

Analyzing **spatio-temporal** patterns in **animal** **behavior** through movement path **recursions**

Chloe Bracis

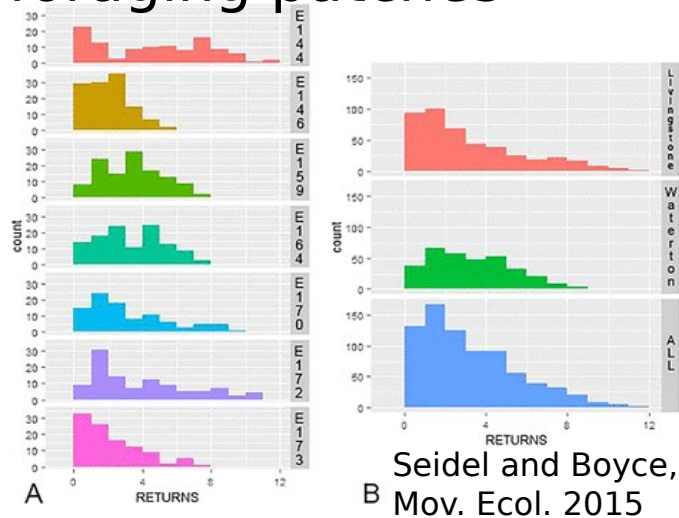
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Why do animals return?

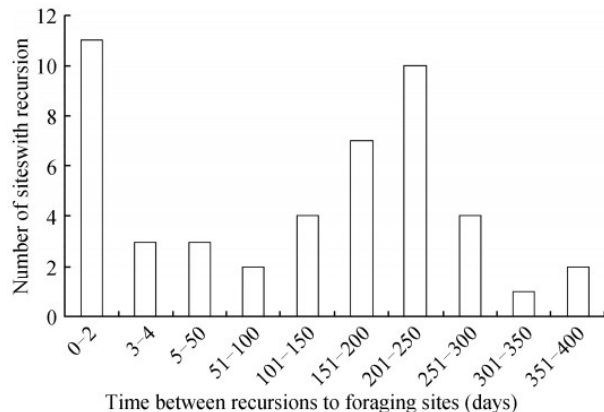


What can we learn studying recursions?

Return frequency to foraging patches

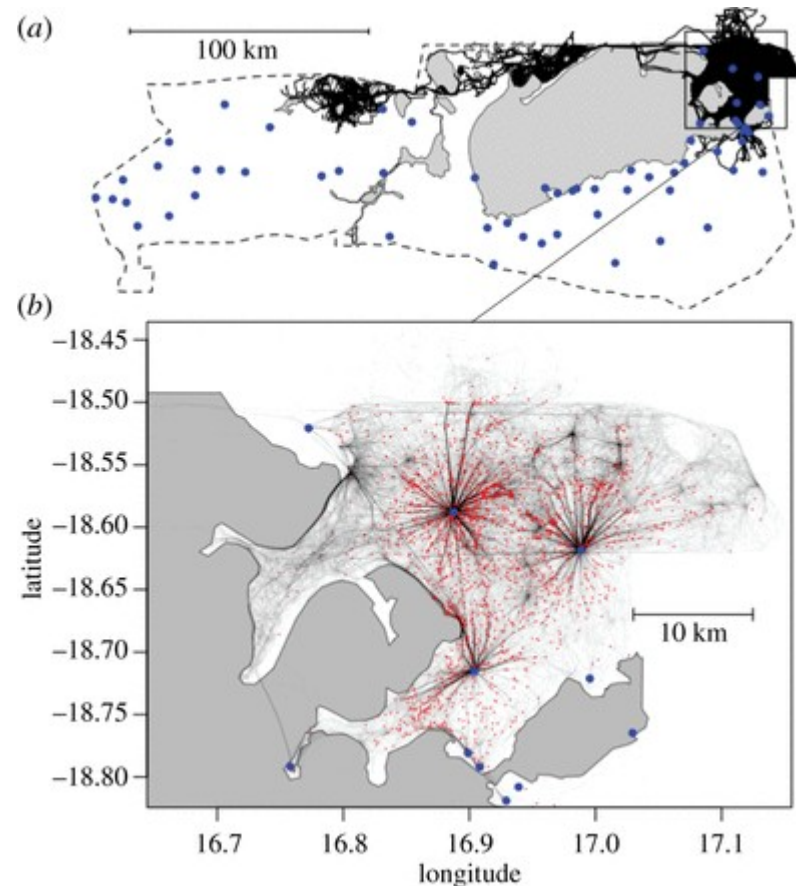


Time between visits



English et al., Curr. Zoo. 2014

Evidence for spatial memory



Polansky et al., Proc. Biol. Sci., 2015

Are recursions understudied?

