Targeting surveillance for *Xylella fastidiosa* in Europe: an epidemiological basis

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European Xylella conference on 2019

Overview

- **Why do we want to conduct surveillance for *Xylella fastidiosa*?**
- **How does the asymptomatic period affect surveillance?**
- **Is host testing better than visual inspection?**
- **Is vector testing better than visual inspection?**

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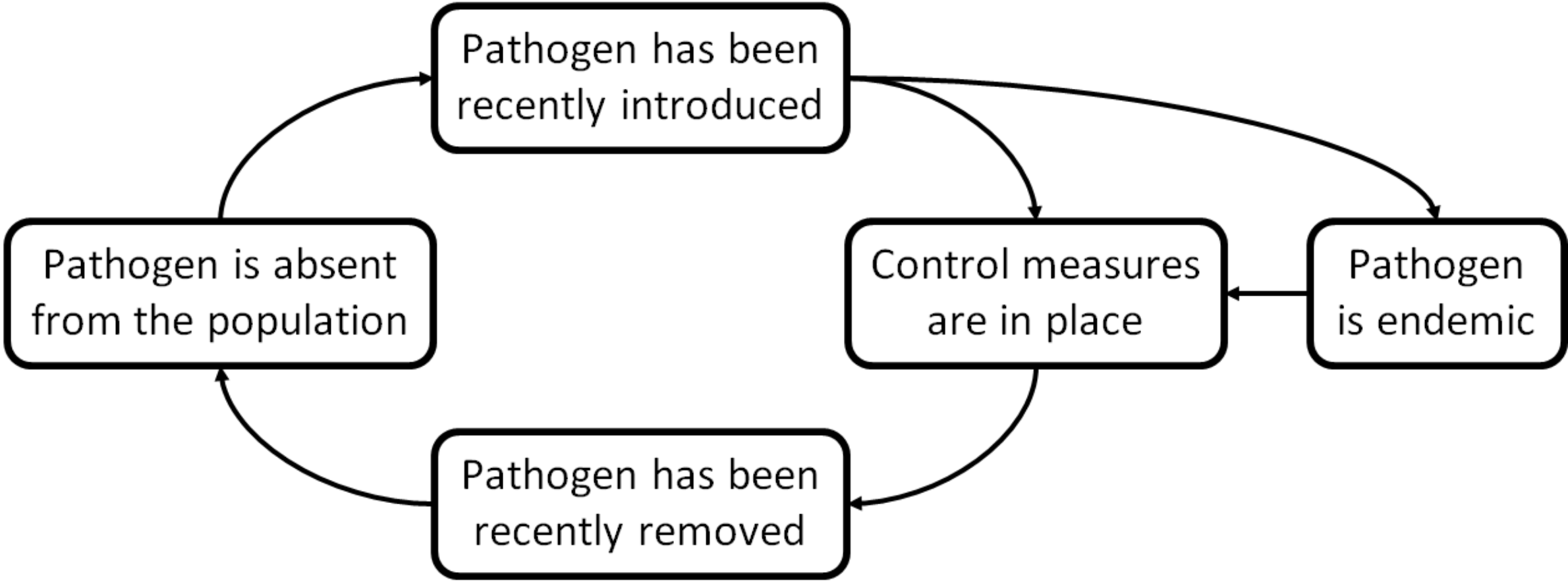

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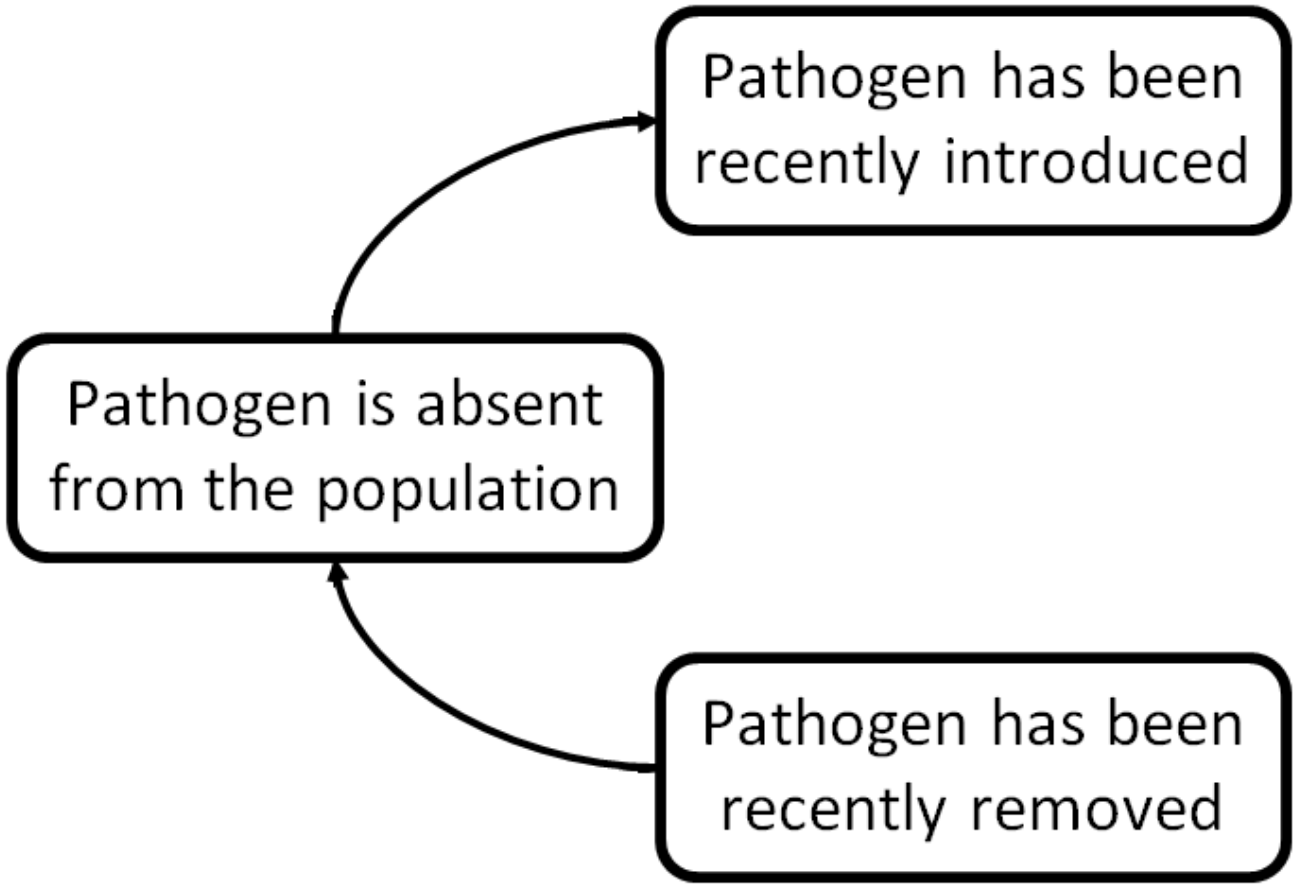

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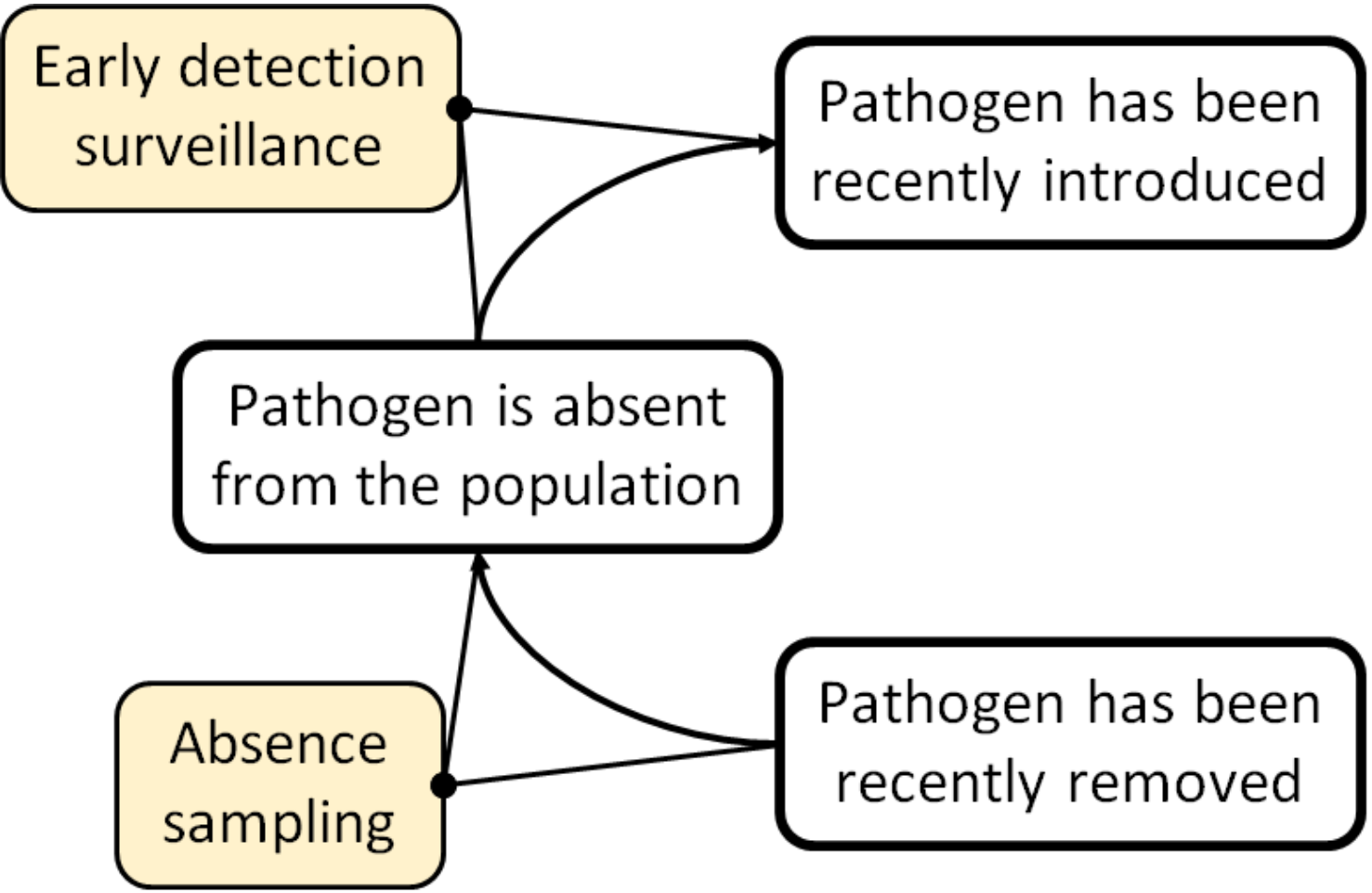

What is the aim of surveillance?

