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Parasitized, non-parasitized, why? A study of factors influencing tick burden in roe deer neonates.

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Context of study

- Ixodes ricinus*, the most common tick in Central Europe, is an important vector of pathogens **threatening human and animal health**¹.
- Tick abundance and repartition increased during last decades with global environmental changes in the continent, which include **climate and habitat changes**, and **increase of deer densities**².
- Indeed, **cervid species** are identified as **key hosts to ticks**, especially **roe deer (*Capreolus capreolus*)** whose populations have increased in recent years in France and Europe³.
- Mammal **newborns** have a naïve and immature immune system and are therefore more vulnerable to tick infestations.
- Thus it is important to **improve knowledge of factors influencing the tick burden of neonates**. Here, we study roe deer fawns monitored during 27 years in a French population with a novel Bayesian model.



Problematics & Hypotheses

Biotic and abiotic factors: which ones favor ticks?

Tick burden should increase with:

- H1: age of the fawn**, as they become more mobile and more exposed to questing ticks in the vegetation. We also assume that there will be a renewal of ticks with a number of ticks that will become constant on the fawn⁴.
- H2: Spring weather conditions**, with higher tick burden during **warm and wet conditions**, which favor tick activity⁵.
- H3: habitat structure**, with higher tick burden in habitats with important shrub cover and ground-based vegetation which retains humidity⁶.
- H4: roe deer density**, with higher tick burden when number of adult roe deer is the highest, which there are more hosts to participate in the tick cycle and therefore in its reproduction and dispersal⁷.



Material & methods

Study site:

« Territoire d'Étude et d'Expérimentation » of Trois-Fontaines (Grand-Est, France)



An enclosed forest of 1360 ha (48°38'N, 4°54'E)

Dataset available:

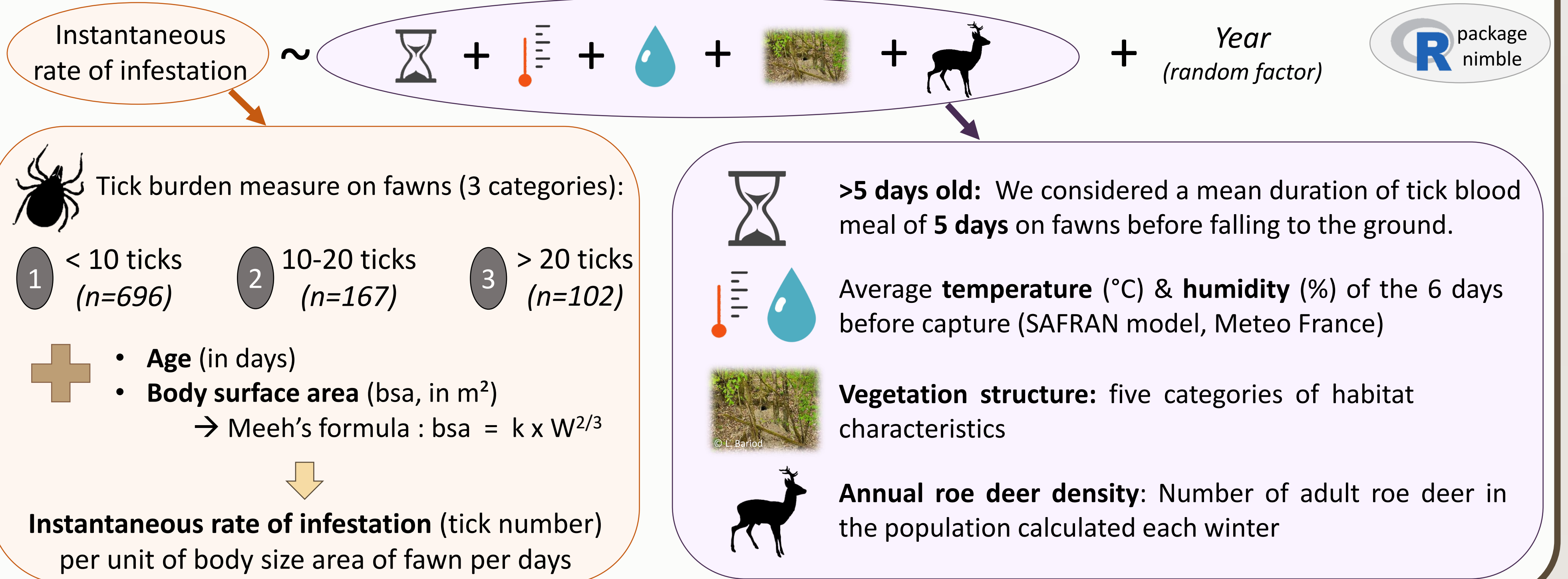
27 years
1992 → 2018



965 newborn fawns

Captured during breeding period of the female roe deer (late April to mid-June)

Bayesian model describing the infestation process of the roe deer fawns by ticks according to several factors



