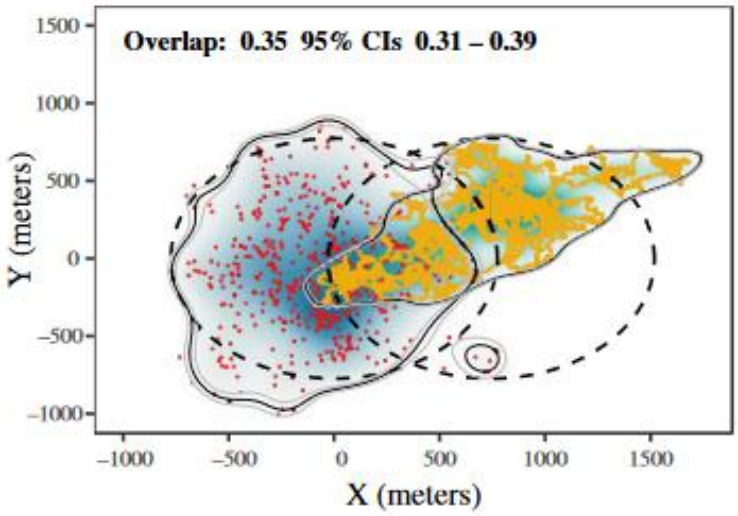
Statistical inference for home range overlap

Kevin Winner[1] | Michael J. Noonan[2, 3] | Christen H. Fleming[2, 3] | Kirk A. Olson[4] | Thomas Mueller[2, 5, 6] | Daniel Sheldon[1, 7] | Justin M. Calabrese[2, 3]

aKDE



KDE

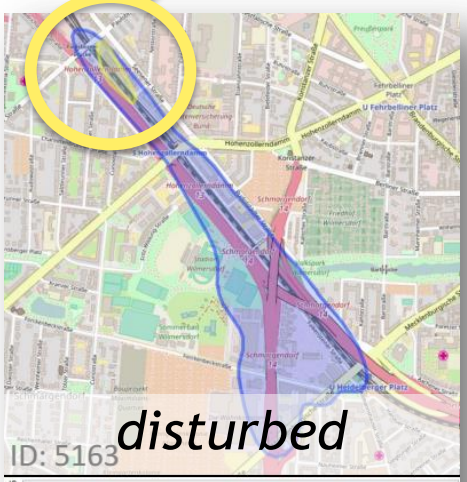


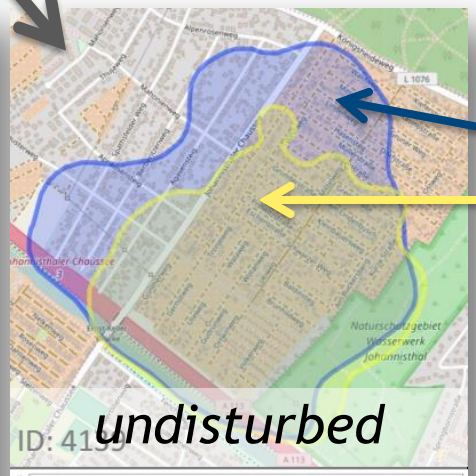
Note how in all cases AKDE-based overlap estimates were relatively consistent and provided coverage of the true overlap, whereas KDE-based overlap estimates varied substantially and consistently failed to provide coverage of the truth

Behavioral adjustment in space use

Rothenburgstr. 12

High resolution GPS-tracking
With time-interval 4 min



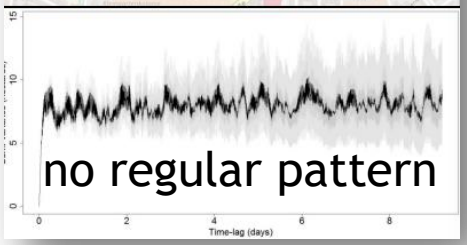


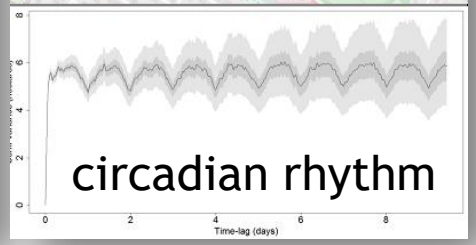
Space use - area

Night

Day

continuous-time movement model (ctmm) and autocorrelated kernel density estimator (aKDE)