Early detection surveillance

- ‘How bad is it **when we first detect it**?’

Absence sampling

- ‘How bad could it be **if we don’t detect it**?’

What is the aim of surveillance?

Early detection surveillance

- ‘**How bad is it** when we first detect it?’

Maximum prevalence at first detection = $3\left(\frac{r}{\left(\frac{N}{\Delta}\right)}\right)\left(\frac{e^{r\lambda}}{Se}\right)$

Absence sampling

- ‘**How bad could it be** if we don’t detect it?’

Bourhis et al. (2019) Journal of Theoretical Biology 461 (2019): 8-16.
Mastin et al. (2019) Philosophical Transactions of the Royal Society B 374.1776: 20180261.

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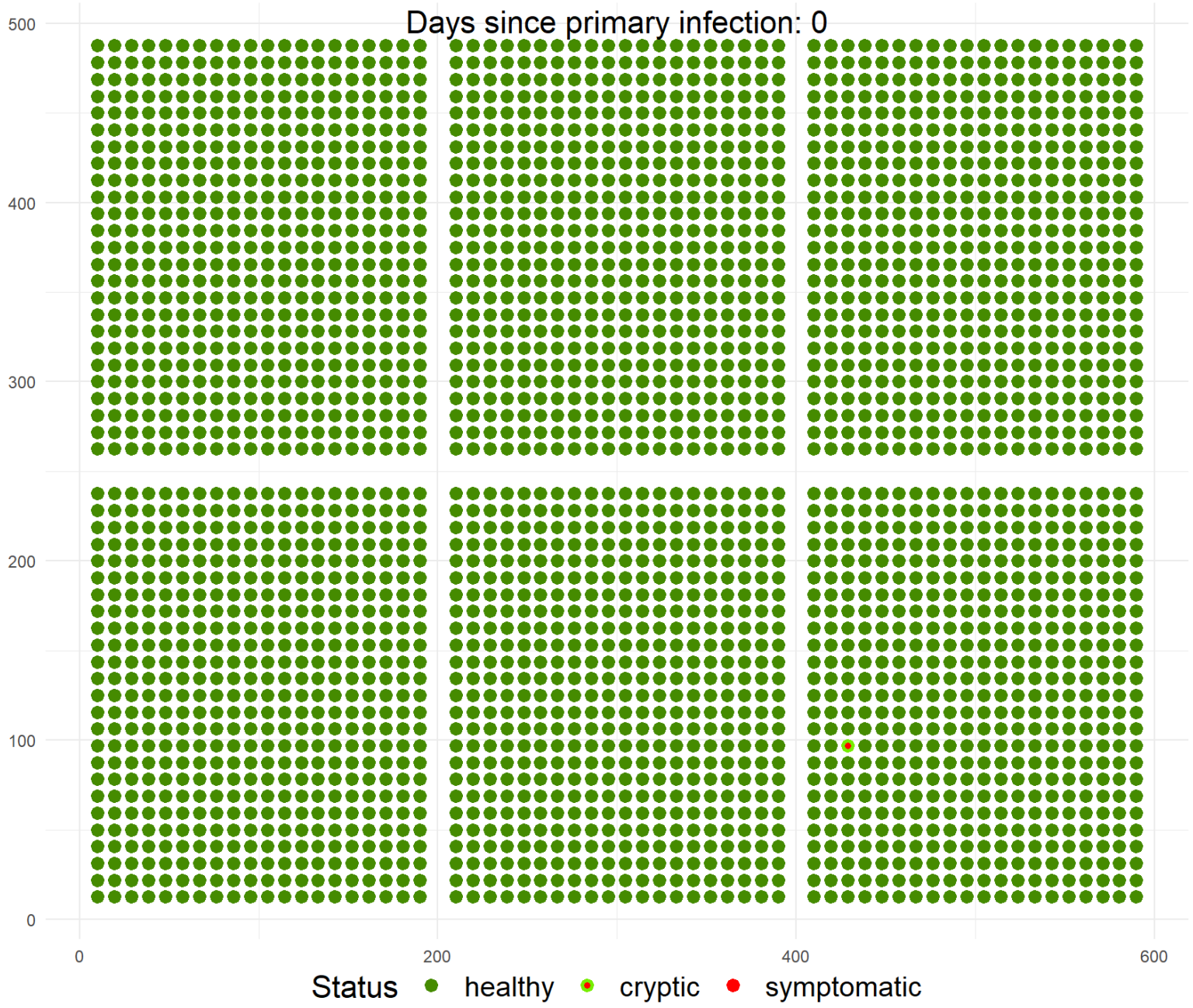

XF ACTORS

University of Salford MANCHESTER

Uninfected

Infected without symptoms

Infected with symptoms

Bourhis et al (2019). Philosophical Transactions of the Royal Society B 374.1776: 20180262.

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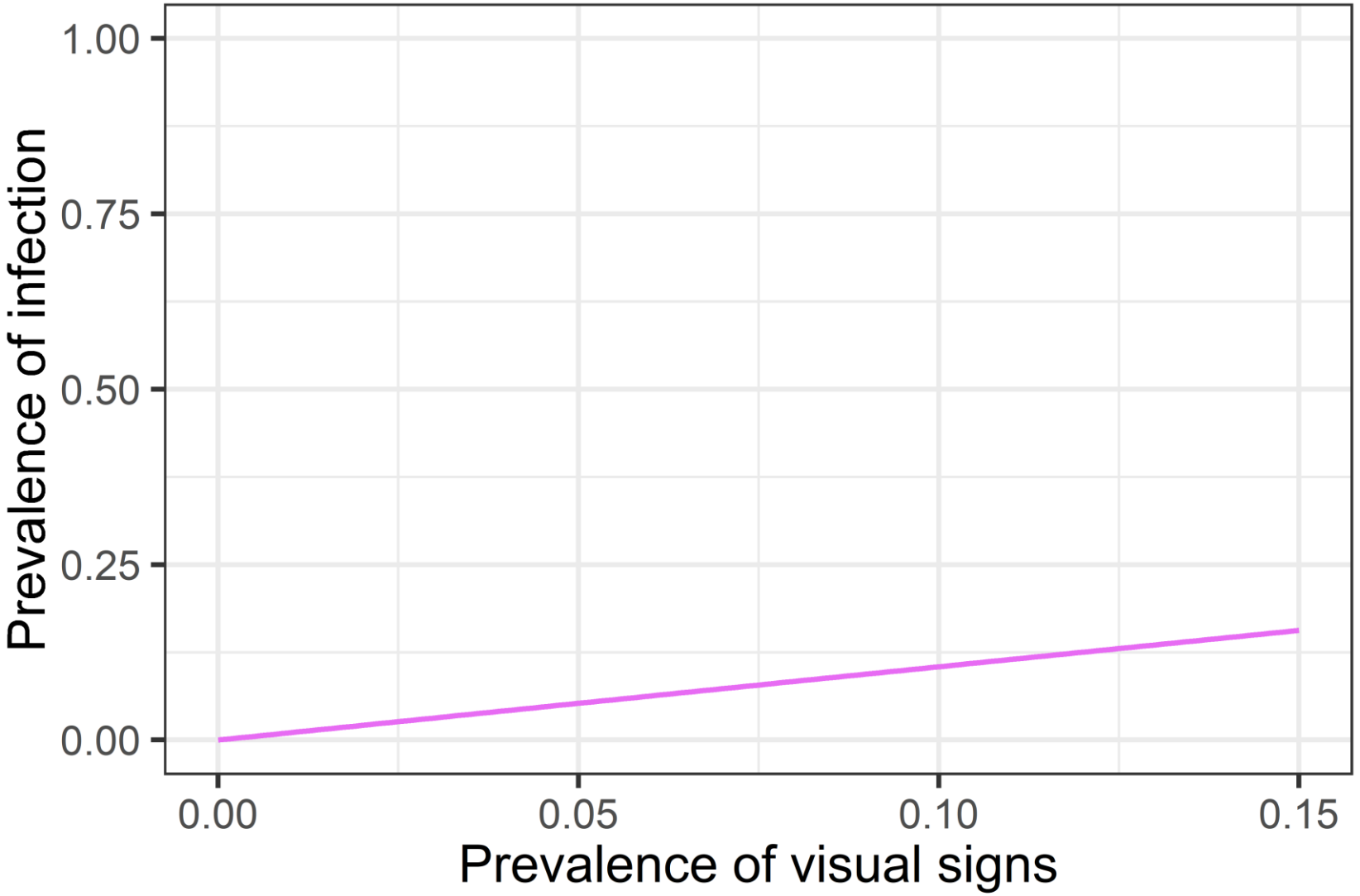
What does the asymptomatic period mean for surveillance?



Sudden oak death

(*Phytophtora ramorum*)

Alonso Chavez et al. (2016) Journal of Theoretical Biology 407 (2016): 290-302.

