

A roller coaster introduction to spatial analysis using R

Photo by Mark Asthoff on Unsplash

Stephanie Kramer-Schadt (IZW)

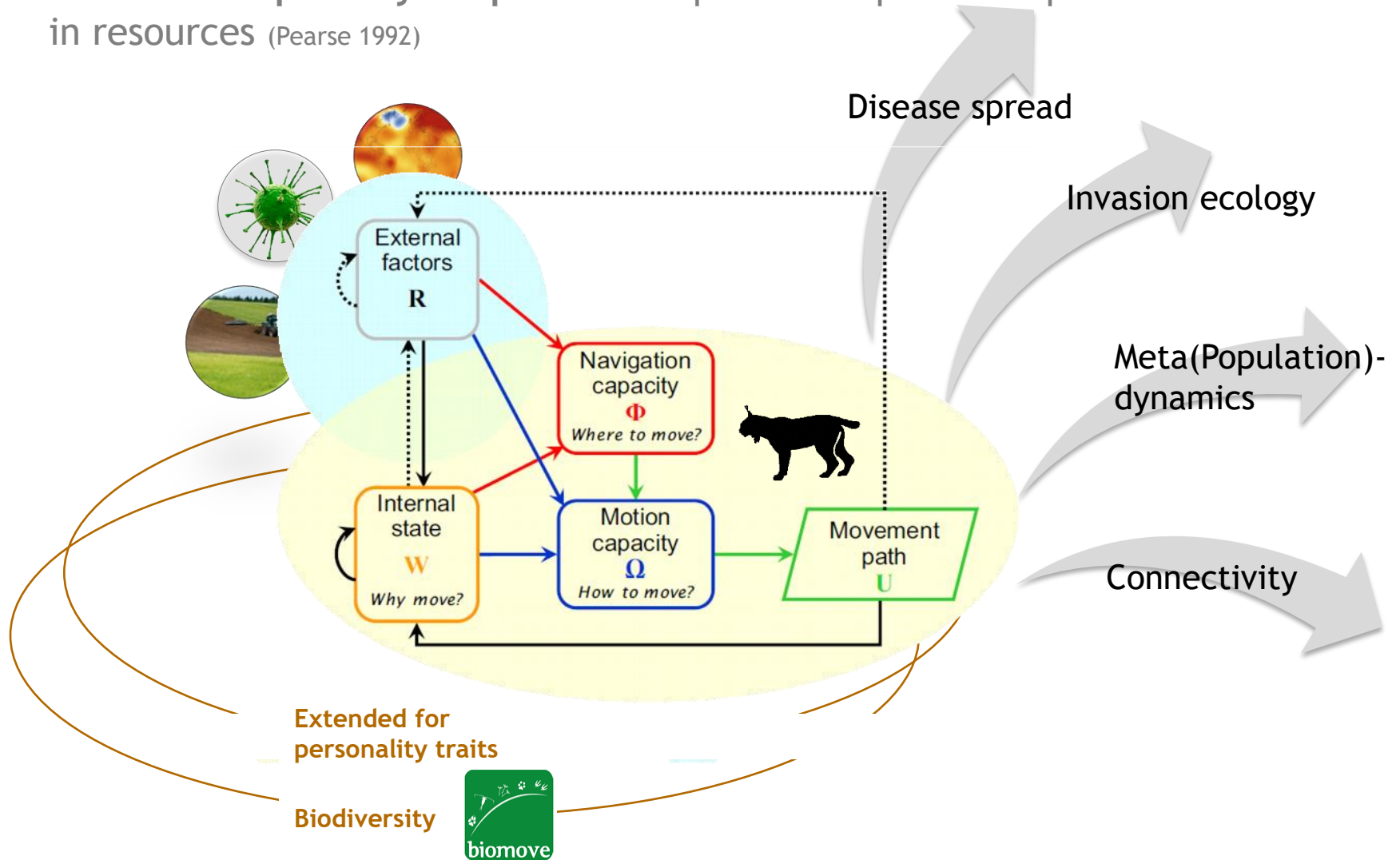


A green field with scattered red leaves.

DAY 2

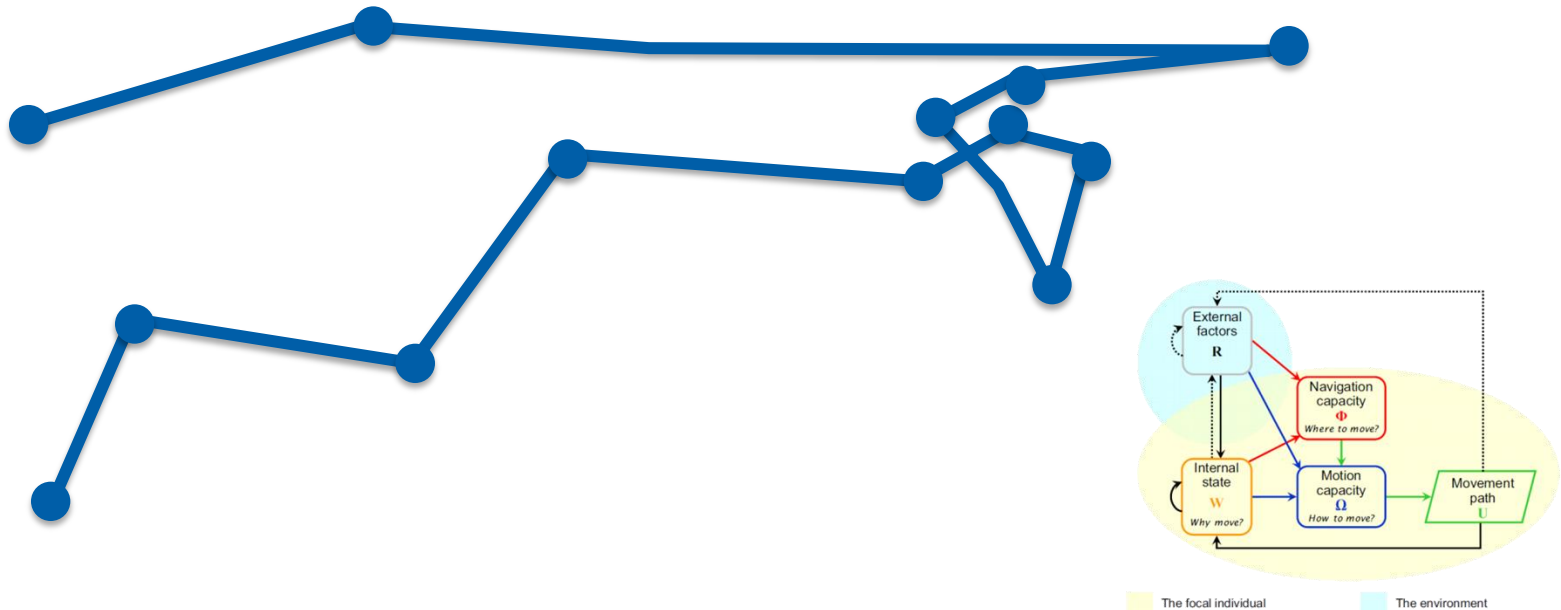
> Movement analysis

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



➤ Movement analysis

How can we deduce from a line on internal states, motion capacity, or effects of habitat etc?



