Development of a strategy for risk based surveillance of bovine TB in Scotland

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Work undertaken at the Institute of Biodiversity, Animal Health and Comparative Medicine - University of Glasgow

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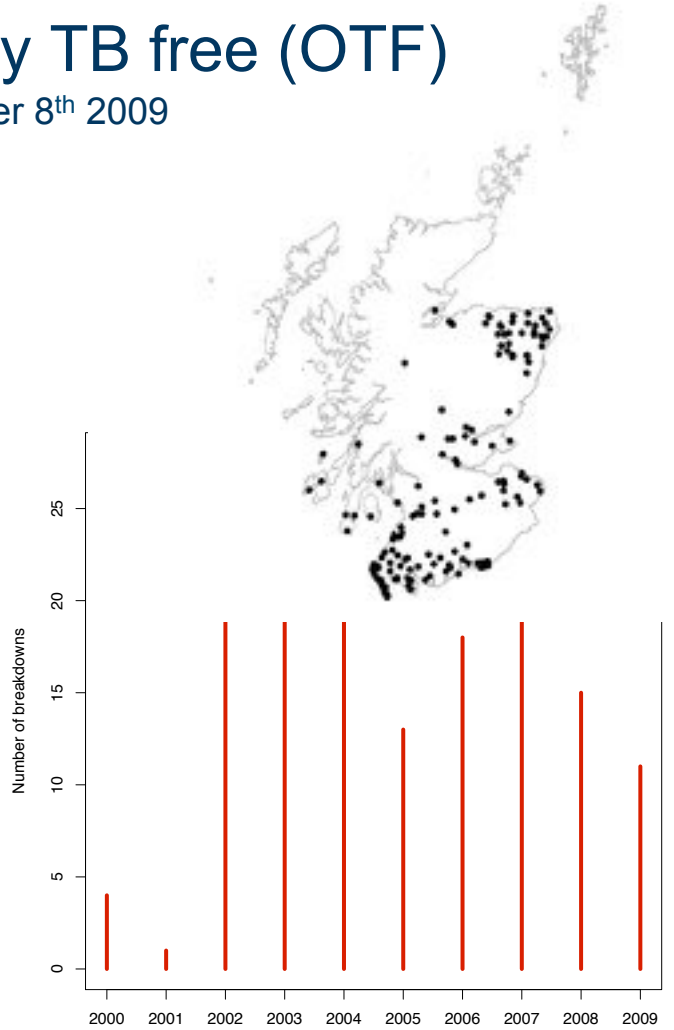
Background to this project

Scotland is Officially TB free (OTF)

Since September 8th 2009

- Despite being at high risk, there are few breakdowns in Scotland.
- There is little spread within Scotland – most disease is introduced.
- Scotland continues to actively screen ~200,000 animals on ~2,700 herds each year under the RHT policy.



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Background to this project

The aim of this Scottish Government project is to evaluate risk based alternatives to RHT.

- Identify the risk of infection and the determinants of infection.
- Evaluate current surveillance strategies.
- Use information on risk of infection to develop refined strategies for surveillance.
- Evaluate alternative diagnostic tests.

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Risks of breakdown

Scotland specific model

Predictor	Unit	OR (95% CIs)	Z value	P
Intercept			3.948	<0.001
x-coordinate	x/100000	0.010 (0.003, 0.040)	-6.565	<0.001
y-coordinate	y/100000	0.094 (0.046, 0.191)	-6.536	<0.001
Herd type	Other	1		
	Fattening	2.127 (1.293, 3.501)	2.971	<0.001
Size	0 - 9	1		
	10 - 99	0.839 (0.367, 1.921)	-0.414	0.346
	>=100	3.445 (1.749, 6.784)	3.577	<0.001
Movements from HRAs	0	1		
	1 – 10	1.407 (0.883, 2.243)	1.436	0.145
	>10	4.203 (2.503, 7.058)	5.430	<0.001
Irish imports	No	1		
	Yes	6.248 (4.133, 9.445)	8.691	<0.001
x * y		1.851 (1.518, 2.258)	6.075	<0.001

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Risk factors in high risk areas are different to Scotland.

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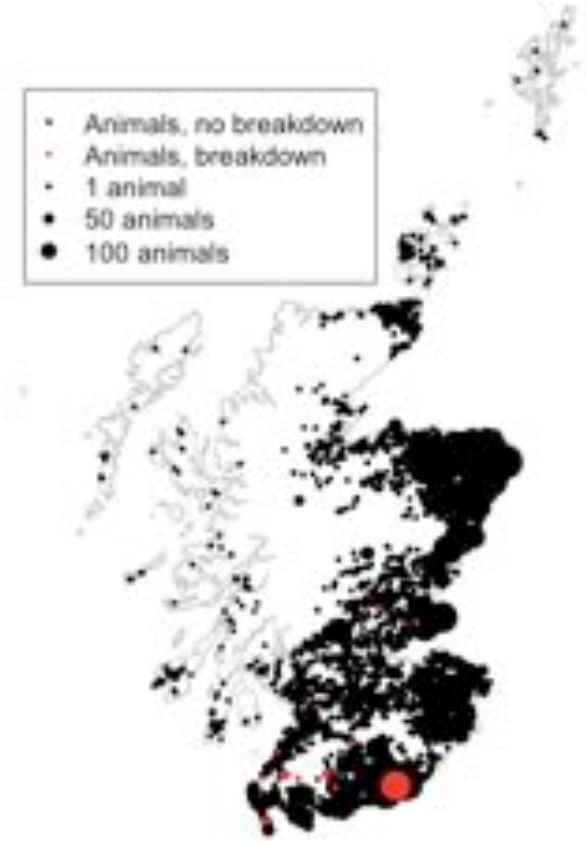
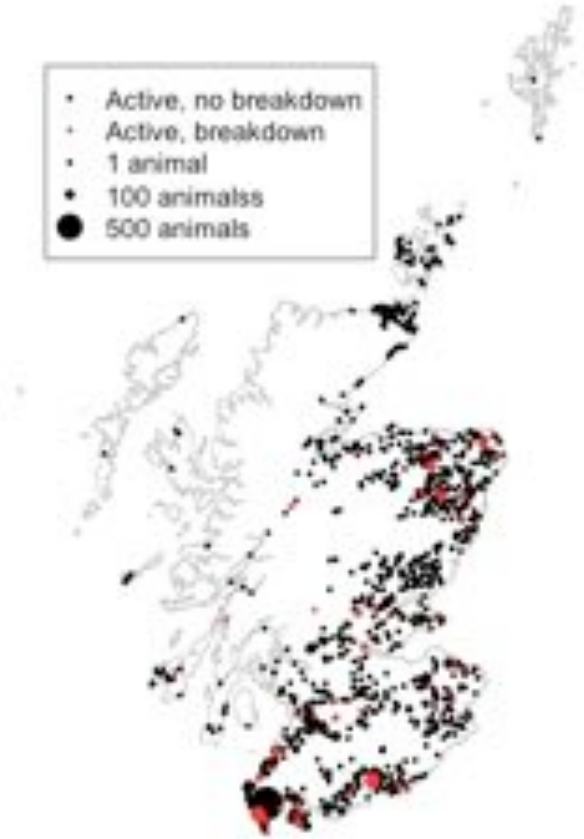
Risk of infection - high risk imports