esa

ECOSPHERE

SYNTHESIS & INTEGRATION

Recursive movement patterns:
review and synthesis across species

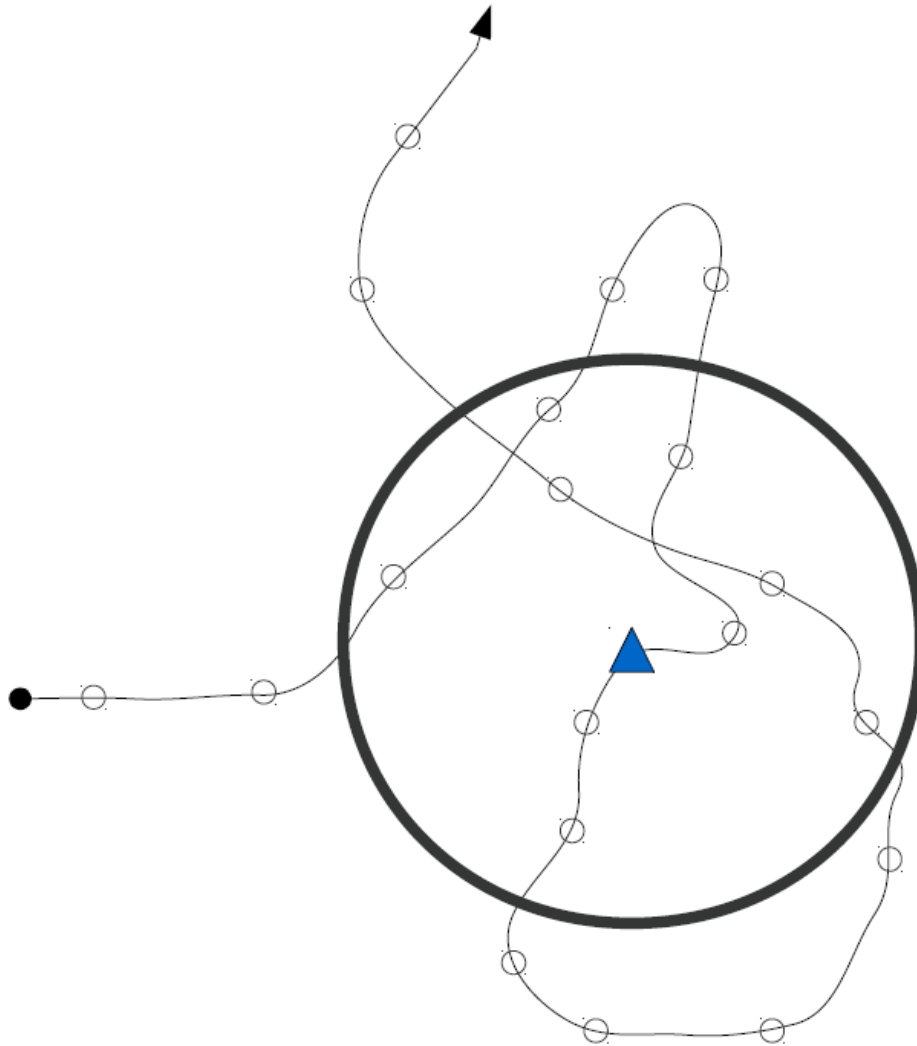
ODED BERGER-TAL^{1,2,†} AND SHIRLI BAR-DAVID³

“Recursive movement pattern, i.e., returns to previously visited areas, is a widespread phenomenon in the animal kingdom... Nevertheless, the wide scope and generality of this phenomenon may be still considerably underestimated by the scientific community.”

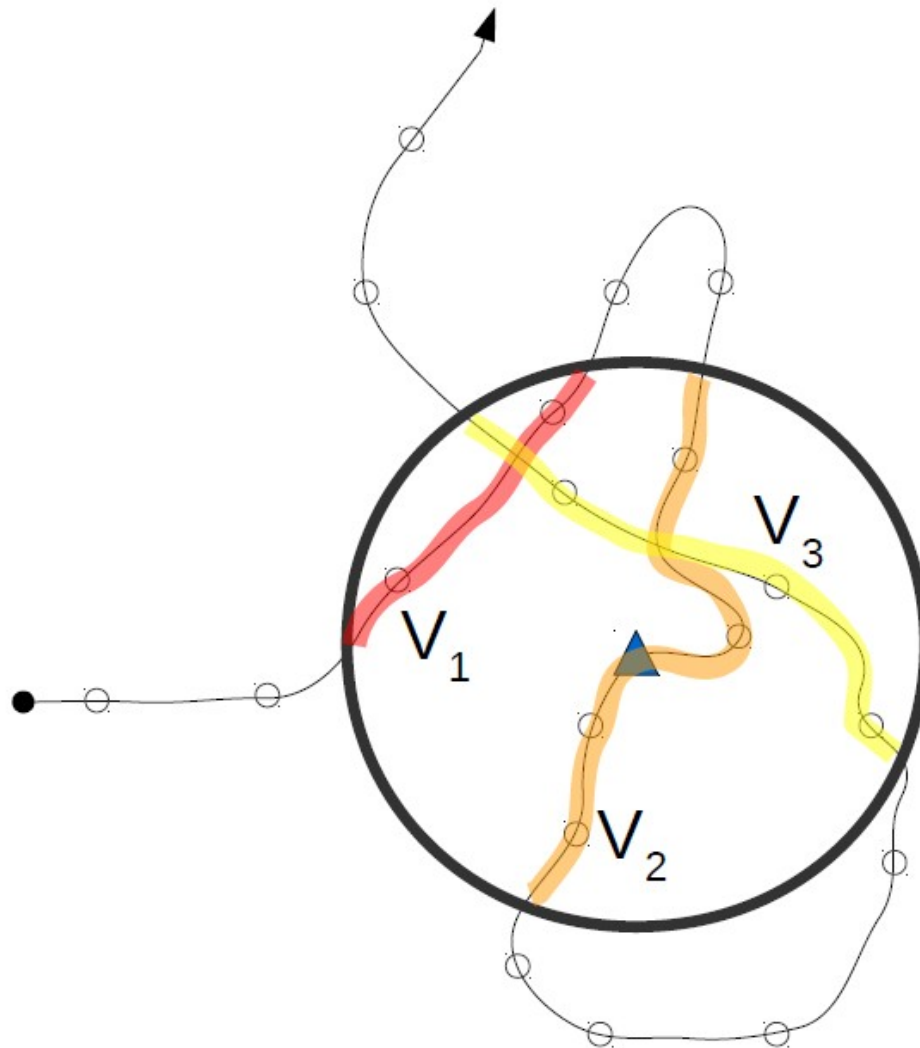
recurse package

- R package available on CRAN
- Calculates the number of recursions within a specified radius from a movement trajectory
- Other metrics like residence time, time between visits, entrance and exit times

