Probability of freedom from paratuberculosis in Danish dairy herds

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Objective

- To develop a method to estimate probability of freedom from paratuberculosis in Danish dairy herds based on individual milk-ELISA testing;

Terminology

- Sensitivity – probability that an infected individual will test positive
- Specificity - probability that an uninfected individual will test negative
- Design prevalence – pre-determined prevalence level that you wish to be confident of detecting with your testing strategy
- Probability of freedom – probability that the true prevalence is less than the design prevalence
- **Note:** some high PFree herds may still be infected but at less than the design prevalence

Methods

- Simulation model implemented in R and on web
- Age-specific sensitivity and specificity estimates used
- A distribution of observed values used for design prevalence (5% - 85%, mean = 34%)
- Analysis based on actual or simulated test results for 19 herds
- Calculate average Se and Sp for each herd based on age structure
- Calculate probability of observed result for uninfected herds and for herds infected at design prevalence
- Calculate probability of freedom (PFree) for observed result
- Simulate for 1,000 iterations

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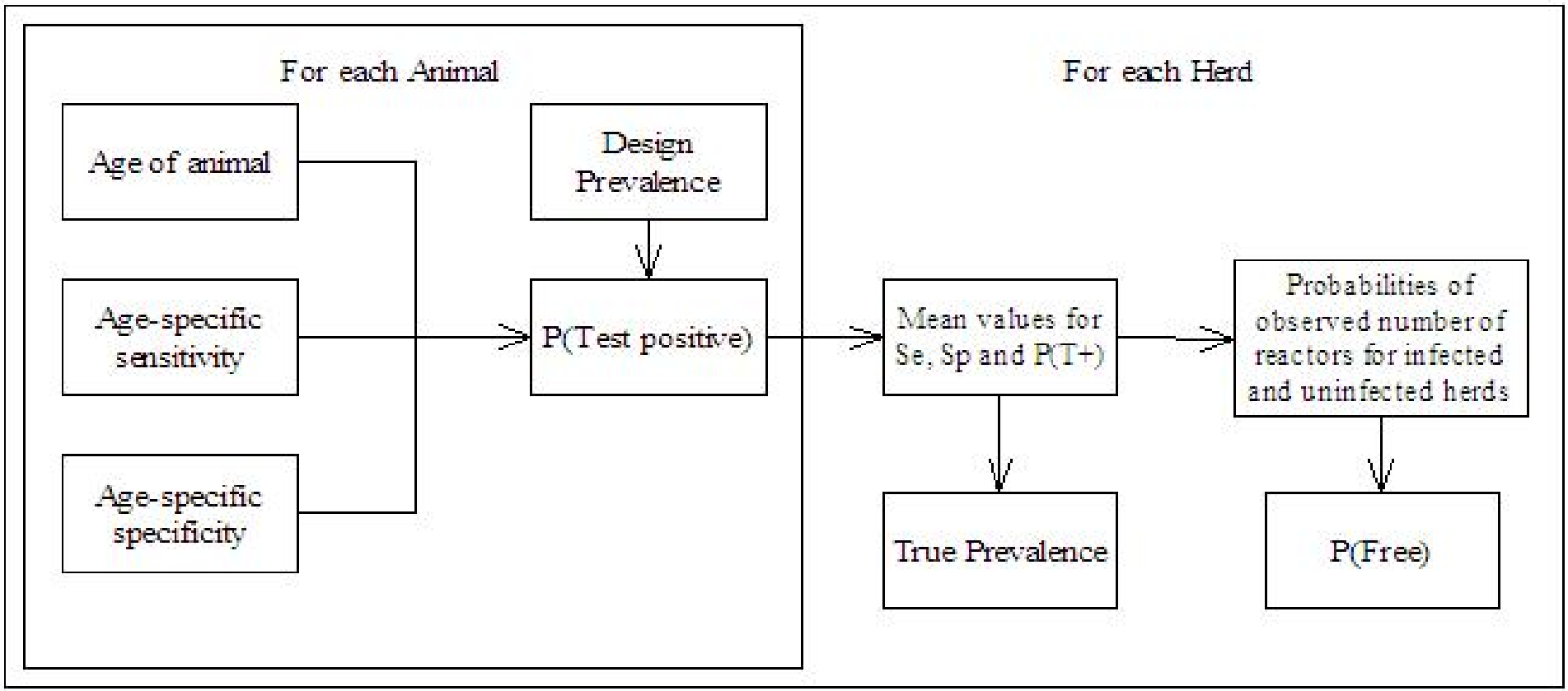

