Making Sense of Absence: A Bayesian Framework.

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Importance of determining pest absence

- Gaining and maintaining market access to trade with other countries without additional phytosanitary measures.
- Determining when we are confident that a pest has been eliminated from an area post-control.

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NB: what's the difference?

Inference from Ignorance.

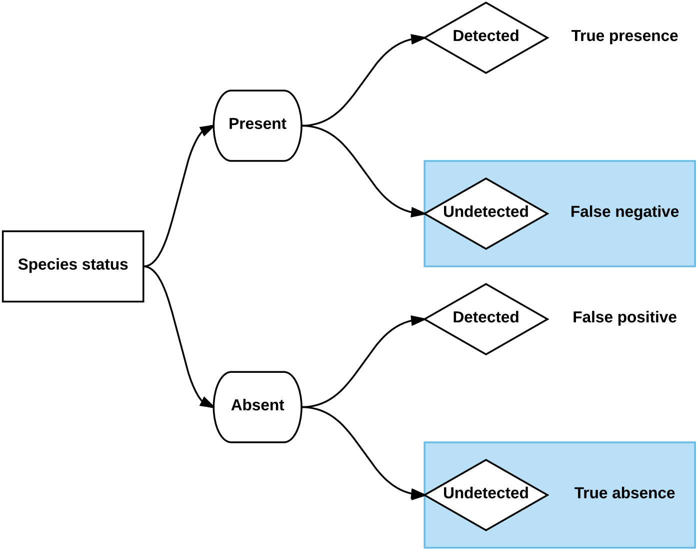
McArdle (1990)

$$\alpha = 1 - (1 - p)^N \qquad (1)$$

Cannon (2002)

$$\alpha = 1 - (1 - S \times p)^N \qquad (2)$$

What Can Possibly Go Wrong?



Quantifying probability of absence, given no detections

We need two things:

1. A prior estimate of the probability of occurrence, and
2. An estimate of the sensitivity of the surveillance system to detect the pest.

Probability of absence, given no detections

$$p_a = \frac{\Pr(\text{Prior non-occurrence})}{\Pr(\text{Prior non-occurrence}) + \Pr(\text{Failed detection}) \times \Pr(\text{Prior occurrence})}$$

Case study: Mediterranean fruit fly

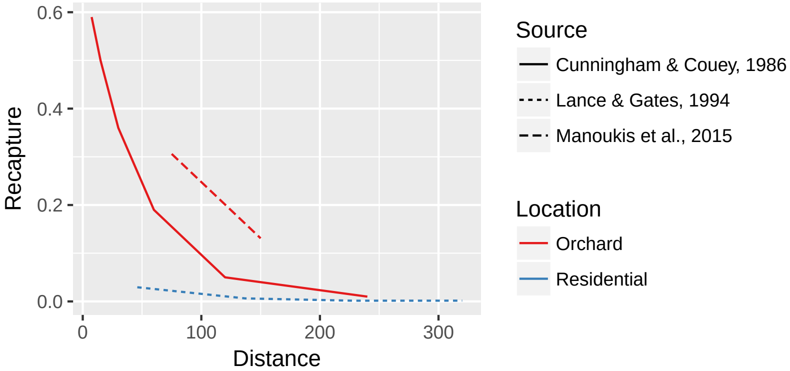
Source: Katja Schulz - Washington, D.C., USA

Medfly

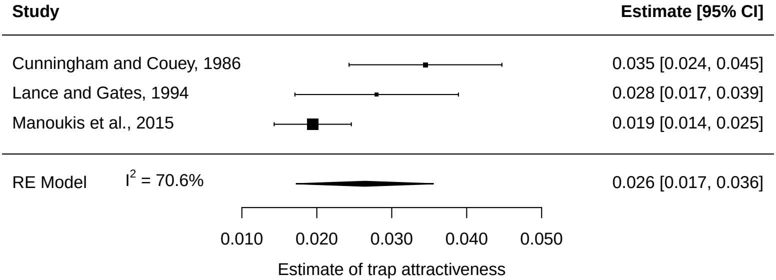
- *Ceratitis capitata*
- Major quarantine pest world-wide
- Highly polyphagus
  known to feed on over 300 horticultural species
- Countries with established populations face significant trade barriers
- \$4.8B of Australia's \$6.9B horticultural industry is FF-sensitive.

Source: Gail Hampshire - Cradley, Malvern, UK

Medfly trap sensitivity



Medfly trap sensitivity



Prior probability of occurrence

Prior belief a pest is present in a cell will likely depend on three things:

- An arrival rate (*How likely is it to arrive?*)
- Climatic suitability (*Is the local climate suitable?*)
- Availability of hosts (*Is there available food?*)

And he quoth . . .

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- Let the prior for arrival be 0.3.
- Let the prior for each cell be 0.01.

And he quoth ...

- Let the prior for arrival be 0.3.
- Let the prior for each cell be 0.01.

And the 200 m. trap sensitivity be 0.0005, and let's use a candidate allocation of traps to cells.

```r
detection_rate <- 0.0005   # Effectiveness / sensitivity
area_prior <- 0.3          # Arrival rate (80 years)
n_cells <- 120             # Number of cells within state
n_flies <- 1               # Trigger
super_pop <- 20            # Design prevalence

prob_absence(detection_rate, area_prior, n_cells,
             n_flies, super_pop, n_effort = rep(0, 120),
             aggregate = TRUE)

## [1] 0.7

prob_absence(detection_rate, area_prior, n_cells,
             n_flies, super_pop, n_effort = cell.grid,
             aggregate = TRUE)

## [1] 0.7160708
```

```r
prob_absence(detection_rate, area_prior, n_cells,
             n_flies, super_pop, n_effort = rep(0, 120),
             aggregate = TRUE)

## [1] 0.7

prob_absence(detection_rate, area_prior, n_cells,
             n_flies, super_pop, n_effort = rep(25, 120),
             aggregate = TRUE)

## [1] 0.7574084
```

```r
super_pop <- 50

prob_absence(detection_rate, area_prior, n_cells,
             n_flies, super_pop, n_effort = rep(0, 120),
             aggregate = TRUE)

## [1] 0.7

prob_absence(detection_rate, area_prior, n_cells,
             n_flies, super_pop, n_effort = rep(25, 120),
             aggregate = TRUE)

## [1] 0.8261191
```

Caveats — beware the black swan.

Questions?

The Imperative
Inference from Ignorance
Case Study: MedFly
Caveats

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Questions?

- The Imperative
- Inference from Ignorance
- Case Study: MedFly
- Caveats