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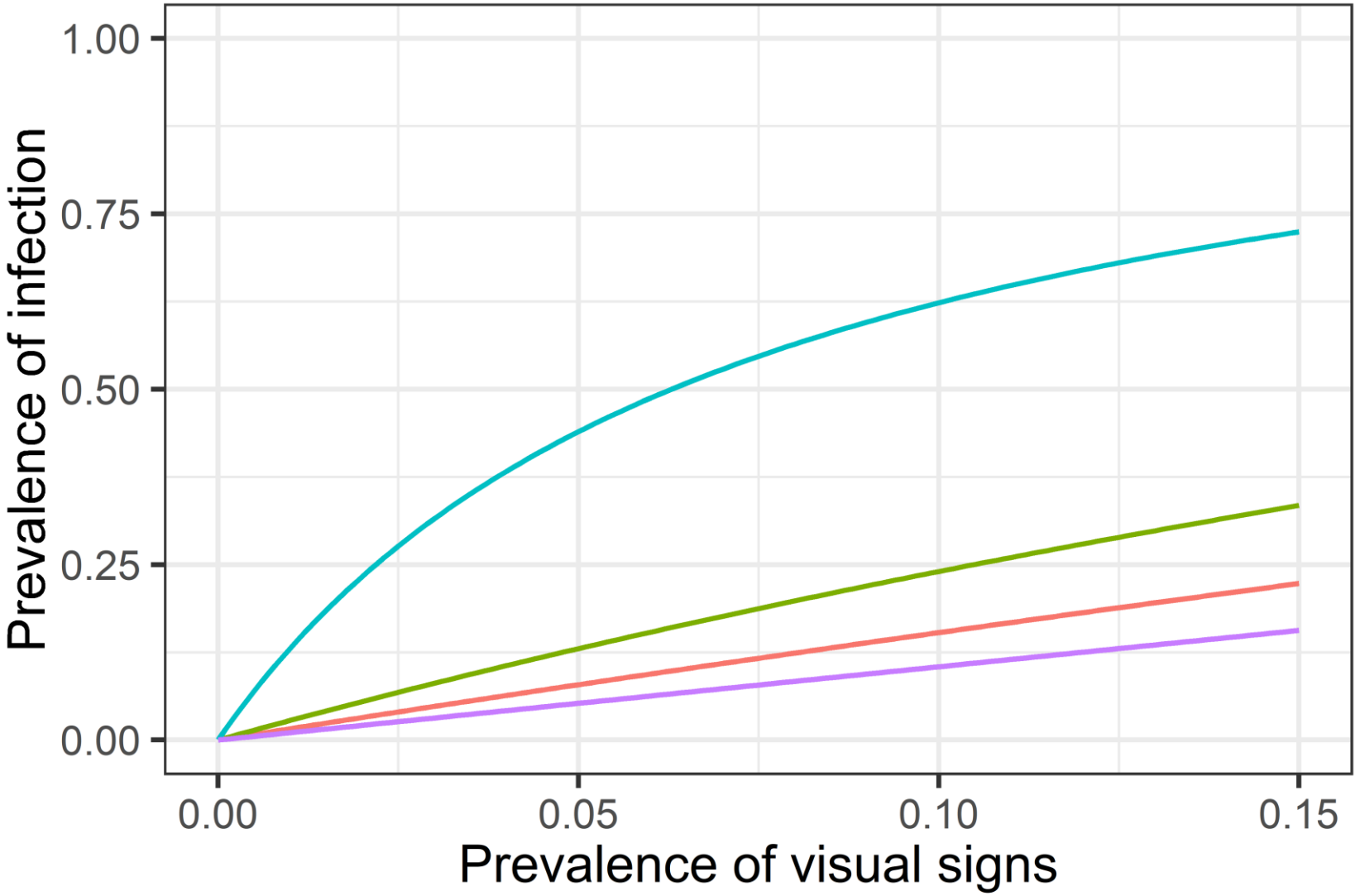

Huanglongbing
(*Ca*. Liberibacter asiaticus)

Citrus canker
(*Xanthomonas axonopodis*)

Ash dieback
(*Hymenoscyphus fraxineus*)

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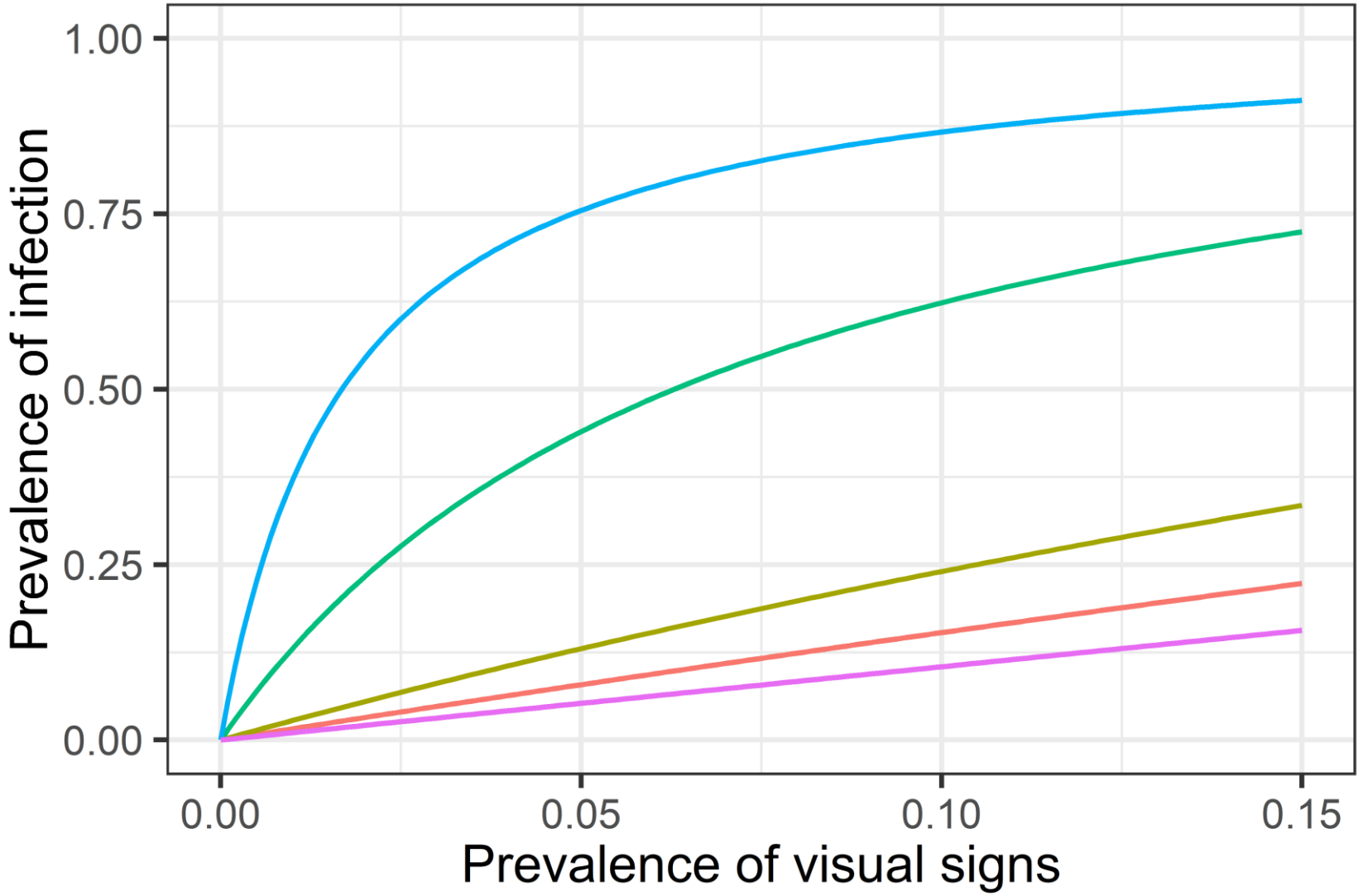

Olive quick decline
(*Xylella fastidiosa*)

Huanglongbing
(*Ca*. Liberibacter asiaticus)

Citrus canker
(*Xanthomonas axonopodis*)

Ash dieback
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EFSA Panel on Plant Health (2019) EFSA Journal 17.5 (2019): e05665.