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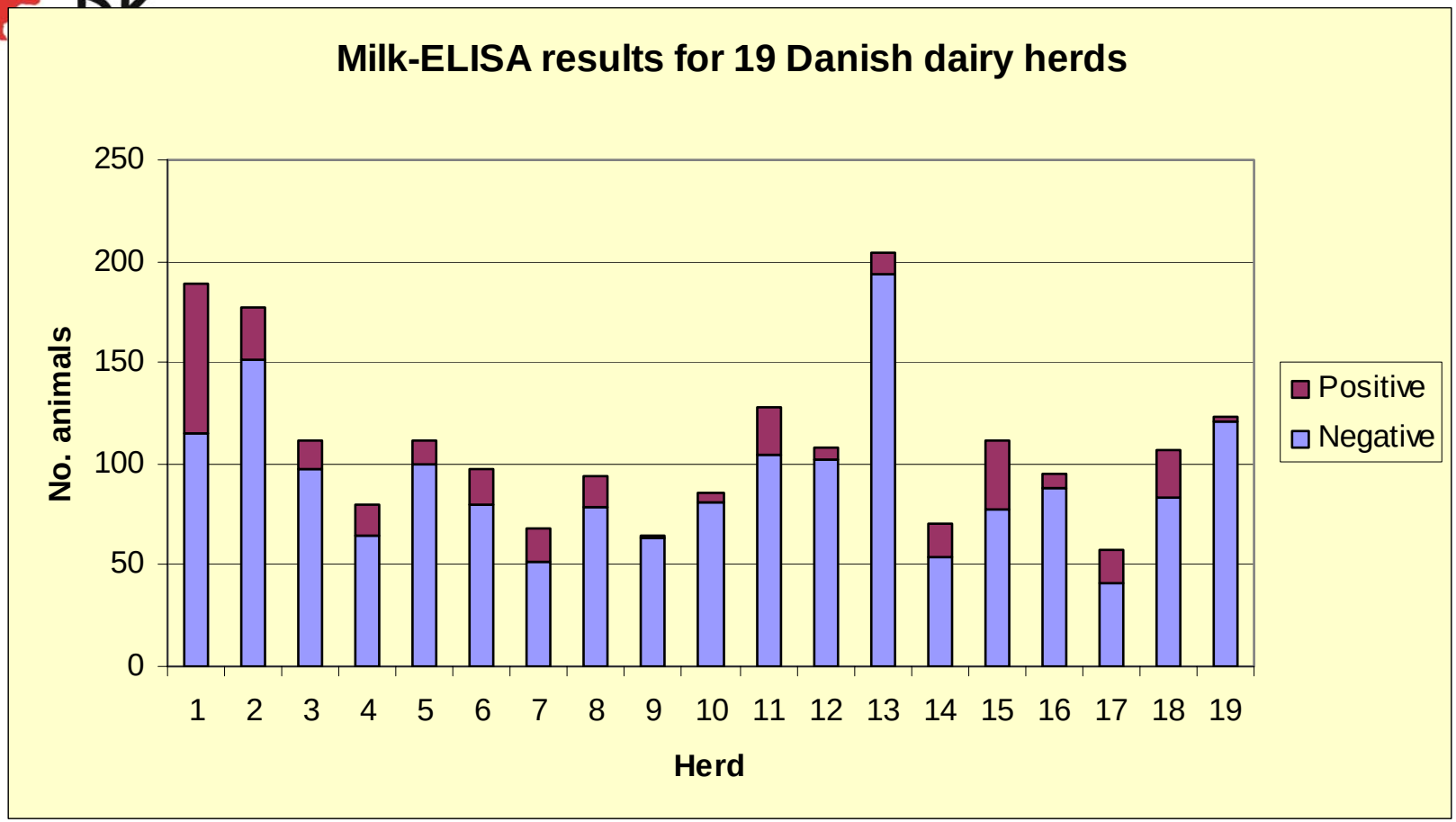
