Modeling and estimating the dynamics of *Xylella fastidiosa* based on French surveillance data

The emergence of Xf in Corsica: Probably not a recent story

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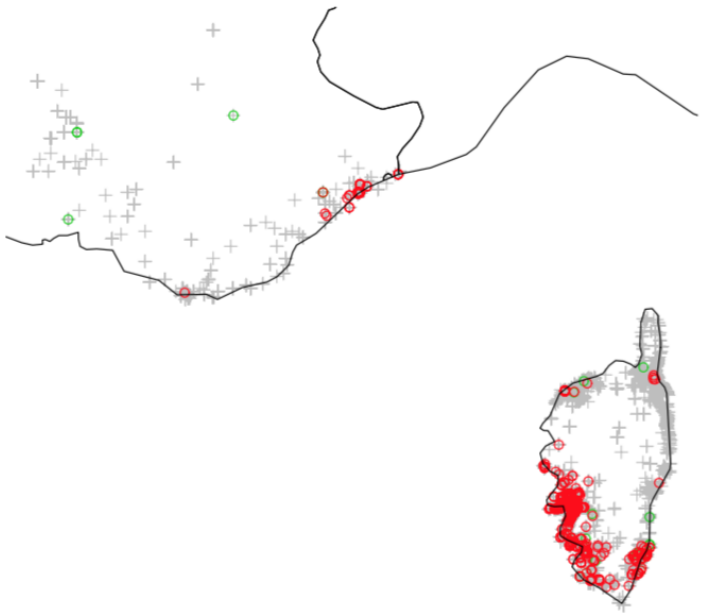
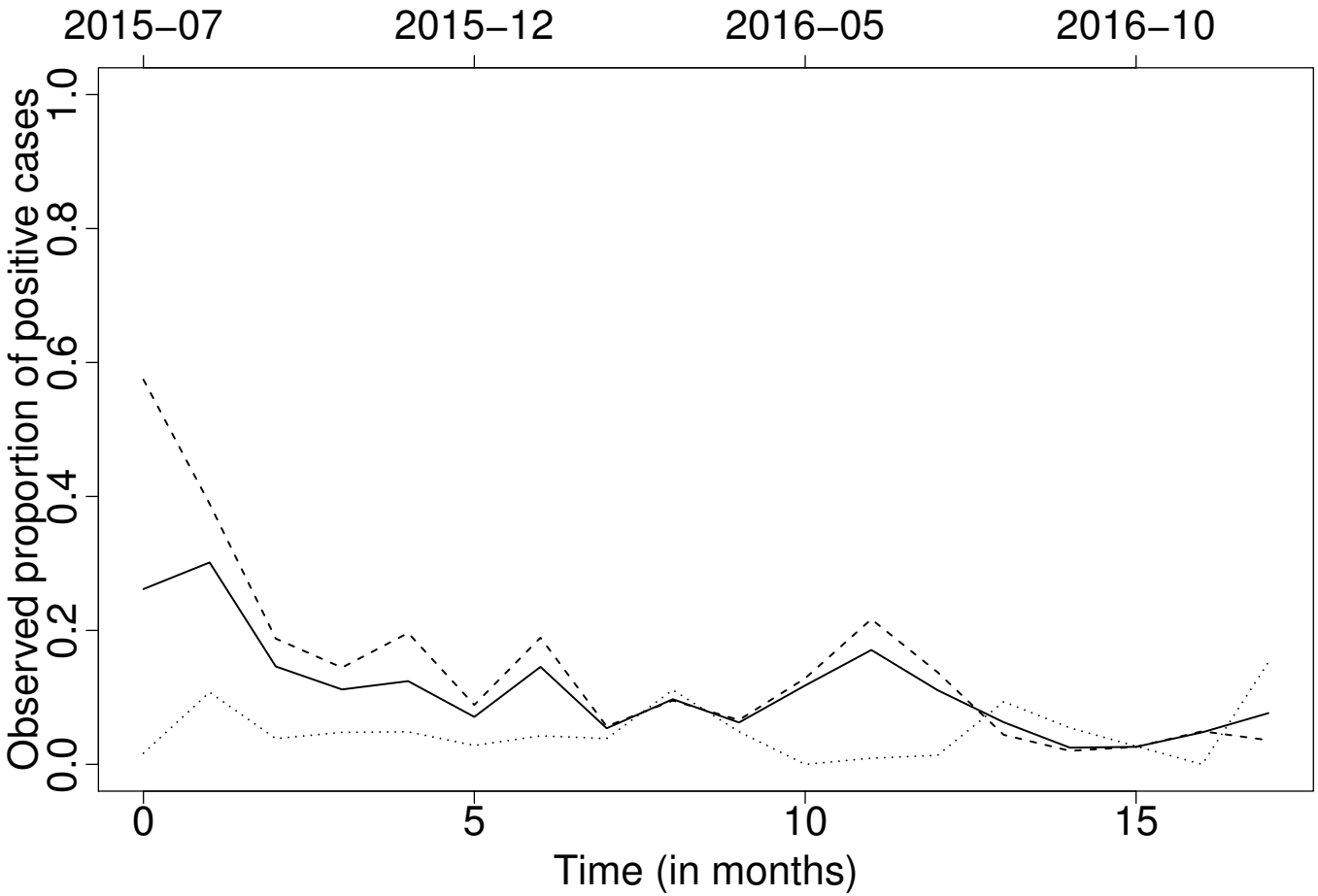
Xylella fastidiosa : Surveillance data in France