Imports from HRAs



Imports from Ireland



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Methods for implementing RBS

Herd risk criteria

- Larger herds
- Herds importing animals from HRAs
- Herds slaughtering few animals
- Dairy

Testing frequency

- Four year
- Two years
- One year
- Never

Desired outcome

- Improved detection
- Maintain current levels
- Allow lower detection

Success metrics

- Detected breakdowns
- Undetected breakdowns
- Number of herds tested pa
- Number of cattle tested pa
- False positives (unconfirmed breakdowns)

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Surveillance model formulation

Based upon a model developed by the VLA to calculate herd level freedom from infection.

System sensitivity

$$se_{system} = 1 - (1 - se_1)(1 - se_2)(1 - se_n)$$

Herd sensitivity (Part herd)

$$se_{herd} = 1 - (1 - \frac{n \times se_{animal}}{N})^d$$

Herd sensitivity (Whole herd test)

$$se_{herd} = 1 - (1 - se_{animal})^d$$

$$sp_{herd} = sp_{animal}^{N}$$

$$d = N \times p_{star}$$

Next stage - Probability of infection (Adjusted prior)

$$prior_{t+1} = ((1 - p(free)) + p(Intro)) + (((1 - p(free)) * p(Intro))$$

Probability of freedom (posterior)

$$p(free) = \frac{1 - prior_t}{(1 - prior_t) + prior_t \times (1 - se_{system})}$$

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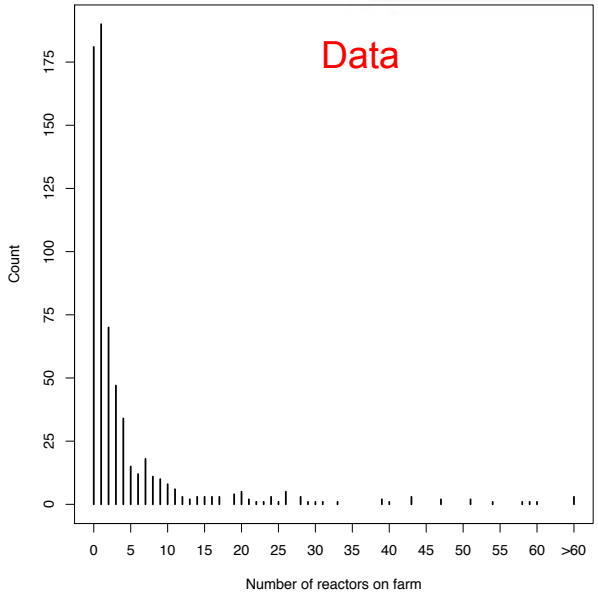
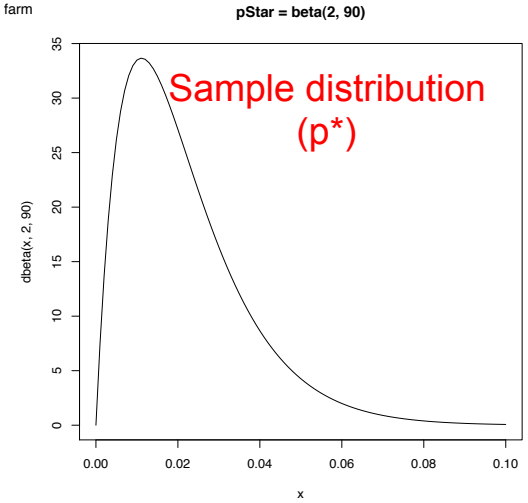
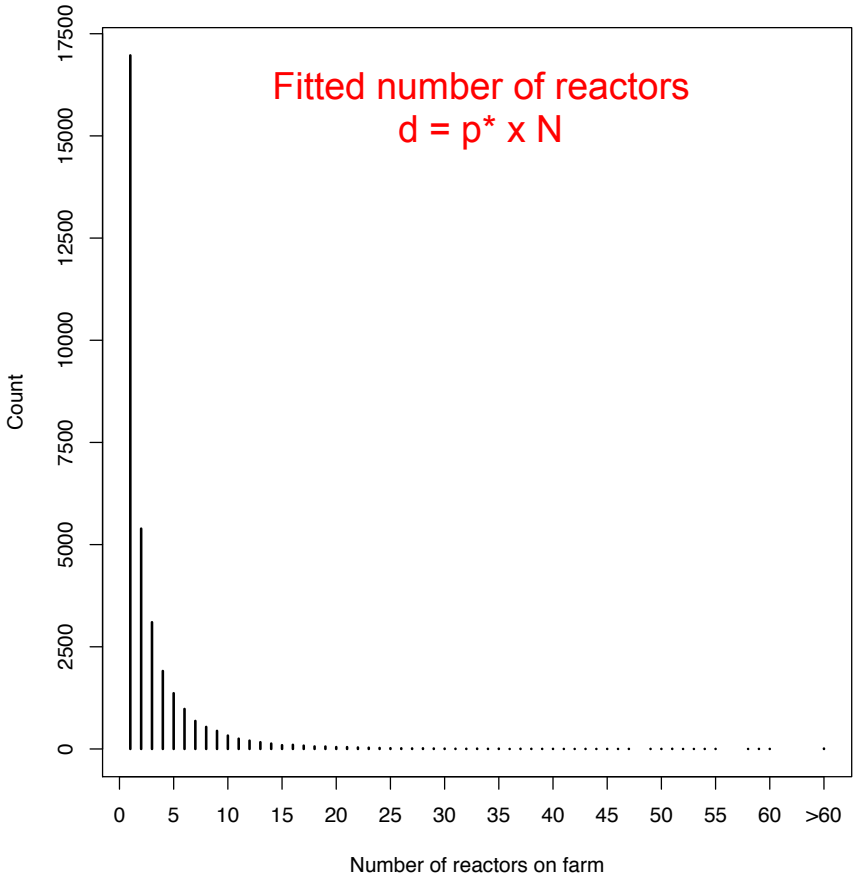
Herd prevalence (p*)







