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Modern approaches to surveillance for emerging plant pathogens

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Surveillance for emerging diseases

- Surveillance in agricultural and natural landscapes increasingly important for control of emerging diseases
- How to design effective surveillance strategies?
- Statistical approaches are useful but tend to treat epidemics as if they were static

Epidemiological modelling

Multiple, conflicting, surveillance objectives

If we know when and where disease will occur, we can adjust our surveillance strategy to optimise relative to the specific objective:

- Early detection
- Delimiting new foci
- Characterising incidence & distribution
- Informing epidemiology
- Targeting disease control
- Supporting claims for disease-freedom

Epidemiological modelling approach

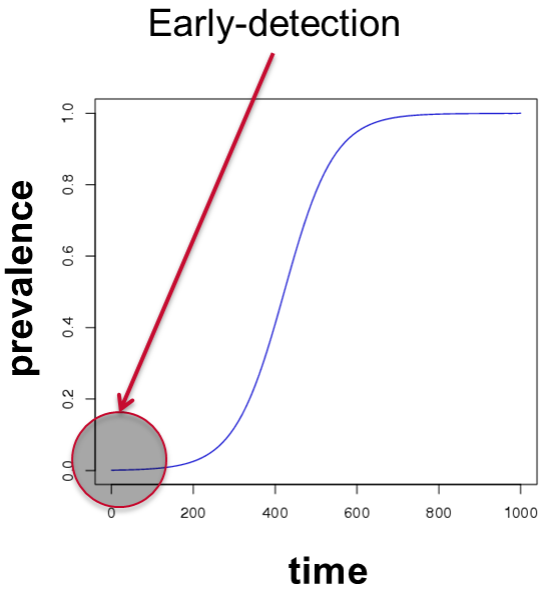
When and where will disease occur?

Accounting for epidemiology:

- Temporal spread
- Spatial spread
- Heterogeneous pathosystems

Temporal spread

- How does the epidemic growth rate influence surveillance?



Mean detection-prevalence "rule of thumb":

$$\frac{r}{N/\Delta} = \frac{epidemic\ growth\ rate}{sampling\ rate}$$

N number of trees sampled
Δ number of days between rounds of sampling
r daily rate of increase of the epidemic

Take-home message: adjust surveillance intensity proportional to rate of epidemic growth

Parnell et al (2015) Proc Roy Soc B. DOI: 10.1098/rspb.2015.1478

Temporal spread

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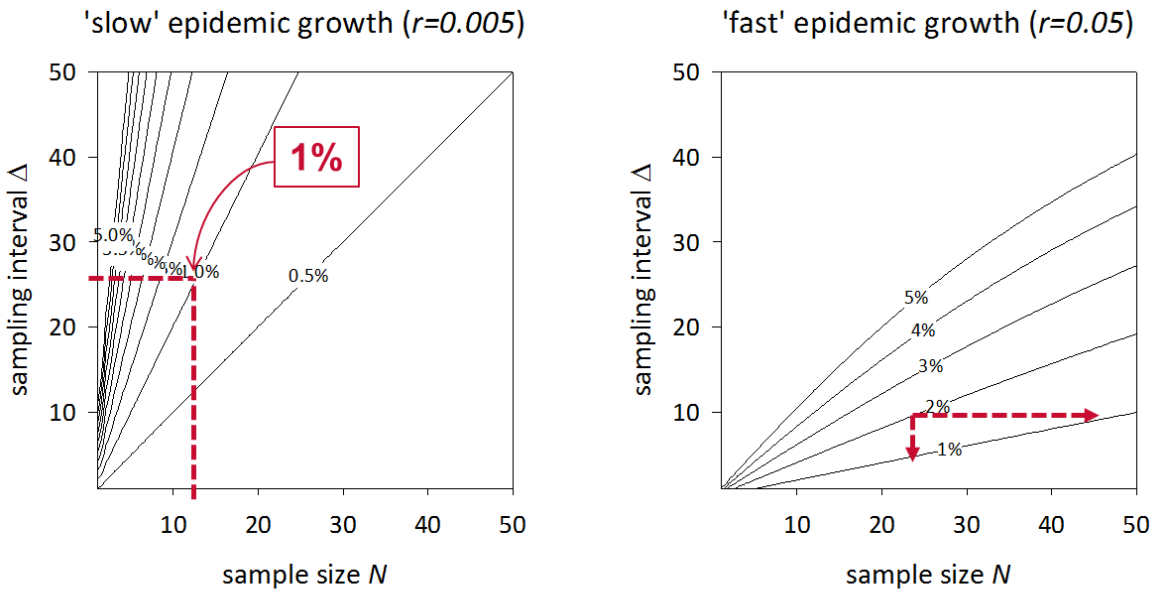


