How does human behaviour impact dog rabies outbreaks?

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How does rabies persist at low incidence?

<1% of the dog population becomes rabid annually

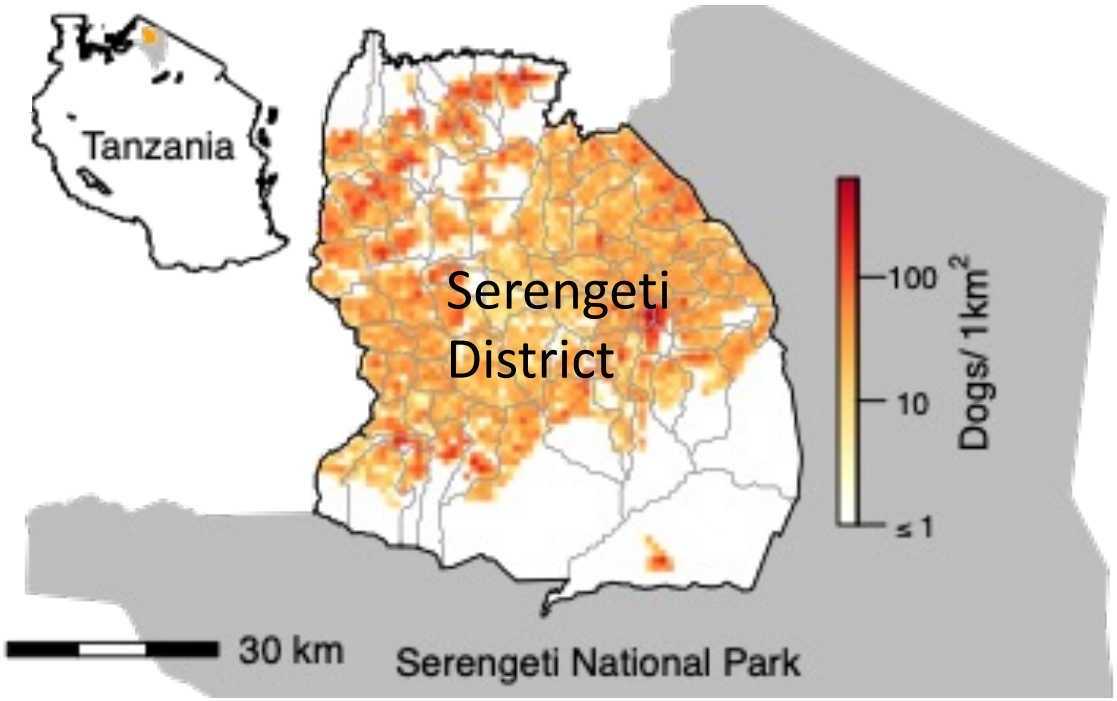
Despite:

- Large free-roaming dog populations
- Absence of acquired immunity
- Limited dog vaccination

Human behaviour:

- Is killing/tying of rabid dogs dependent on recent local cases and how does this impact the size of outbreaks?

Serengeti District, Tanzania



- ~340,000 people and ~80,000 dogs
- Annual dog vaccination campaigns since 2003
- Contact tracing since 2002
- Rabies has remained endemic
- 28% of dogs were tied or killed before any bites were observed

What affects the decision to restrict before biting?