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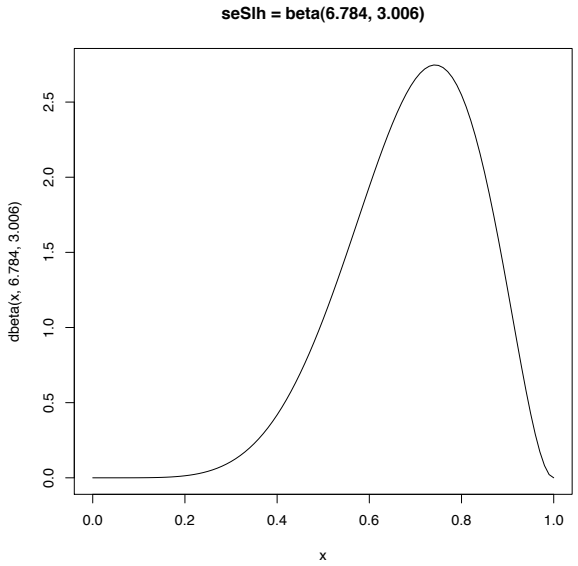
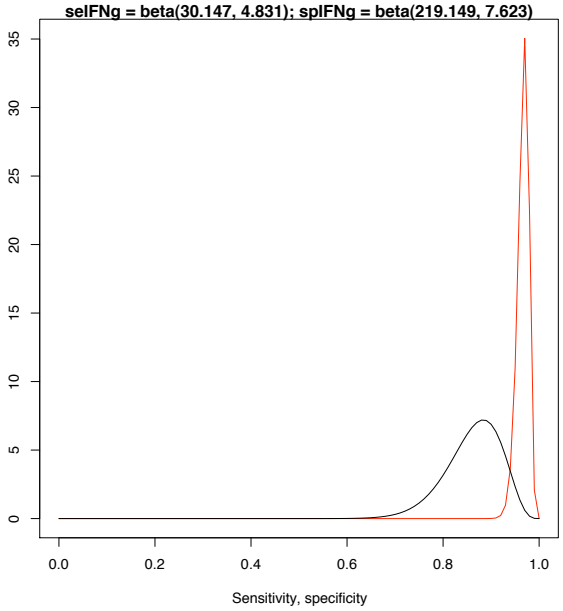
Diagnostic tests

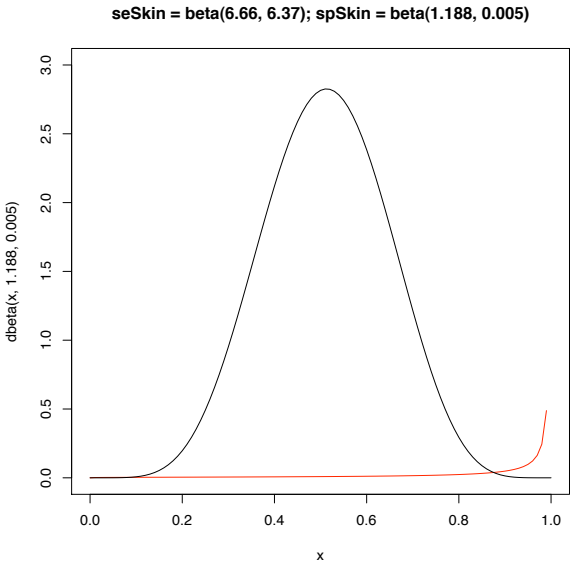
Meat inspection



Gamma-Interferon



SICCT (standard)



From AHVLA meta-analysis study team.

