

Comparing modelling approaches for estimating resource selection in central place foragers species



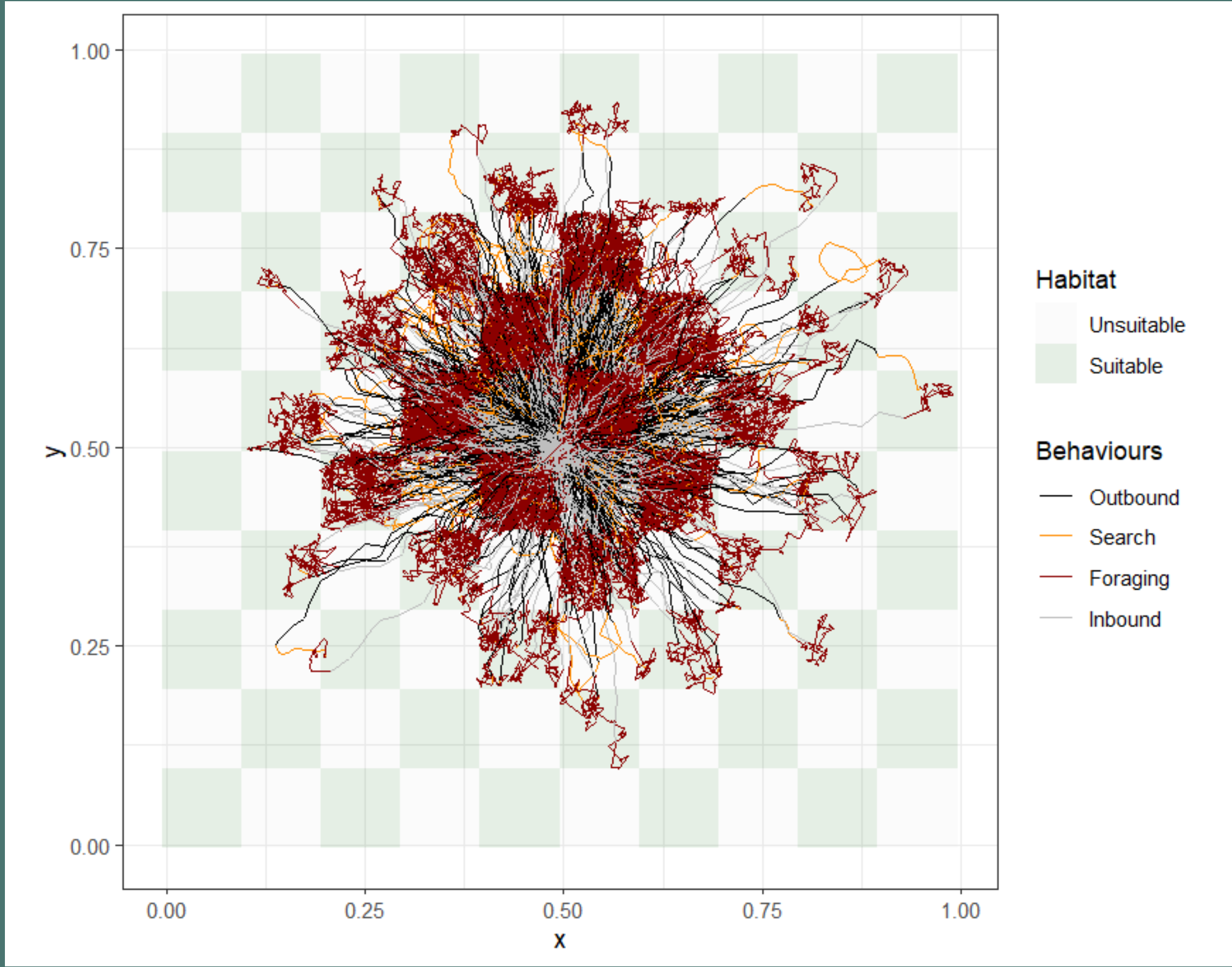
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Telemetry data are often highly autocorrelated in space and time, thus challenging the assumption of independence between observations and subsequent inference using resource selection frameworks. Failure to correctly account for autocorrelation in tracking data can lead to overly narrow confidence intervals, bias in parameter estimates and model selection. Here we compare different common approaches for mitigating the statistical problems posed by autocorrelation, using simulated datasets.