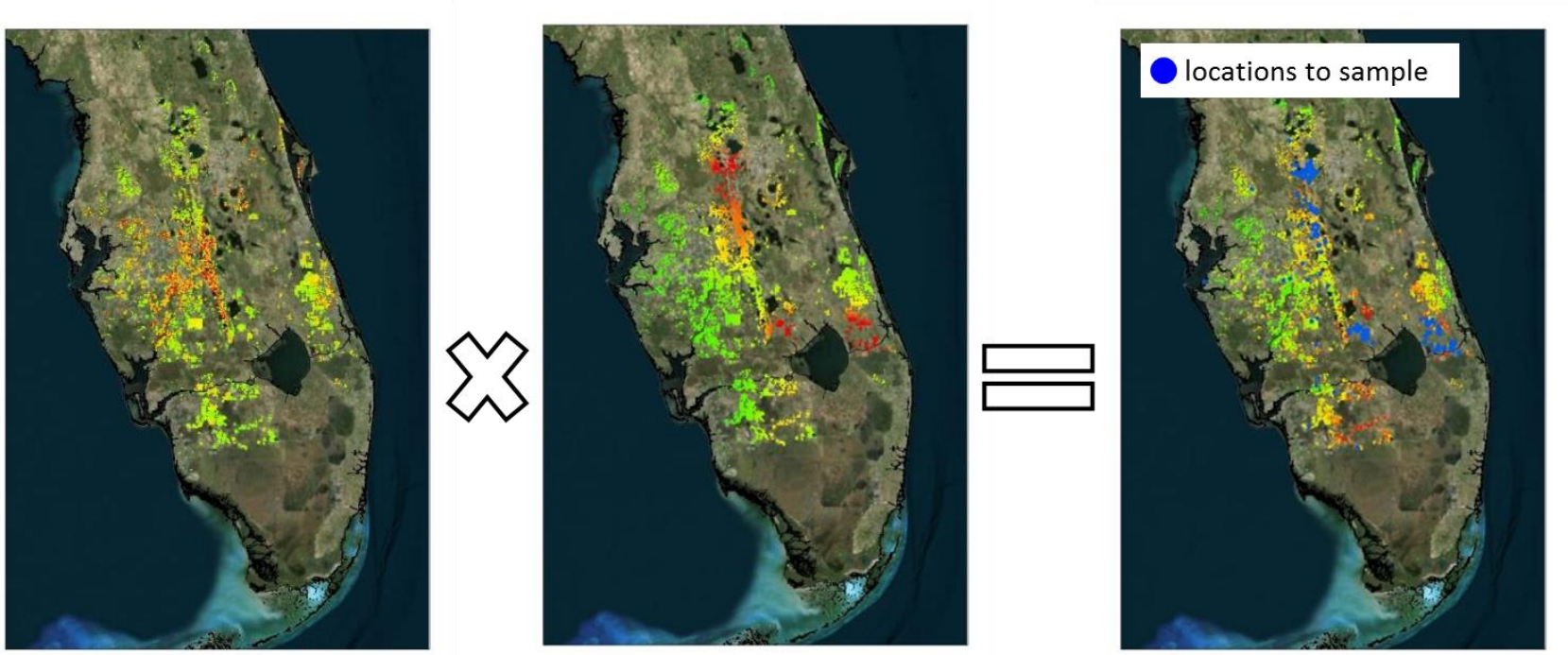
(i) Sample size *N* (*how much sampling*)
(ii) Survey interval Δ (*how often*)

Take-home message: For 'fast' epidemics it is better to sample 'little and often' rather than all in one go

Spatial spread

- Use of models to characterise spatially-varying risk

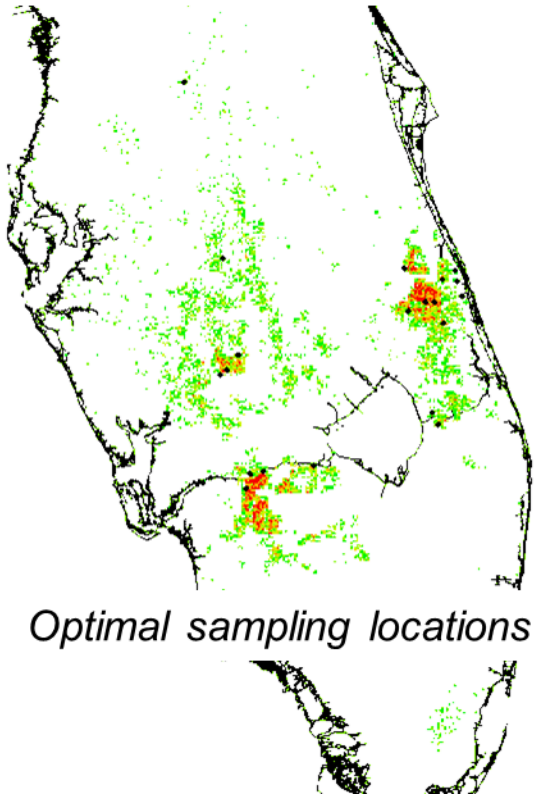
Example: Citrus Greening (HLB) in Florida



potential consequences (planting age & size) X probability of infection (distance to known outbreaks) = risk weighting (where to target samples)