- July 2015 : *in situ* detection of Xf in Corsica
- A stratified surveillance was settled and data were centralized
- 2 years later : >20000 analyzed samples in Fr. (real-time PCR)
- 5.9% of positives in Corsica, 1.8% in PACA



- Our aim : inferring the dynamics of Xf with a mechanistic-statistical approach that handles specificities of the surveillance-based observation process

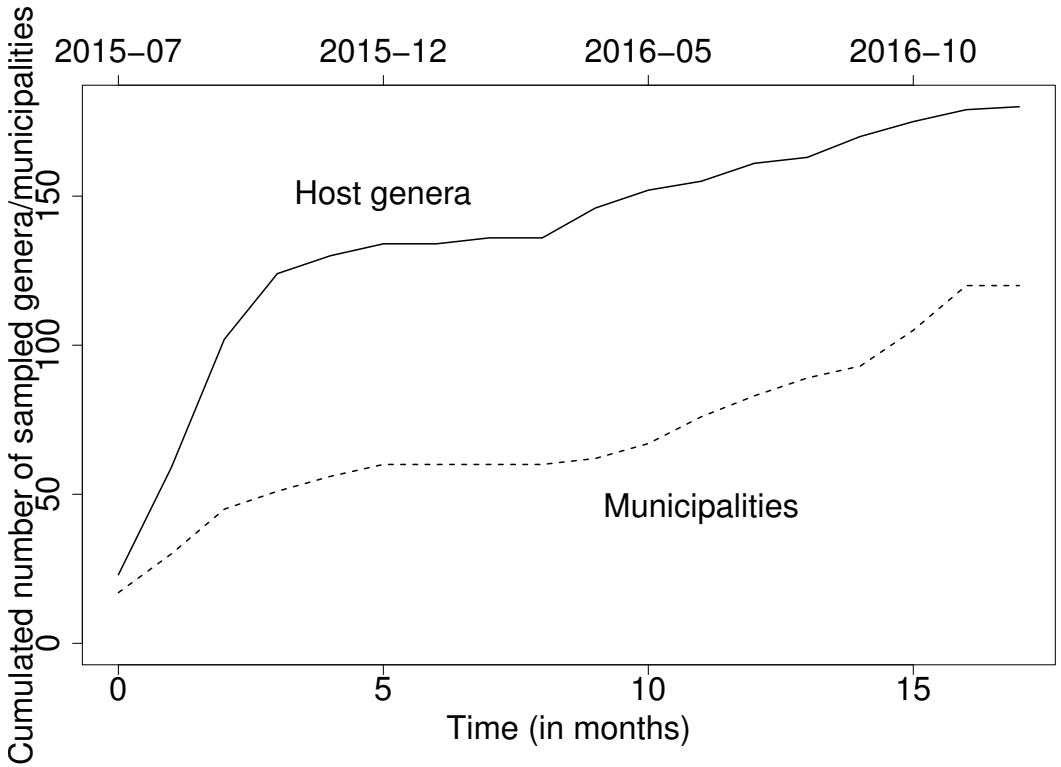
Decrease of observed prevalence in South Corsica : What does it mean ?