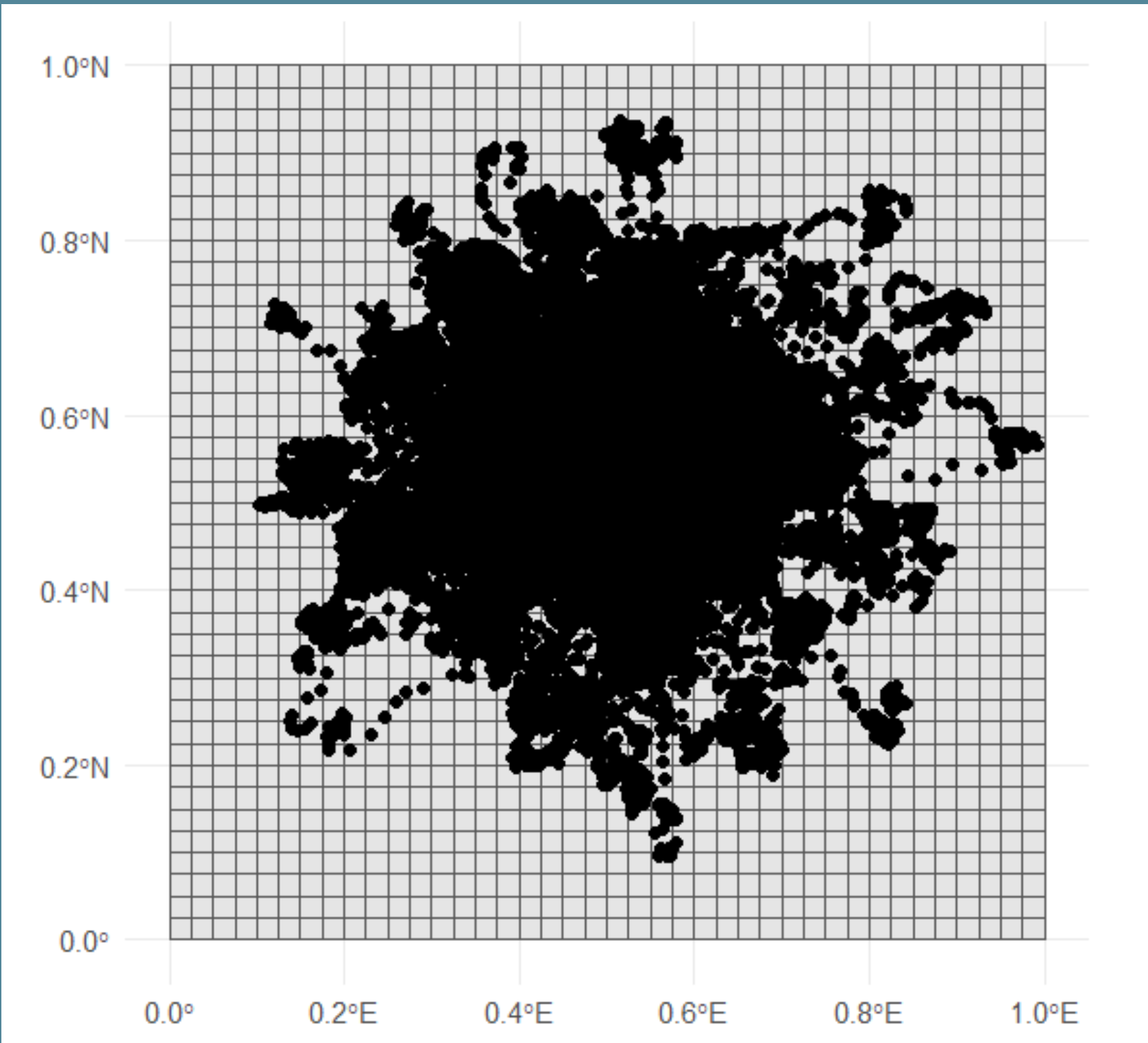
Data simulation

We simulated a binary habitat taking values 0 or 1 in a checkerboard pattern, to ensure homogeneous habitat availability, with no spatial bias relative to the home range centre. We then simulated 25 trips for 50 individuals with 4 states. Stage 2 and 3 (search and foraging) were modelled using correlated random walks (CRWs) while stage 1 and 4 (outbound and inbound), biased random walks (BRWs) were used (Michelot et al., 2017). At each time step, the state process is simulated based on a transition probability matrix. Step lengths and bearings are simulated using a gamma and von Mises distributions, respectively. Step-selection was set as a function of habitat, with suitable habitat being preferred.