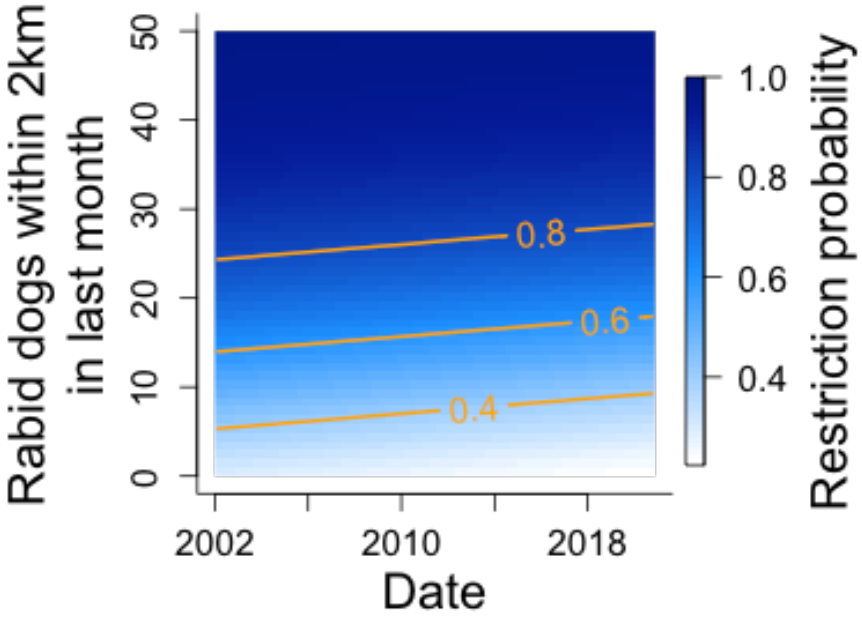
GLMM:

- Bernoulli response = Restricted before biting
- Explanatory variables:
  - Number of dog rabies cases within 2km in last month
  - Date
  - Owner status
  - Aggression
- Random effect = Village

What affects the decision to restrict before biting?

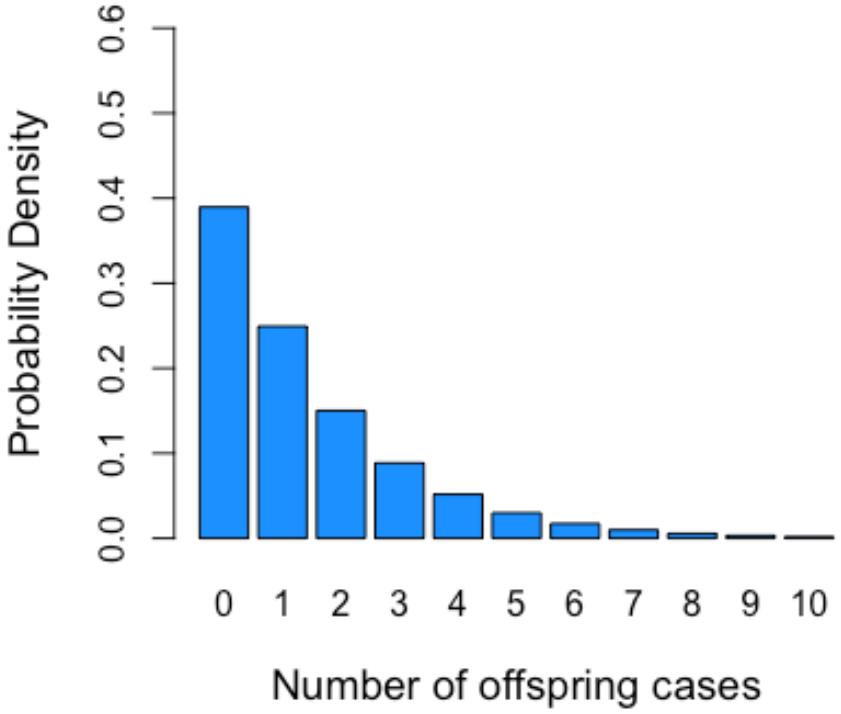
GLMM:

- Bernoulli response = Restricted before biting
- Explanatory variables:
  - Number of dog rabies cases within 2km in last 1 months
  - Date
  - Owner status Known -> 3.8 times odds of restriction
  - Aggression Yes -> 4.4 times odds of restriction
- Random effect = Village

