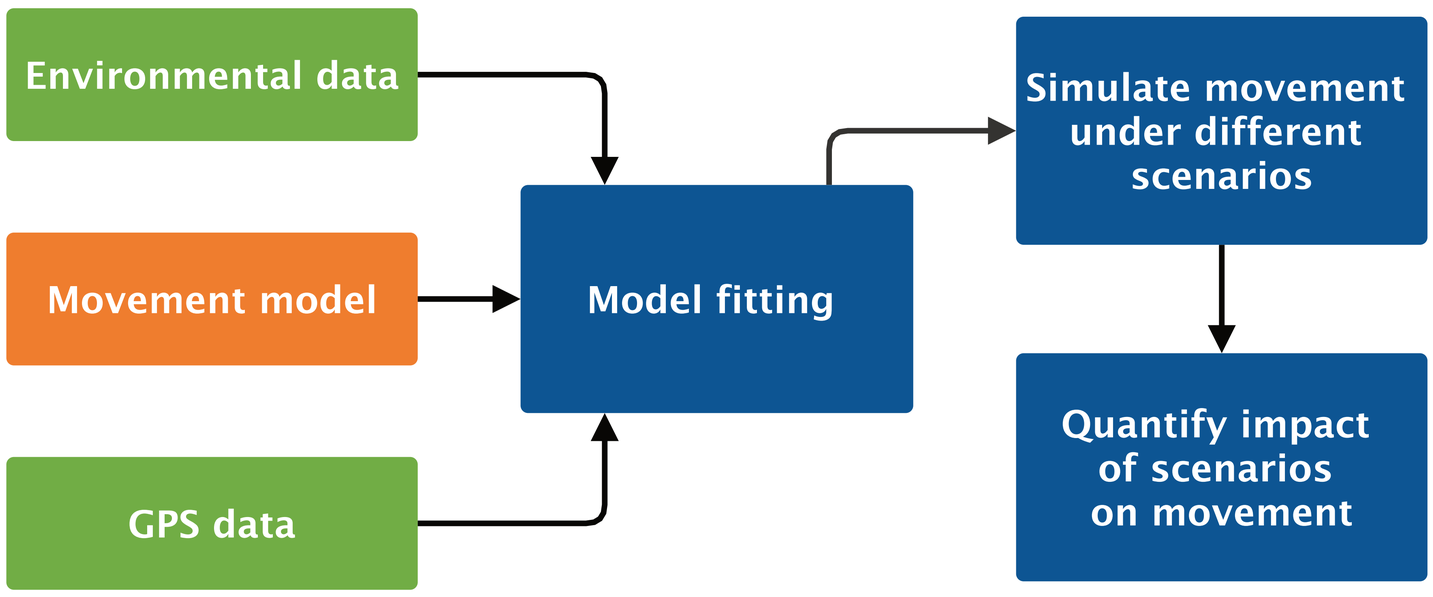
A framework to predict the impacts of infrastructure on wildlife movement



The outlined framework can **quantify** the **behavioural response** of wildlife to changes in their habitat (e.g. new infrastructure) and allows for further **prediction** of impacts, such as **habitat fragmentation & connectivity**.

Predicting the impacts of infrastructure on movement during the planning of a project aids **mitigation** efforts, supporting the achievement of the UN **Sustainable Development** Goals.

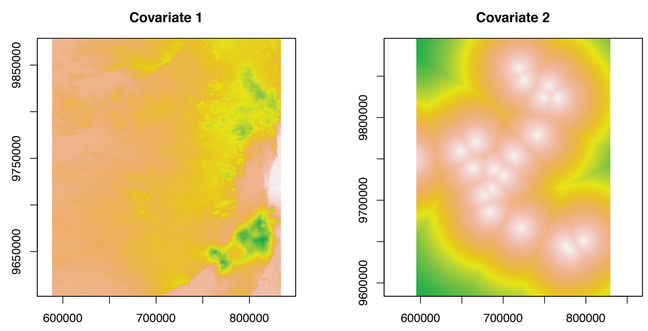
MEMORY-ADJUSTED STEP SELECTION MODEL

1. From current location, generate *N* available locations using distributions of step lengths (SL) and turning angles (TA).

$$SL \sim Gamma(k, \theta)$$

$$TA \sim vonMises(\mu, \kappa)$$

2. Extract covariate information at each location.



3. Calculate relative probability of selecting each location with coefficients (estimated via model fitting and/or expert opinion) describing preference for each of *n* covariates.