> Two frameworks

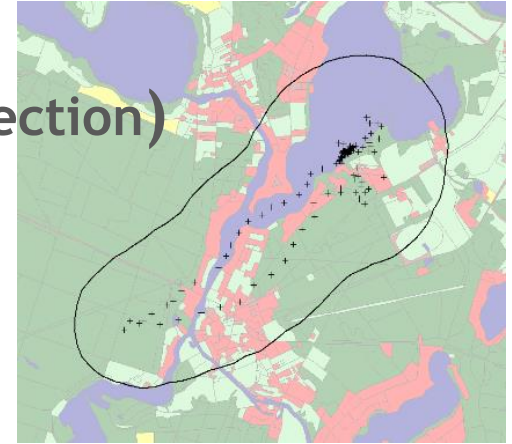
- Analysis of the **ranging area** (& habitat selection)

MCP

UD kernel

aKDE,

R-packages
adehabitatHR
ctmm



Two frameworks

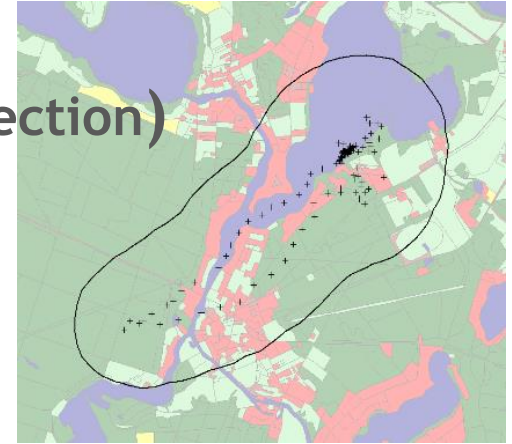
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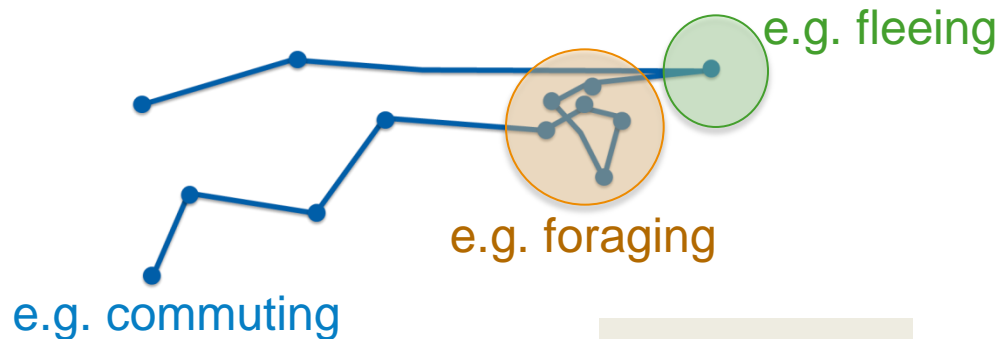
aKDE,

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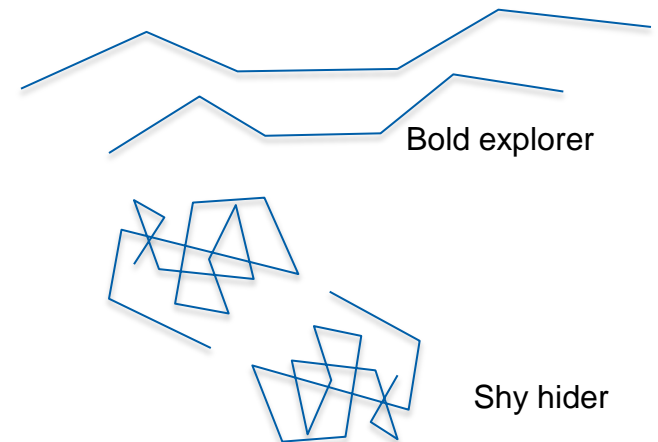
- Analysis of the **trajectory**

