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Wildlife Research

Supplementary Material

Site fidelity trumps disturbance: aerial shooting does not cause surviving fallow deer (*Dama dama*) to disperse

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Searching behaviours of helicopter shooting teams approximate a Lévy walk

The movement patterns of predators searching for prey can often be described using diffusion and random walk processes derived from statistical physics (Bartumeus and Catalan 2009). One such process, observed in a wide range of taxa including protists, humans and pelagic birds, is the Lévy walk (Reynolds 2018). A Lévy walk is a stochastic movement process comprising clusters of short steps connected by longer steps, with this pattern recurring across all spatial scales. Lévy walks are characterised by a long-tailed (power law) step length distribution:

$$P(l_j) \sim l_j^{-\mu}$$

with $1 < \mu < 3$, where l_j is the step length and μ is the power law exponent. Lévy walks represent an efficient search pattern for a predator with imperfect information about the locations of sparse and randomly-distributed prey (Sims *et al.* 2012), such as helicopter shooting teams searching for groups of deer in a woodland–pastoral matrix.

We used GPS tracking data from four helicopter shooting teams in three operations (A1, A2, C) to estimate the power law exponent characterising search patterns over 19 separate days of aerial shooting operations. We used the prep_data() function from the *bayesmove* package (ver. 0.2.1, J. Cullen and D. Valle, see https://cran.r-project.org/package=bayesmove) to estimate step lengths (m) from tracking data recorded at 15-s intervals by the helicopter's on-board location following system (TracPlus Global, Dunedin, New Zealand). Location fixes within 100 m of the staging area to which helicopters returned approximately every 2 to 2.5 h were discarded. For each combination of shooting team and day, we constructed a frequency distribution of step lengths using 20 bins. We then estimated the power law exponent using regression of the $\log_{10}$ relationship between step length and frequency. Model adequacy and explanatory power were assessed using residual plots and coefficient of determination (R^2) values.

In total, 16 out of the 19 shooting days examined provided an acceptable model fit and a R^2 value $\geq$ 0.6. Power law exponent estimates ranged from 0.58 to 1.68 (Fig. S1). Twelve of these models (79%) returned a power law exponent estimate between 1 and 3, consistent with expectations of helicopter shooting teams using a Lévy walk movement pattern to hunt for deer.

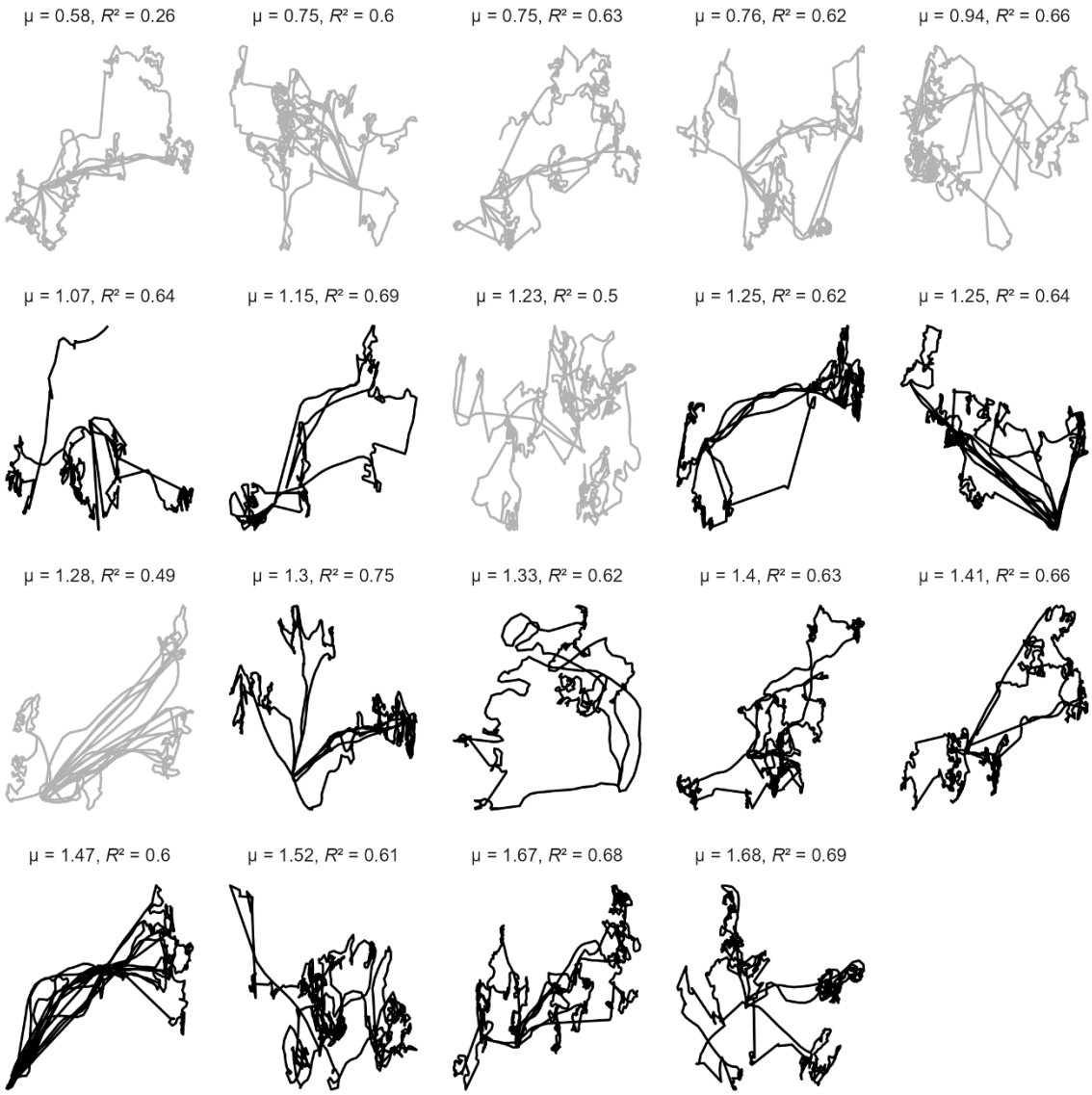

Figure S1. Flight paths of helicopter shooting teams, recorded at 15-s intervals, over 19 days of aerial shooting. Paths drawn in black represent flight paths that correspond to a Lévy walk pattern ($1 < \mu < 3$) with R^2 of the estimating model ≥ 0.6.

References

Bartumeus F, Catalan J (2009) Optimal search behavior and classic foraging theory. *Journal of Physics – A. Mathematical and Theoretical* **42**(43), 434002.

Reynolds AM (2018) Current status and future directions of Lévy walk research. *Biology Open* **7**(1), bio030106.

Sims DW, Humphries NE, Bradford RW, Bruce BD (2012) Lévy flight and Brownian search patterns of a free-ranging predator reflect different prey field characteristics. *Journal of Animal Ecology* **81**(2), 432-442.