Space use - periodicity

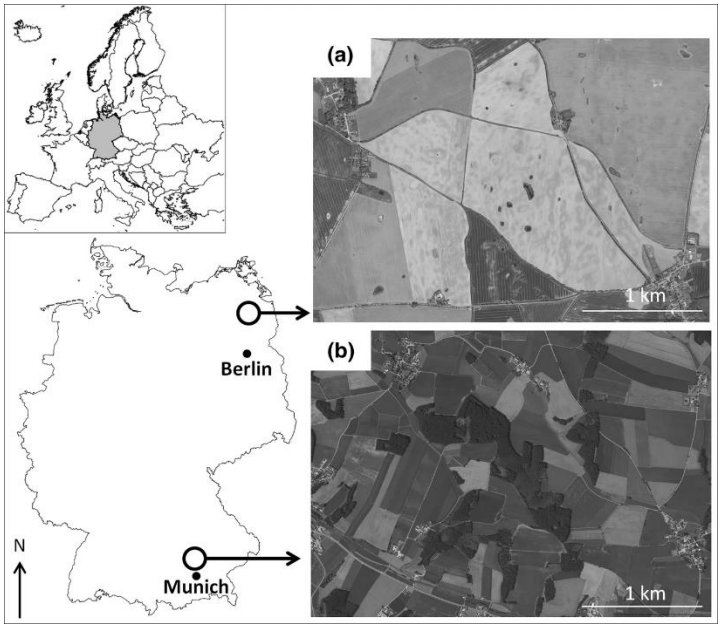
Ctmm-based semivariogram

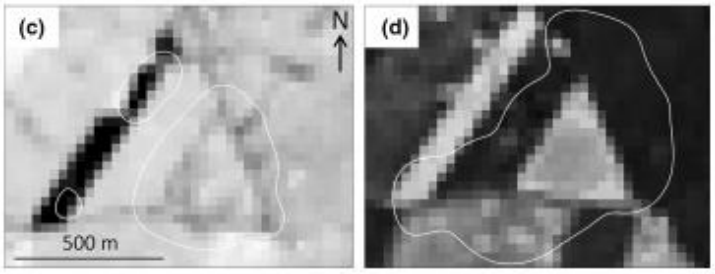
Landscape Ecol (2018) 33:1505–1517
https://doi.org/10.1007/s10980-018-0676-2

RESEARCH ARTICLE

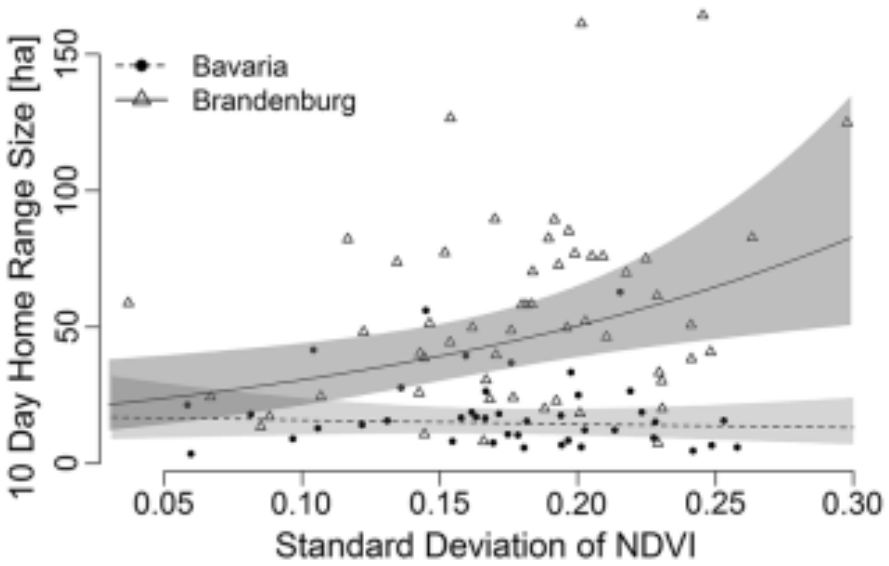
Spatiotemporal variability in resources affects herbivore home range formation in structurally contrasting and unpredictable agricultural landscapes