Results

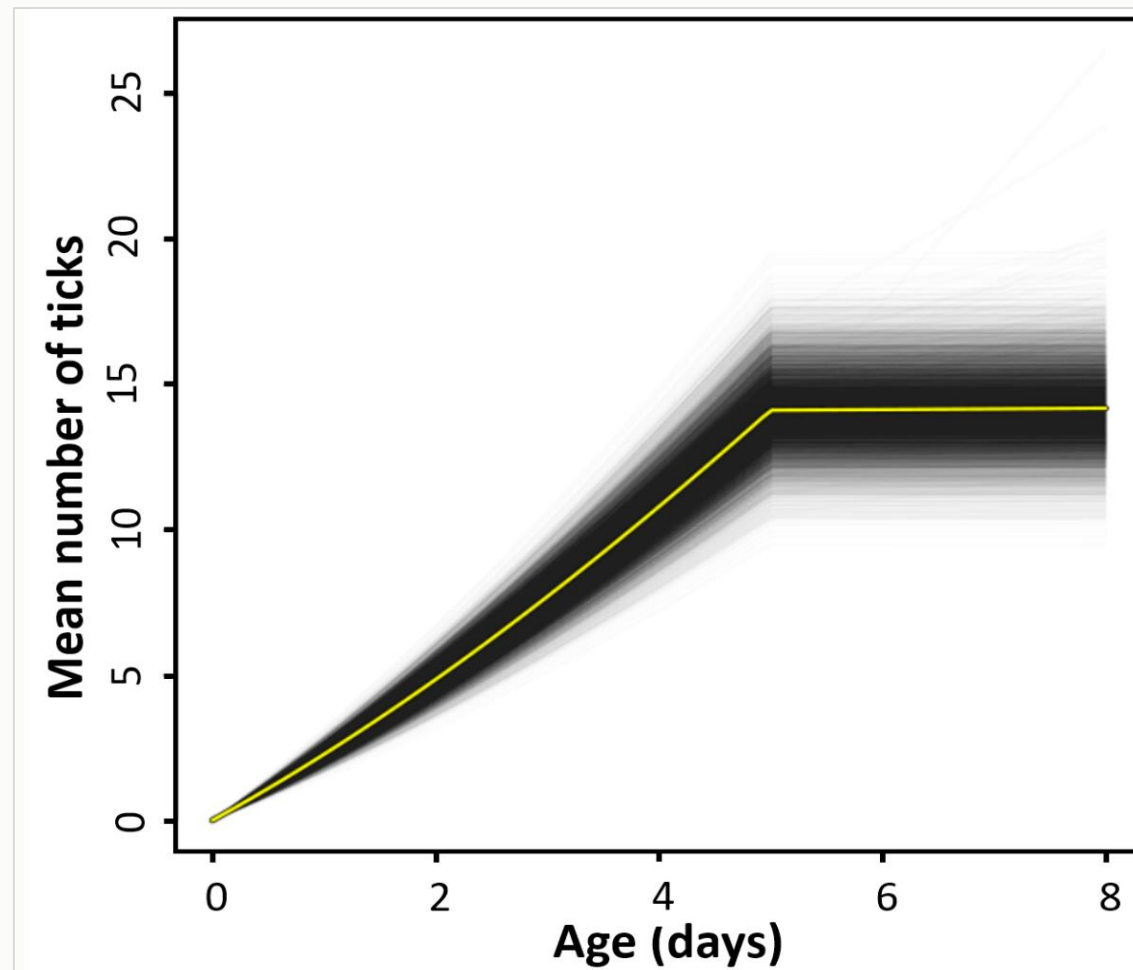
Bayesian model with the most probable combination of variables to explain the infestation rate of fawns

Instantaneous rate of infestation \sim Age + Humidity + Year (random factor)

Hypothese 1

The instantaneous risk of infestation increases the first 5 days of fawn life and after becomes equal to zero.

Est. of >5 days old: -17;7 [-45.75; -2.6]_{CI95%}



Hypothese 2

Humidity 6 days prior the fawn capture had significant effects on the tick burden of fawn.

Est. of Humidity: 0.013 [-0.003; 0.03]_{CI95%}

Temperature 6 days prior the fawn capture had no significant effects on the tick burden of fawn.

Est. of Temperature: -0.005 [-0.047; 0.037]_{CI95%}

Hypotheses 3 and 4

Vegetation structure, where the fawn was found, had no significant effect on the tick burden of fawn.