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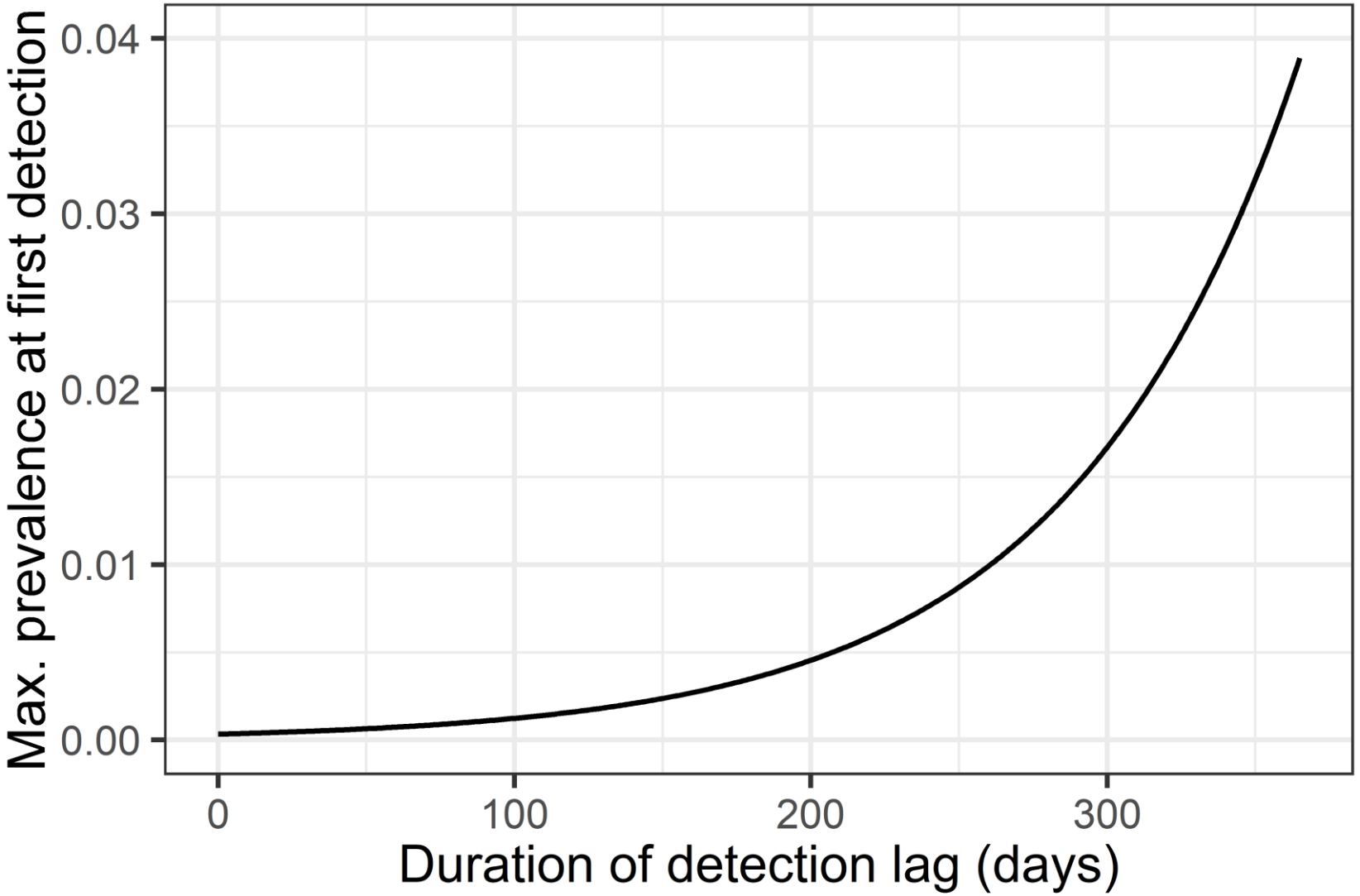
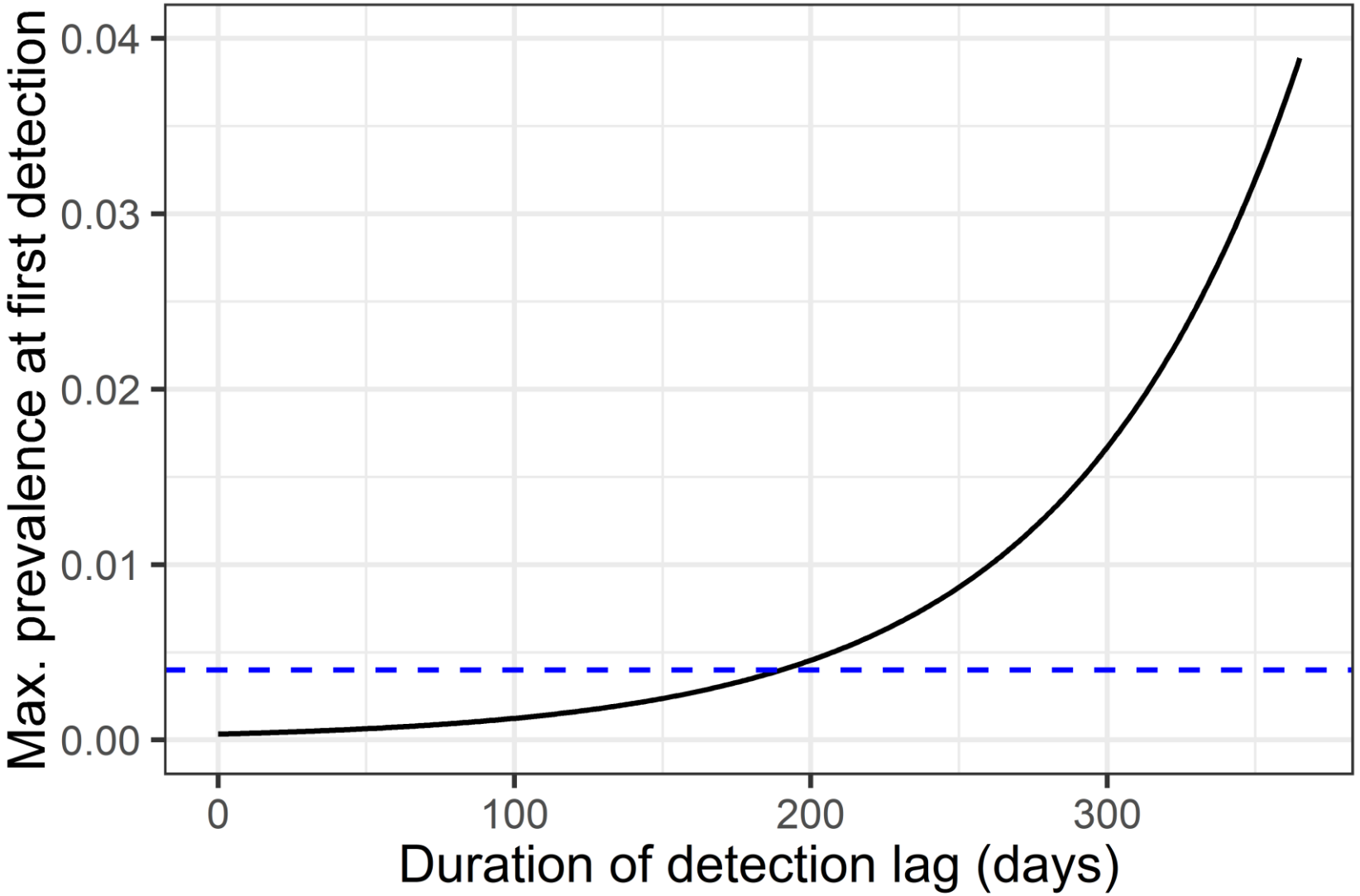
- **Is host testing better than visual inspection?**
- Is vector testing better than visual inspection?

How does the asymptomatic period affect the detection-prevalence?



Sampling 840 trees per day over 50 days.

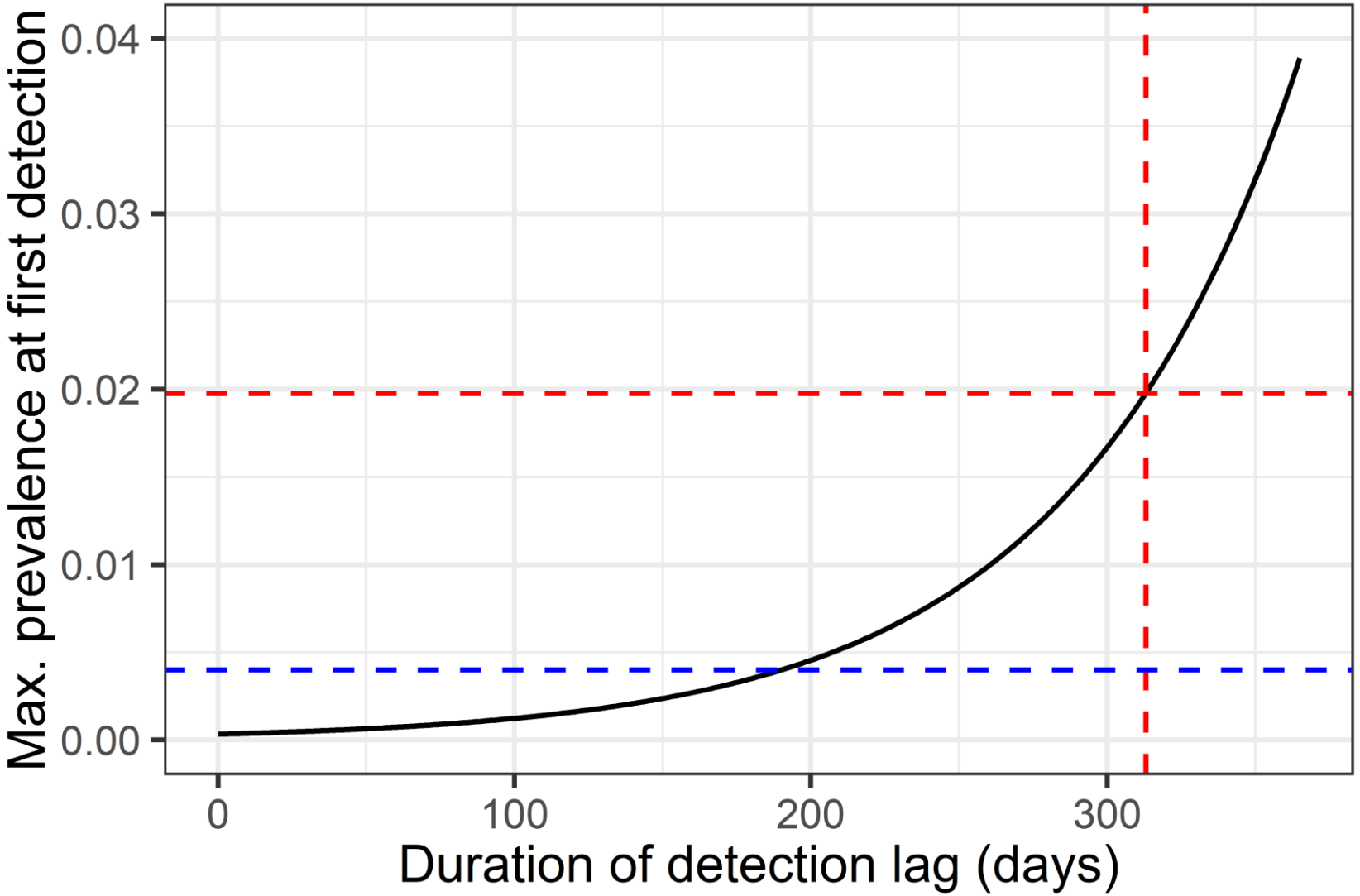
How does the asymptomatic period affect the detection-prevalence?



Sampling 840 trees per day over 50 days.

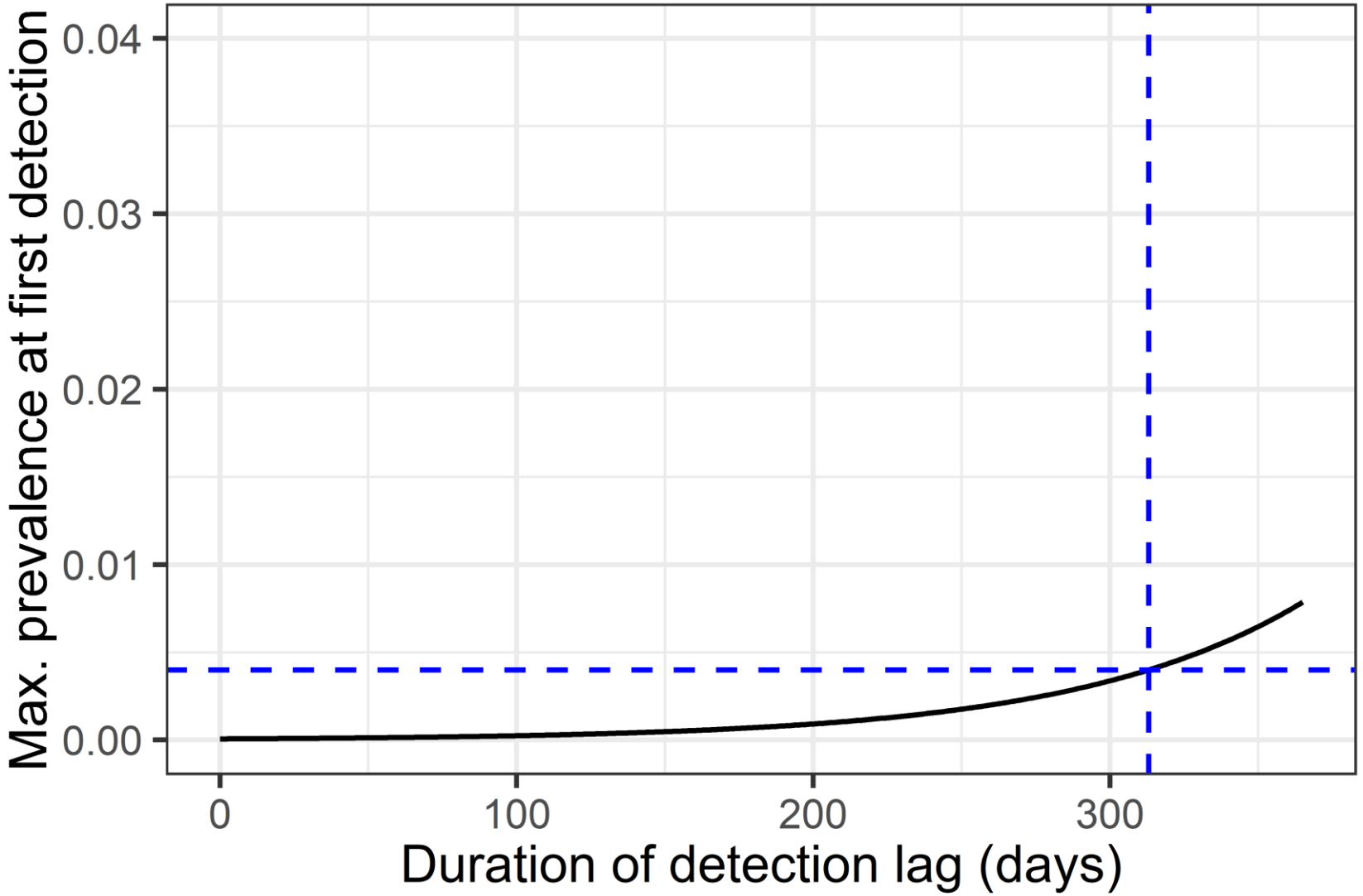
Assuming incursions are potentially eradicable if detected before a prevalence of 0.004.