Step length and turning angle distinguish movement types

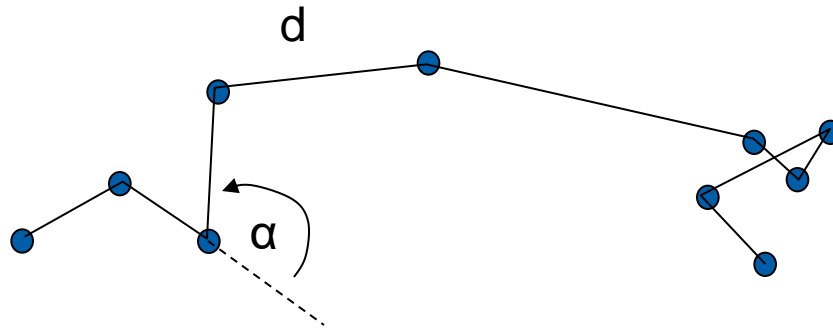


R-packages
HMM
moveHMM

Behavioral syndrome/ personality

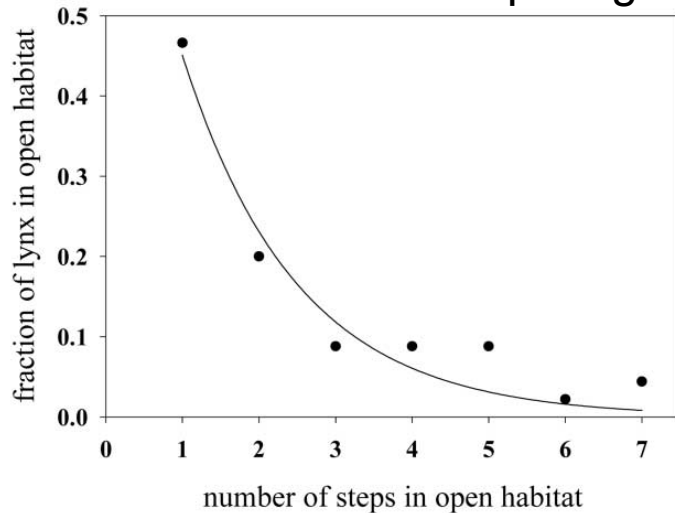


➤ Movement pattern from trajectory

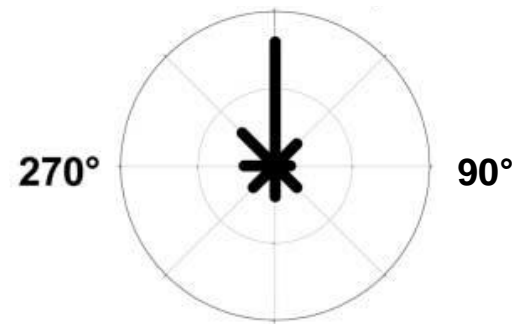


d – Step length
 α – Turning Angle

Distribution of step length



Distribution of turning angles



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

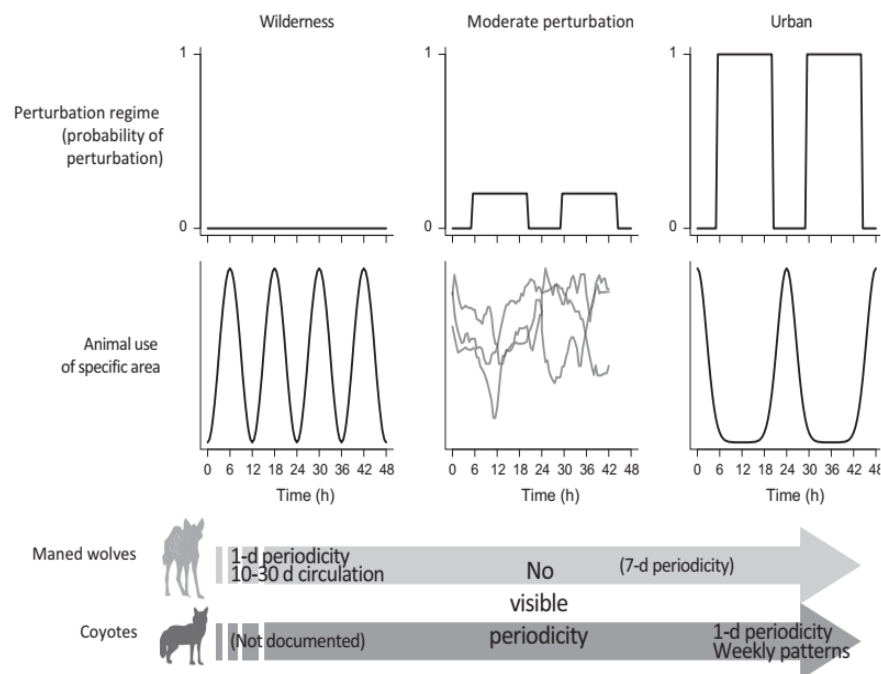
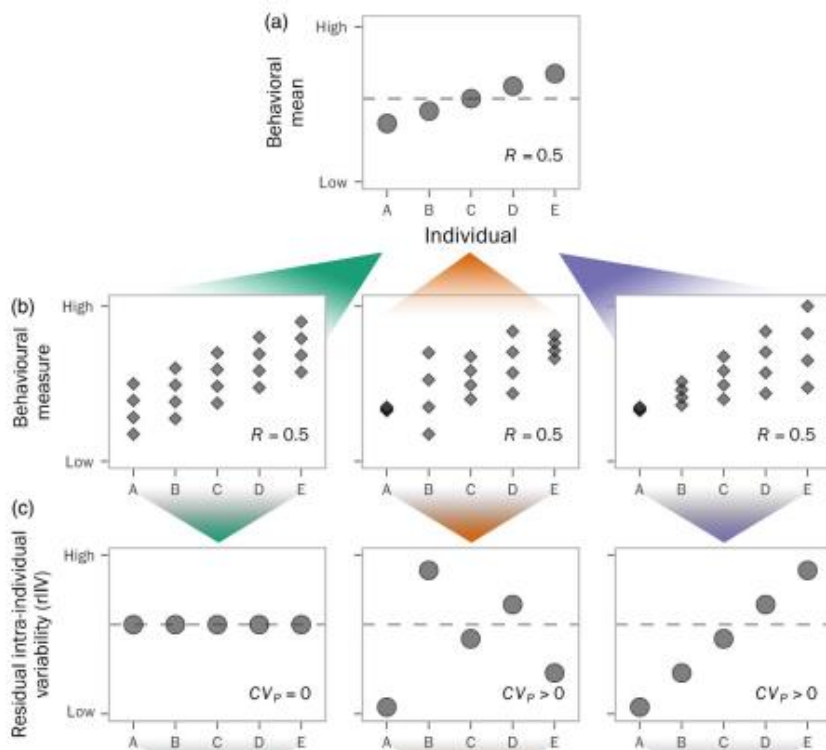
Anne G. Hertel^{1,2} | Raphaël Royauté³ | Andreas Zedrosser^{2,4} | Thomas Mueller^{1,5}

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

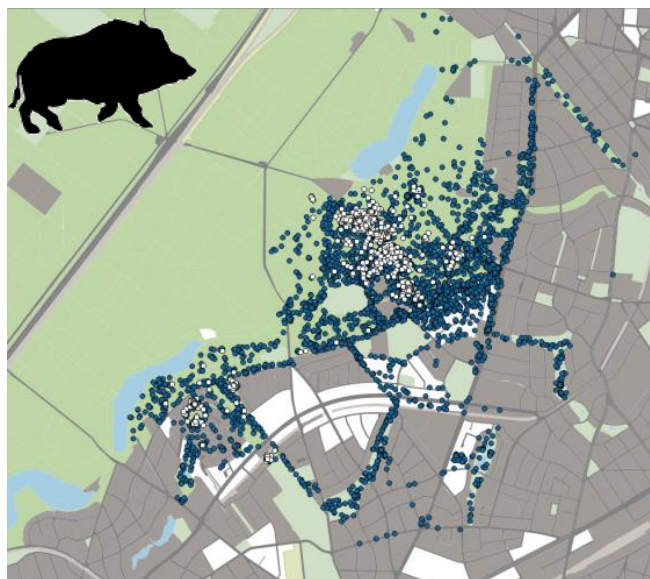
Periodic continuous-time movement models uncover behavioral changes of wild canids along anthropization gradients

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

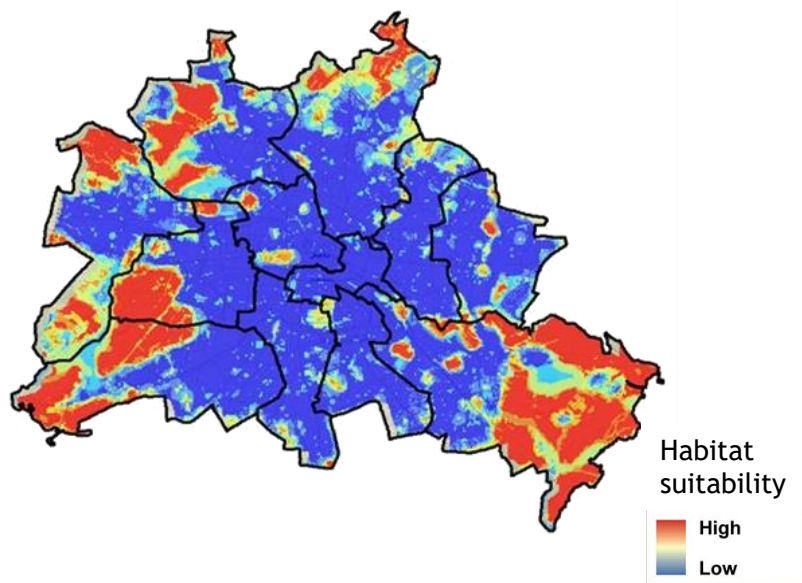


➤ Behavioral adjustment in habitat use



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

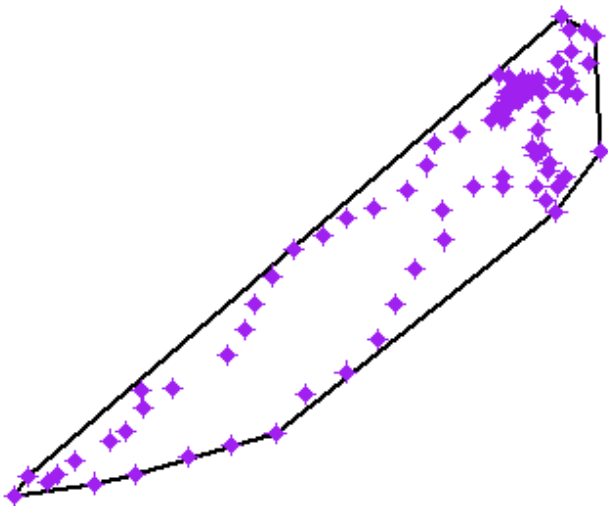
Binomial response: Wild boar vs. CRW / day vs. night

Predictor variables: Landscape, Origin rural vs urban, Season
AIC based model selection of candidate models