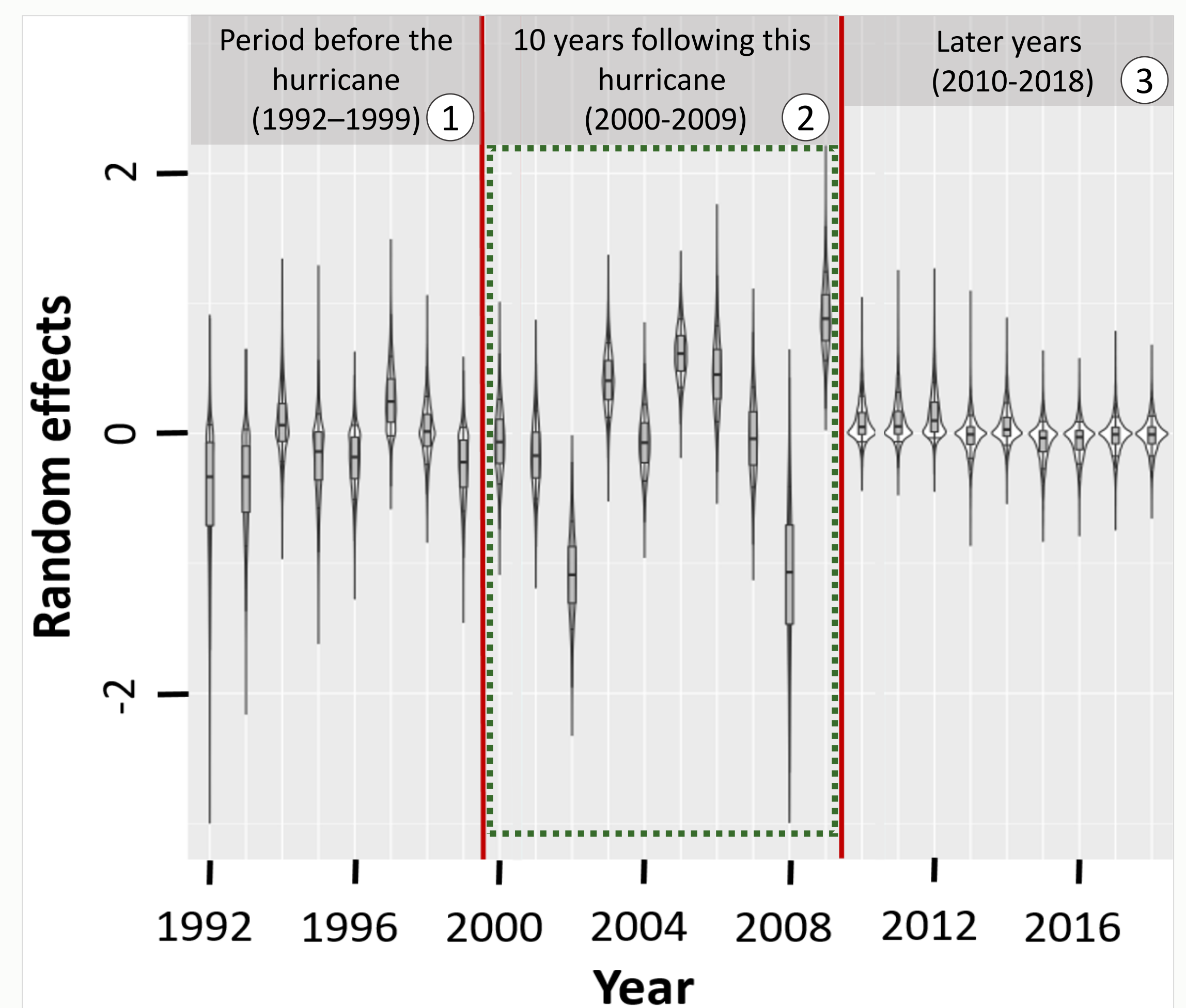
Est. of habitat1: -0;07 [-0.32; 0.15]_{CI95%} Est. of habitat2: 0.06 [-0.16; 0.29]_{CI95%} Est. of habitat3: -0.10 [-0.33; 0.11]_{CI95%} Est. of habitat4: 0.11 [-0.12; 0.37]_{CI95%} Est. of habitat5: -0.01 [-0.24; 0.22]_{CI95%}

Roe deer density had no significant effect on the tick burden of fawn.

Est. of Roe deer density: 0.002 [-0.001; 0.005]_{CI95%}

Random effect of the year

Vertical red lines delimit three periods according to the Lothar hurricane (December 1999):



Standard deviation of the year random effect for each period:

1 Est.: 0.427 [0.024; 1.112]_{CI95%} 2 Est.: 0.807 [0.410; 1.516]_{CI95%} 3 Est.: 0.160 [0.01; 0.442]_{CI95%}

Conclusion

- The level of tick burden became constant when fawns were 5 days old and more. This result could be explained by the **depletion of questing ticks in the habitat of fawns** and the **turnover of tick feeding on fawns**. Indeed, ticks take their blood meal on hosts for a few days before falling to the ground, where they molt or lay eggs during few weeks.
- Humidity was significant but no effects of temperature, vegetation structure or roe deer density were found on the tick burden of fawn. However, we noticed a **strong heterogeneity of tick burden between years** suggesting two explanations:
 - Others variables could be involved, such as **local density of various host species** or **habitat characteristics** of fawn, which may be important for tick activity.
 - The environmental variables used in this study affected the infection process **at other spatial or temporal scales**.
- This would require **additional data on ticks in the environment**, at different times of the year, which would allow a more precise study in Trois-Fontaines to improve our understanding of tick infection in ungulate newborns.

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