

Rabies in your neighbourhood?

A simulation study on the spread of dog rabies and its control following its incursion in France

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Context and objectives

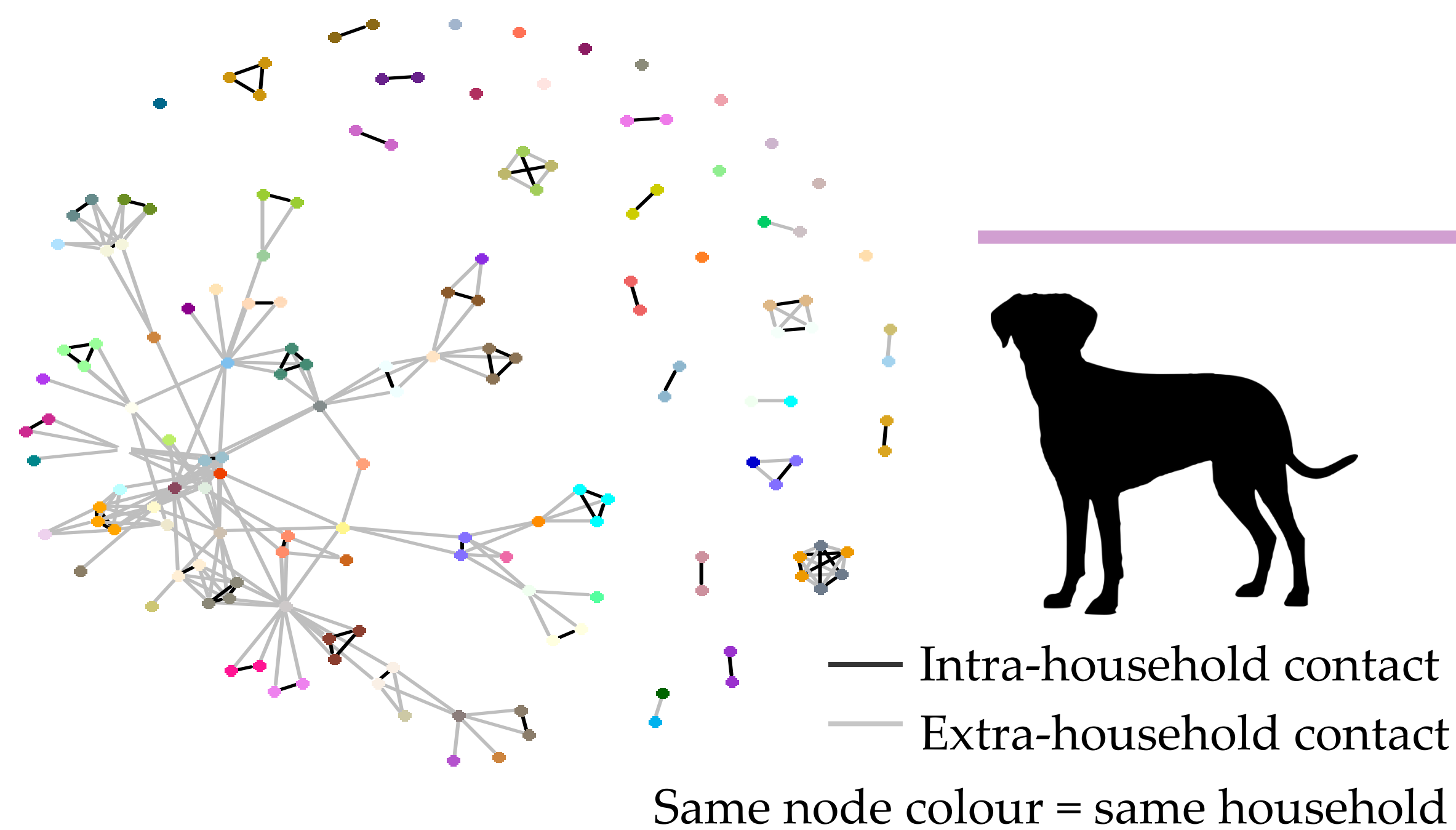
- Mainland France acquired **rabies-free status** for nonflying mammals in 2001.
- There have been **12 importations of infected dogs** since then, threatening animal and public health as it is a major zoonosis.
- Importation of an infected dog in 2008 led to two **secondary transmission events** in dogs.

What is the potential for rabies to spread in domestic dog populations in France mainland following an incursion ?
How to prevent this spread ?