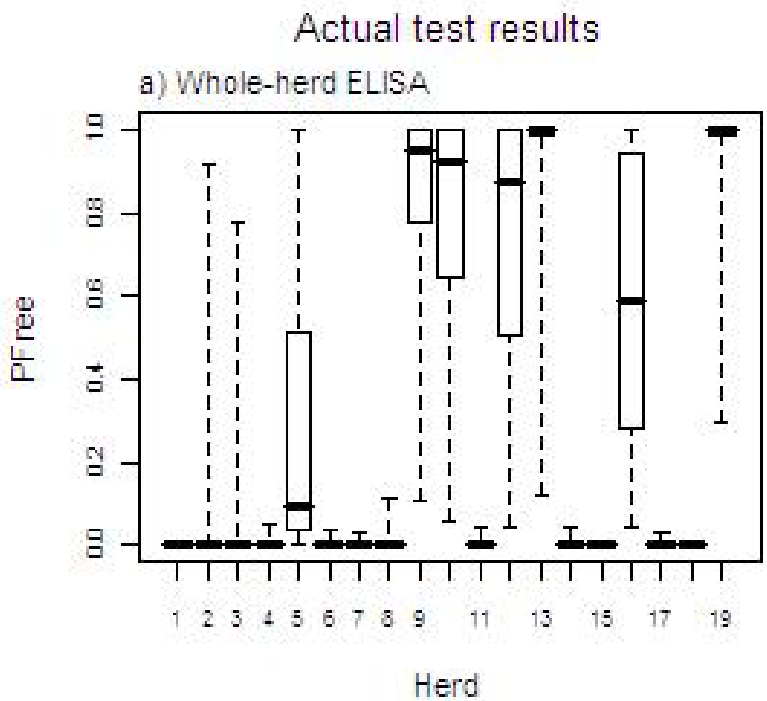
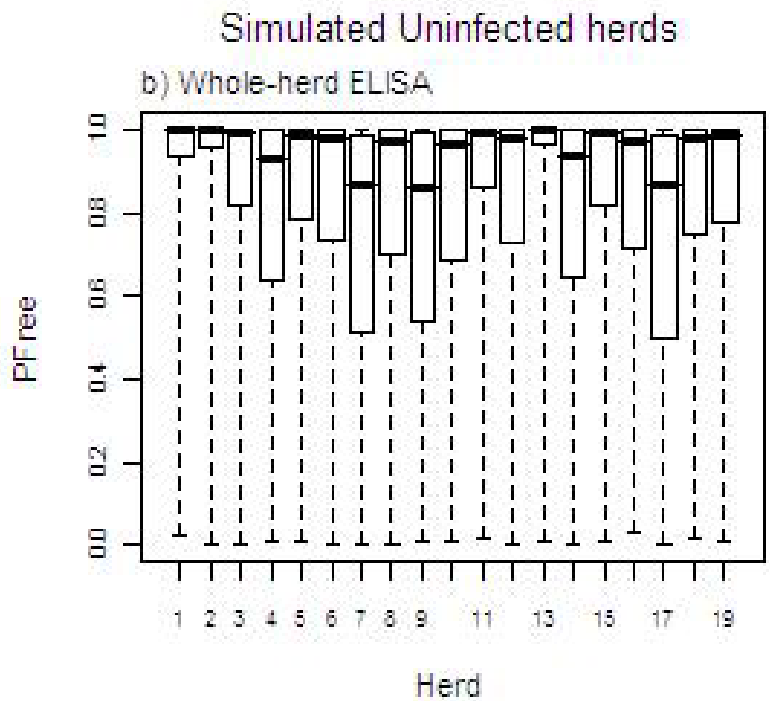
Results