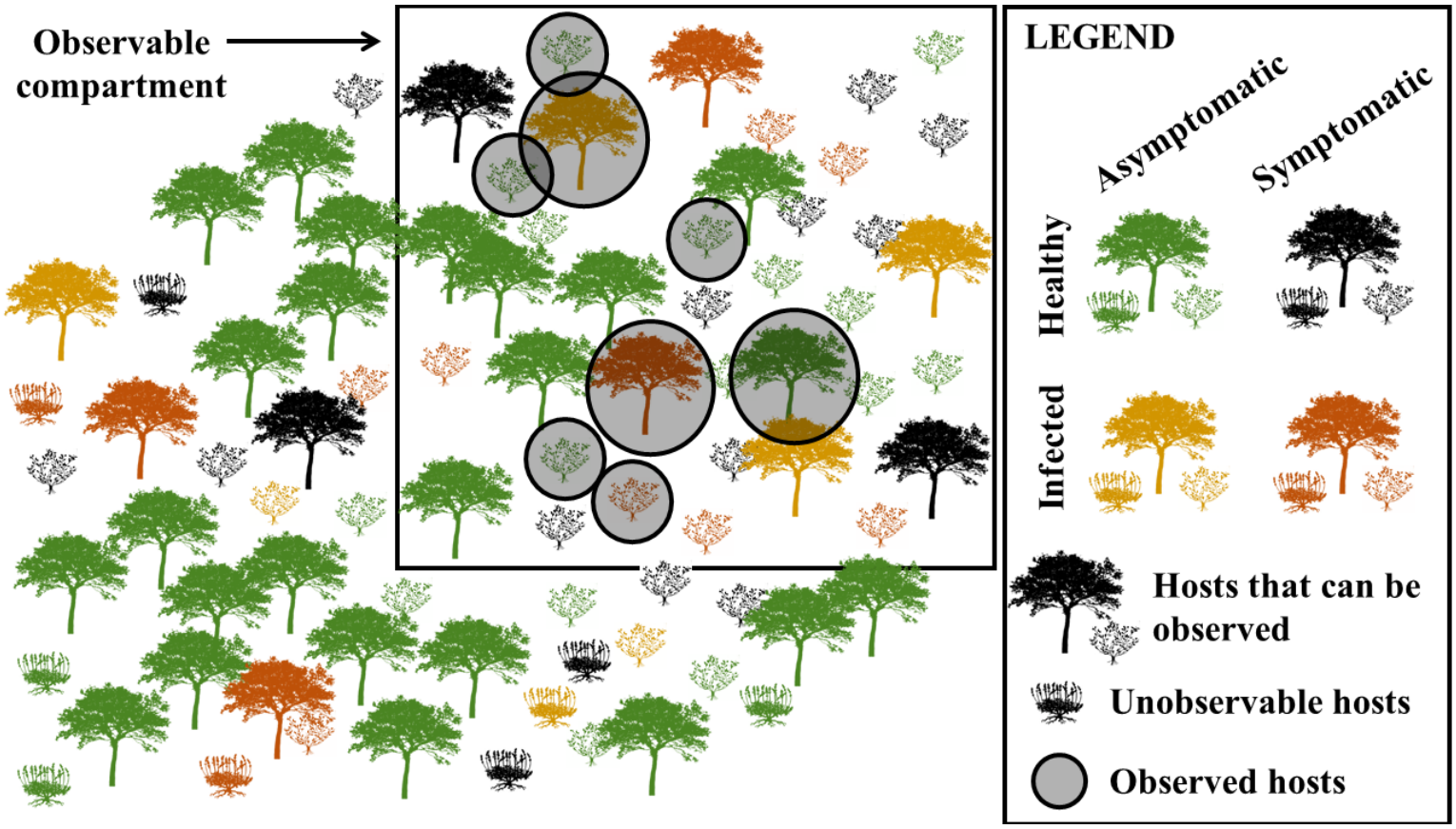
— all hosts - - - symptomatic hosts ··· asymptomatic hosts

Decrease of observed prevalence in South Corsica : What does it mean ?