How does the asymptomatic period affect the detection-prevalence?



If inspecting **at this rate using visual inspection alone, the maximum prevalence at first detection is around 2%**.

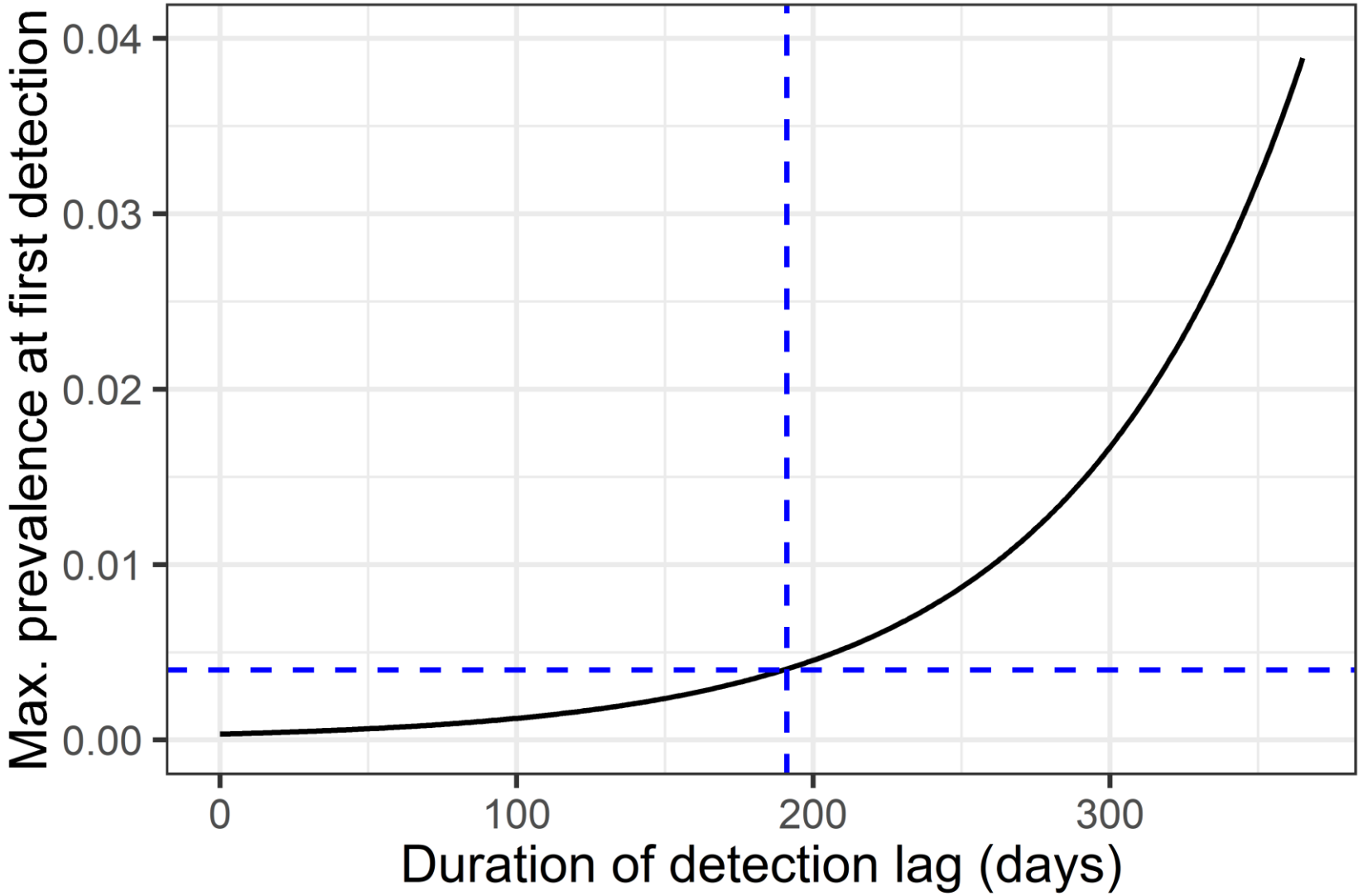
How do we reduce the impact of the asymptomatic period?



We could achieve this by **increasing our sampling effort fivefold** (over 4,000 trees per day over the 50 day surveillance period).

This sampling intensity is unlikely to be practical.

How do we reduce the impact of the asymptomatic period?



Or we could **keep the current sampling rate and use a test which can detect infection earlier than visual inspection** (at around 6 months).

Host-based diagnostic tests have some potential to improve surveillance.

Mastin et al. (2019) Philosophical Transactions of the Royal Society B 374.1776: 20180261.

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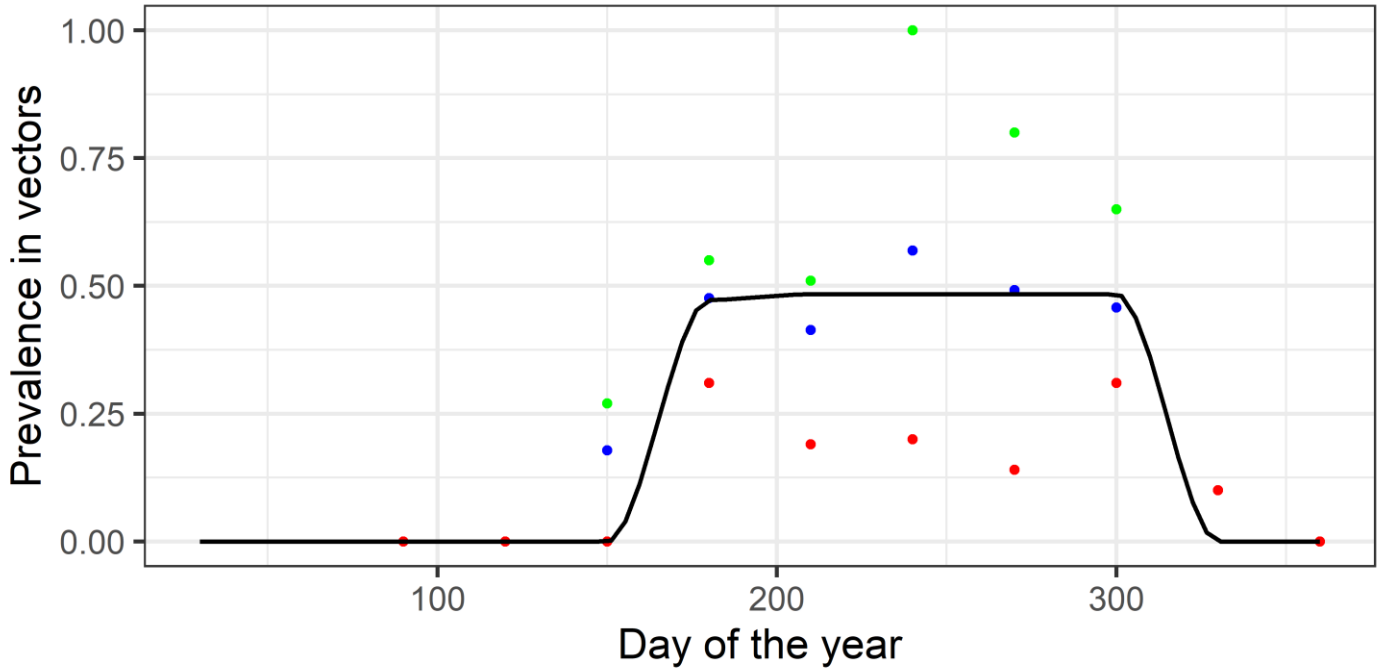
- **Is vector testing better than visual inspection?**

Should we sample vectors?

- We created an **epidemiological model of *X. fastidiosa* transmission between hosts and vectors**.