Relative probabilities in standard step selection are calculated as:

$$w_{u_{t,i}} = \exp(b_1 x_1 + b_2 x_2 + ... + b_n x_n)$$

Adjustment to account for often **incorrect assumptions** that individuals have **no memory** and **perfect knowledge**

A minimum spatio-temporal distance, *H*, between available locations and previous locations is a proxy for past experience, adjusting the knowledge individuals have of available locations:

$$H = \max\left(\frac{1}{1 + \exp(a_0 + a_1 d_{ij} + a_2 t_{ij})}\right)$$

$$w'_{u_{t,i}} = \bar{w}_{u_t} + H(w_{u_{t,i}} - \bar{w}_{u_t})$$

4. Select next step using adjusted relative probabilities.

$$selected \sim Multinomial(1, w'_{u_{t,i}})$$

SIMULATION DEMONSTRATION

How will wildebeest movement in Serengeti NP be impacted by increased tourism infrastructure in high-use area (HUA)?

Wildebeest behaviour:
1) avoid tourist lodges
2) avoid high elevation
3) avoid high human density

Development scenarios:
A) current tourist lodges
B) additional 10 lodges in HUA
C) additional 25 lodges in HUA
D) additional 50 lodges in HUA

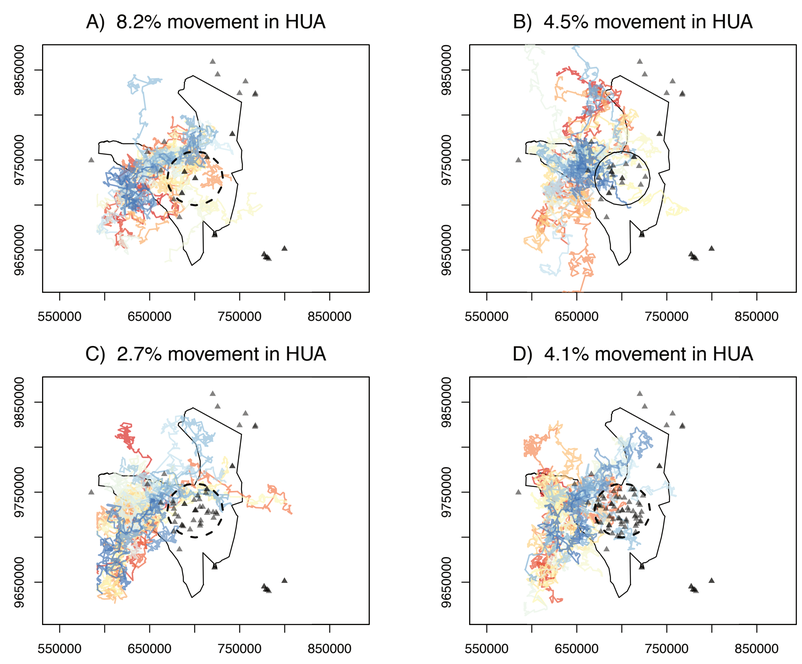


Fig 1: 30 simulated movement tracks per scenario. Movement in HUA (dashed circle) decreases with increasing infrastructure (grey triangles), until scenario D. A threshold in avoidance behaviour is seen.

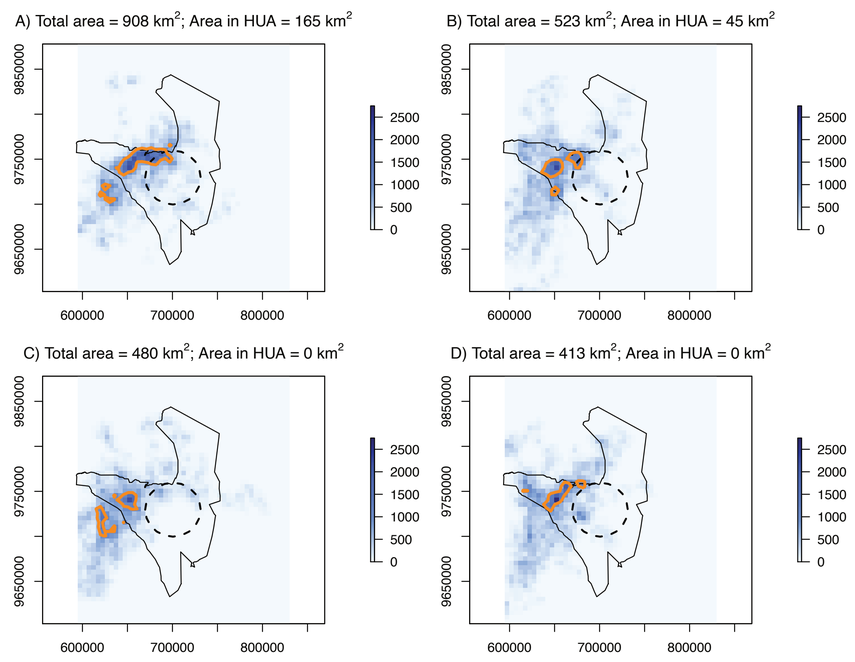


Fig 2: Space use incl. highlighted hotspots with >1000 visits. 18% of hotspot overlaps with HUA in A, demonstrating inherent preference. No hotspot overlap in C and D, indicating effective loss of preferred habitat.

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