2 - Space use

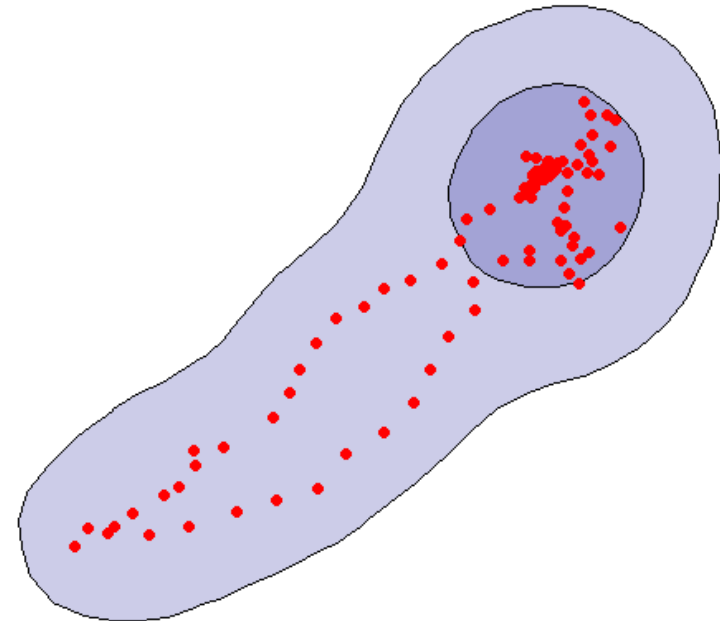
MCP:

Minimum convex polygon



KDE:

Area with estimated density



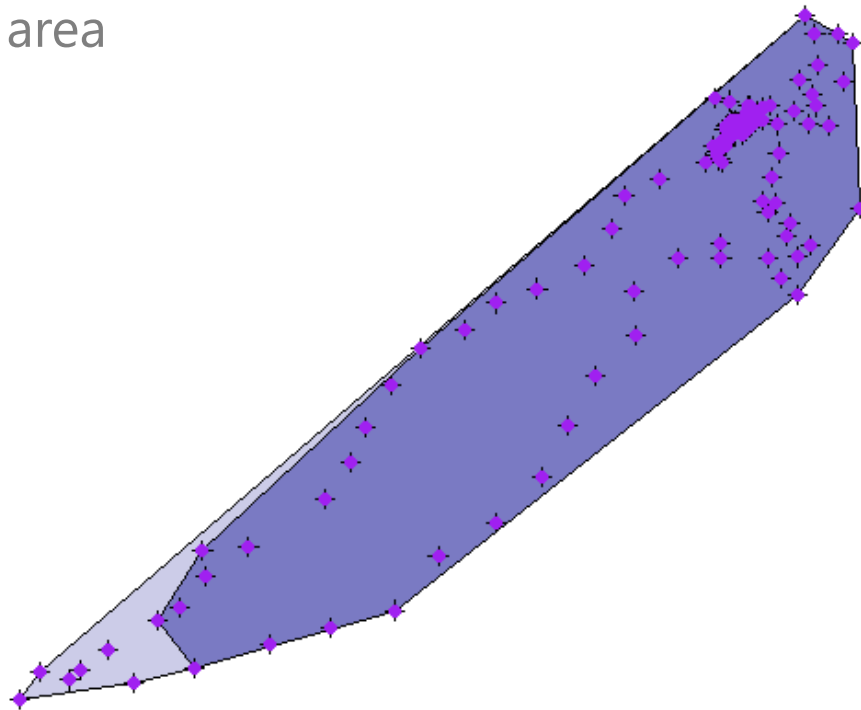
Space use

-> Minimum Convex Polygon MCP

Connect the outer points

Normally 95% closest to the gravity center to remove outliers

Encapsulates area

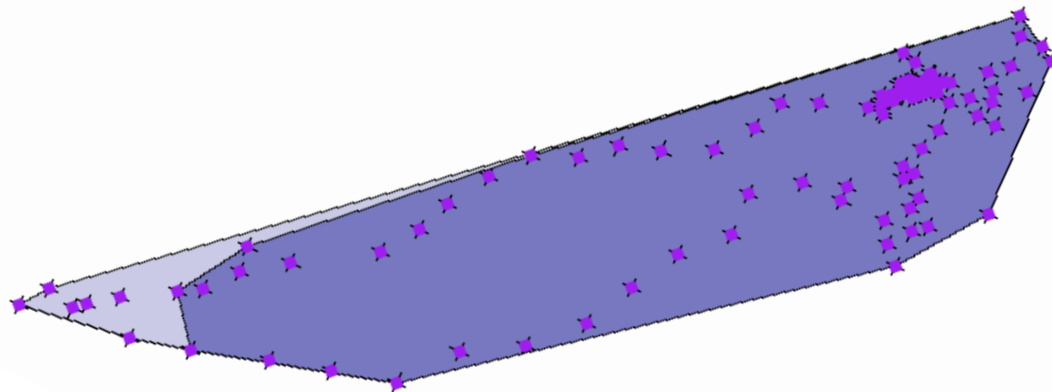


Space use

-> Minimum Convex Polygon MCP

Drawbacks:

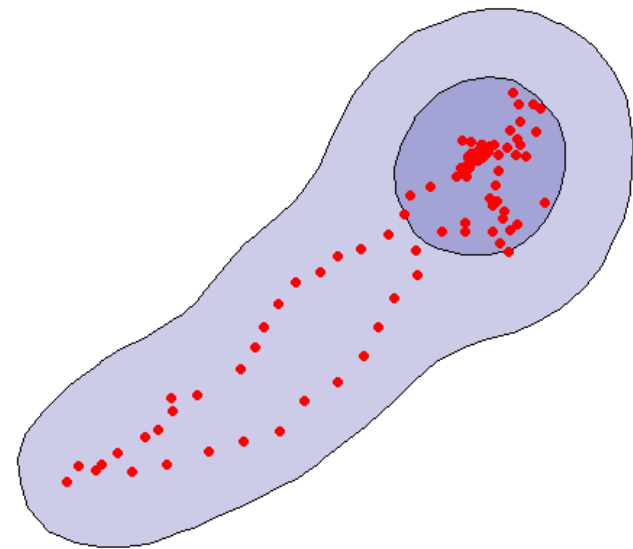
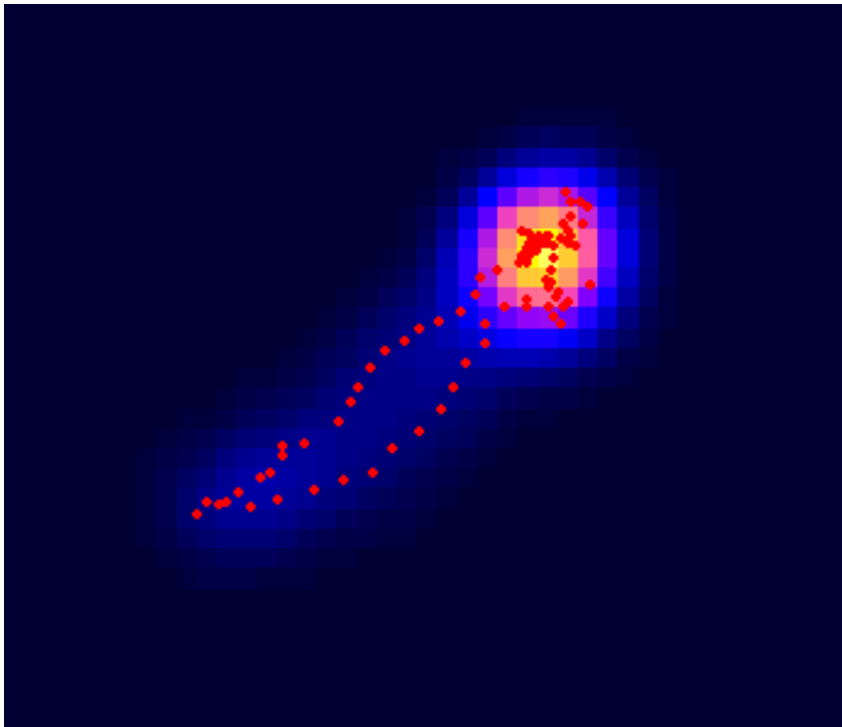
- Unused areas have same importance as used ones
- 95% method might exclude important areas far away
- Areas outside the MCP are not considered