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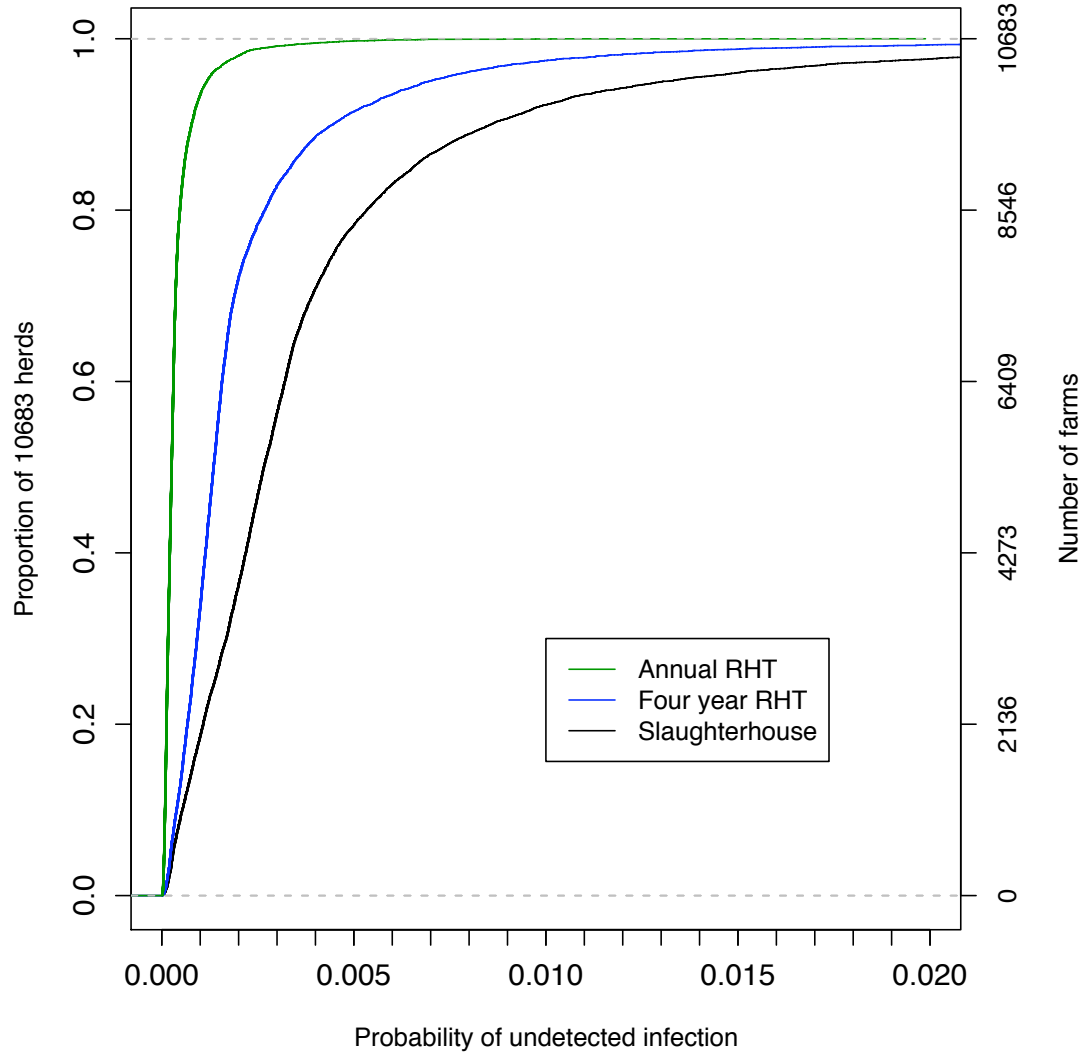
Results of baseline scenarios



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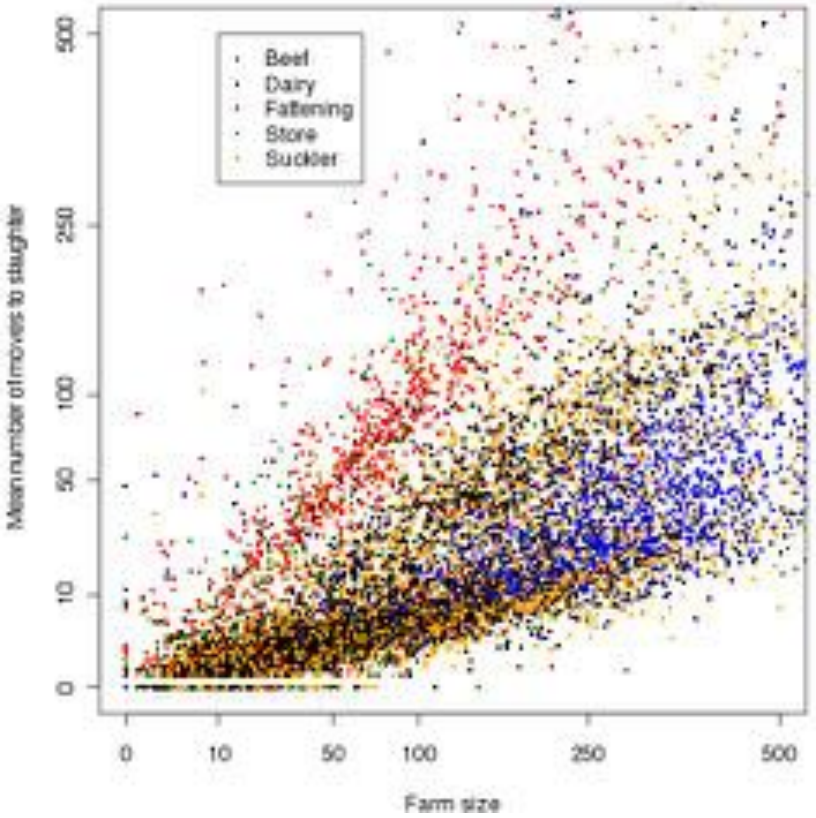
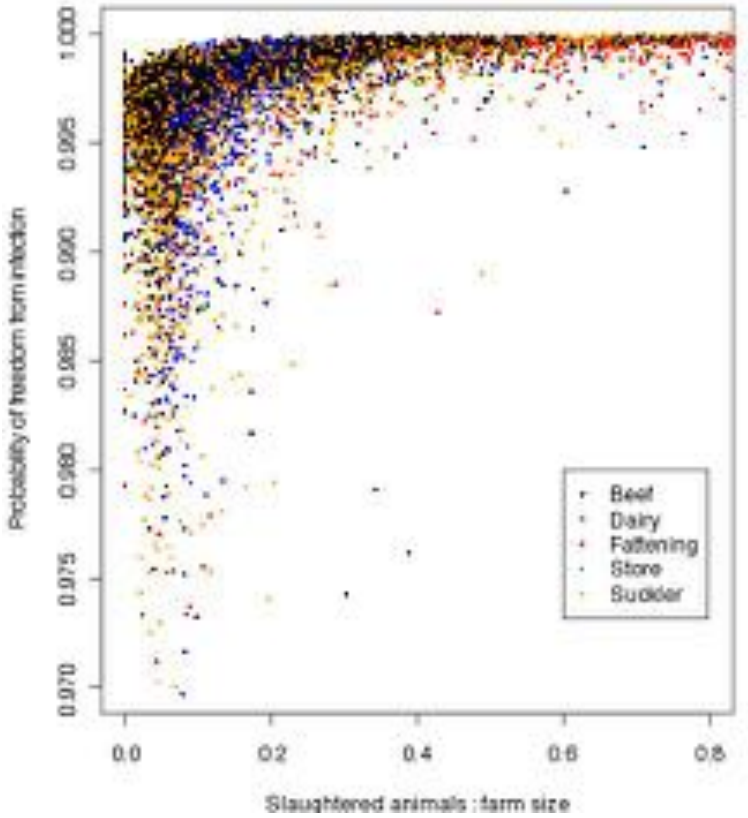
Slaughterhouse surveillance