- A decrease of the actual disease prevalence ?
  (because detected infected plants are destroyed)
- A sampling strategy that varies in time ?
  (preference in sampling at-risk hosts might have decrease with time)



Complex ecological structure of multi-host pathogens



- Unravelling the pathogen dynamic may be complicated by the existence of a hidden compartment, which may play the role of infection reservoir

Competing models

- Construction of several temporal models based on a Susceptible – Infected – Removed (SIR) architecture

	Hidden compartment	
	None	Fraction of the whole population
Preference in sampling	$\phi = 1$	$\phi \in [0, 1]$
None $g \equiv 1$	$\mathcal{M}_1$	$\mathcal{M}_4$
At-risk, constant $g \equiv \text{cst} \in [0, 1]$	$\mathcal{M}_2$	$\mathcal{M}_5$
At-risk, linearly varying g : linear function with values in [0,1]	$\mathcal{M}_3$	$\mathcal{M}_6$ (uniform prior in [0,1] for ϕ) $\mathcal{M}_7$ (a priori large value for ϕ) $\mathcal{M}_8$ (a priori small value for ϕ)

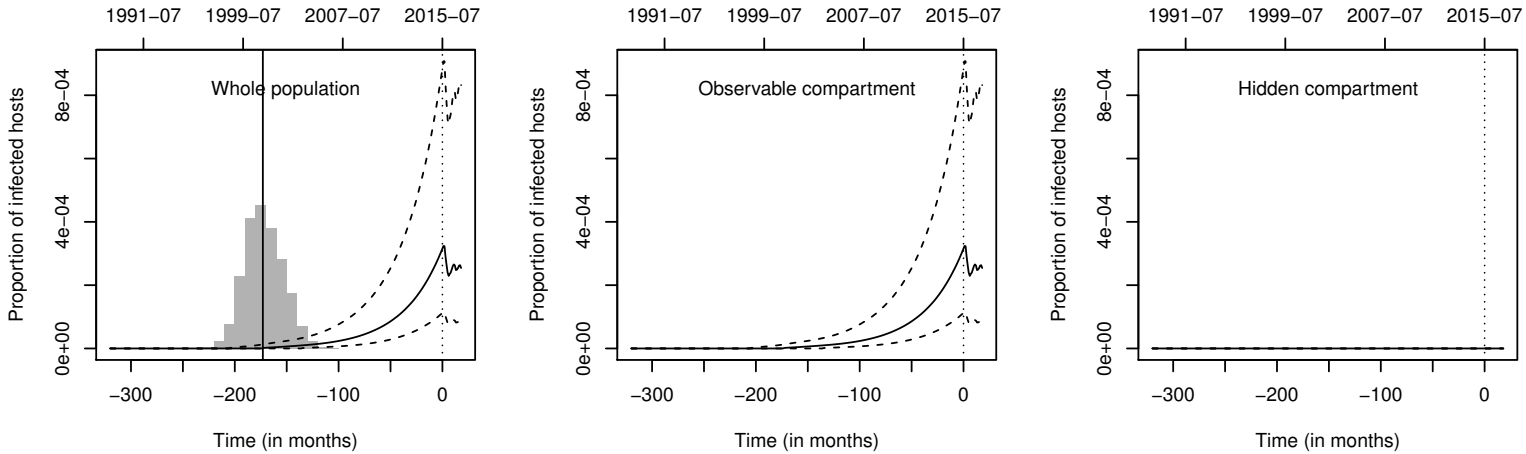
- Bayesian inference (MCMC) from monthly counts of infected/healthy $\times$ symptomatic/asymptomatic plants
- Model selection with BIC, DIC and Bayes factor