Material and methods

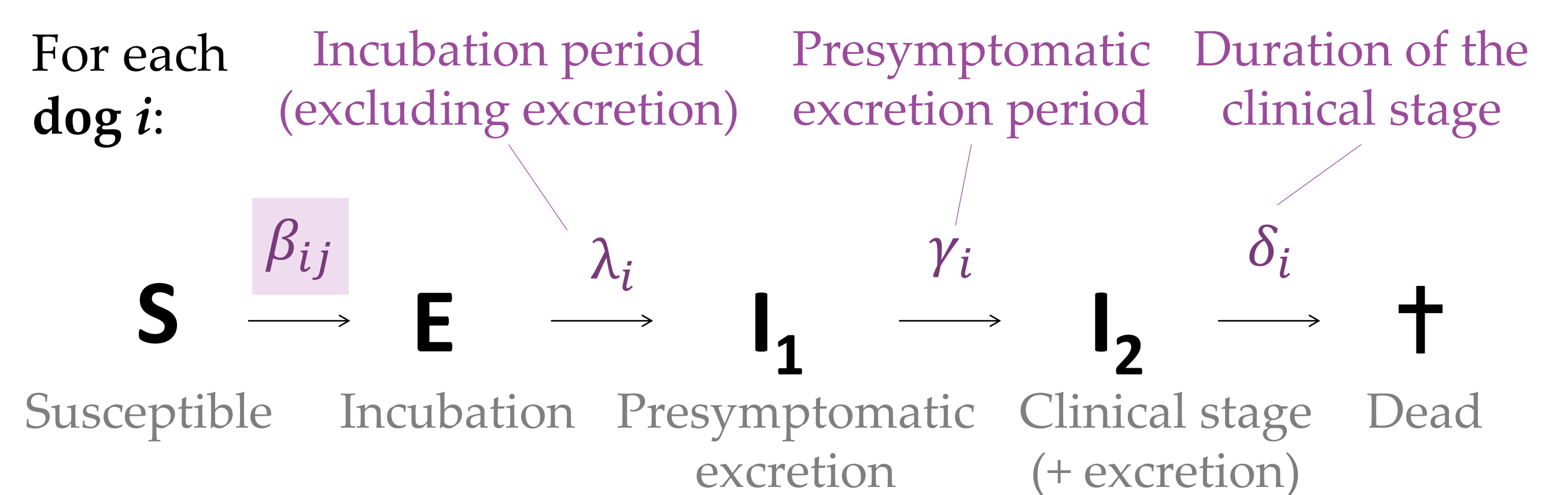
1. Simulation of a **dog contact network** from 100 households:

- Using **survey data**¹ (number of dogs per household, frequency of contact between dogs).
- **Watts-Strogatz algorithm**: network with "small-world" properties.



2. Simulation of **rabies spread in the network**:

- Using **literature** (duration of infection stages) + **assumptions** (probability of bite during a contact).