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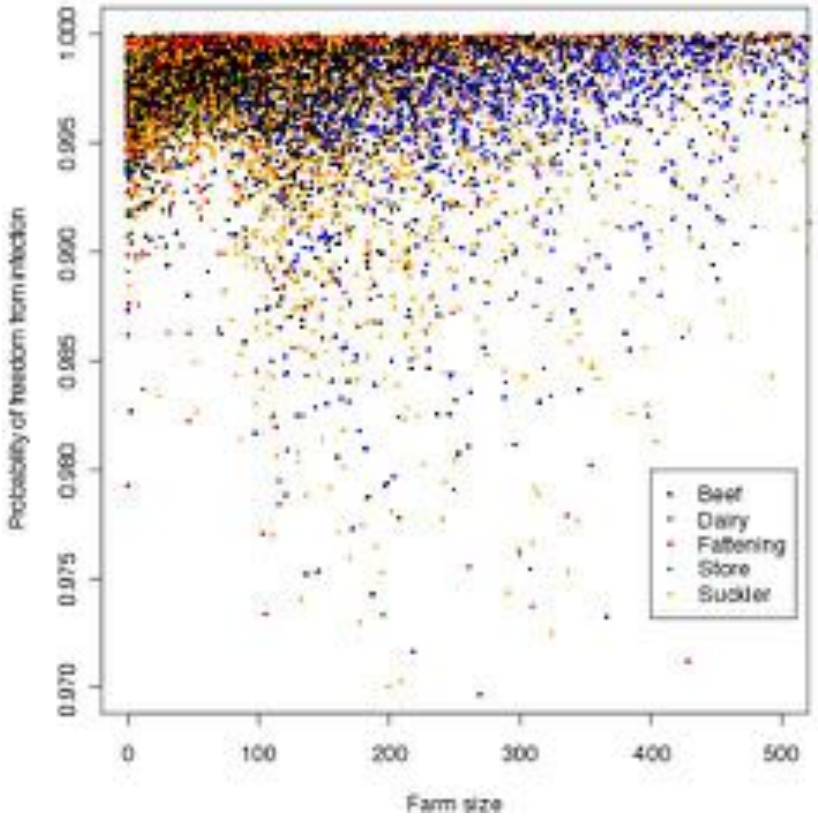
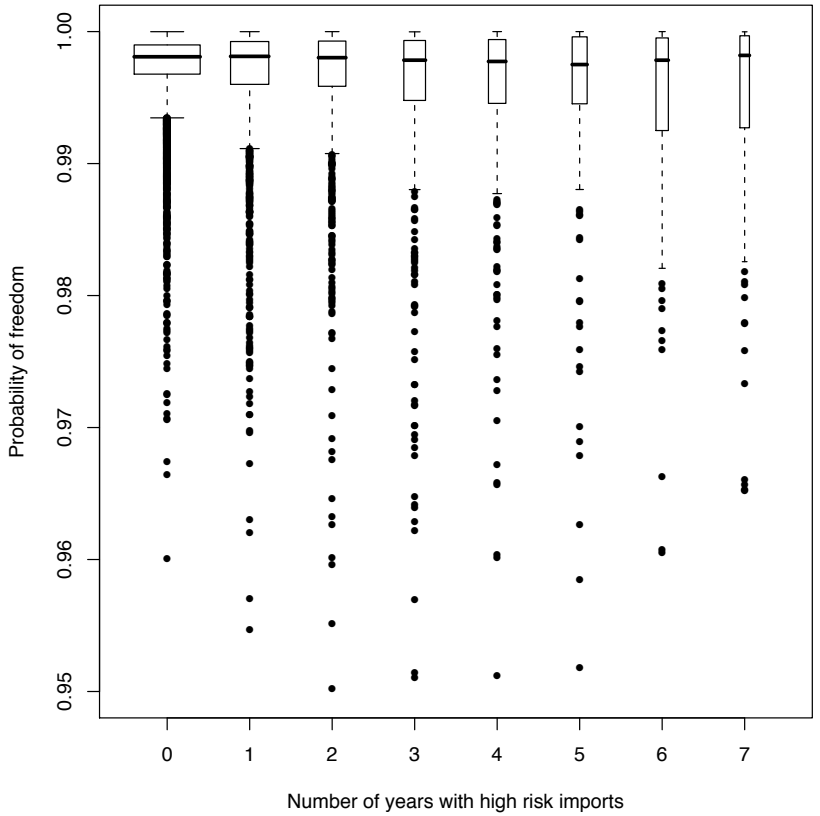
Farm size and imports