W. Ullmann · C. Fischer · K. Pirhofer-Walzl · S. Kramer-Schadt · N. Blaum





- Home range calculation every 10 days
- Extracting values from NDVI raster
- Calculating variance of NDVI cells in HR



Received: 19 October 2018 | Accepted: 23 September 2019
DOI: 10.1111/1365-2656.13116

BIOLOGGING: REVIEW

Journal of Animal Ecology | BRITISH ECOLOGICAL SOCIETY

Navigating through the R packages for movement

Rocío Joo[1] | Matthew E. Boone[1] | Thomas A. Clay[2] | Samantha C. Patrick[2] | Susana Clusella-Trullas[3] | Mathieu Basille[1]

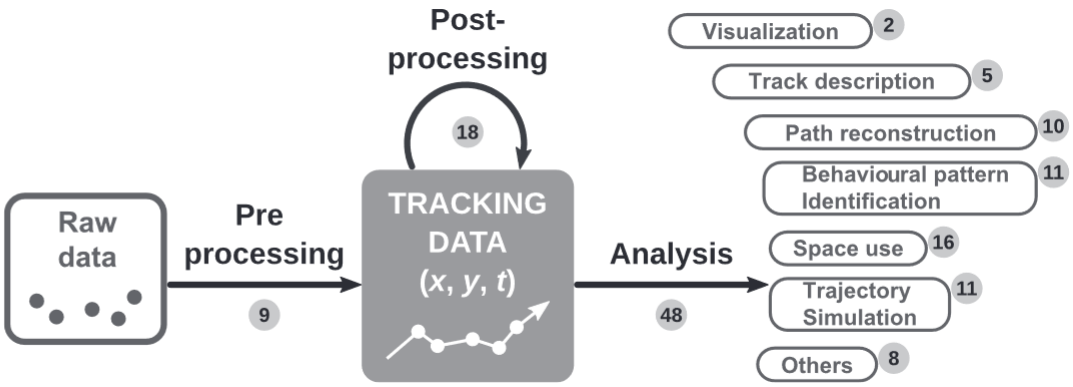
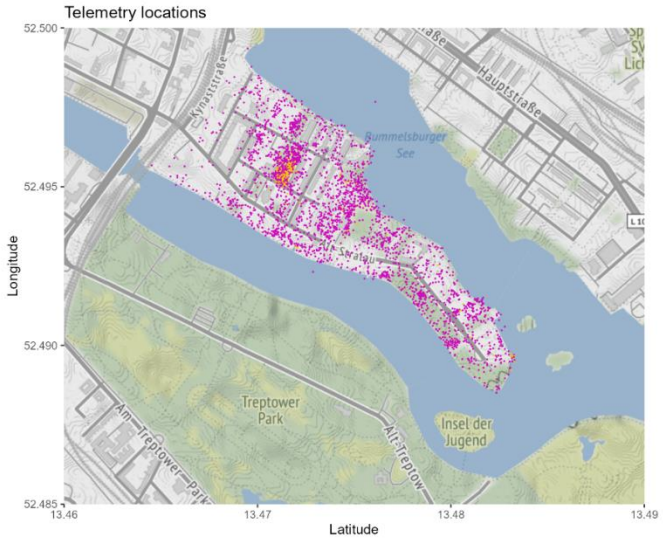
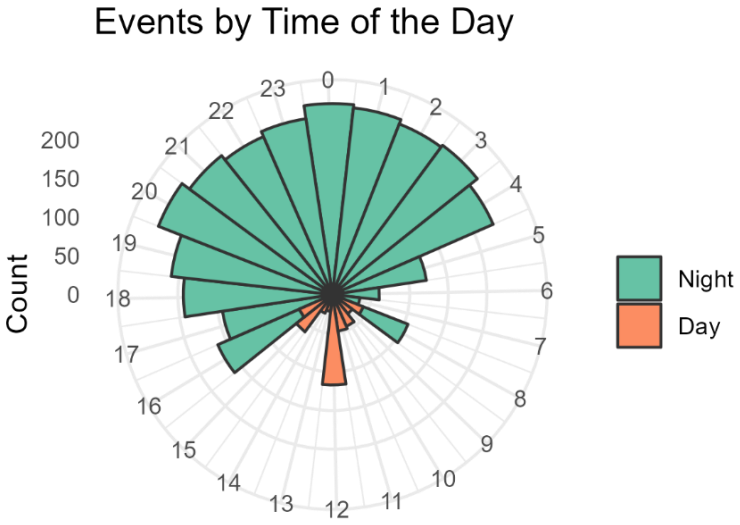