Dualism in model selection

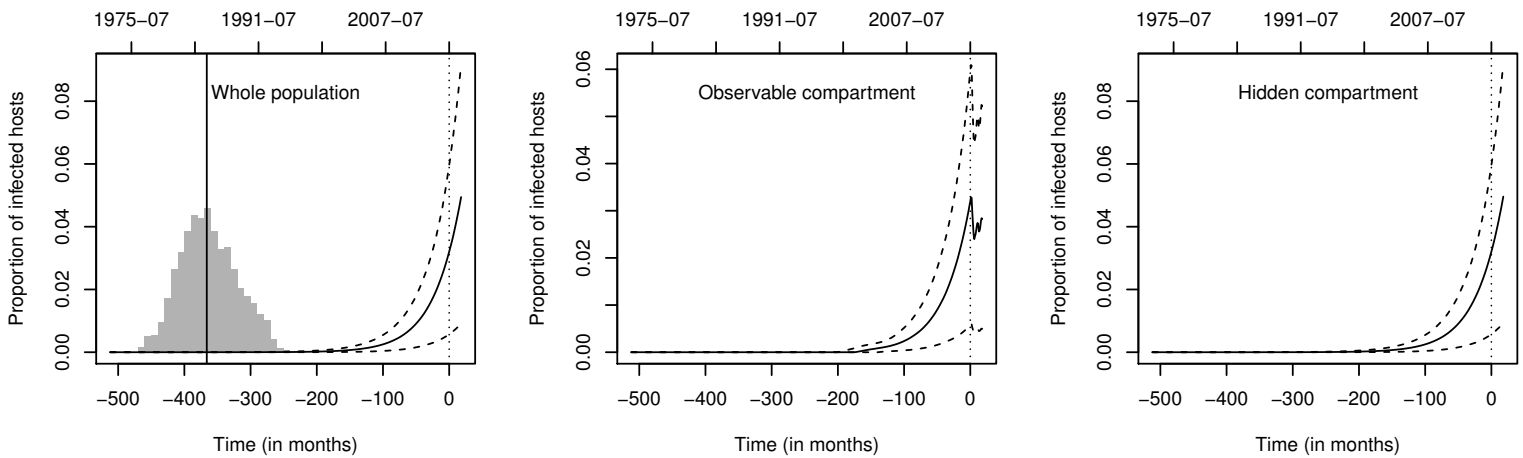
Hidden compartment	Preference in sampling	Model	BIC	DIC	Bayes factor
None	At-risk, varying	$\mathcal{M}_3$	**475**	**356**	1.00
A priori large fraction	At-risk, varying	$\mathcal{M}_8$	488	399	**1.41**

Two scenarios in the past

Scenario 1 : No hidden compartment – Low prevalence – Introduction ≈ 2001 (1985–2005)



Scenario 2 : Hidden compartment – Larger prevalence – Introduction ≈ 1985 (1978–1993)



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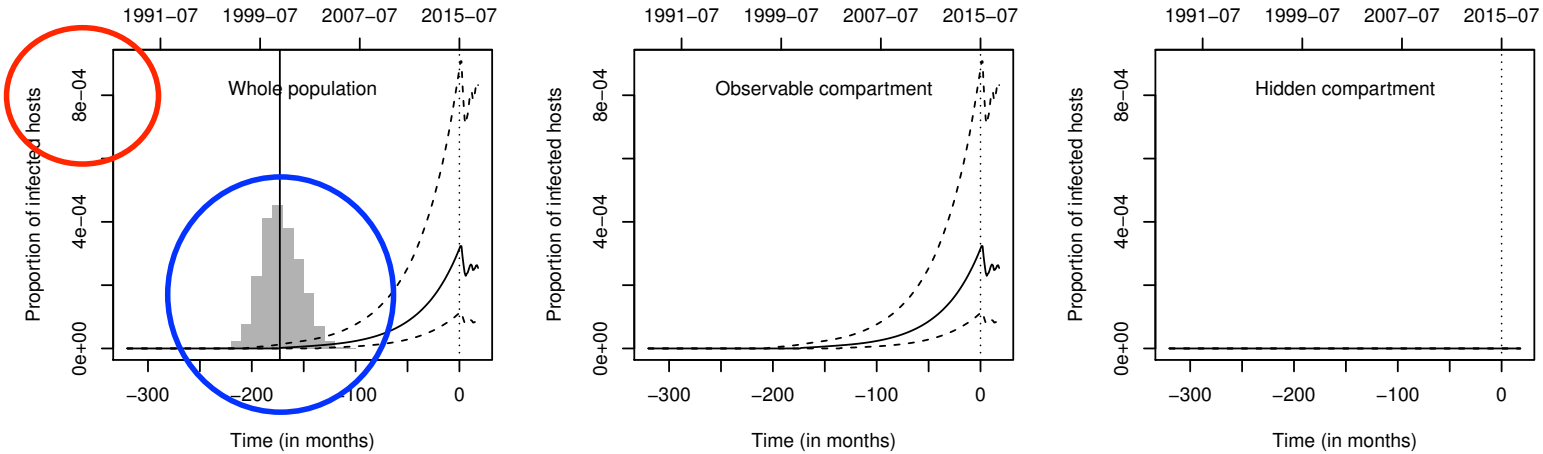