Mastin et al (2017) PLoS Computational Biology 13.8: e1005712

- We fitted this to data on:
  - **Seasonal vector abundance.**
  - ***X. fastidiosa* prevalence in vectors.**
  - ***X. fastidiosa* prevalence in olive.**

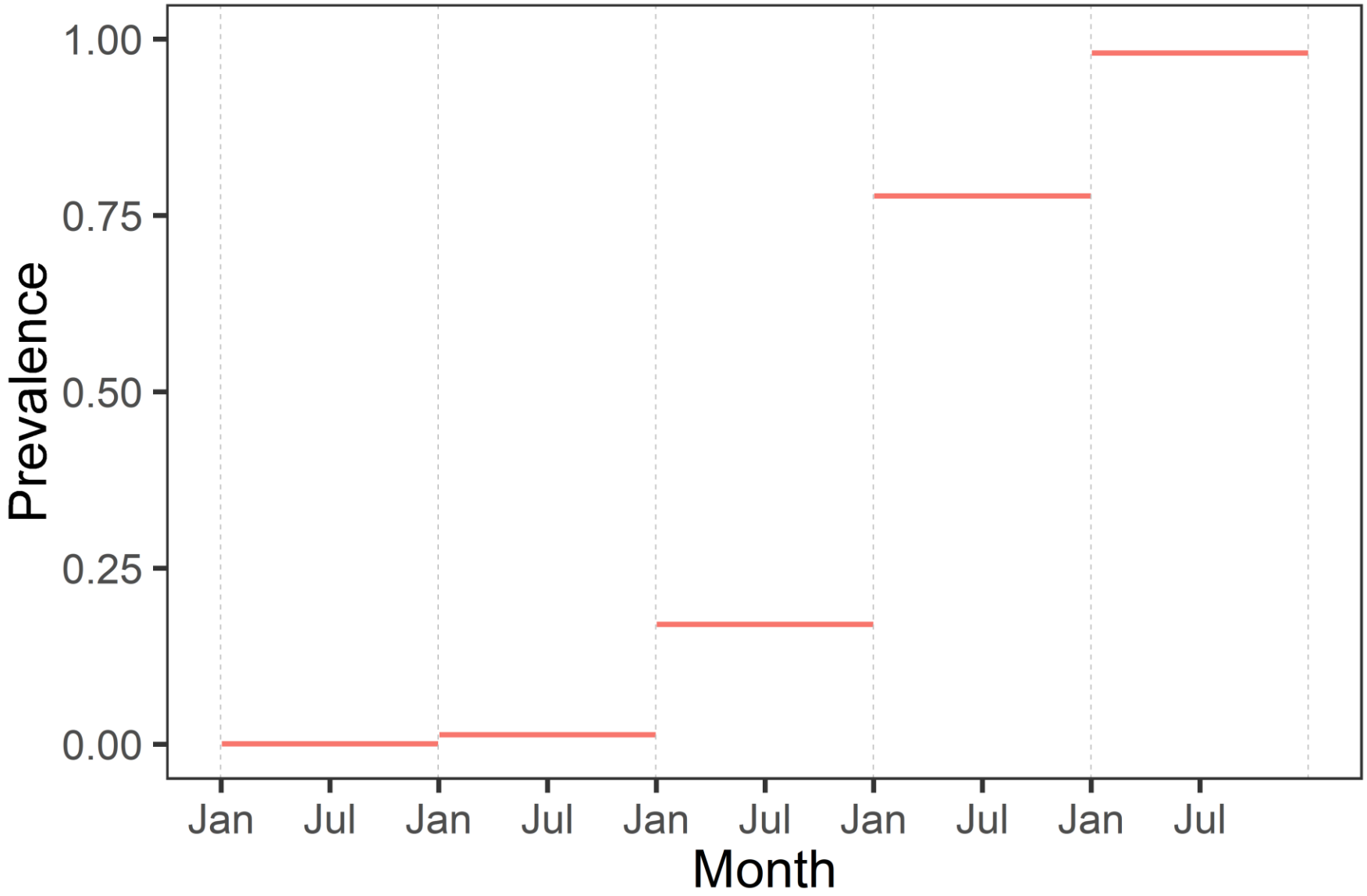


Ben Moussa et al (2016). Journal of Economic Entomology 109.4: 1512-1518.

Cornara et al (2017). Journal of pest science 90.2: 521-530.

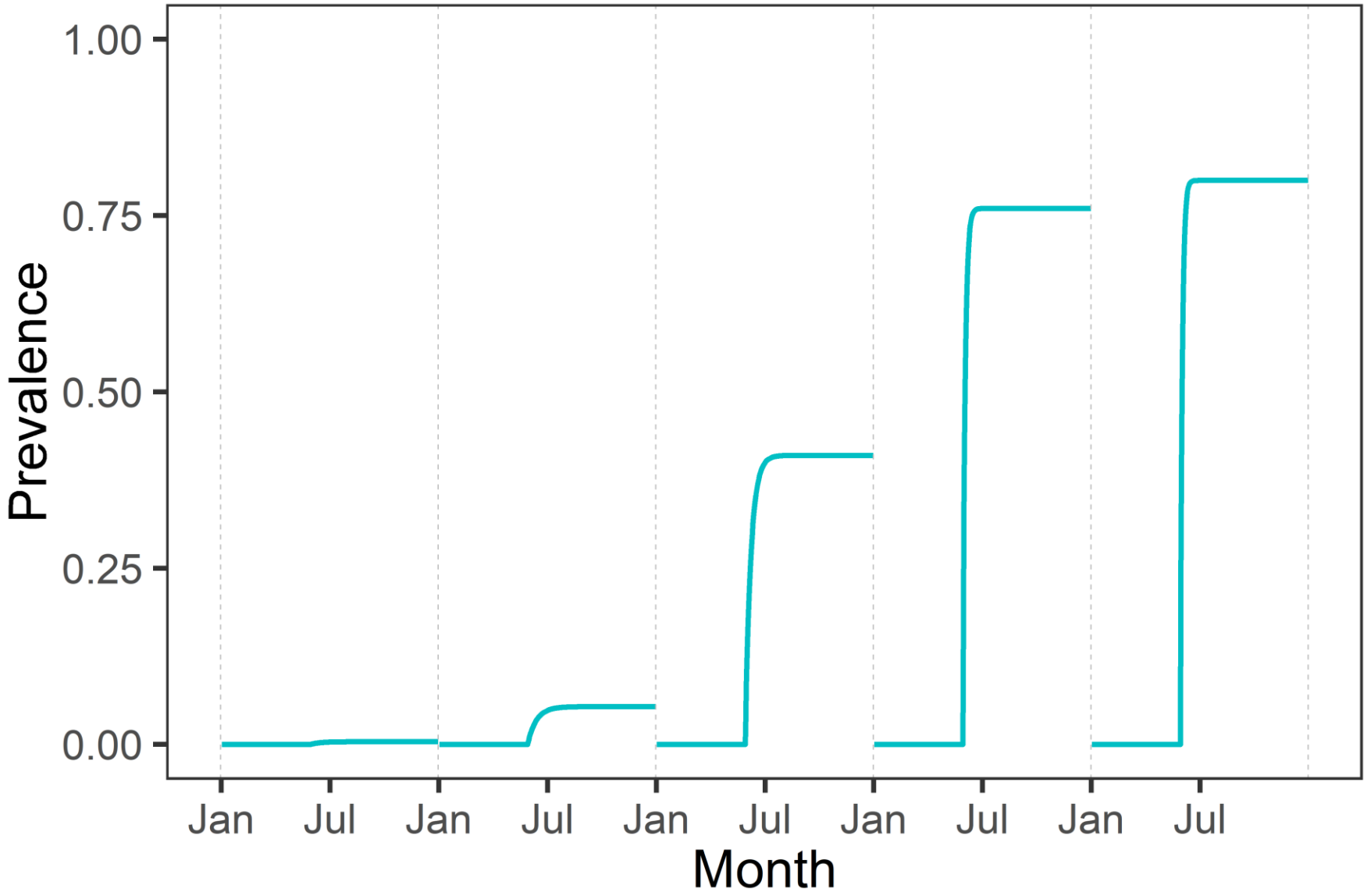
Cornara et al (2017). Journal of Applied Entomology 141.1-2: 80-87.

How does host prevalence change over time?



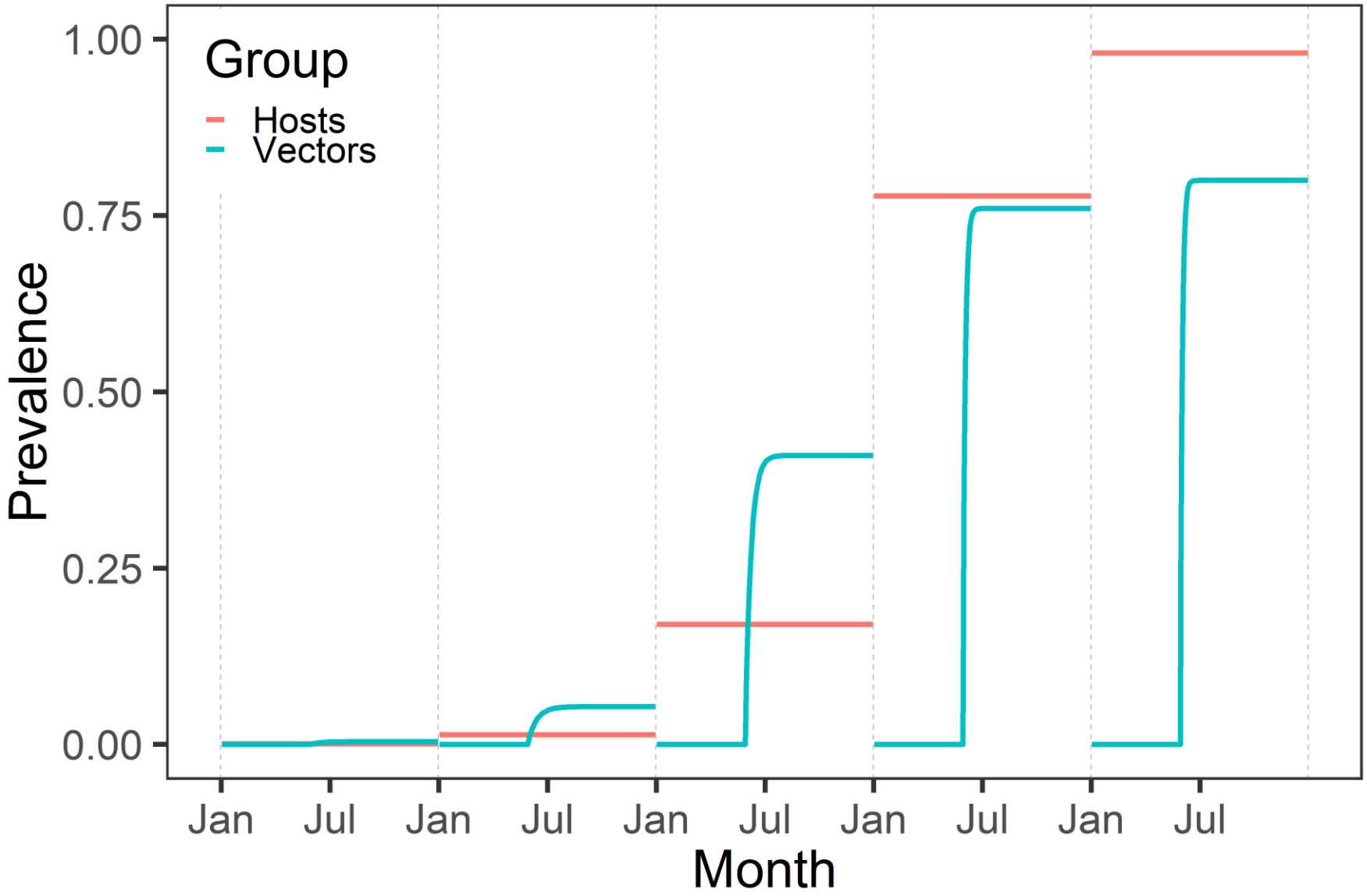
Our model assumes that the **prevalence in hosts** remains relatively static over a single year, but increases between years.