FIGURE 1 Workflow for data processing and analysis in movement ecology. Numbers in parenthesis are the number of packages dealing with each stage of the workflow. Some packages may correspond to more than one category, except for data visualization, where only packages created for that purpose are counted

https://besjournals.onlinelibrary.wiley.com/doi/epdf/10.1111/1365-2656.13116

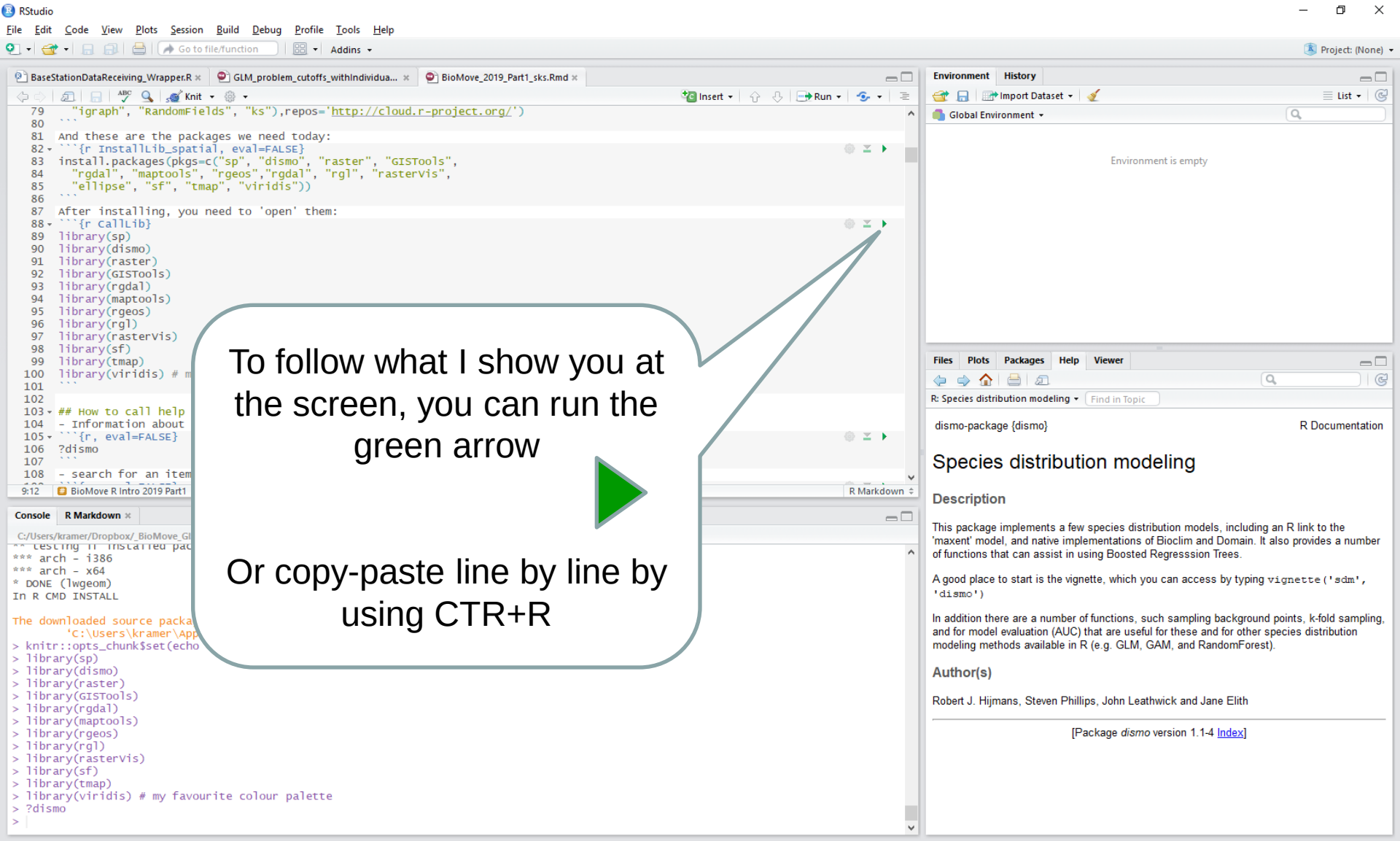
Introduction to movement analysis