Space use

-> Kernel Density Estimator KDE

Calculates probability of presence based on spatial distribution of points



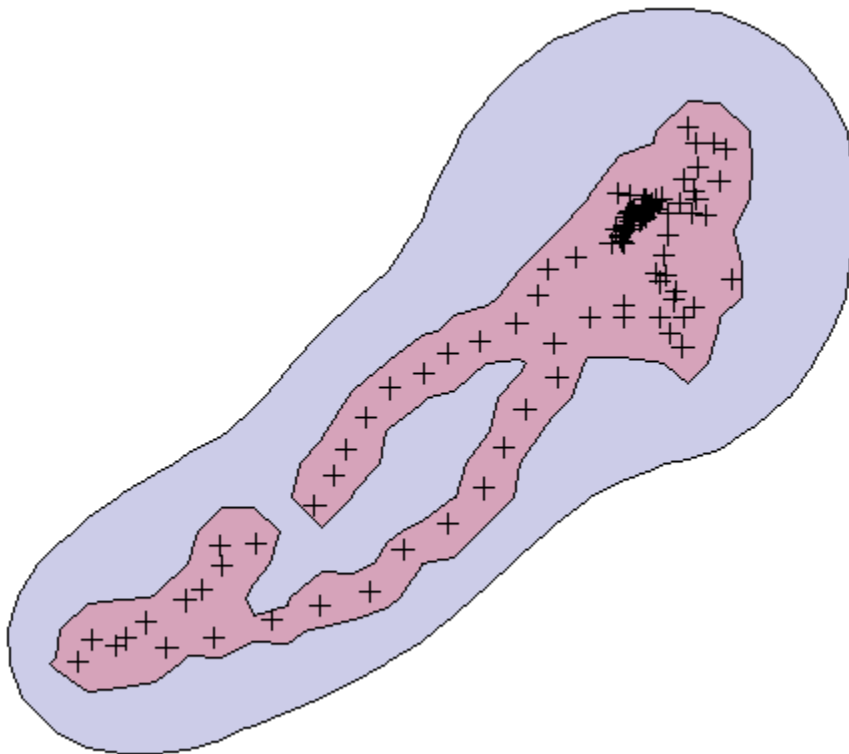
95% home range, 50% core area

Space use

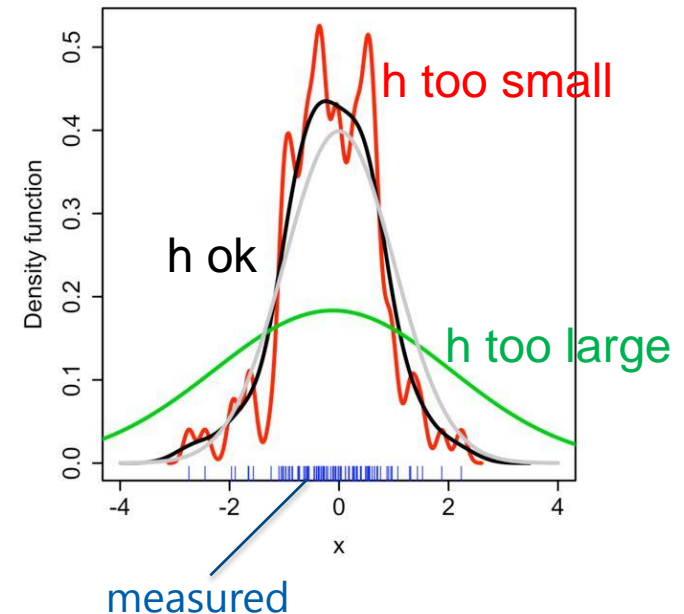
-> Kernel Density Estimator KDE

h-Factor is a smoothing function for the density probability

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



@Manuel Röleke

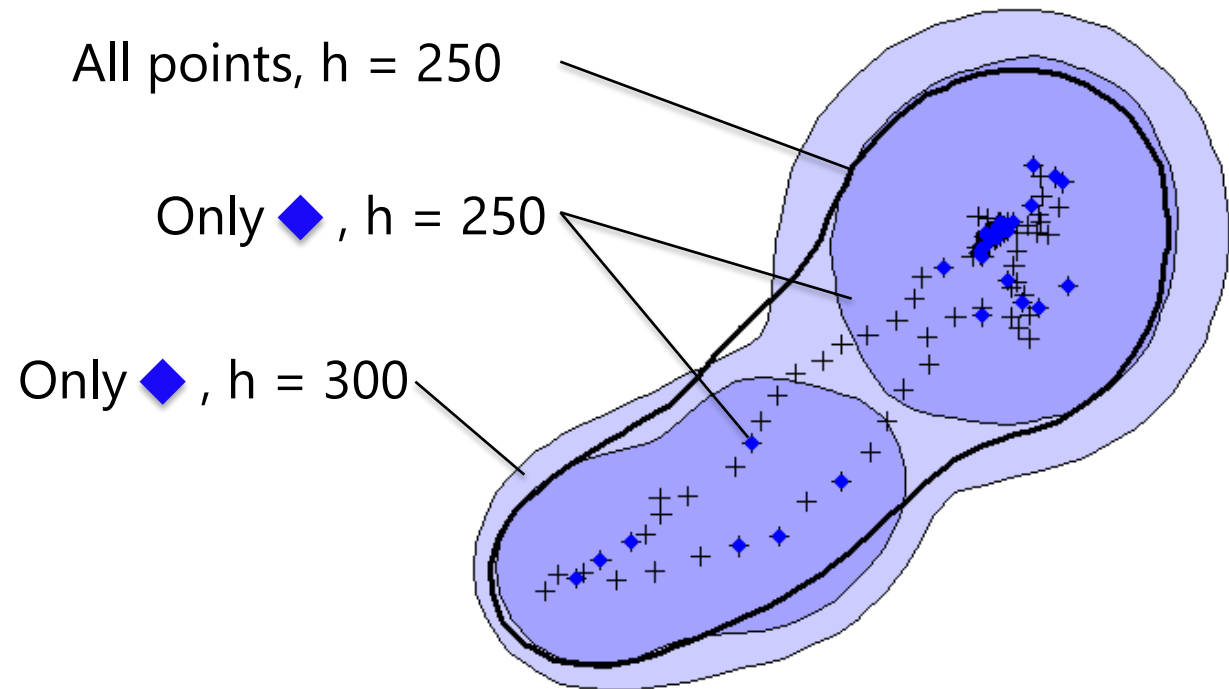


Space use

-> 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

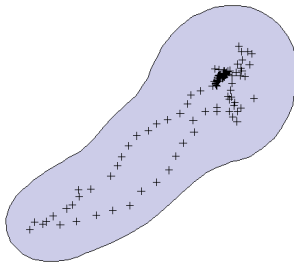
What is the 'correct' h-factor??

It depends on the question...

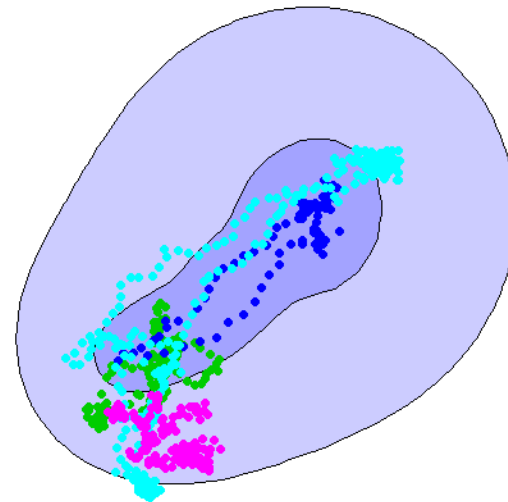
→ Space use of bat 16. Juli?

