Canadian Food Inspection Agency | Agence canadienne d'inspection des aliments

Canadian Food Inspection Agency




Our vision:
To excel as a science-based regulator, trusted and respected by Canadians and the international community.

Our mission:
Dedicated to safeguarding food, animals and plants, which enhances the health and well-being of Canada's people, environment and economy.

Estimating diagnostic sensitivity and specificity using the published literature - a terrestrial animal disease example - bovine brucellosis

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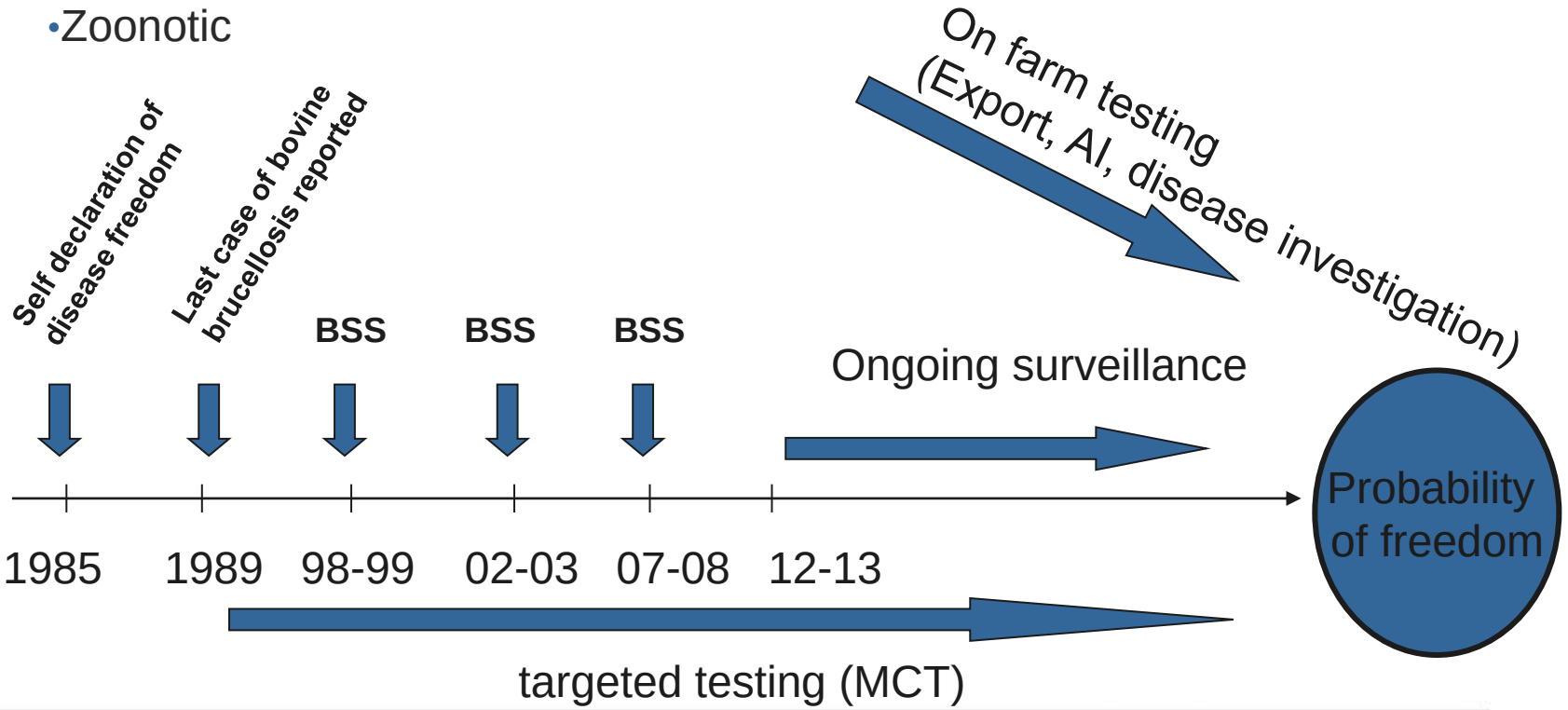
Bovine brucellosis