How does vector prevalence change over time?



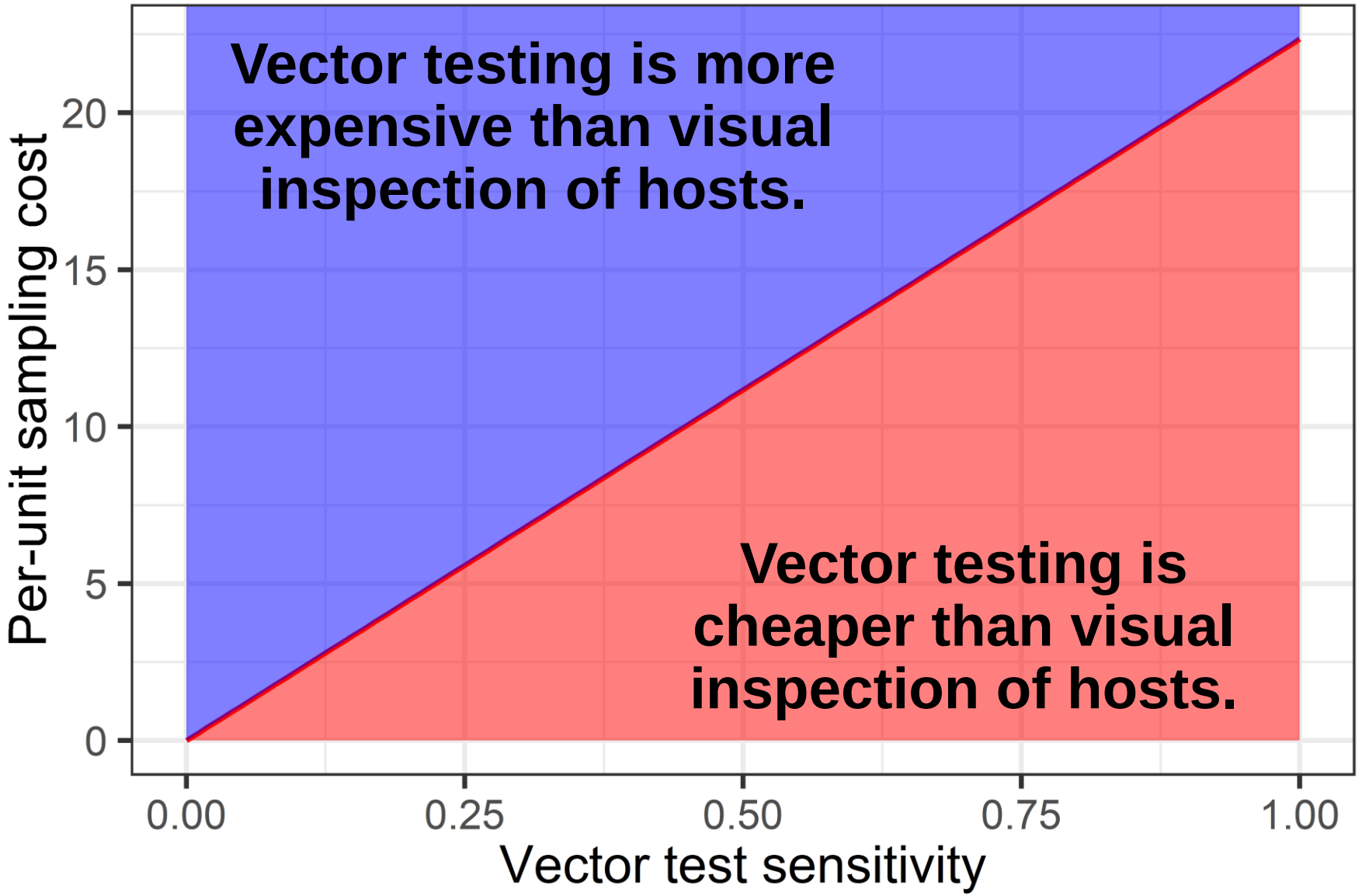
The model allows the **prevalence in vectors** to change on a daily basis, according to the population dynamics of the vectors and the prevalence of host infectiousness.

Should we sample vectors?



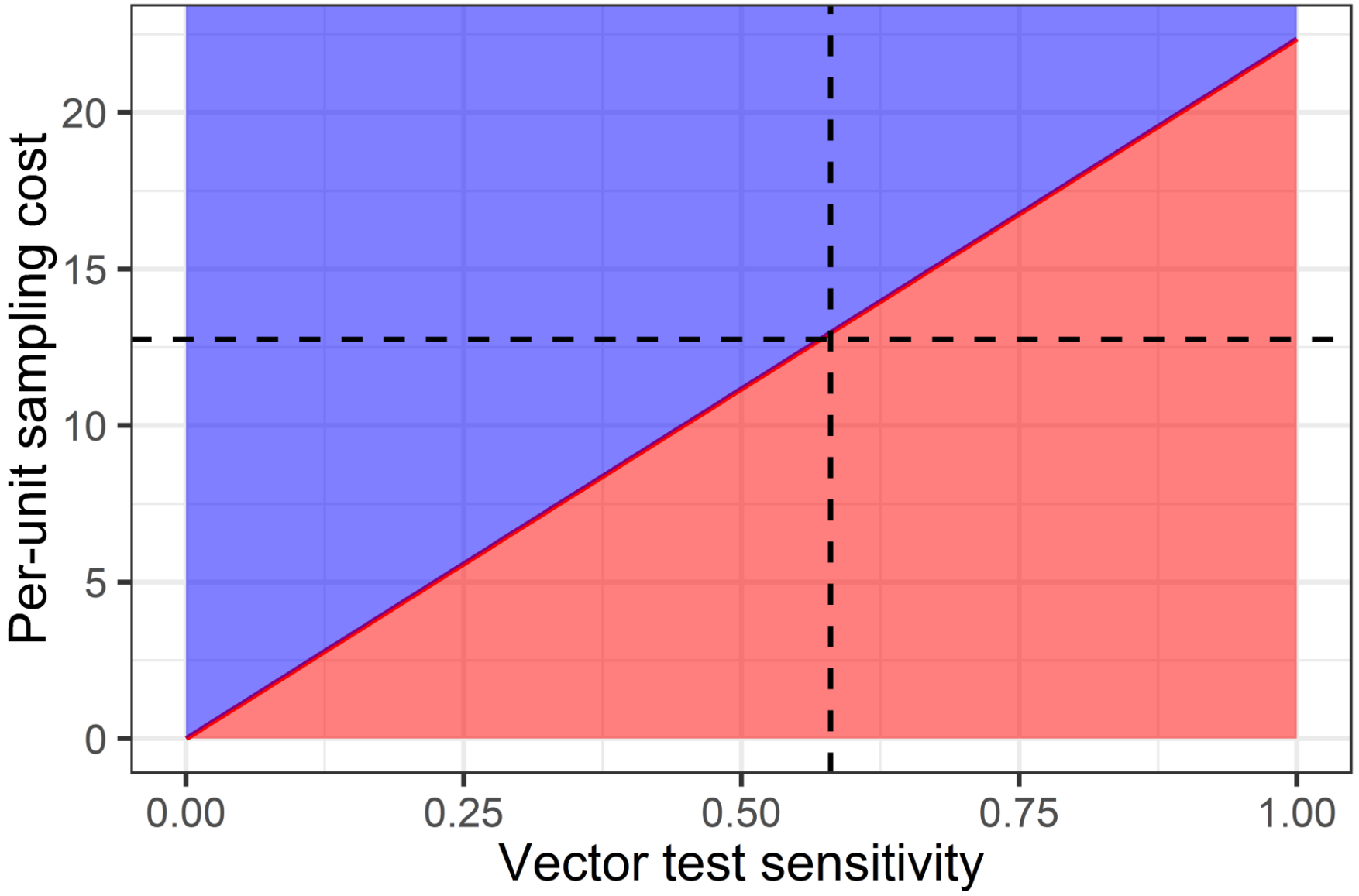
Our model showed that in the early stages of the epidemic, the **prevalence in vectors** was considerably higher than the **prevalence in hosts**.

Should we sample vectors?



Assuming that visual inspection (including confirmatory ELISA and PCR testing) costs around **€5.50 per tree**.

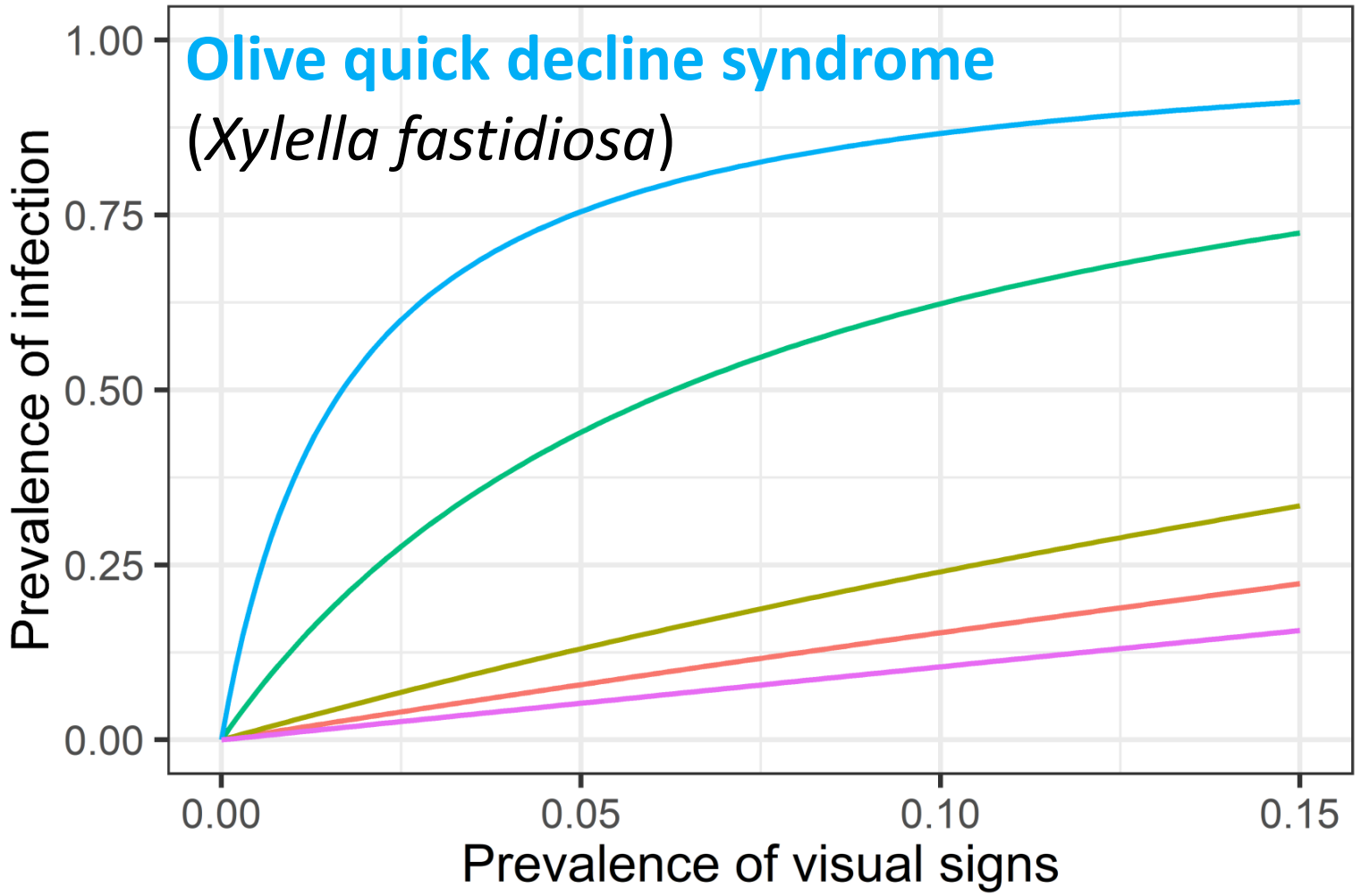
Should we sample vectors?