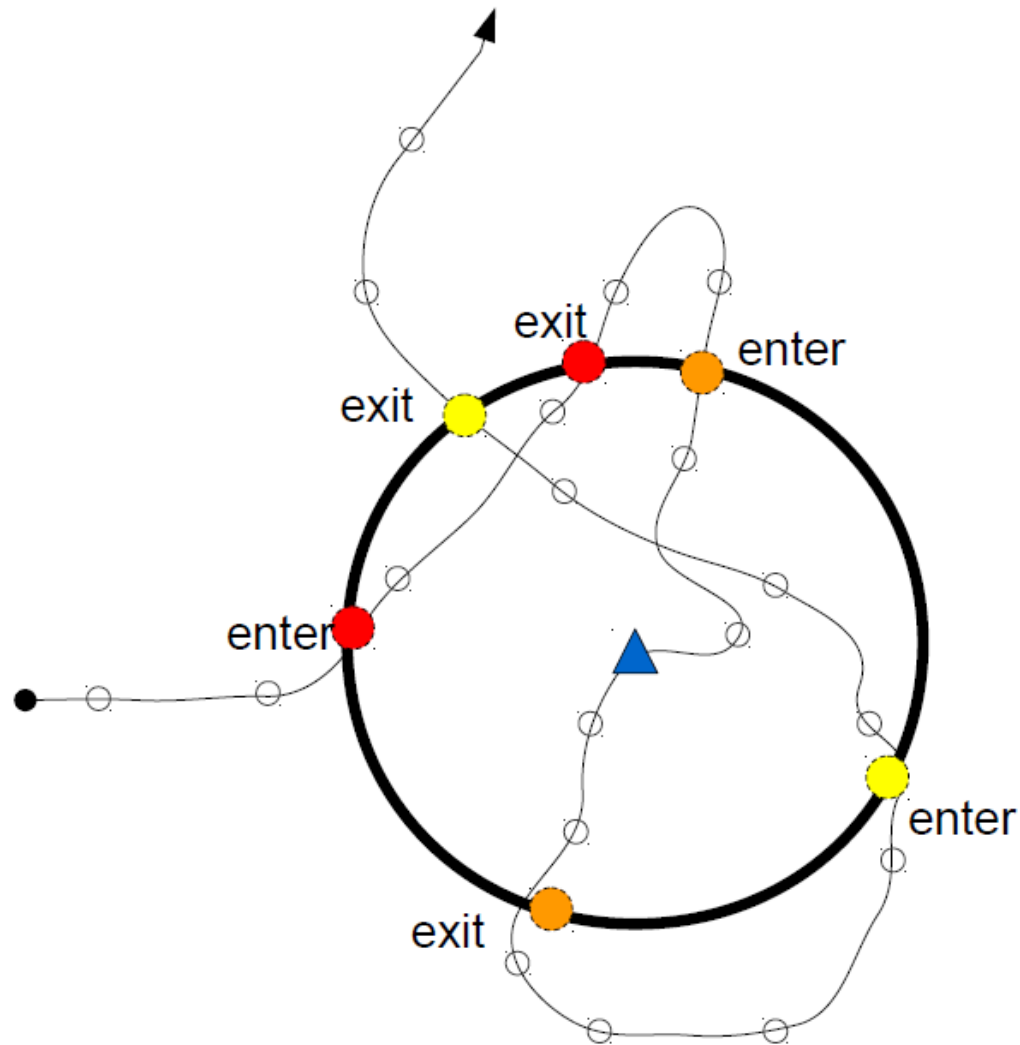
How does it work?