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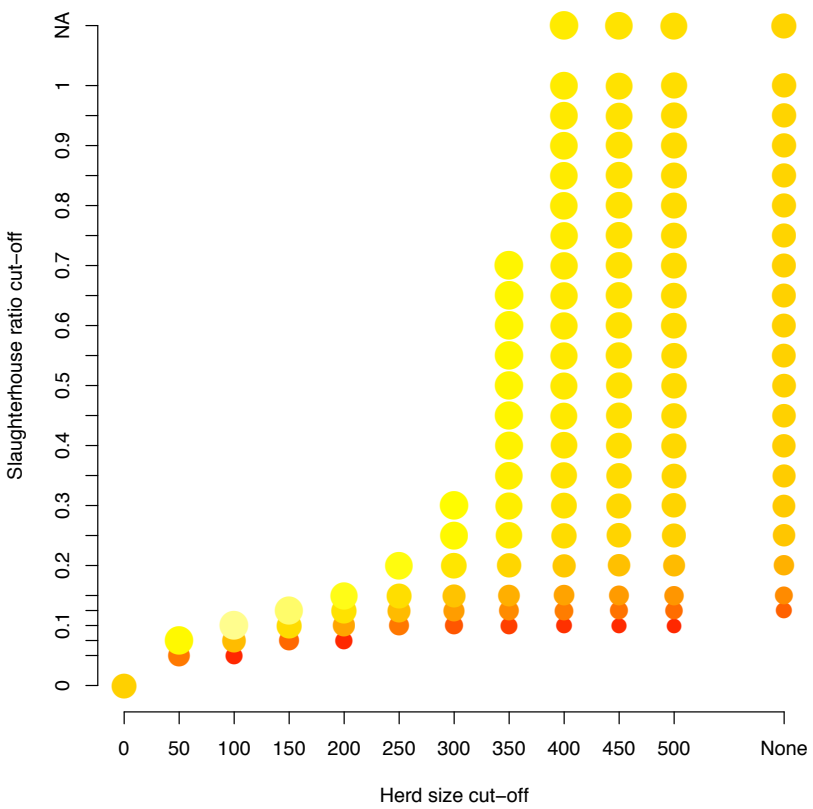
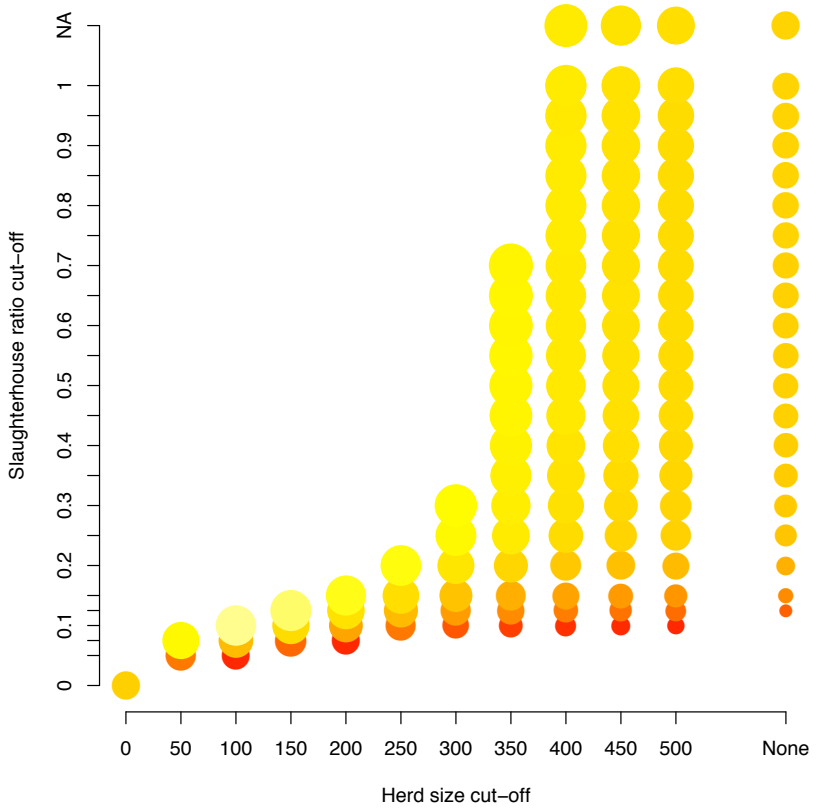
Matrix results

Number of herds tested



Number of animals tested



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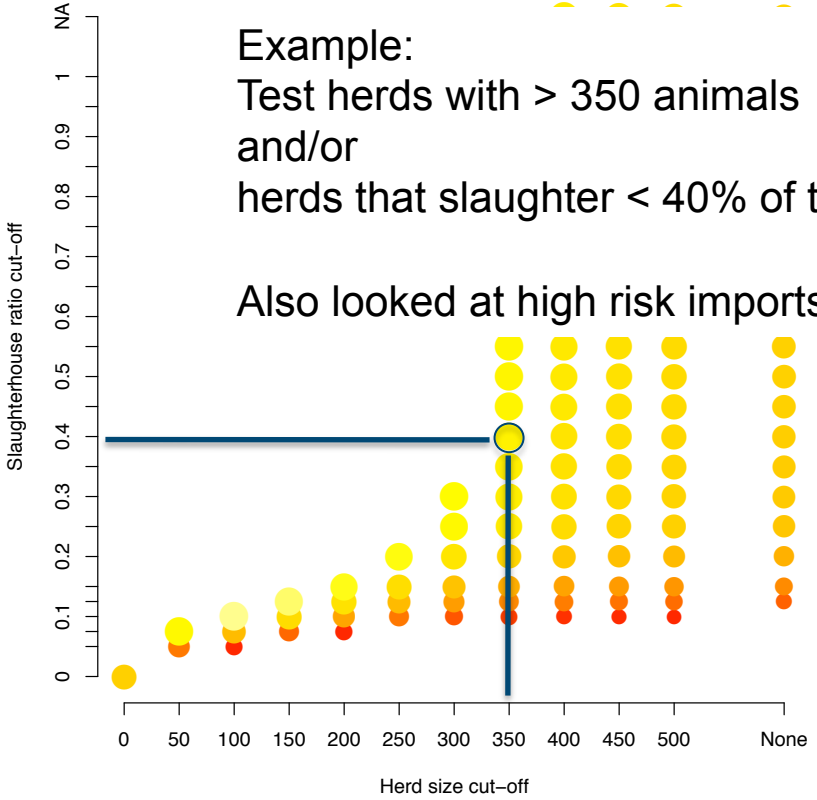
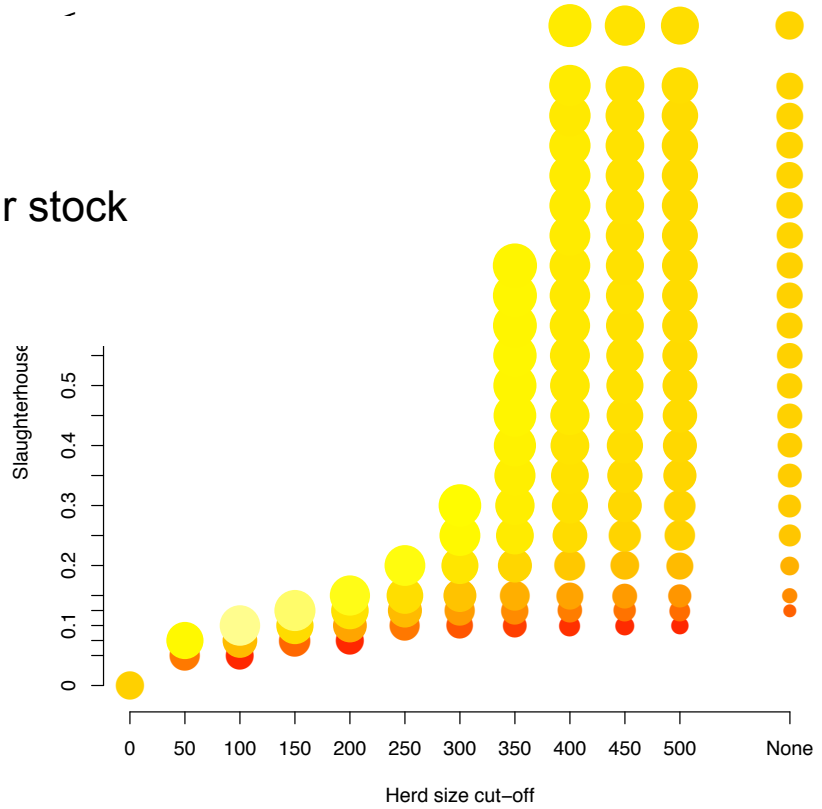