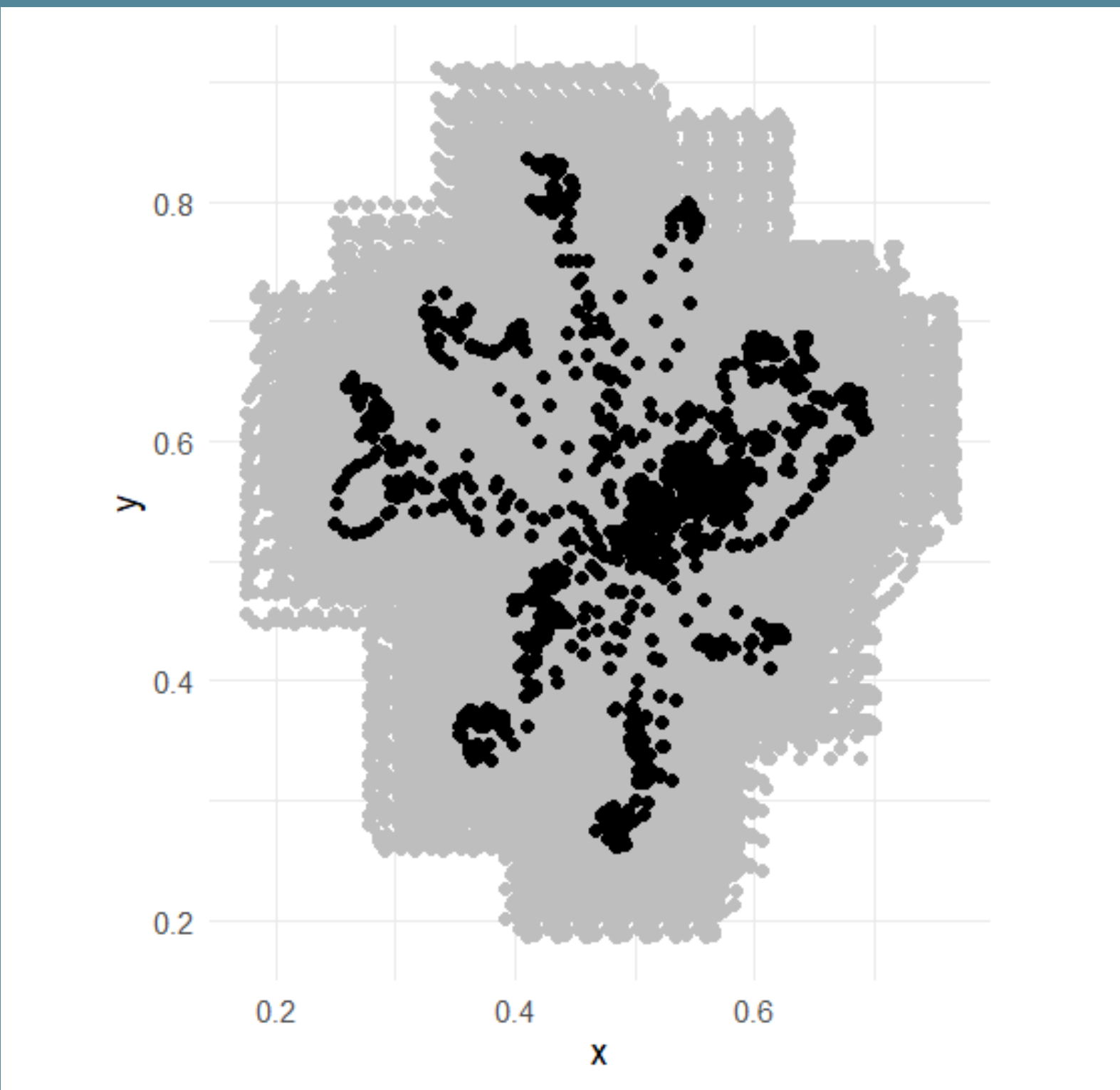
Quadrature points and track processing

Inhomogeneous Poisson Process Log-Gaussian Cox Process



- The area was divided in cells of 0.025* 0.025
- The centroid of each cell was used as a quadrature point
- Quadrature point weights correspond to the area of each cell
- Tracks were thinned to account for temporal autocorrelation

Space Time Point Process



- Based on the time between consecutive points and maximum velocity observed, we select a radius of possible locations used
- The number of possible locations depends on the cell size (here 0.025)
- Each possible location was used as quadrature points
- Quadrature points weights were equal to the area of the cell multiplying by the length of time