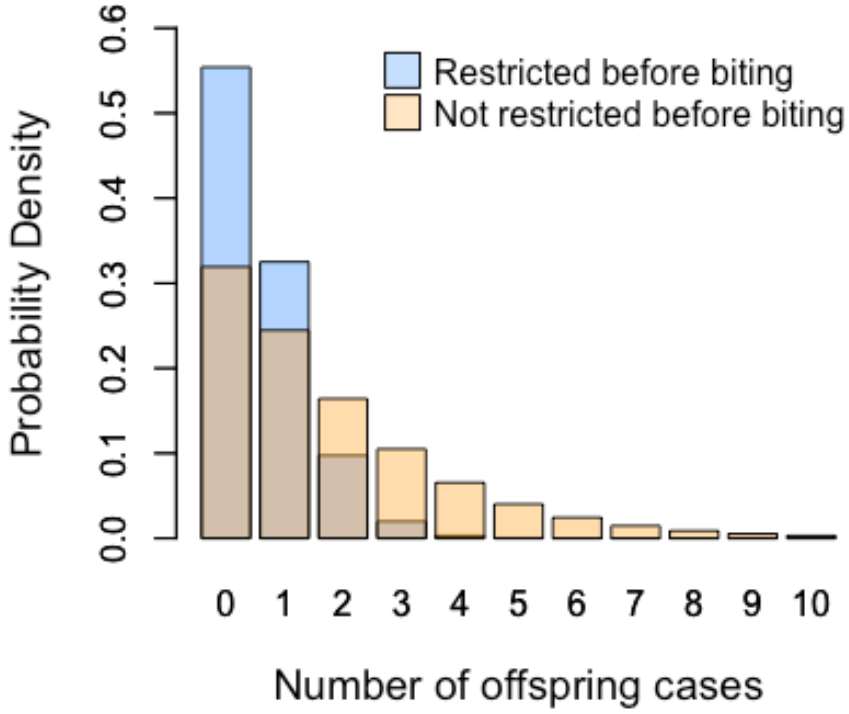


Incorporating human behaviour into a rabies transmission IBM

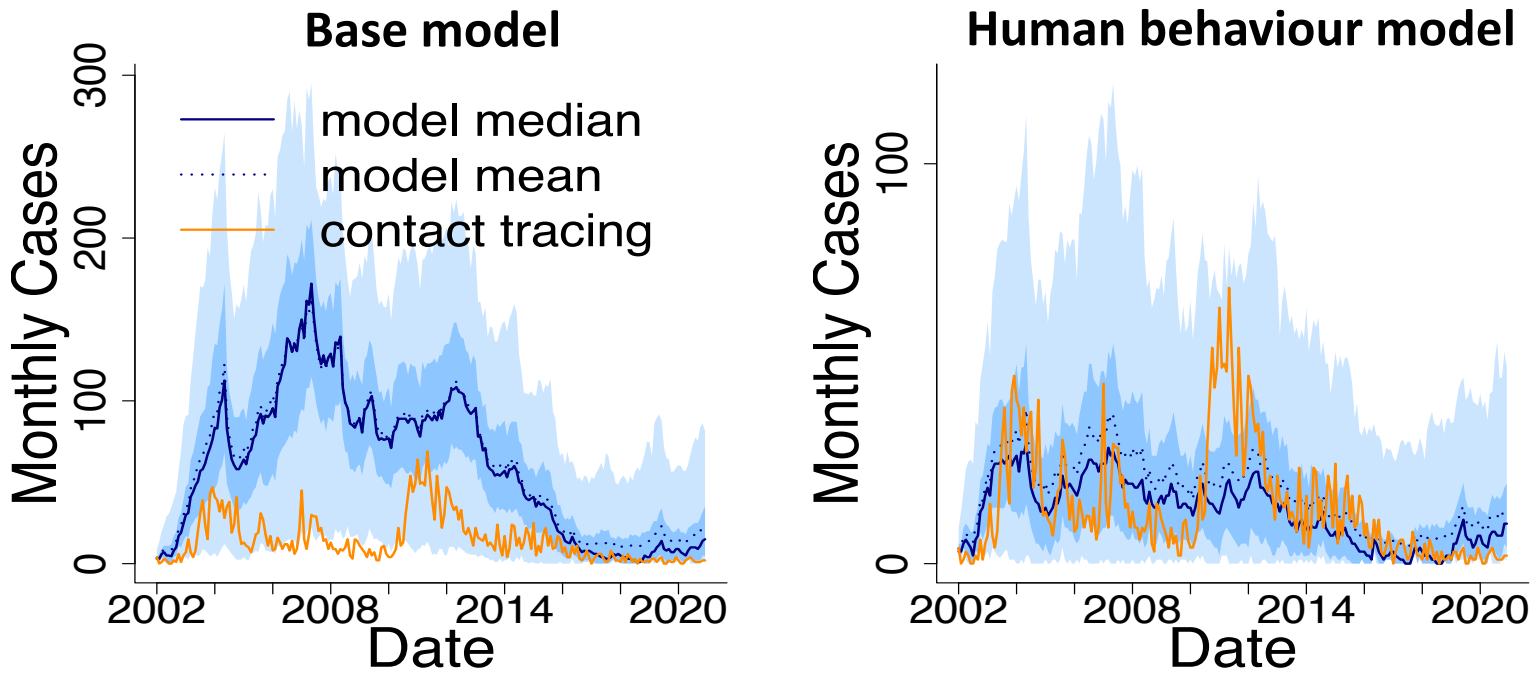
Base model: Offspring cases drawn from a negative binomial distribution fitted to offspring case numbers from contact tracing.