Space use of bat some days later?

$h = 250$



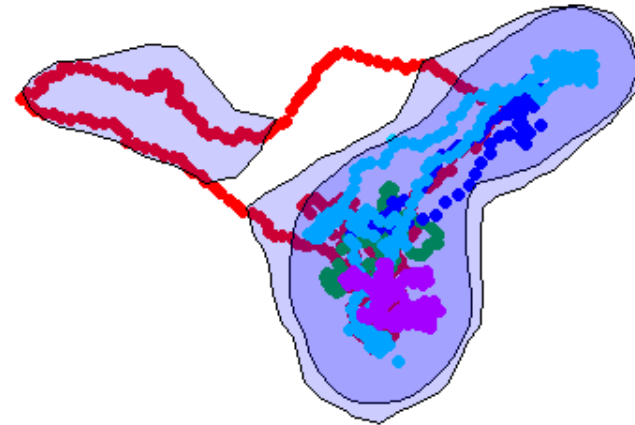
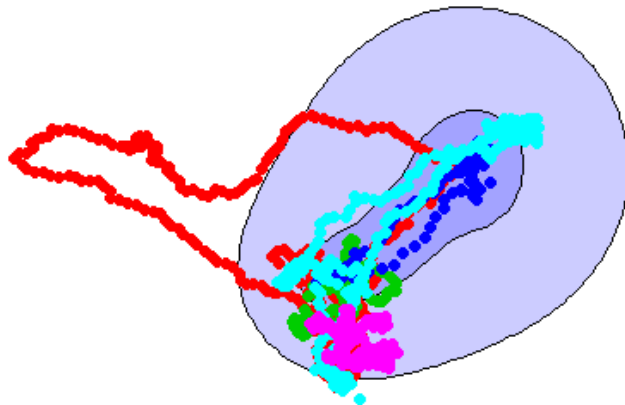
$h = 850$



Space use

-> Kernel Density Estimator KDE

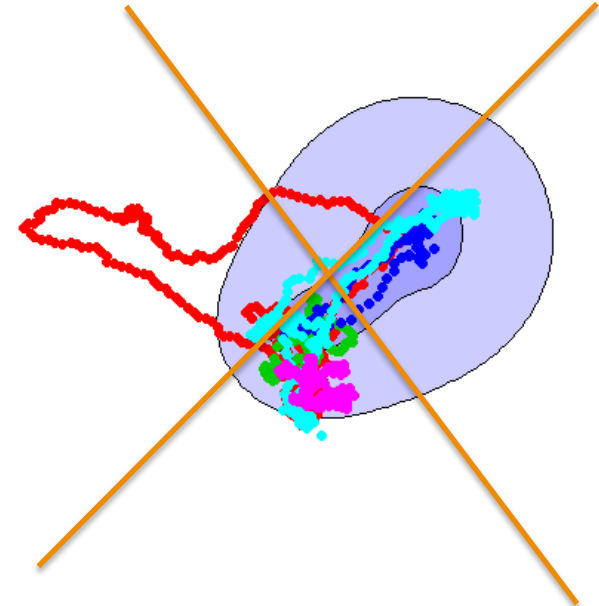
...and you need a lot of data across larger time spans!



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

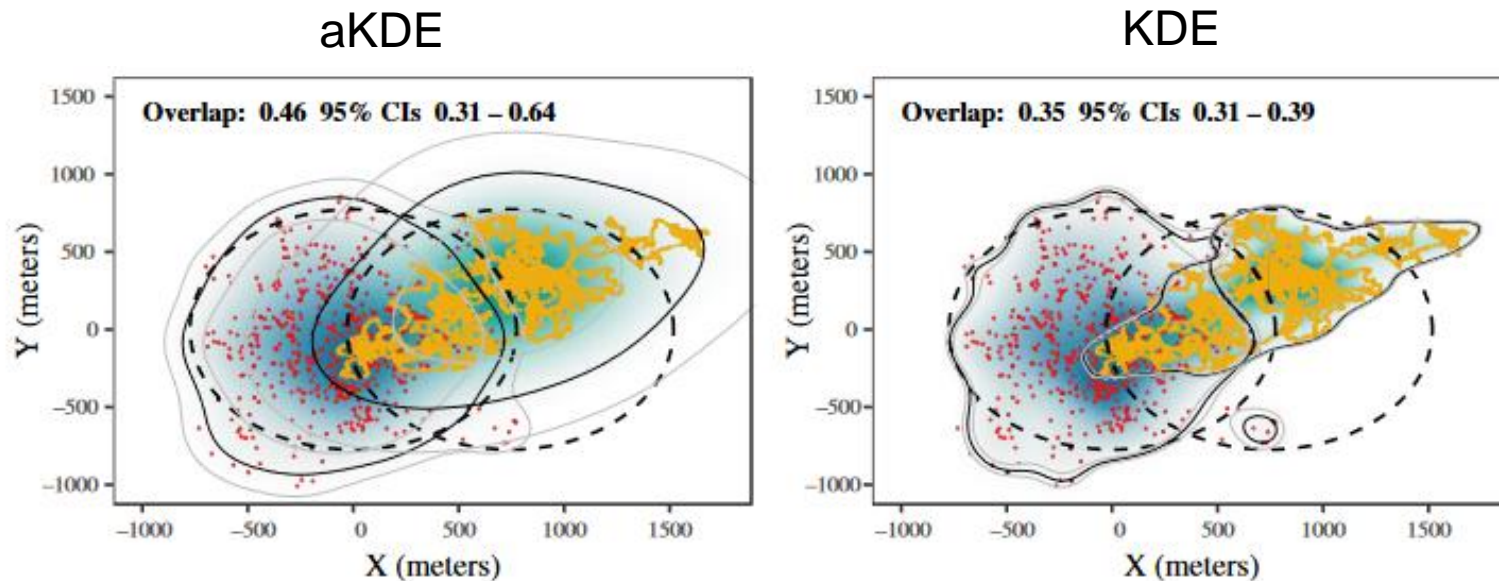
ctmm: an R package for analyzing animal relocation data as a continuous-time stochastic process

Justin M. Calabrese^{1,2*}, Chris H. Fleming^{1,2} and Eliezer Gurarie²



Statistical inference for home range overlap

Kevin Winner¹ | Michael J. Noonan^{2,3} | Christen H. Fleming^{2,3} |
Kirk A. Olson⁴ | Thomas Mueller^{2,5,6} | Daniel Sheldon^{1,7} | Justin M. Calabrese^{2,3}



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

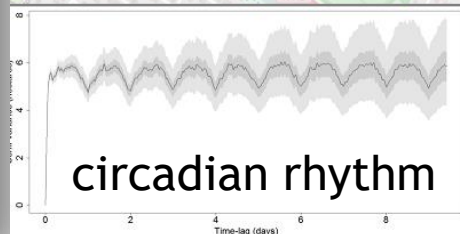
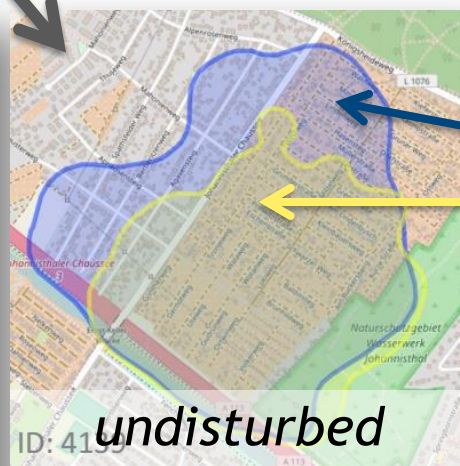
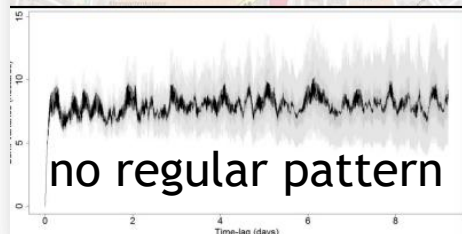
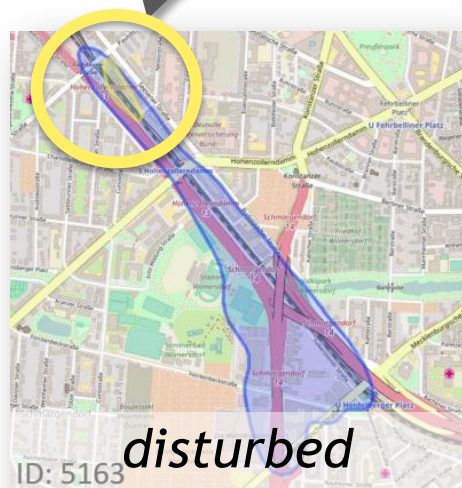
Behavioral adjustment in space use