- Brucellosis (*Brucella abortus*)
- Reportable disease
- Abortion is major clinical sign
- Infected animals remain carriers for life
- Zoonotic



Objective

Critically review the literature to extract data pertinent to the Canadian cattle population for brucellosis serological tests (**BPAT**, FPA, cELISA, TAT, CF) and estimate test sensitivity to be used in Scenario Tree modeling.

Material and methods

- Started with a review of diagnostic tests by Gall and Nielsen, 2004
- Systematic literature search in PubMed using search terms :

  "*Test name* (*eg.* buffered plate agglutination test)" AND "Brucella" AND "sensitivity" AND "cattle" AND publication date ≥ 2002
- Recorded:
  - Reported **Se**, **N** of true positive, **criteria** for true positive
  - Reported **Sp**, **N** of true negative, **criteria** for true negative
  - Analytical approach (Bayesian or traditional)
  - Test protocol details
  - History of vaccination
  - Other species tested

Material and methods

Statistics:

- Data from the articles were compiled and a beta distribution was calculated for each study.
- 2.5th, 25th, 50th, 75th and 97.5th percentiles were calculated
- Summary estimates were **weighted** on the number of animals used to calculate sensitivity in each article.
- Graphical representation of the estimates, as well as the overall estimated low, most likely and high estimate of sensitivity is presented.

Results

- Total of 15 articles on BPAT performance
- 12 articles reviewed
- 3 articles were rejected :

  (1) data was the same as reported in another article

  (2) article was not clear on vaccinal status of animals tested*

  (3) protocol specifications were different from standard

*Because vaccination has been prohibited in Canada since 2000, for the analysis, all vaccinated cattle were excluded and if necessary sensitivity and specificity were recomputed using only non-vaccinated animals.

Data extraction - BPAT

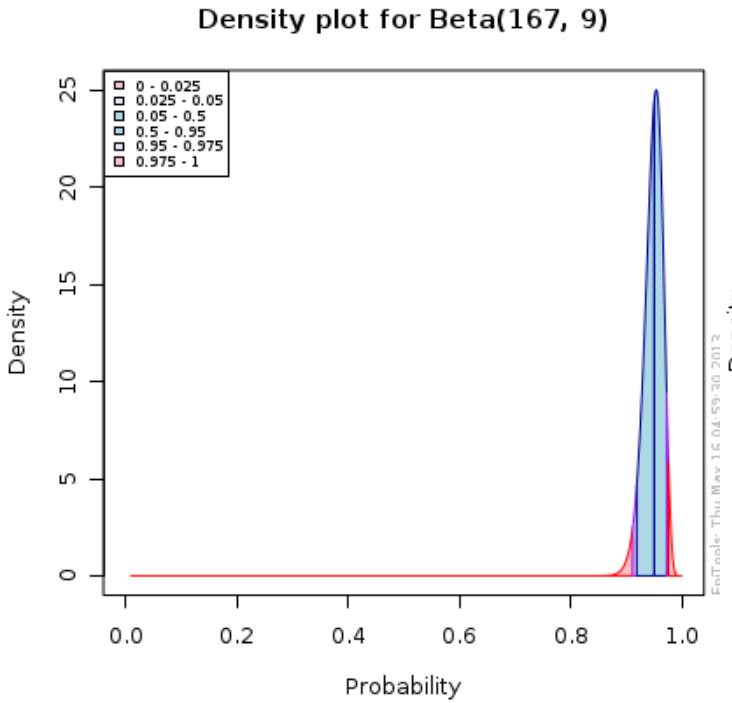
#	Reference	Sensitivity	N / TP	Specificity	n / TN	Protocol details
9	Dohoo *et al.* 1986	95,4% (95%CI: 91,0-98,0%)	n=174 culture +	98,7% (95%CI: 97,7-99,2%)	n=1208 Canadian certified free herds based on annual serology	•Standard protocol •Presence of partial or complete agglutination considered positive
10	Fosgate *et al.* 2002	88,1% (95%CI: 76,2-95,6%)	n=25 estimate	98,1% (95%CI: 96,4-99,3%)	n= 366 estimate	•Bayesian analysis •Total of 391 cattle • Not vaccinated •Trinidad • USDA 2002 protocol •Also bison