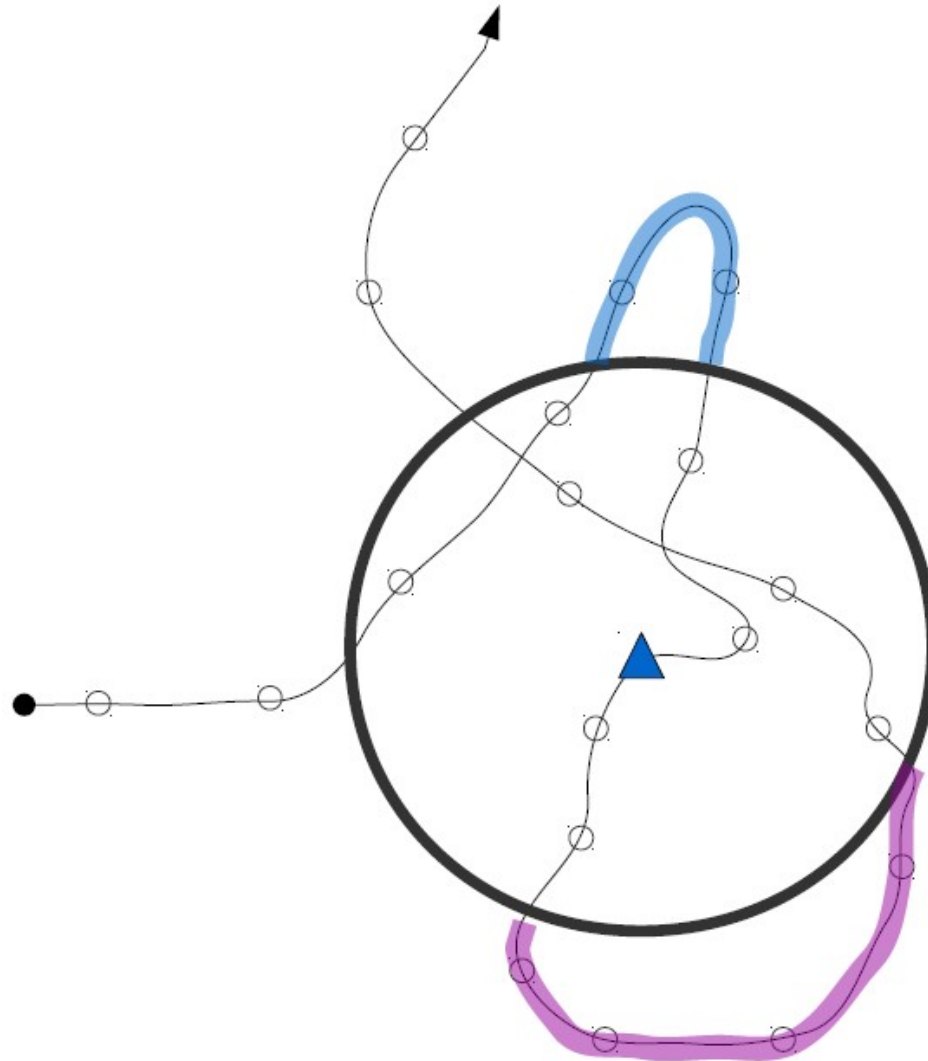
Select segments inside radius



Interpolate entrance/exit times



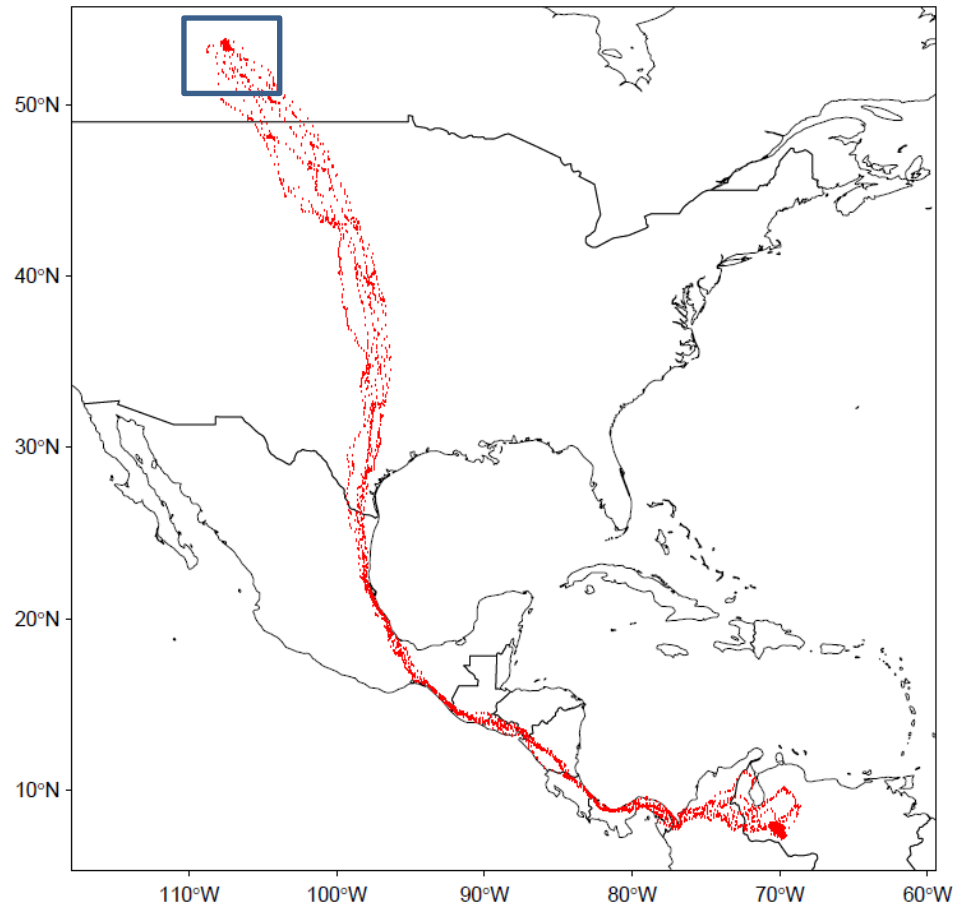
Time between visits



Analyses possible with **recurse** package

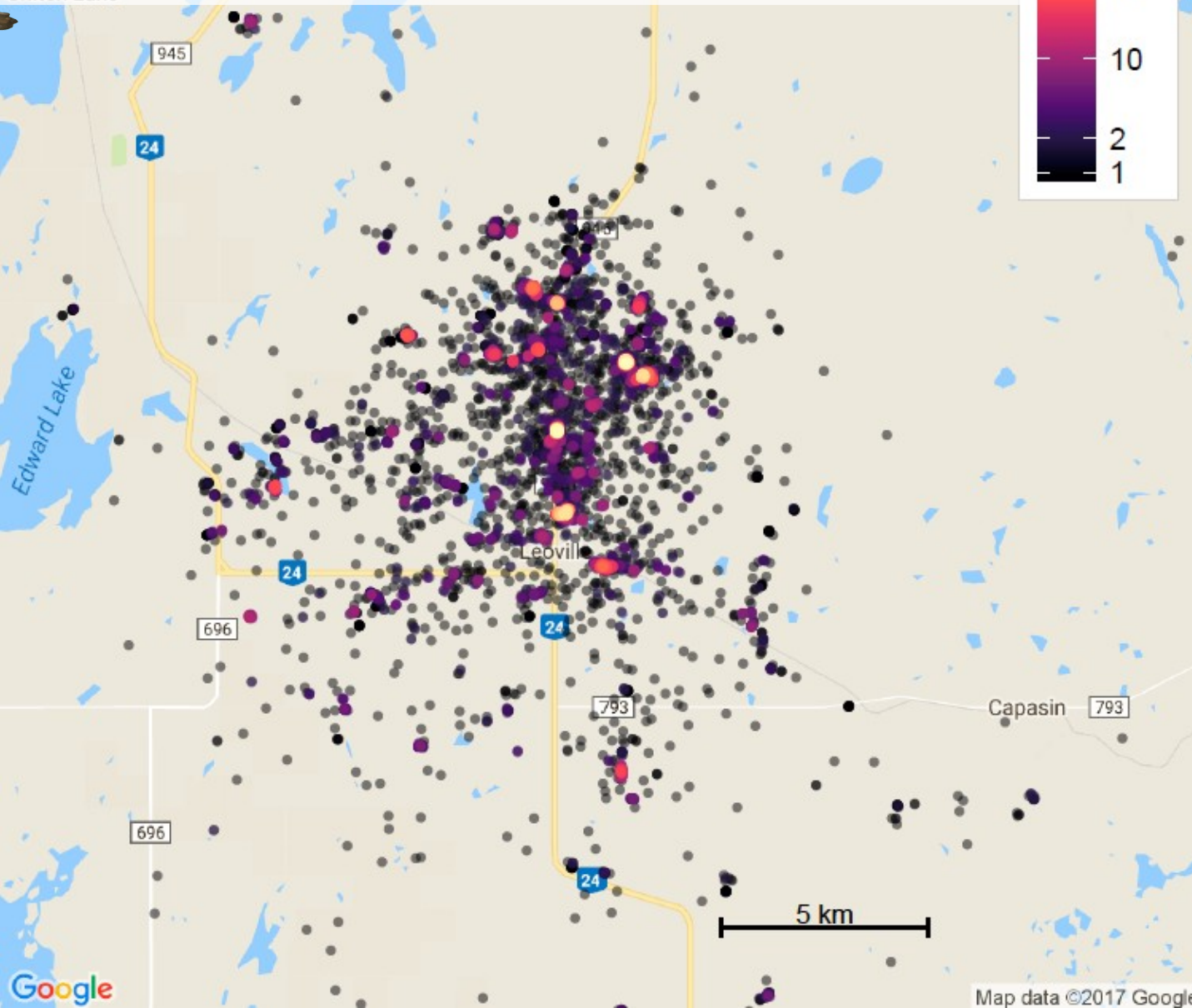
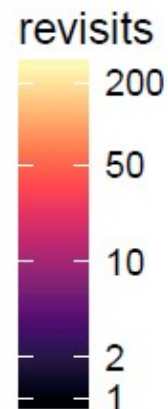
- Identify frequently-used locations across *one* or *multiple* individuals
- Pre-specify locations of interest or examine all trajectory locations
- *Visit-level analysis* of time of day, duration, time since last visit, etc. and combine with other information (e.g, behavioral segmentation)
- Spatially/temporally coincident *visit covariates* (e.g., NDVI, temperature, snow etc.)
- *Intervisit interval* consistency at and across locations
- Visits to user-specified *polygon* (protected area, foraging ground)
- Residence time during *user-specified intervals* (seasonal, etc.)