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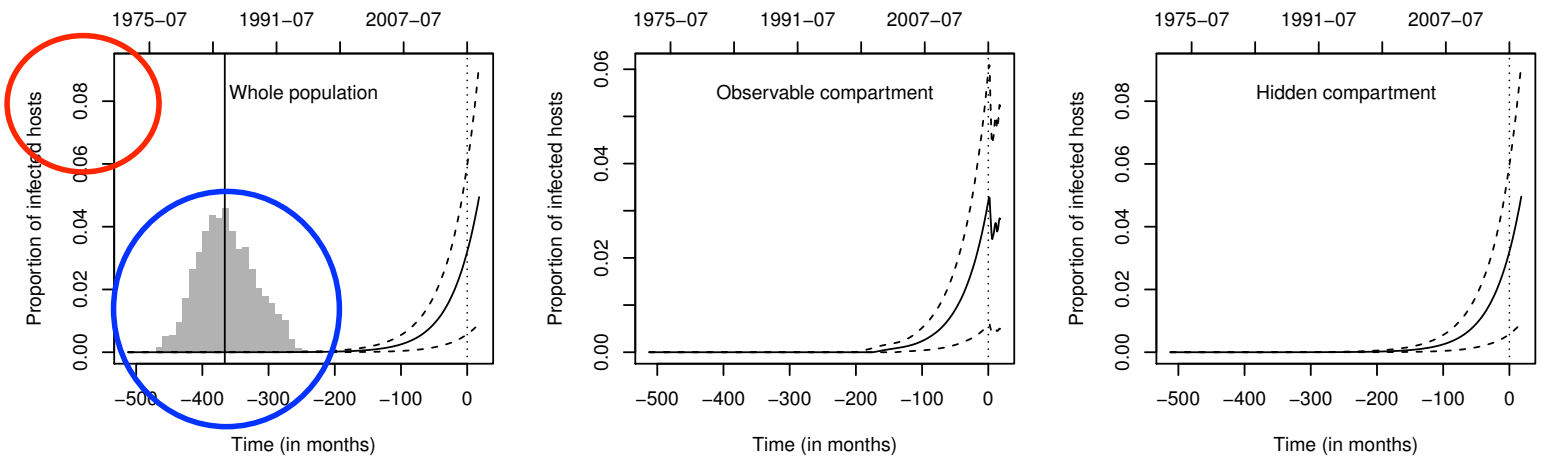