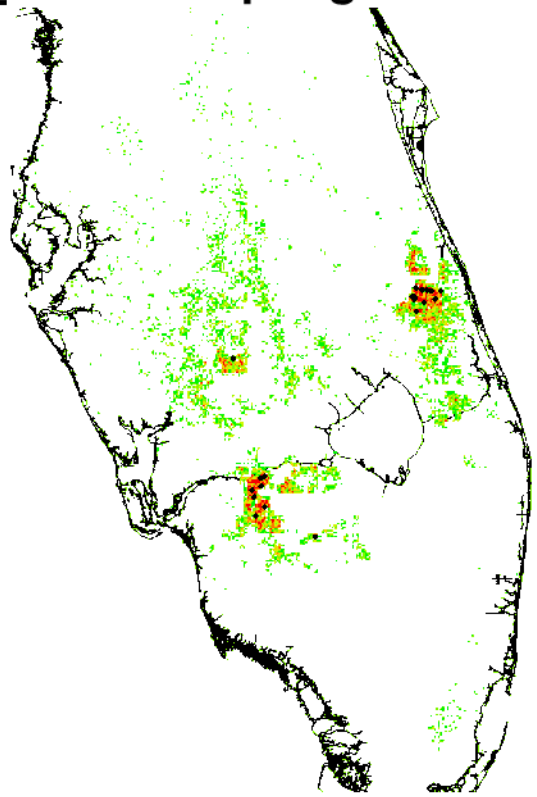
Spatial spread

High local sampling efficiency



- *Optimal sampling locations*

Low local sampling efficiency



Take home message: it isn't always optimal to just visit the highest risk locations…

Heterogeneous pathosystems

Alex Mastin
Salford University

- Pathosystems are complex
- Inoculum spreads through different stages

  - Host
  - Vector
  - Soil
  - Air
  - Wild hosts
  - Susceptibility
  - Other risk categories

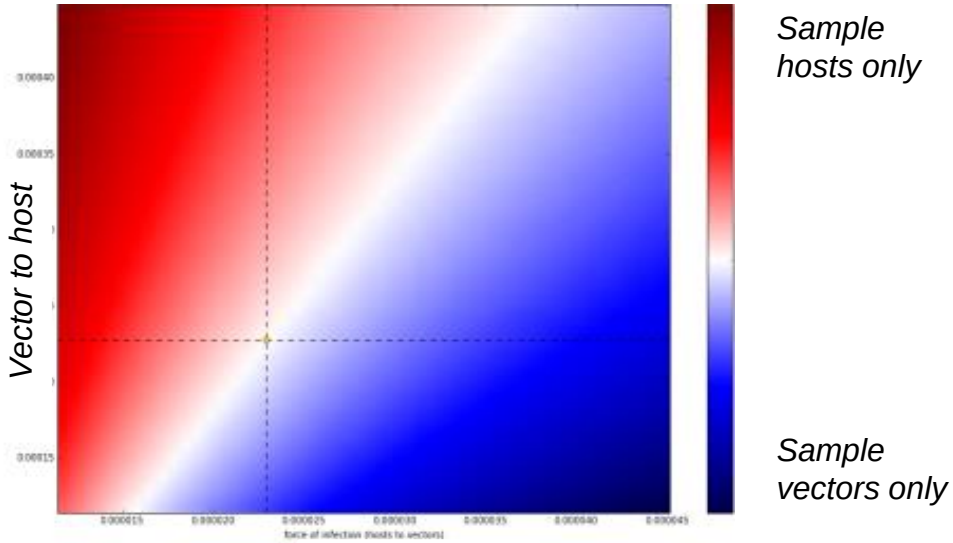
E.g. In a host vector system, often we target hosts. But should we focus sampling on the host population or vectors?

vs

Heterogeneous pathosystems

Is it optimal to sample from the hosts or sample from the vector population?

Effect of transmission parameters on which population to sample



Take-home message: which part of a pathosystem to target depends on a trade-off between the epidemiology of each ‘strata’ and the cost of sampling from each

Epidemiological modelling approach

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