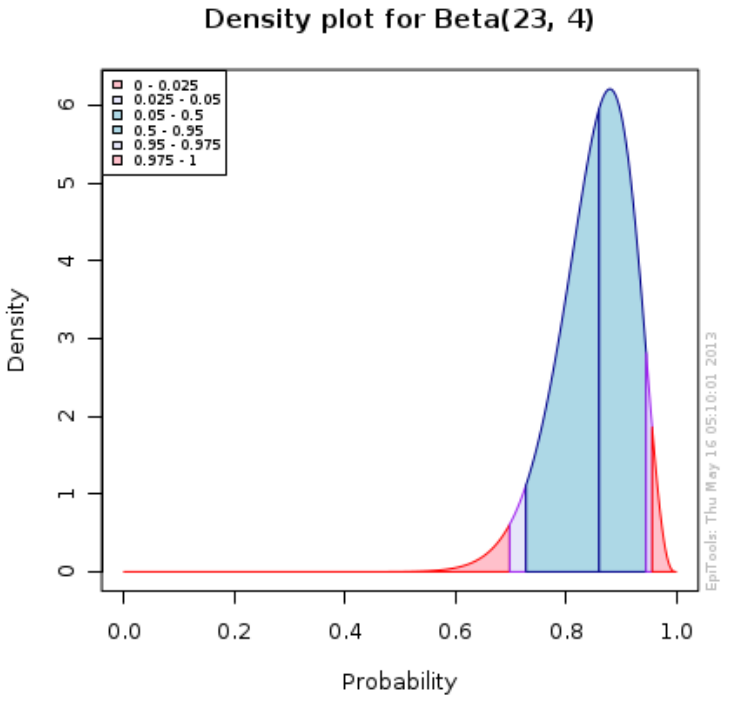
Distribution for sensitivity estimate for each article & weighted average