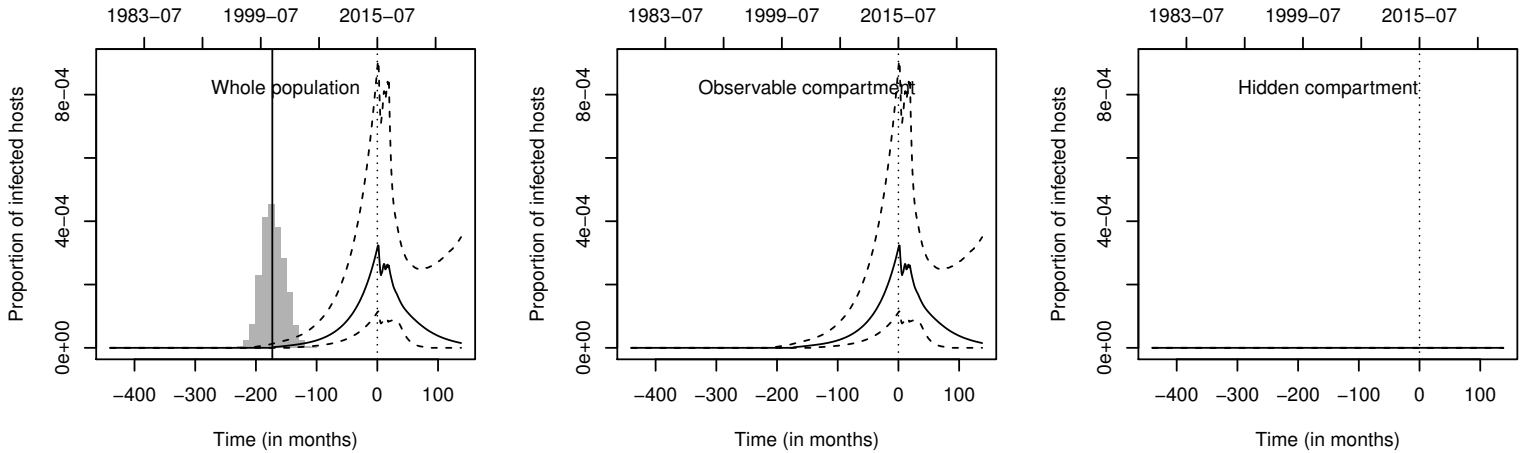
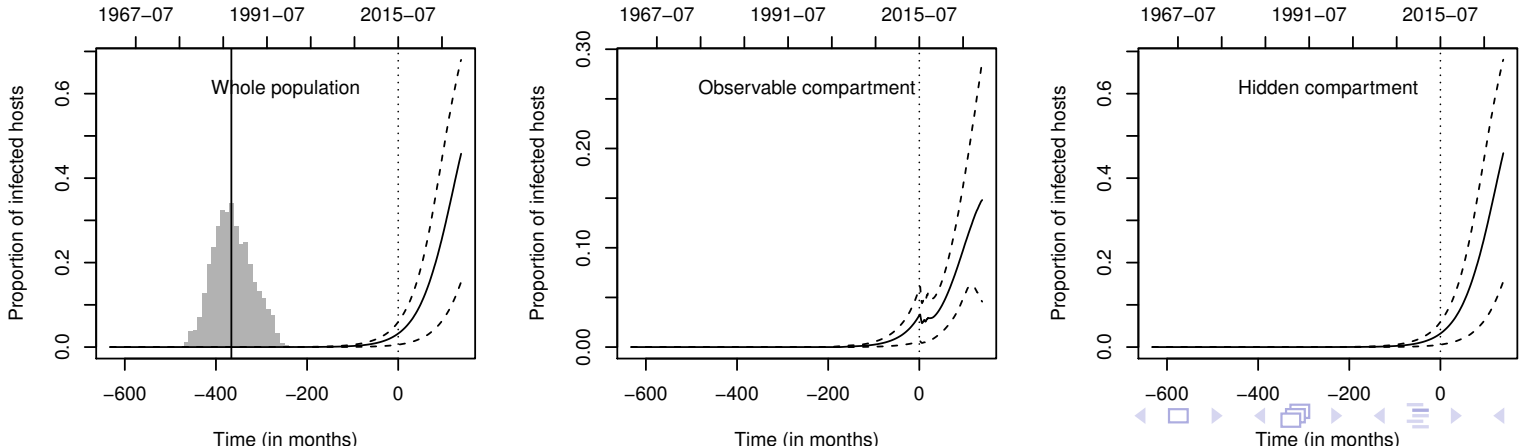