Example:
Test herds with > 350 animals
and/or
herds that slaughter < 40% of their stock

Also looked at high risk imports

Number of animals tested



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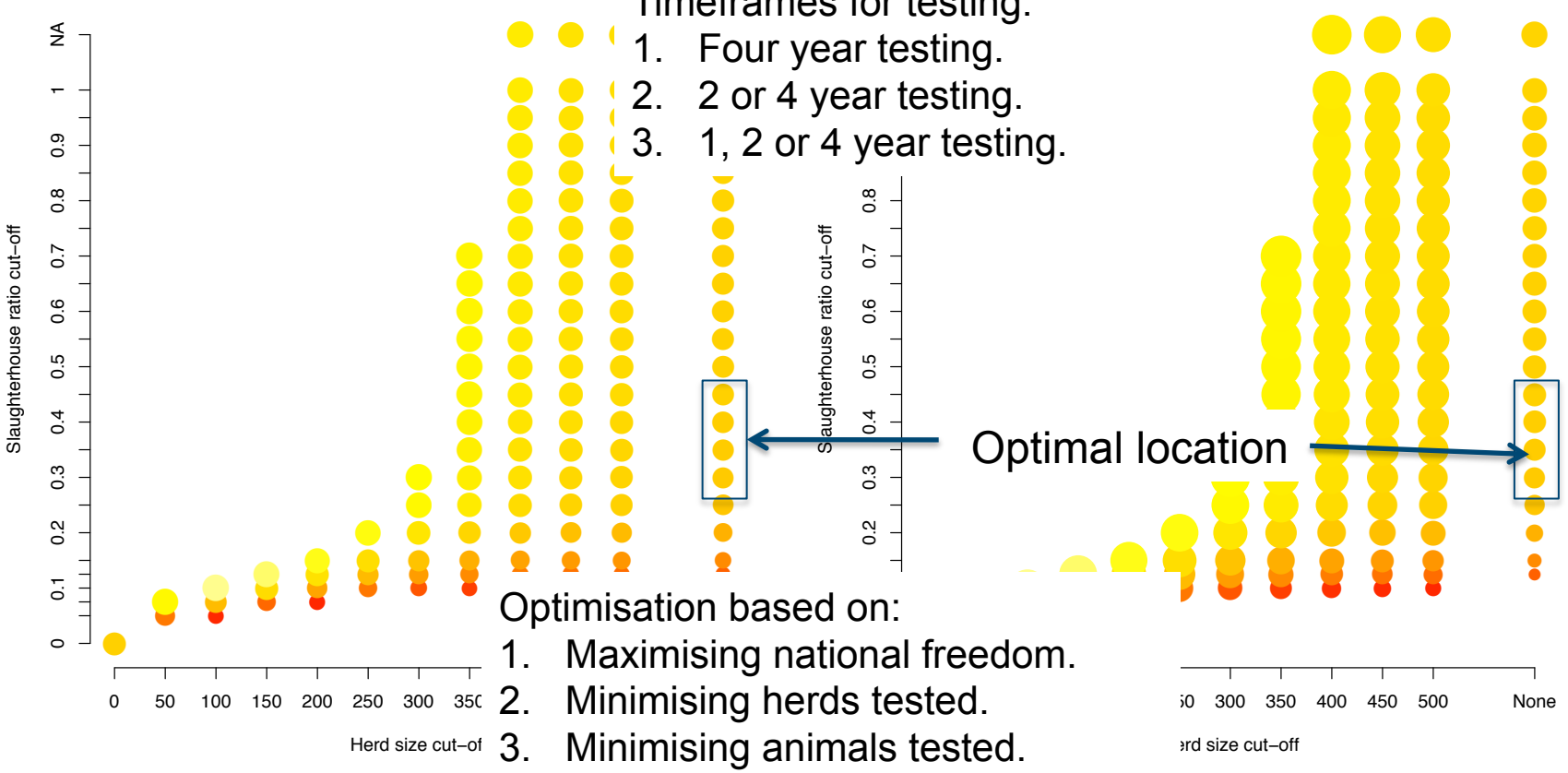
Matrix results

Herds

Animals

Timeframes for testing:

1. Four year testing.
2. 2 or 4 year testing.
3. 1, 2 or 4 year testing.



Optimisation based on:

1. Maximising national freedom.
2. Minimising herds tested.
3. Minimising animals tested.
4. Maximising breakdowns detected.