The current cost of vector collection and testing with the LAMP test is around **€13.00 per insect**.

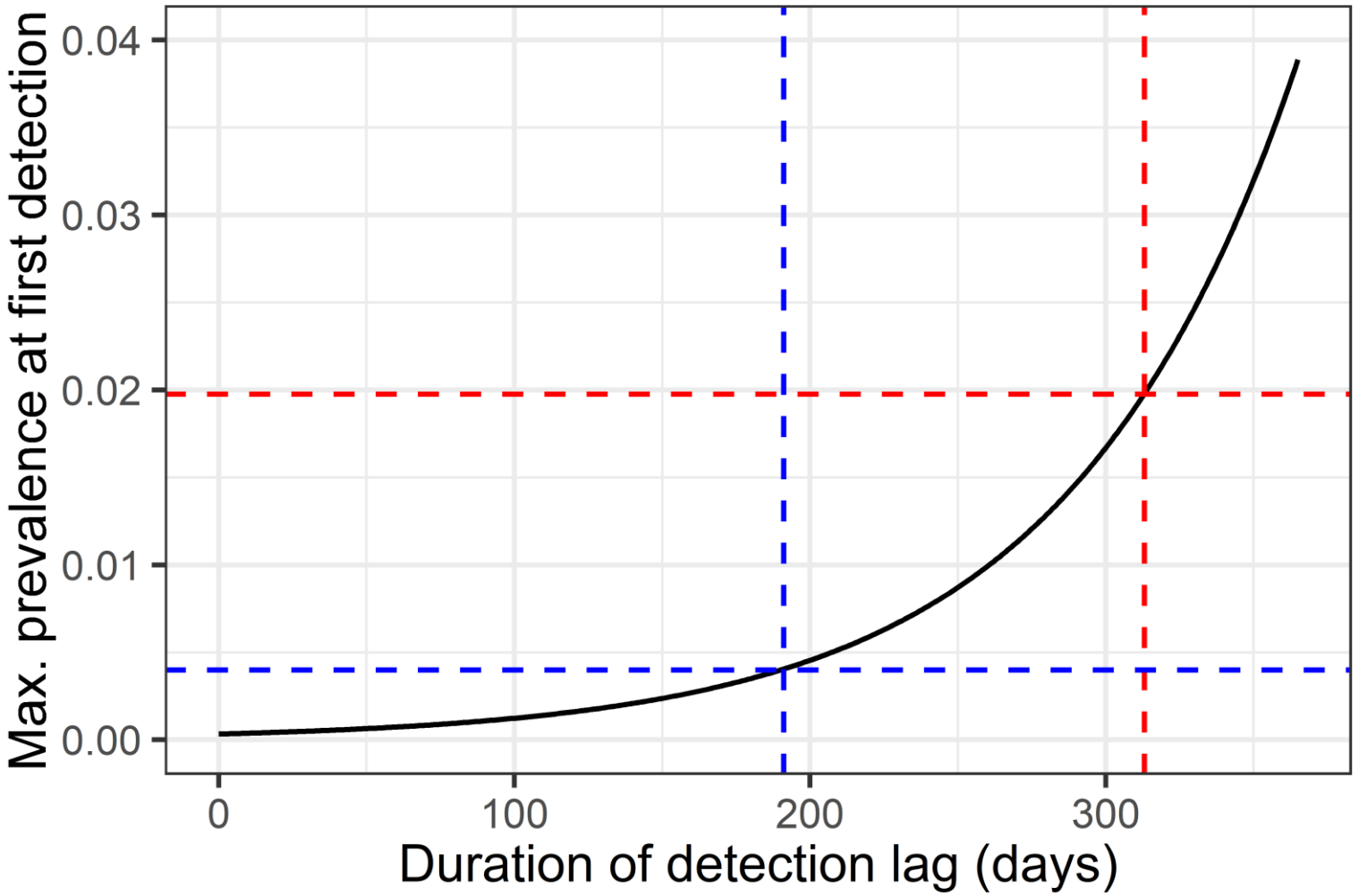
At a **diagnostic sensitivity of 0.58 or more,** vector testing would have a lowest cost than the current approach.

Impact of asymptomatic period



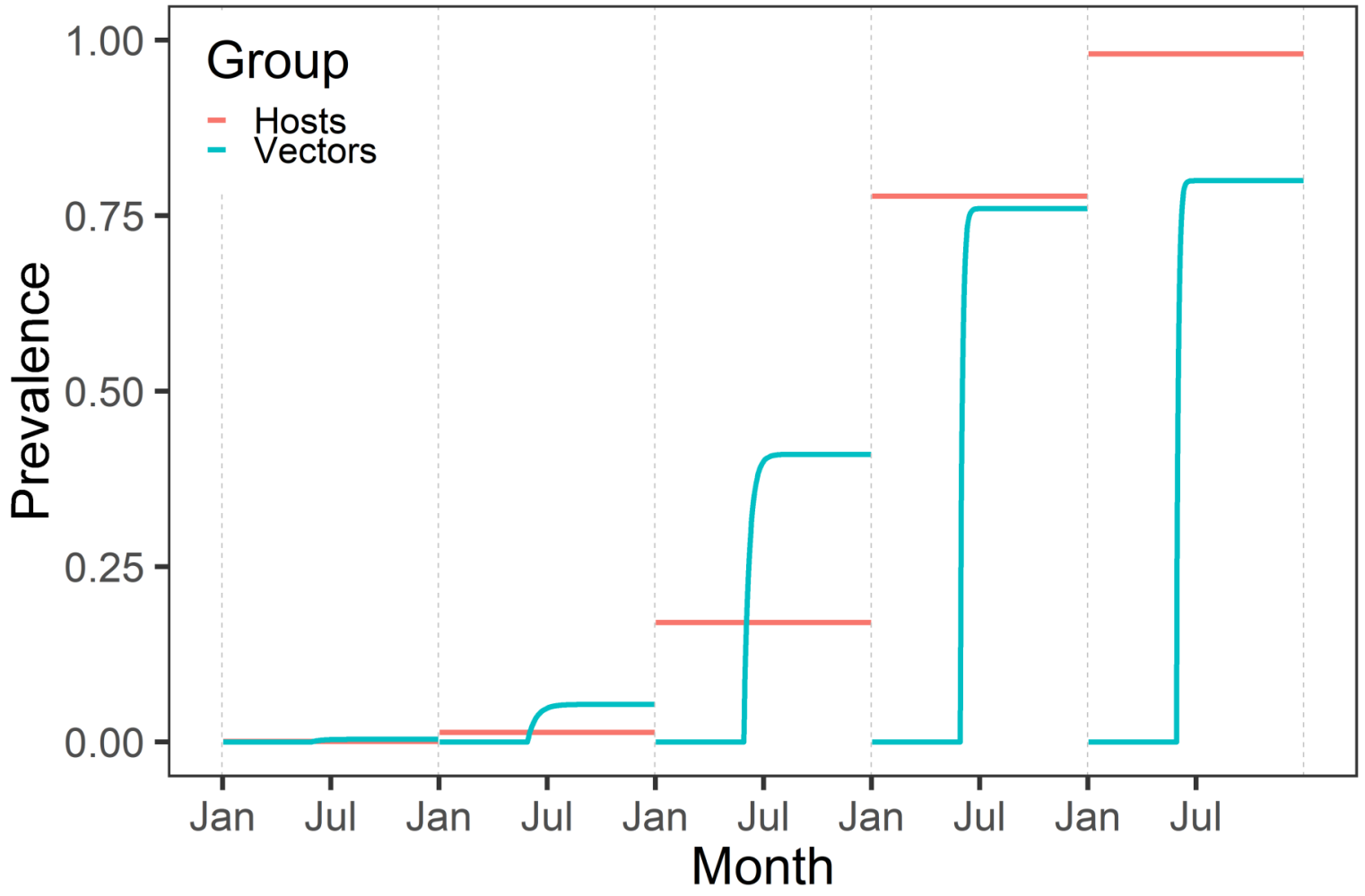
- Surveillance for *X. fastidiosa* is complicated by its:
  - **long asymptomatic period.**
  - **rapid rate of spread.**
- Despite this, **visual surveillance may be appropriate for other surveillance aims**, such as:
  - spatial delimitation.
  - prevalence estimation.

Impact of asymptomatic period



- In order to detect infection using **visual inspection**, **impractically high surveillance efforts** would be required.
- The viability of **alternative detection methods** will depend upon:
  - **How early they can detect infection**
  - **Their ability to detect infection**
  - **Their cost**

Impact of asymptomatic period



- Testing **vectors** instead of **hosts** may also allow earlier detection.
- Our model predicts that **the vector prevalence is much higher than that in hosts** in the early stages of an epidemic.
- Again, we need to consider the **costs** and the **performance** of vector testing methods.

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Thank you all for listening!