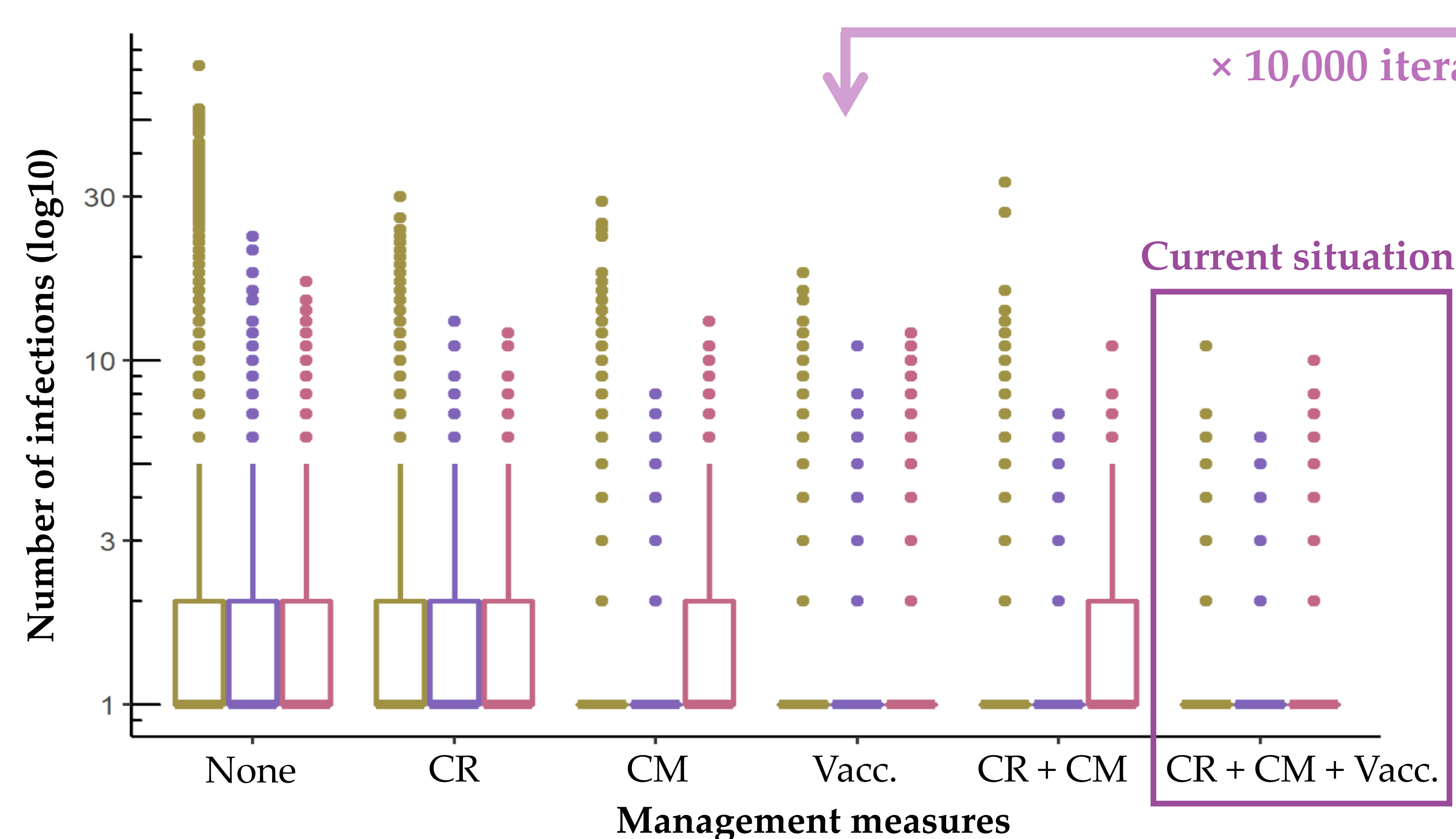


Transmission parameter: $\beta_{ij} = 1 - (1 - \tau)^{y_{ij}}$

τ : probability of rabies virus transmission during a contact (infecting bite). Different between I_1 and I_2 + different between intra- and extra-household contacts.

y_{ij} : number of infectious "neighbours" of dog i in the network on day j .

Results



Human density in the area:

High (yellow), Intermediate (blue), Low or very low (red)

CR: reduction in the frequency of contact between dogs

CM: removal of dogs in contact with the infected dog

Vacc.: preventive vaccination (75% coverage)

- **No persistence** of the infection.

- With the **current management measures** (CR + CM + Vacc.): only **7-10% of rabies incursions lead to at least 1 transmission event**. No major spread event (>10 infections).

- CR, CM and Vacc. taken separately help to **reduce the frequency of transmission events**.

- **No additive effect** of CM and CR.

Discussion and conclusions

- Simulation study = **simplification of a more complex reality + assumptions**.
- Useful to **compare management scenarios and provide scientific evidence to policy makers**.
- **No persistence** of rabies in French dog populations and **low spread potential**, even without management measures.
- **Targeted management measures** (CM) may be sufficient to further limit the spread, in addition to preventive vaccination.
- Rabies incursion simulations in **other rabies-free countries**: results are similar in dog populations that are mostly restrained (e.g. Japan²) but the spread potential appears to be greater in free-roaming dog populations (e.g. Australia³⁻⁶).

References:

¹ Crozet et al. (2022) *Transbound Emerg Dis*.

² Kadowaki et al. (2018) *Epidemiol. Infect.*

³ Sparkes et al. (2016) *Prev. Vet. Med.*

⁴ Dürr and Ward (2015) *PLoS Negl Trop Dis*

⁵ Hudson et al. (2019) *PLoS Negl Trop Dis*

⁶ Hudson et al. (2019) *Epidemiol. Infect.*

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