- 2 herds < 5%, 4 herds 5 – 7%
- 7 herds 10 – 20%
- 6 herds > 20%

Results


Actual test results
a) Whole-herd ELISA
PFree
0.0
0.2
0.4
0.6
0.8
1.0
1 2 3 4 5 6 7 8 9 11 13 15 17 19
Herd


Simulated Uninfected herds
b) Whole-herd ELISA
PFree
0.0
0.2
0.4
0.6
0.8
1.0
1 2 3 4 5 6 7 8 9 11 13 15 17 19
Herd

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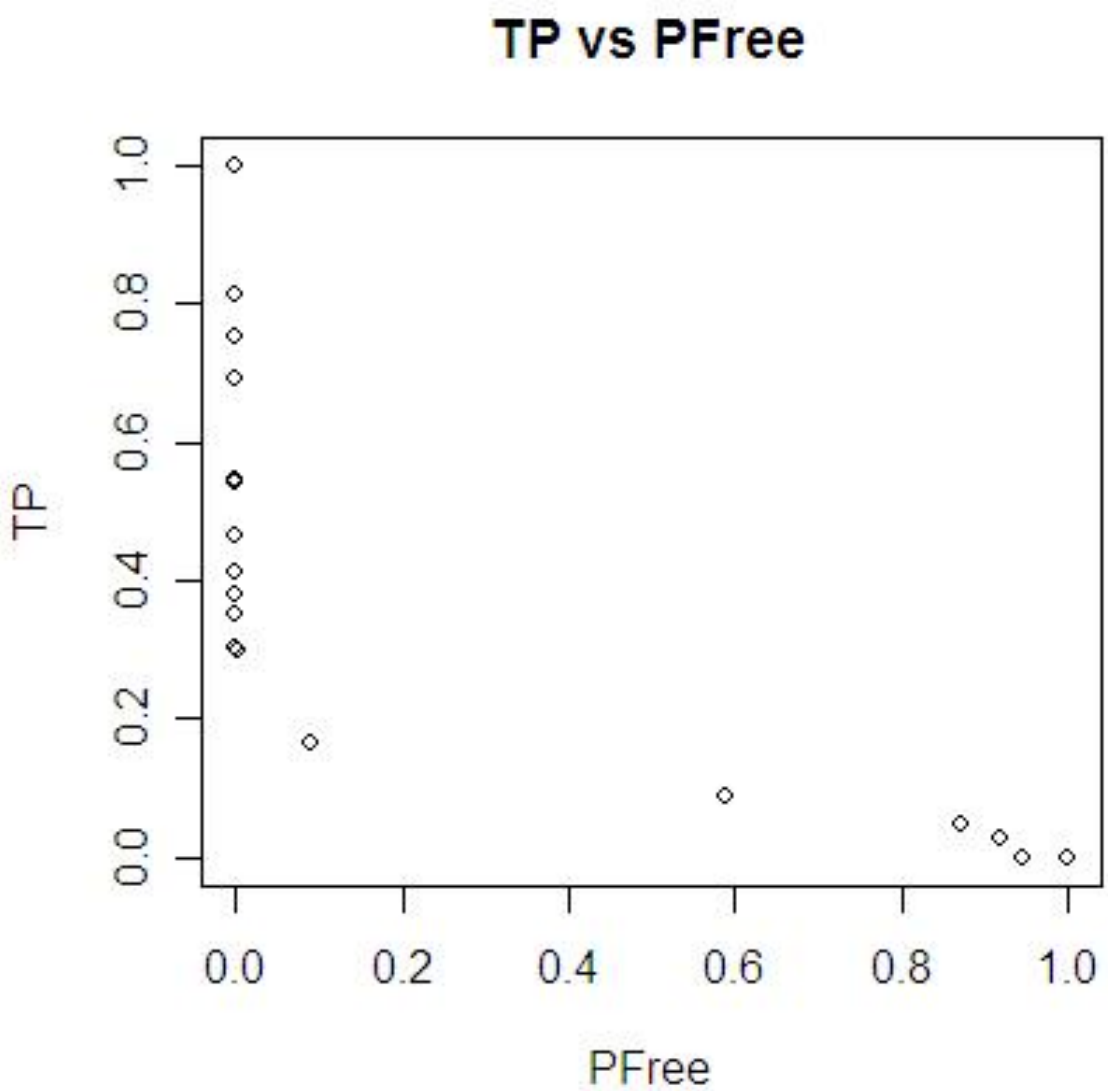