Example: Leo the Turkey Vulture



Nest or roosts: 50 m radius

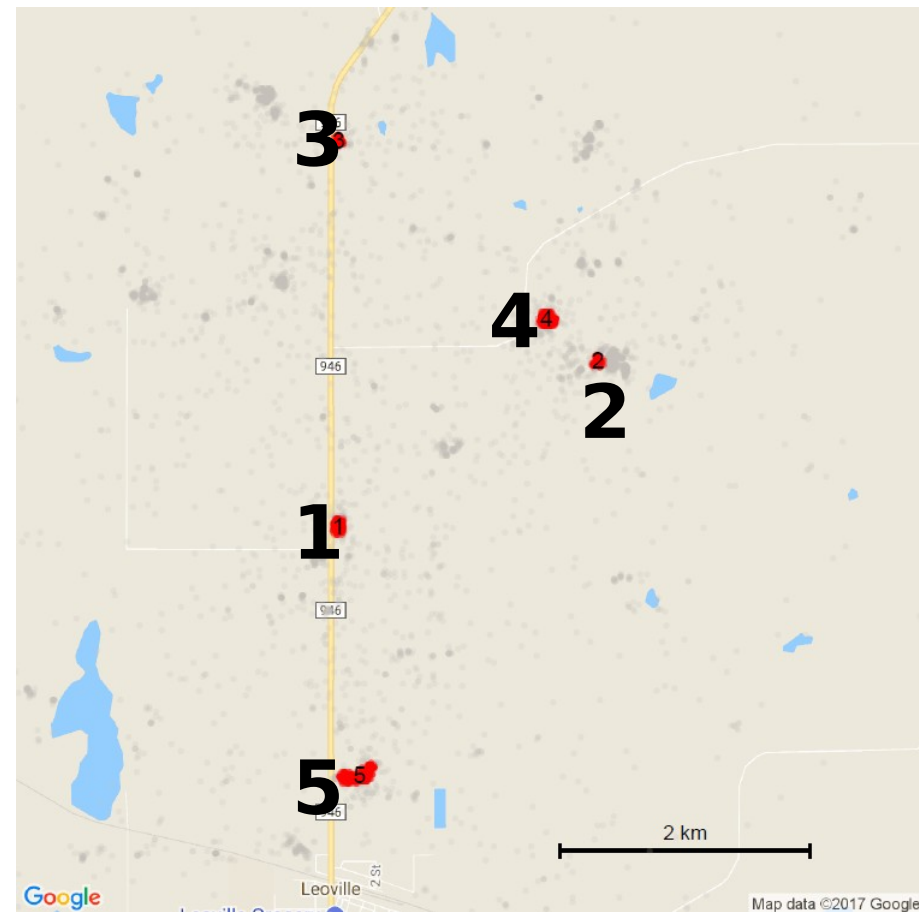
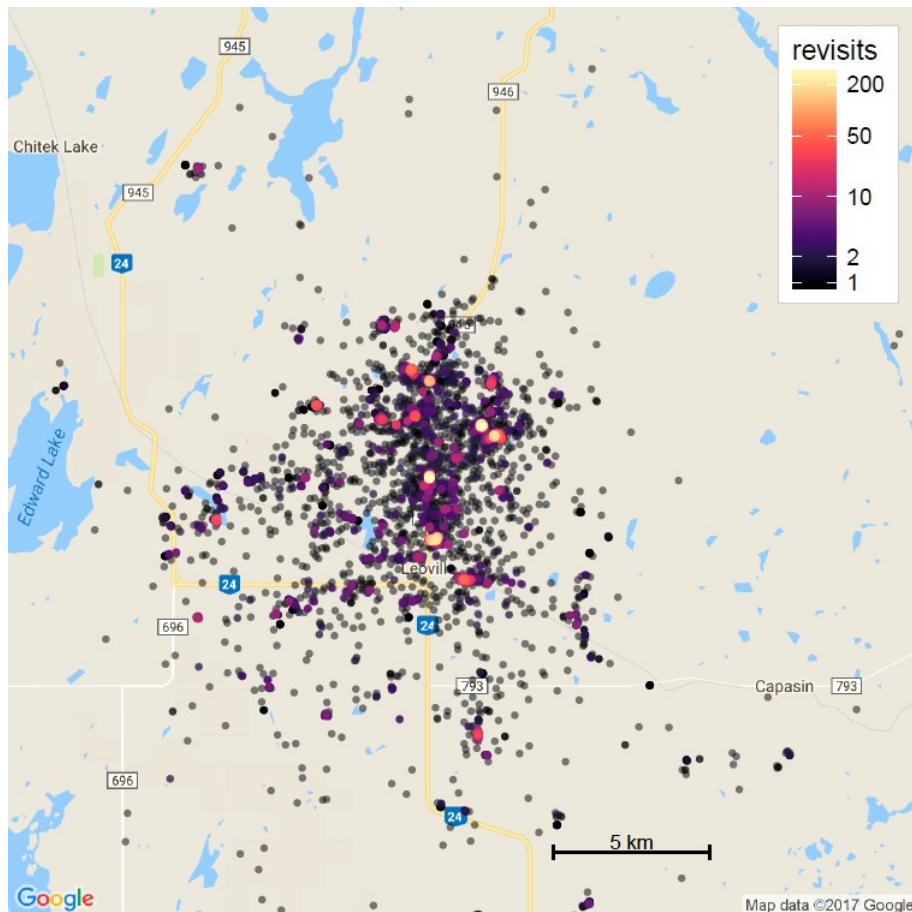
Chitek Lake