Model approaches*

Inhomogeneous Poisson Process (IPP)

(Dovers et al., 2023, Matthiopoulos et al., 2023)

$$\log \lambda_k = \text{Habitat}(\mu_k) \beta$$

Log-Gaussian Cox Process (LGCP) (Dovers et al., 2023)

$$\log \lambda_k = \text{Habitat}(\mu_k) \beta + s_1(\mu_k)$$

Space Time Point Process (STPP)

(Johnson et al., 2013, Hooten et al., 2017)

$$\log \lambda_k = \text{Habitat}(\mu_k) \beta + s_1(\mu_k) + \hat{\mu}(\mu_k)$$

s_1 is a two-dimensional thin-plate regression spline of x, y

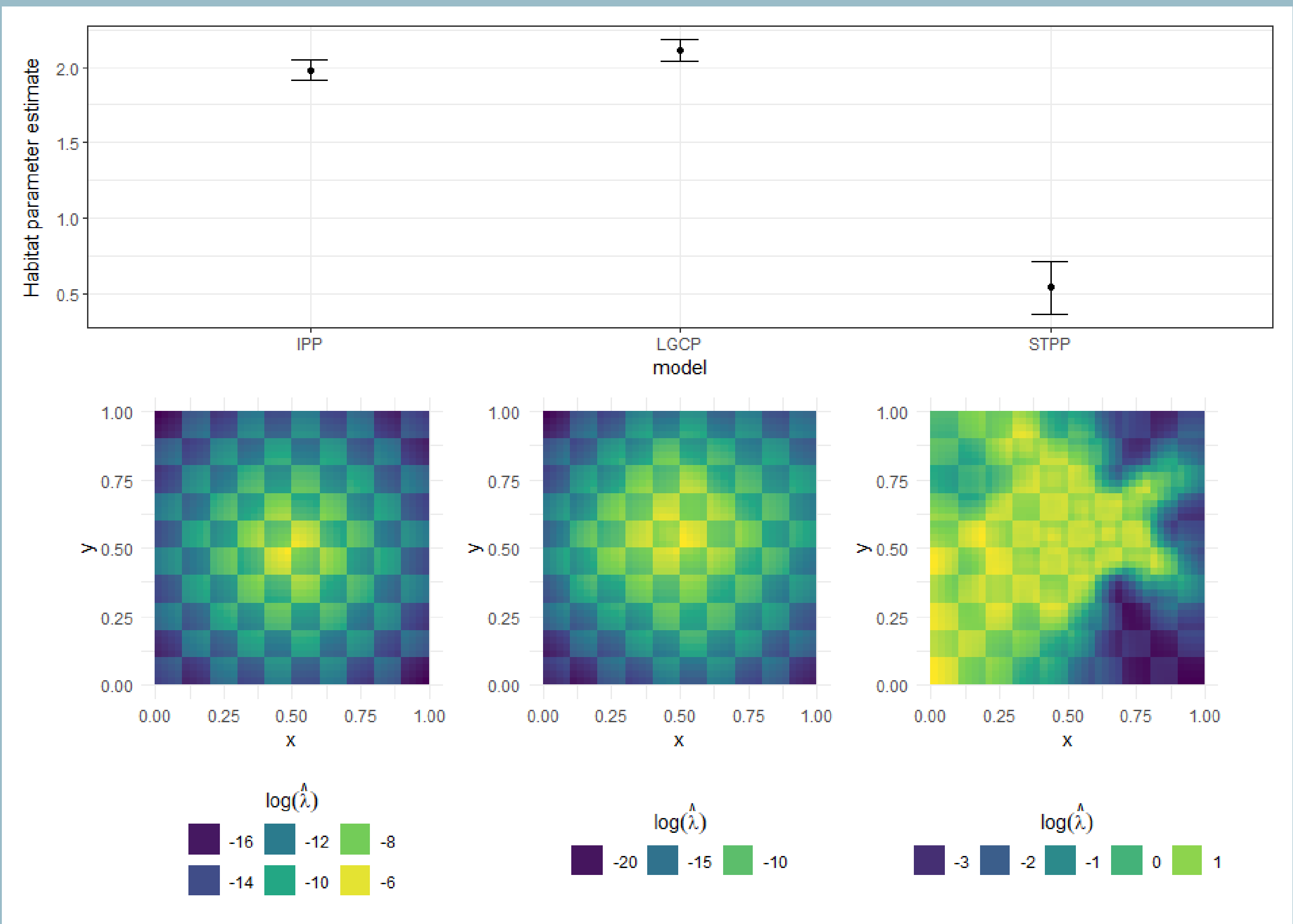
μ_k are the cells centroids

$\hat{\mu}$ is the kernel density map

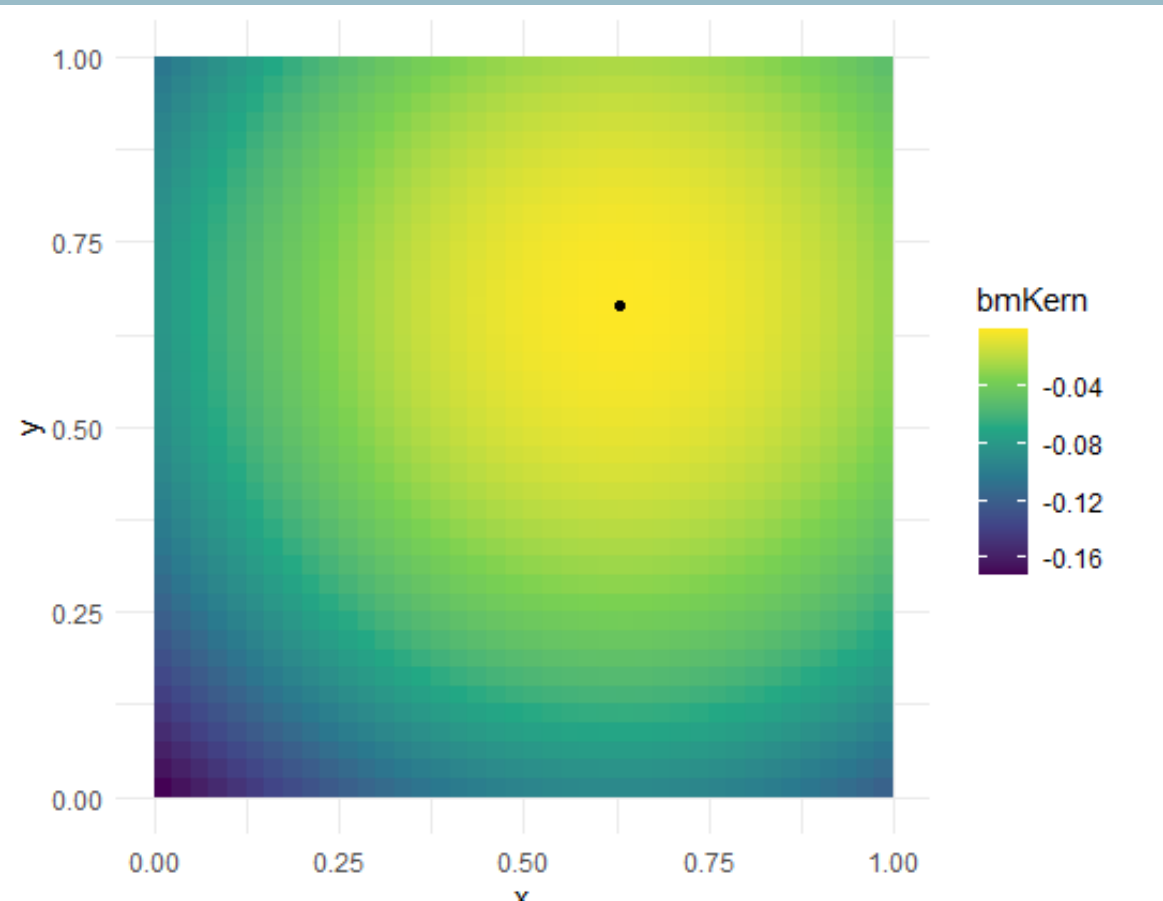
$$\hat{\mu}(\mu_k) = -0.5 * d(\mu_k, \mu_{k-1})^2 / (t_k - t_{k-1})$$

$d(\mu_k, \mu_{k-1})^2$ is the Euclidian distance between consecutive points

Results



- Only 5 individuals used to run the full STPP due to high computational time to extract quadrature points
- Moving to INLA
- Spatial marginalised STPPs (mSTPPs)
- Brownian movement kernel currently having a strong effect
- Explore other movement models such as Ornstein–Uhlenbeck (OU) model



*not an exhaustive list of methods

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Dovers, Elliot, Jakub Stoklosa, and David I. Warton. "Fitting log-Gaussian Cox processes using generalized additive model software." *The American Statistician* (2024): 1-16.

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