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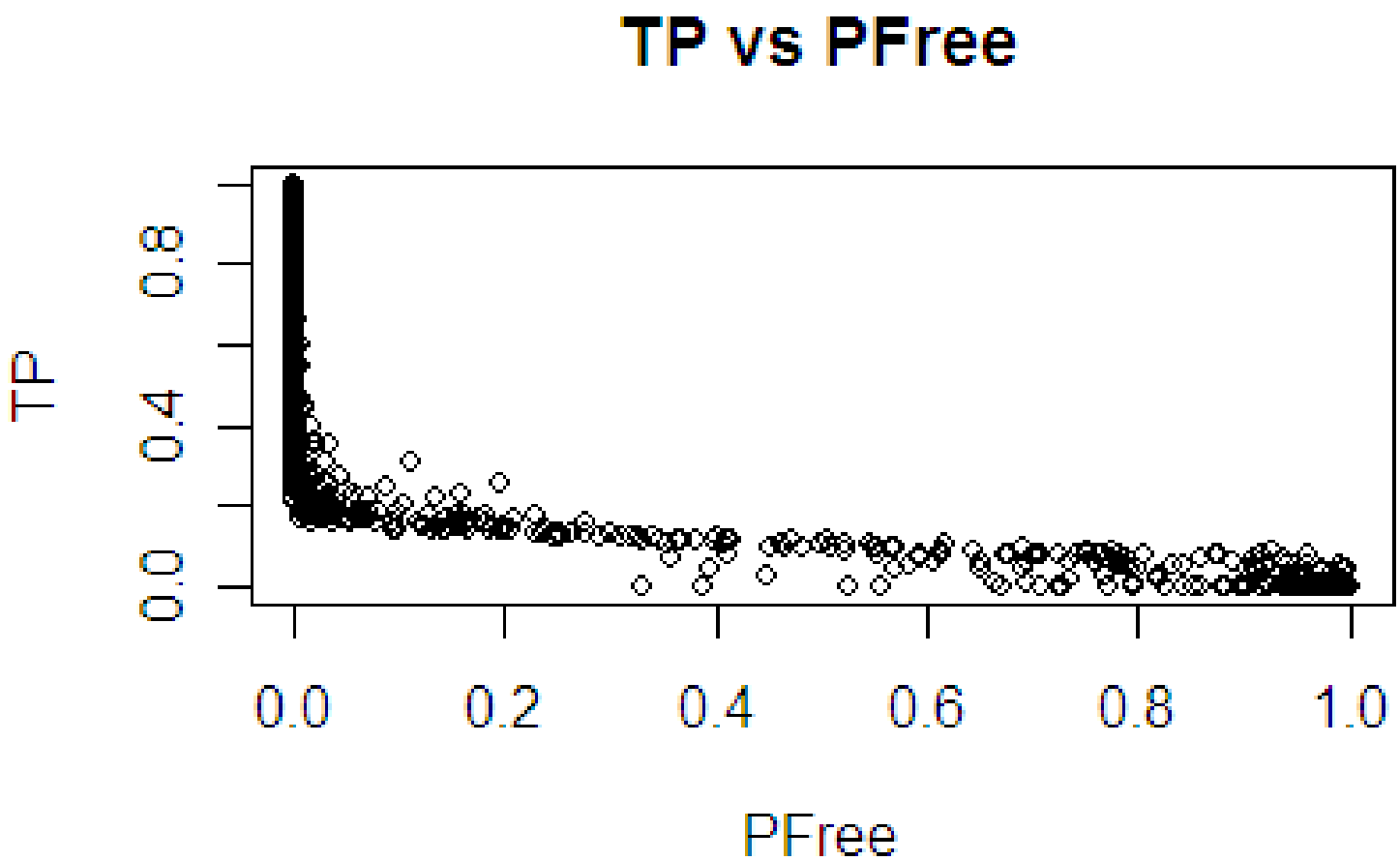
844 herds (Operation ptb)