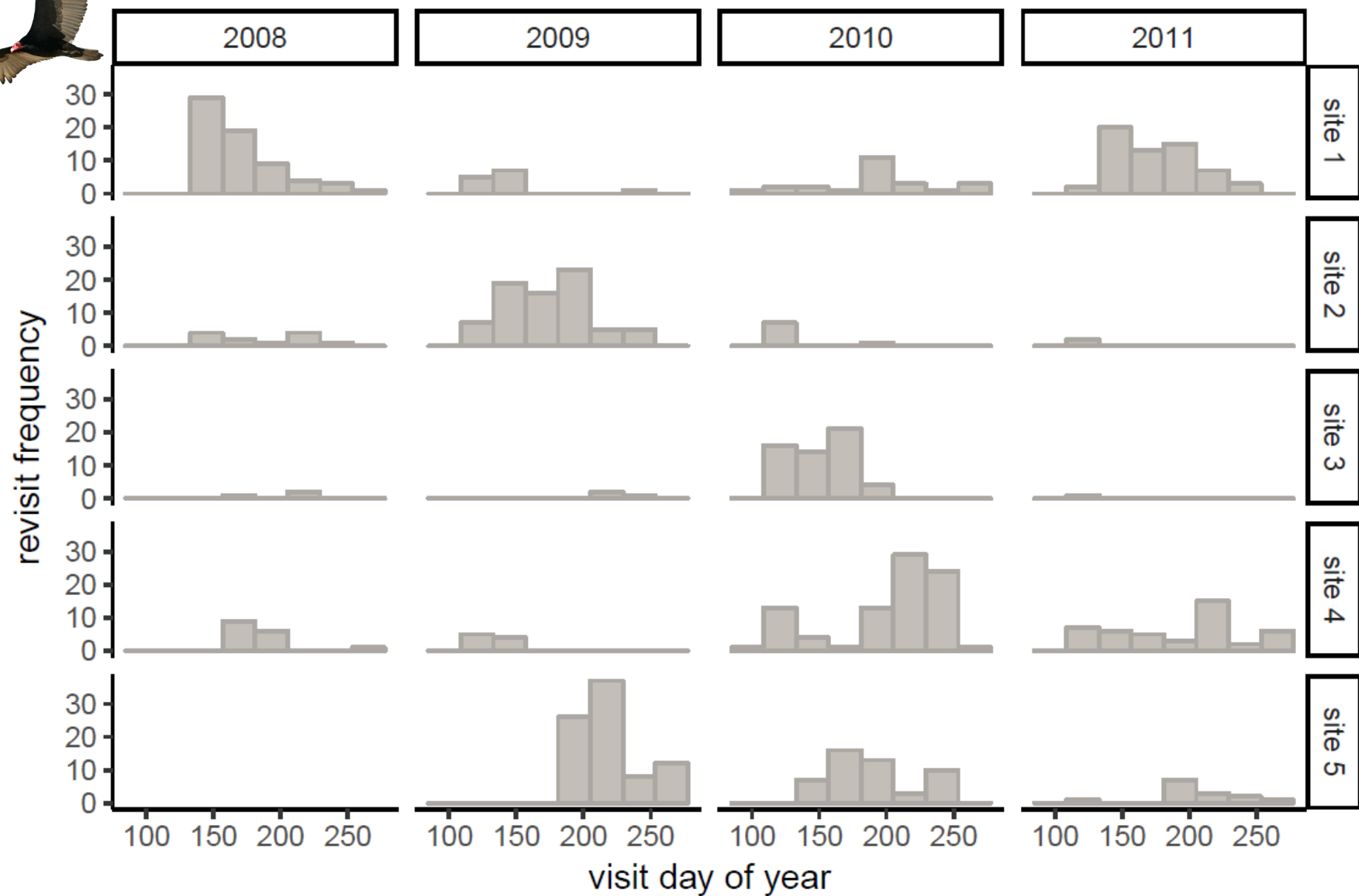




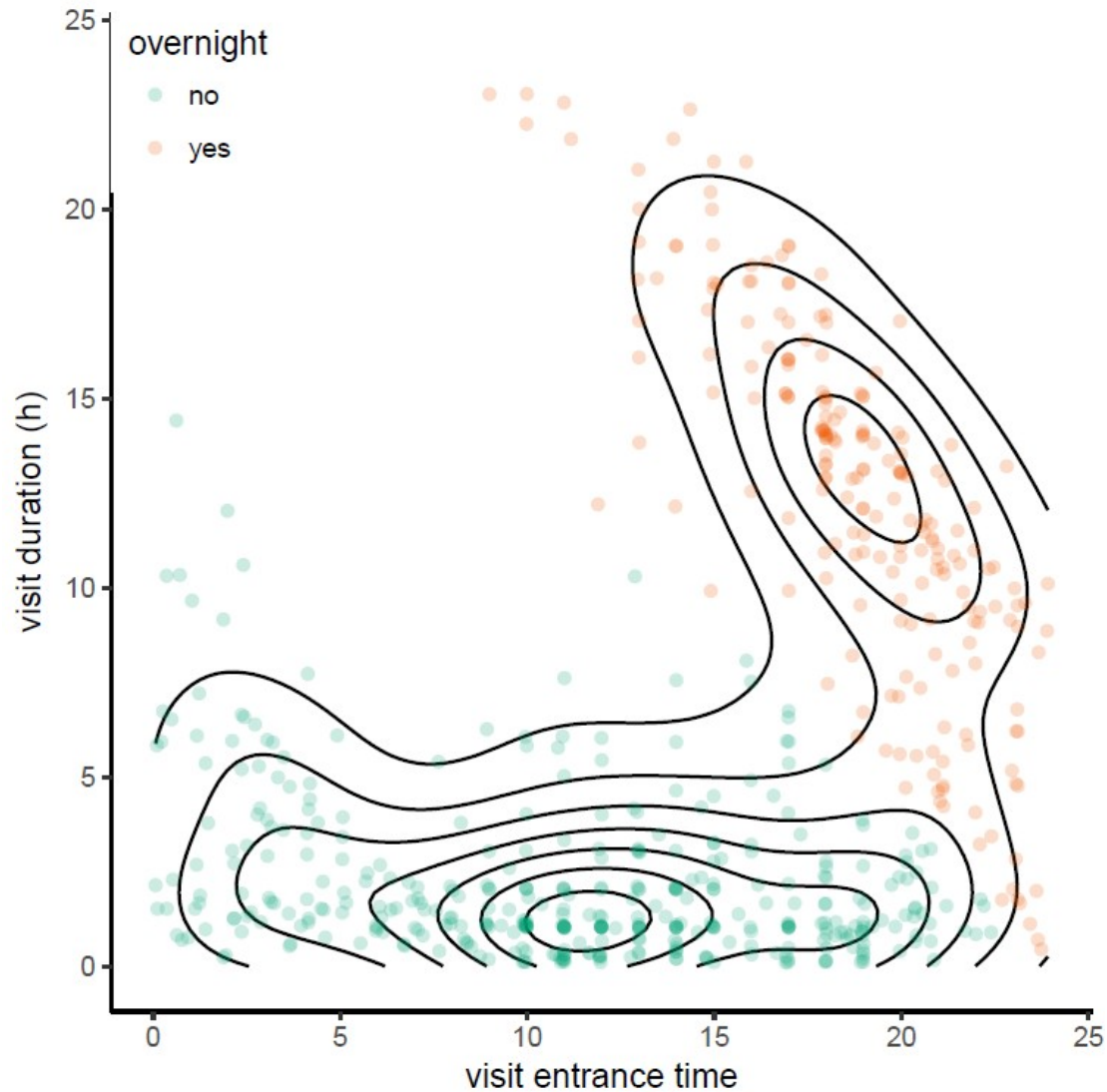
Clustering: find highly revisited sites

Look at sites with > 75 visits, i.e. nests or roosts: **5 sites**



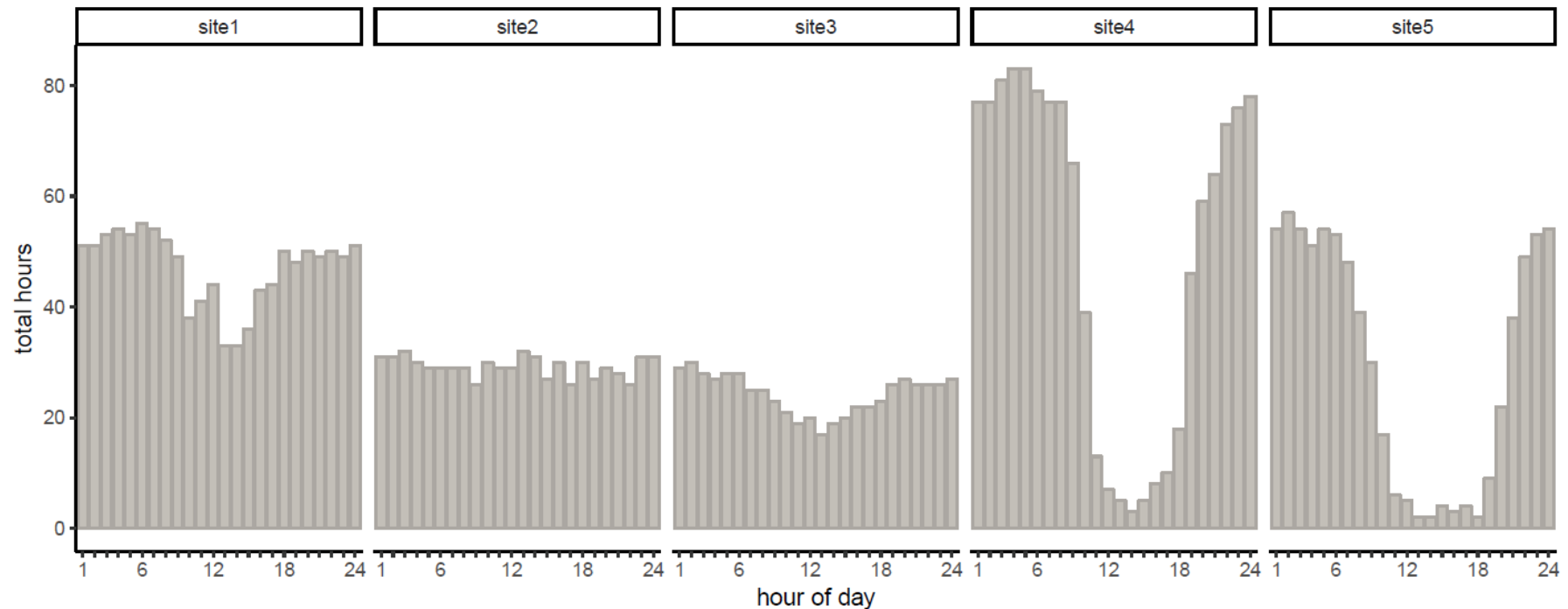
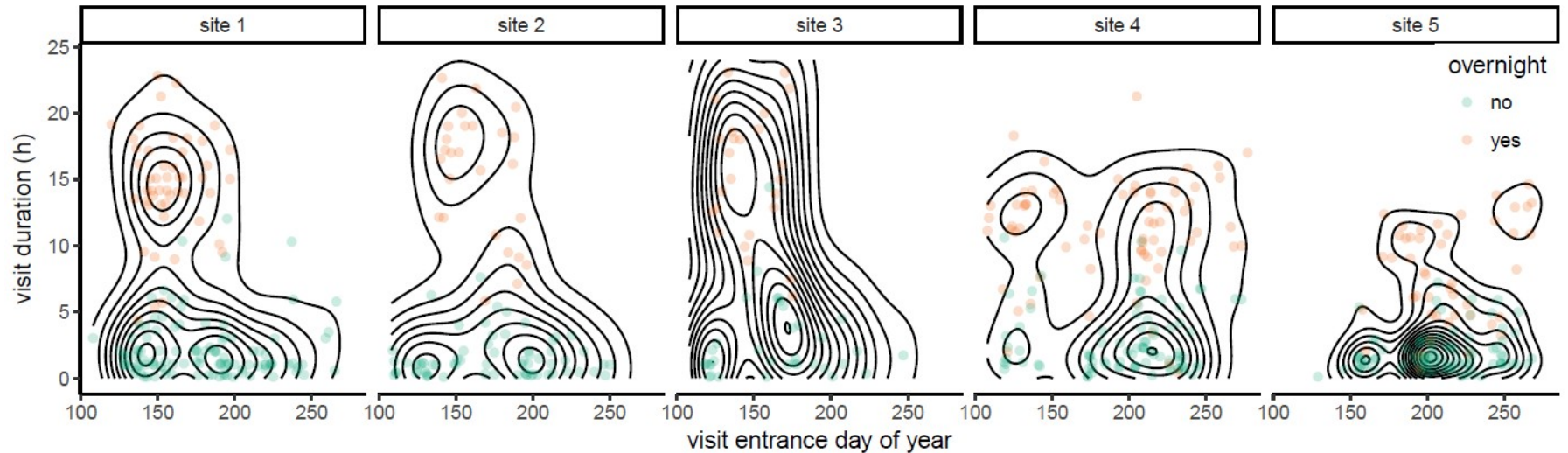


Visit duration varies by time of day





Patterns of visit timing and duration



What have we learned about Leo?

- Identified 5 frequently used sites (nests/roosts)
- Temporal pattern of visitation, seasonally and among years
- Partitioned visits: short non-overnight and longer overnight with dawn departure
- Partitioned sites 1-3 vs 4-5: visit time of day and overnight visit seasonal pattern



Resources for **recurse** package

- CRAN: recurse vignette

<https://cran.r-project.org/web/packages/recurse/vignettes/recurse.html>

- Bracis, C., Bildstein, K. L., & Mueller, T. (2018). Revisitation analysis uncovers spatio-temporal patterns in animal movement data. *Ecography*, 41(11), 1801-1811.

Source code in supplemental material