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Detailed breakdown

Criteria	Points	Testing interval by points score	No. of herds (%)	bTB (RHT)*
Improved				
Slaughtering <25% of stock	+1	0 points = no testing	2687 (22·9)	26 (1)
		1 point = 4 year testing	8052 (68·6)	52(26)
Receiving 'high risk' animals in >3 years and slaughtering <50% of stock	+1	2 points = 2 year testing	991 (8·4)	20 (9)
Similar				
Slaughtering <25% of stock and/or receiving 'high risk' animals in >3 years and slaughtering <40% of stock	1	0 points = no testing	2788 (23·8)	29 (1)
		1 point = 4 year testing	8942 (76·2)	69 (35)
Lower detection 1				
Slaughtering <12·5% of stock and/or receiving 'high risk' animals in >3 years and slaughtering <25% of stock	1	0 points = no testing	4658 (39·7)	55 (15)
		1 point = 4 year testing	7072 (60·3)	43 (21)
Lower detection 2				
Slaughtering >25% of stock	−1	−1 or 0 points = no testing	4971 (42·4)	19 (3)
Slaughtering <5% of stock	+1	1 point = 4 year testing	5340 (45·5)	58 (22)
Receiving 'high risk' animals in >3 years	+1	2 points = 2 year testing	1288 (11·0)	20 (11)
Having >100 animals	+1	3 points = annual testing	131 (1·1)	1 (0)

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All results

Surveillance scenario	Interval (years)	Herds tested p.a.	Cattle tested p.a.	Fitted no. of detected infections, total	Latent infections		False positives 2008
					2008	Mean	
Baseline scenarios							
Slaughterhouse only	n.a.	0	0	76·25	43·60	33·78	0
Current	**4**	**2933**	**439 292**	**95·08**	**19·00**	**16·96**	**64·27**
Maximum	1	11730	1 757 168	104·39	2·81	2·69	255·19
Risk-based surveillance							
Better	2/4	2509	388 812	96·59	17·62	16·03	56·03
Similar	4	2236	317 108	94·53	19·74	17·51	48·69
Lower detection 1	4	1768	209 425	92·81	21·71	18·86	37·37
Lower detection 2	1/2/4	2110	441 823	95·17	19·56	17·30	53·86
Interferon-gamma test							
Current	4	2933	439 292	97·70	13·85	12·62	2137

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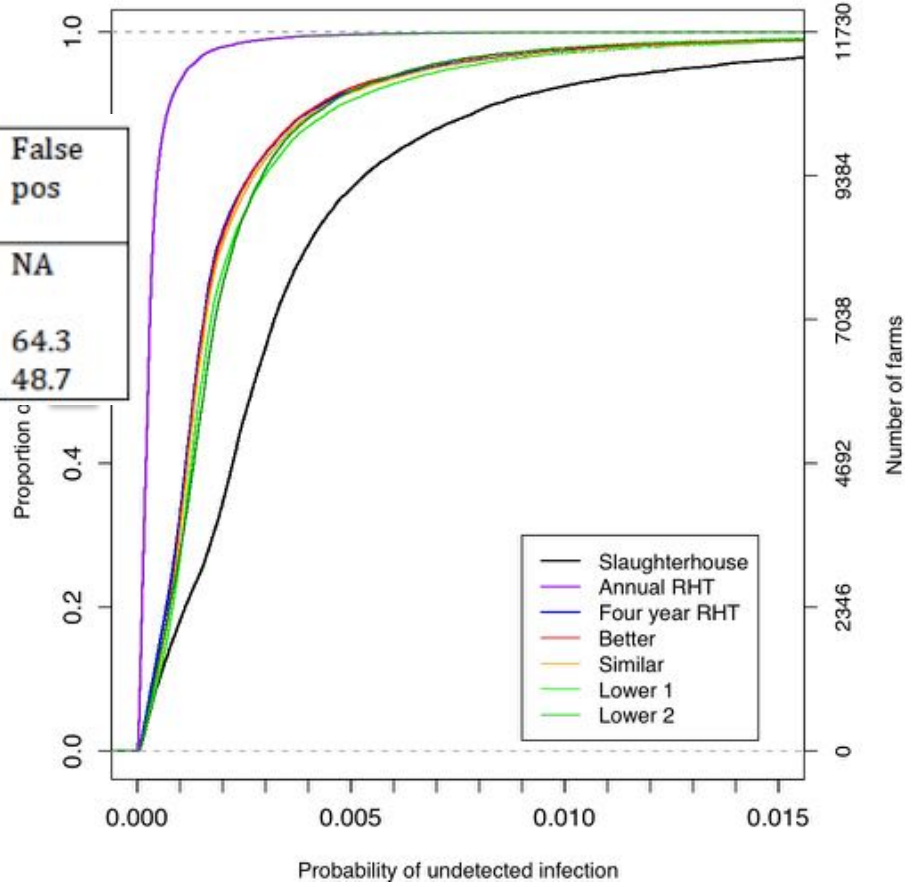
Selected scenarios

Developed “Improved”, “Similar” and “lower detection scenarios”.

Surveillance scenario	Interval	Herds tested pa	Cattle tested pa	Latent infections	False pos
Slaughterhouse only	NA	NA	NA	33.8	NA
Current	4 yr	2,933	439,292	17.0	64.3
Similar	4 yr	2,236	317,108	17.5	48.7

“Similar” strategy tests:
Herds that slaughter <25% of their stock and/or regularly import high risk animals.

Herds that slaughter >40% of stock are exempt.



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Summary

- Risk of infection with bTB in Scotland depends largely on imports.
- Slaughterhouse surveillance alone is insufficient to maintain freedom from disease.
- Current 4 year RHT is effective at maintaining disease freedom.
- By testing holdings according to herd size, number of animals slaughtered and sourcing of animals surveillance can be reduced.
- Based upon a simple system that could be applied elsewhere and to other diseases.
- The final report is being considered with great interest by Scottish Government, DEFRA and EFSA.

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Acknowledgements

Co-authors

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Richard Orton
Anthony O'Hare
David Logue
Dominic Mellor

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