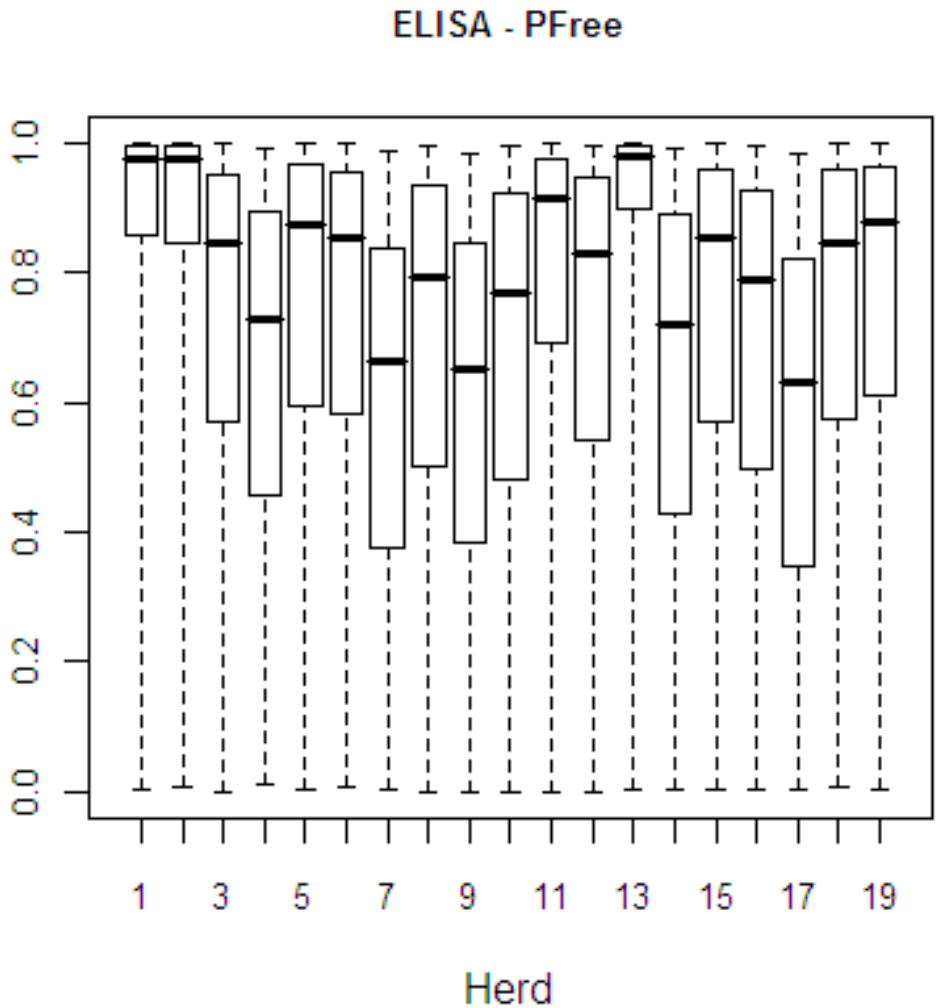
Discussion

- Only 2/19 herds had high PFree values
- 12/19 PFree = 0
- 5/19 had intermediate values
- 2 infected herds had high PFree
  - 1 had prior testing, possibly biased result
  - 1 low-prevalence only confirmed 1 year later
- Map never cultured from 1 herd with low PFree – why?

Design prevalence issues

- Distribution rather than point value reflects industry situation
- Generally high (mean 34%) compared to more acute diseases
- Some herds likely to be infected at low prevalence despite high PFree
- May need to review and decrease if prevalence drops as control improves
- Problems with identifying high PFree herds at lower DP – ? update estimates over time

PFree for DP=20% in simulated uninfected herds



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Issues to consider

- Good for identifying infected herds, not so good for identifying uninfected herds (better tests required)
- Poor power in smaller herds
- Updating PFree estimates with repeated testing:
  - Discounting value of historical data
  - Lack of independence between repeated tests in individual herds
- Calculation based on probability of actual result, not on hypothetical cut-off (not HSe/HSp)

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Acknowledgment

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