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

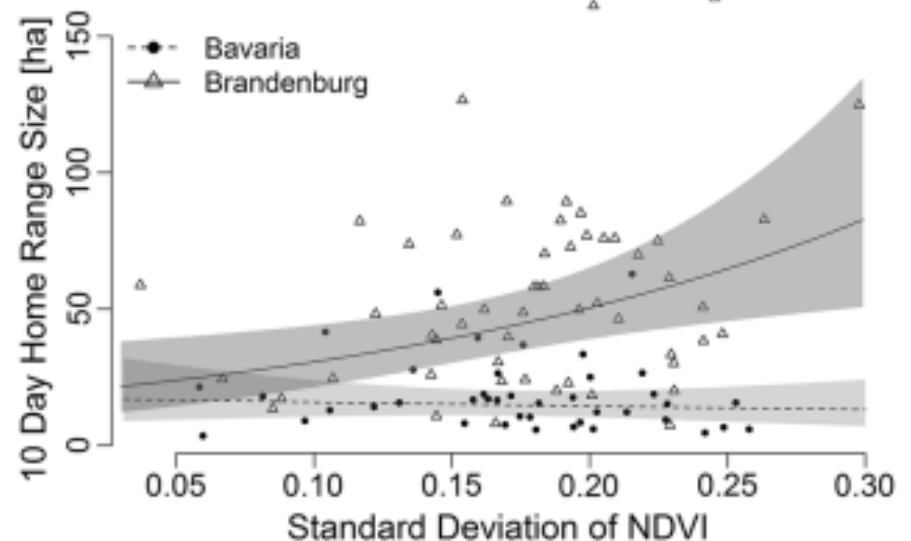
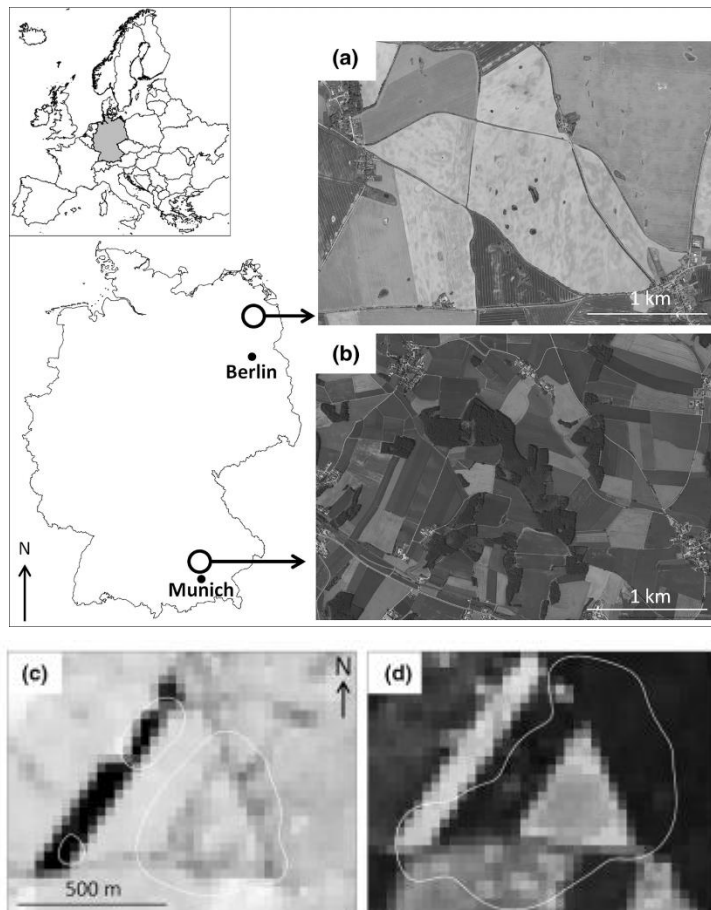


Spatiotemporal variability in resources affects herbivore home range formation in structurally contrasting and unpredictable agricultural landscapes

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

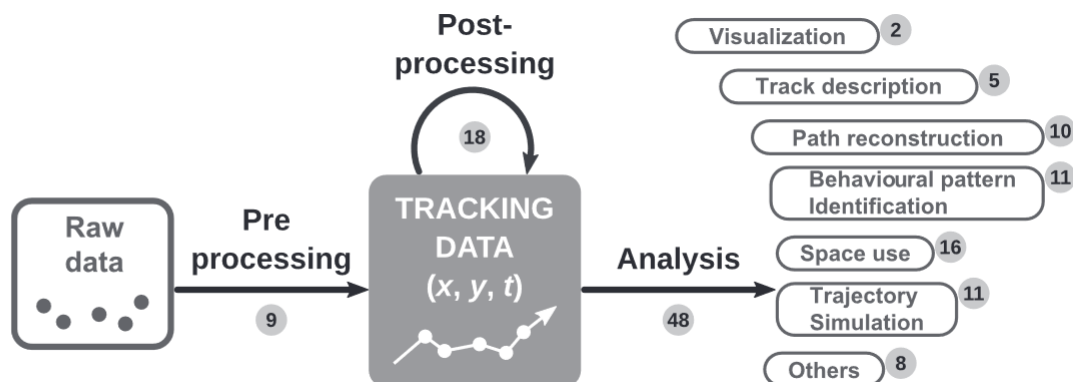




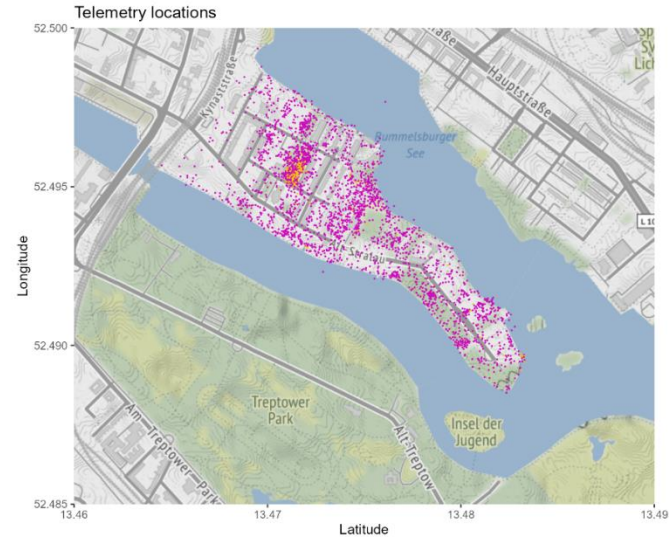
Navigating through the R packages for movement