Human behaviour model: Use fitted GLMM to draw whether dog is restricted. Draw offspring cases from the appropriate distribution.

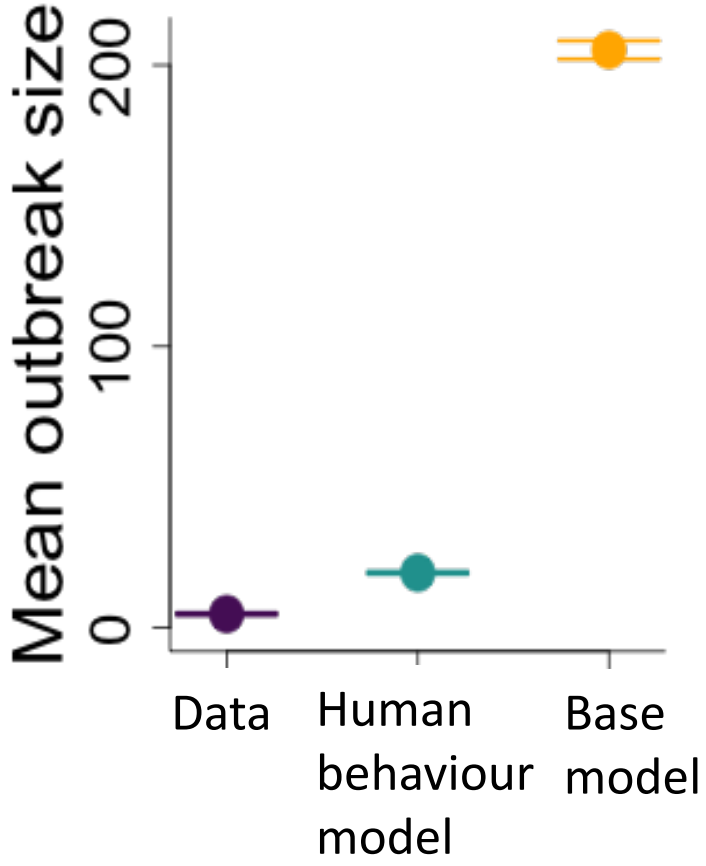


Including incidence-dependent human restriction improves the match between model and data



Cases from contact tracing (orange) compared to IBM predictions (blue) with and without changing human behaviour. Shading: 50 and 95 percentile intervals from 500 simulations.

Incidence-dependent human restriction reduces outbreak sizes



Outbreak = 2+ cases, <30 days apart, within the same village

Mean size of outbreaks is much closer to that observed in the data when we include human behaviour.

Summary/Future work

- People are more likely to restrict rabid dogs before they bite when there have been recent cases locally.
- This behaviour substantially reduces incidence and outbreak sizes, helping maintain characteristic low rabies incidences.
- Need to explore how this impacts other aspects of transmission, e.g. persistence in the ‘end game’, the influence of vaccination gaps, urban vs rural dynamics
- Does sensitisation from recent local cases impact other decisions? E.g. whether to vaccinate in the next campaign