Implications for the future (with cst but reinforced surveillance effort and cst preference in sampling)

Prediction under model $\mathcal{M}_3$: the surveillance could decrease the overall prevalence and allow Xf eradication



Prediction under model $\mathcal{M}_8$: the hidden reservoir does play the role of an infection reservoir and makes the control difficult



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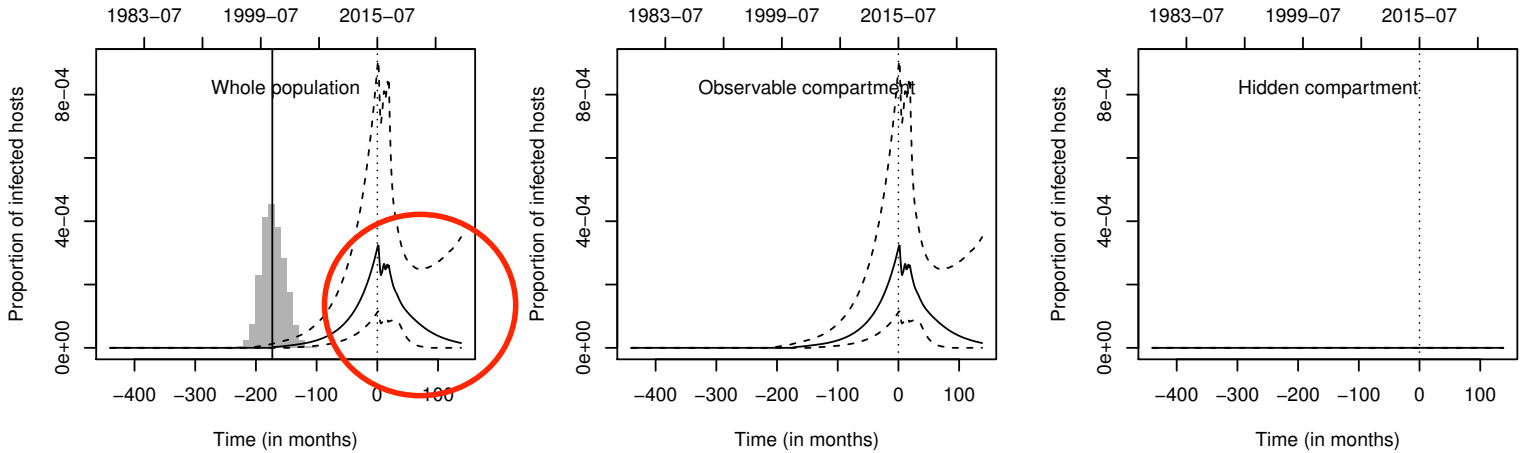

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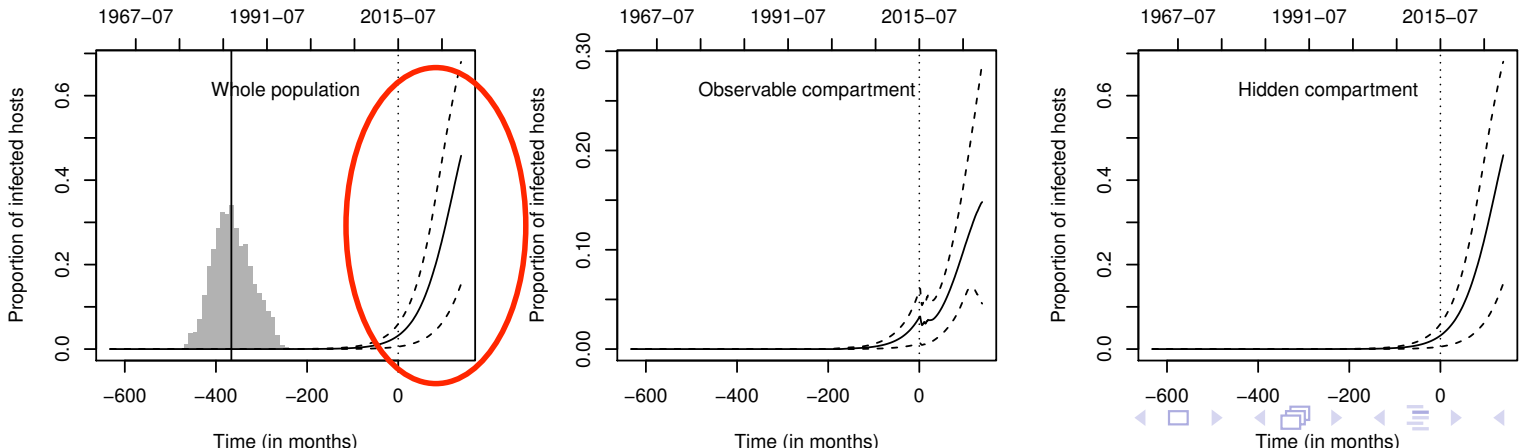

Discussion

- Our work opens a scientific debate about the introduction and the prevalence of Xf in Corsica
  - Need to apply complementary approaches using more data
  - E.g. fit of spatio-temporal models to data
    $\longrightarrow$ see Candy Abboud's poster

- Today, pieces of evidence in support of the scenario with an introduction around 1985 and a hidden compartment
  - Mean dates of molecular divergence between French and American isolates (Denancé N, Rieux A,Jacques M- A) :
    $\approx$ 1980 for strain ST6
    $\approx$ 1965 for strain ST7
    $\longrightarrow$ Lower bounds of the introduction date
  - Percentage of Xf-positives *Philaenus* sampled from cistus (Cruaud A, Rasplus J-Y, Santoni S, Gonzales A-L) :
    $\approx$ 20%
    $\longrightarrow$ Cistus could contribute to the hidden compartment