Rocío Joo¹ | Matthew E. Boone¹ | Thomas A. Clay² | Samantha C. Patrick² |
Susana Clusella-Trullas³ | Mathieu Basille¹

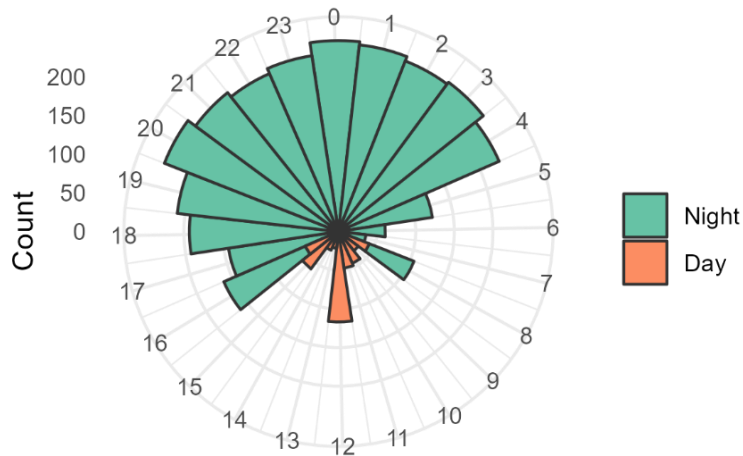
FIGURE 1 Workflow for data processing and analysis in movement ecology. Numbers in parenthesis are the number of packages dealing with each stage of the workflow. Some packages may correspond to more than one category, except for data visualization, where only packages created for that purpose are counted



➤ Introduction to movement analysis



Events by Time of the Day



https://github.com/stephkramer/Course4_MoveQ

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

The screenshot shows the RStudio interface with the following components:

- Source Editor:** Contains R code for installing and loading packages. A green arrow points to the `install.packages` line, with a callout box explaining that the code can be run line-by-line using `CTR+R`.
- Console:** Shows the output of the `install.packages` command, indicating that the packages were successfully installed.
- Environment:** Shows the Global Environment, which is currently empty.
- Files:** Shows the R Markdown file being edited.
- Plots:** Shows the R Markdown file being edited.
- Packages:** Shows the R Markdown file being edited.
- Help:** Shows the R Markdown file being edited.
- Viewer:** Shows the R Markdown file being edited.

Code in Source Editor:

```
79 "igraph", "RandomFields", "ks"), repos="http://cloud.r-project.org/")
80
81 And these are the packages we need today:
82 {r InstallLib_spatial, eval=FALSE}
83 install.packages(pkgs=c("sp", "dismo", "raster", "GISTools",
84 "rgdal", "maptools", "rgeos", "rgdal", "rgl", "rasterVis",
85 "ellipse", "sf", "tmap", "viridis"))
86
87 After installing, you need to 'open' them:
88 {r callLib}
89 library(sp)
90 library(dismo)
91 library(raster)
92 library(GISTools)
93 library(rgdal)
94 library(maptools)
95 library(rgeos)
96 library(rgl)
97 library(rasterVis)
98 library(sf)
99 library(tmap)
100 library(viridis) # my favourite colour palette
101
102
103 ## How to call help
104 - Information about
105 {r, eval=FALSE}
106 ?dismo
107
108 - search for an item
```

Console Output:

```
C:\Users\kramer\Dropbox\ BioMove_GL
*** testing if installed pack
*** arch - i386
*** arch - x64
* DONE (lwegeom)
IN R CMD INSTALL

The downloaded source packa
'C:\Users\kramer\AppData
> knitr::opts_chunk$set(echo
> library(sp)
> library(dismo)
> library(raster)
> library(GISTools)
> library(rgdal)
> library(maptools)
> library(rgeos)
> library(rgl)
> library(rasterVis)
> library(sf)
> library(tmap)
> library(viridis) # my favourite colour palette
> ?dismo
```

Environment: Environment is empty

Files: R: Species distribution modeling - Find in Topic

Plots: R: Species distribution modeling - Find in Topic

Packages: R: Species distribution modeling - Find in Topic

Help: R: Species distribution modeling - Find in Topic

Viewer: R: Species distribution modeling - Find in Topic

Species distribution modeling

Description

This package implements a few species distribution models, including an R link to the 'maxent' model, and native implementations of Bioclim and Domain. It also provides a number of functions that can assist in using Boosted Regression Trees.

A good place to start is the vignette, which you can access by typing `vignette('sdm', 'dismo')`

In addition there are a number of functions, such as sampling background points, k-fold sampling, and for model evaluation (AUC) that are useful for these and for other species distribution modeling methods available in R (e.g. GLM, GAM, and RandomForest).

Author(s)

Robert J. Hijmans, Steven Phillips, John Leathwick and Jane Elith

[Package *dismo* version 1.1-4 [Index](#)]



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and Wildlife Research
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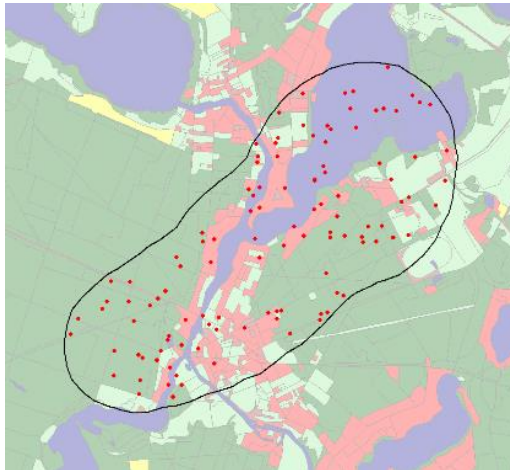
Exercise time



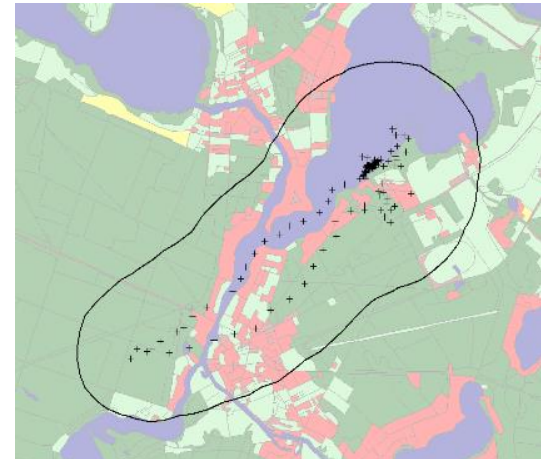
➤ Habitat use -> preference = use vs availability

Background reflects availability

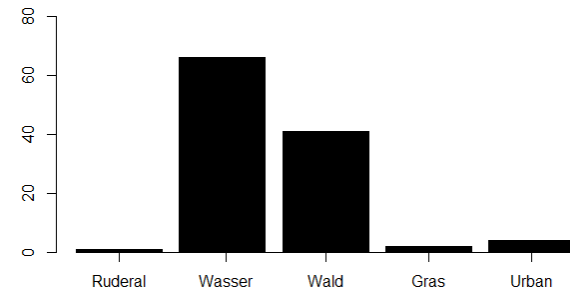
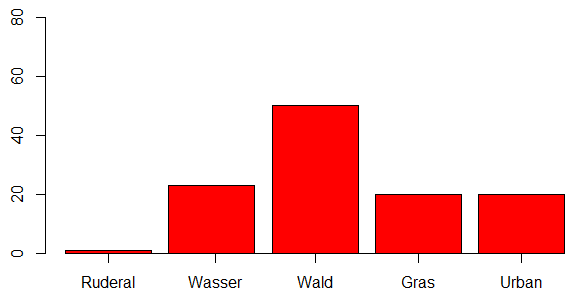
availability



use



comparison





THE END