https://github.com/stephkramer/Course4_MoveQ

R-Studio/ File/ Rmarkdown -> rmd-file



To follow what I show you at the screen, you can run the green arrow

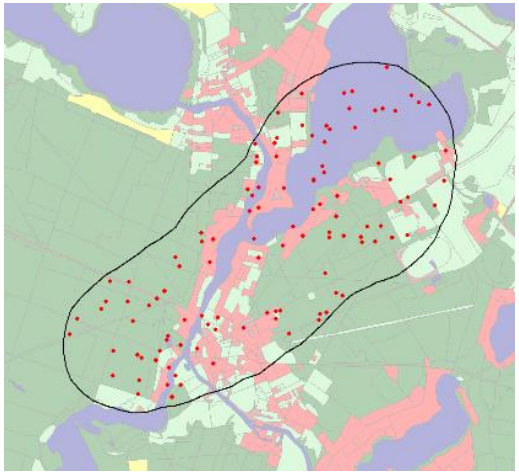
Or copy-paste line by line by using CTR+R

Exercise time

Habitat use -> preference = use vs availability

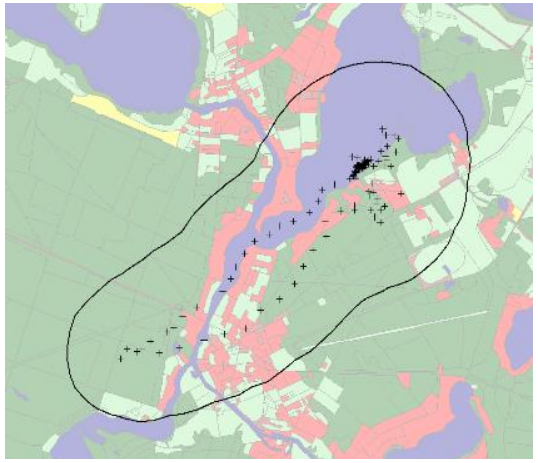
Background reflects availability

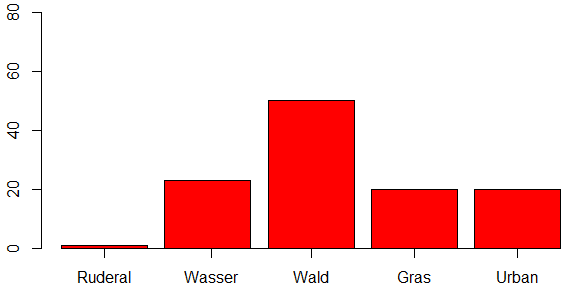
availability

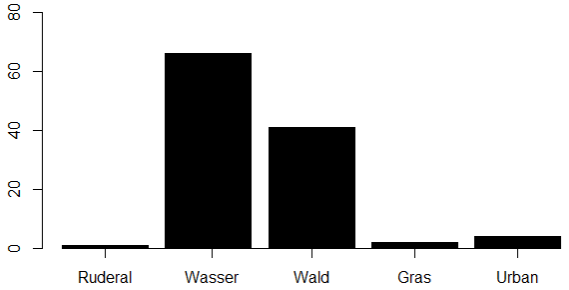


comparison

use







THE END