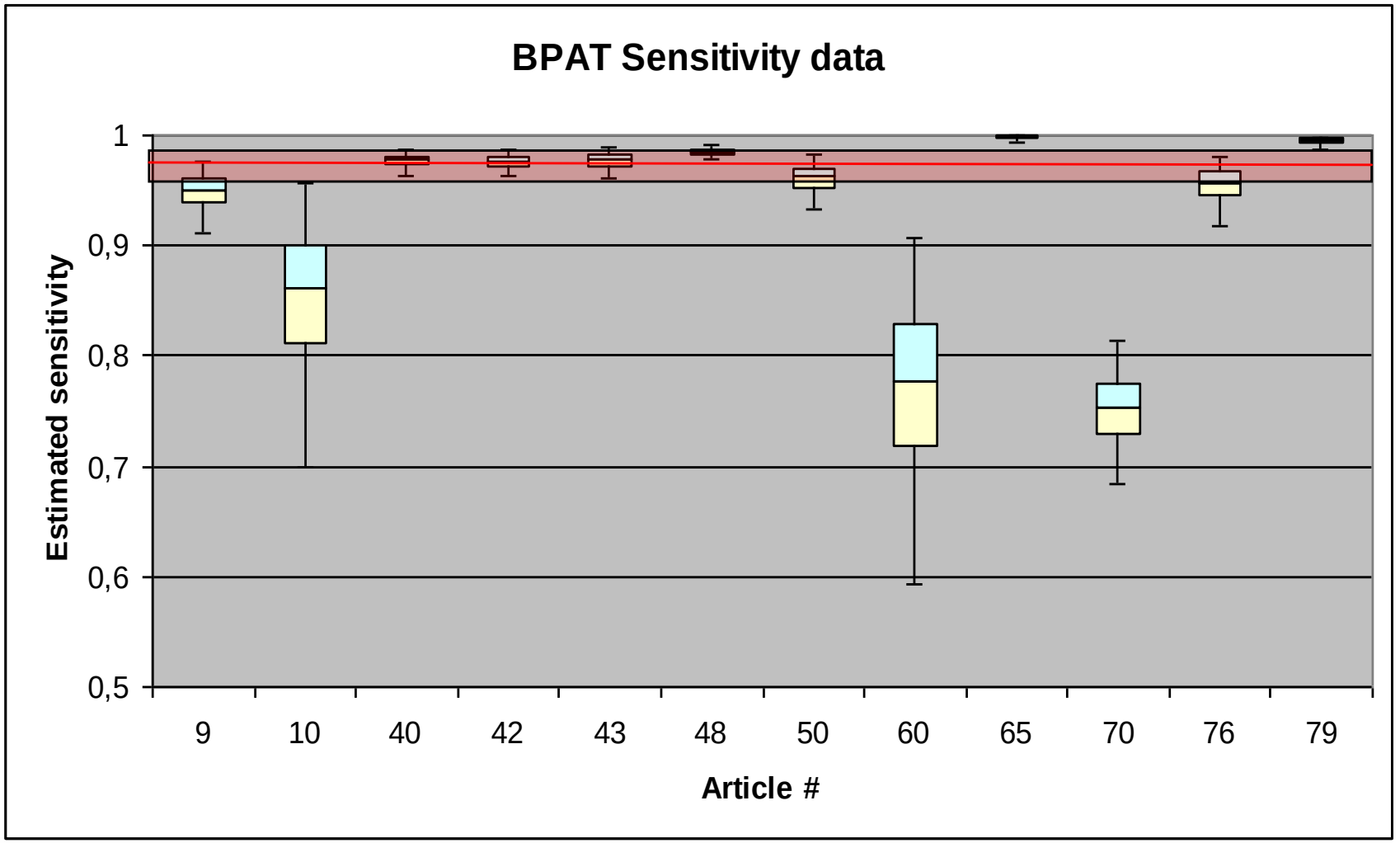
Article	Standard	Se	n tested	n positive	Alpha value	Beta value	2.5% percentile	5% percentile	25% percentile	50% percentile	75% percentile	95% percentile	97.5% percentile	Mean	Mode	Standard deviation
9	culture	95,40%	174	166	167	9	0,9119	0,919	0,9388	0,9506	0,9608	0,9729	0,9762	0,9489	0,954	0,0166
10	bayesian	88,00%	25	22	23	4	0,6985	0,7281	0,8114	0,8606	0,9015	0,9457	0,9564	0,8519	0,88	0,0671
40	culture	97,87%	609	596	597	14	0,9638	0,9663	0,9733	0,9776	0,9814	0,9861	0,9874	0,9771	0,9787	0,006
42	culture	97,80%	636	622	623	15	0,9634	0,9659	0,9728	0,977	0,9808	0,9854	0,9868	0,9765	0,978	0,006
43	culture	97,88%	424	415	416	10	0,9602	0,9633	0,9721	0,9773	0,9818	0,9872	0,9887	0,9765	0,9788	0,0073
48	culture	98,62%	1084	1069	1070	16	0,9773	0,9788	0,983	0,9856	0,9879	0,9907	0,9915	0,9853	0,9862	0,0037
50	serology	96,49%	228	220	221	9	0,9323	0,9379	0,9531	0,9622	0,9701	0,9793	0,9819	0,9609	0,9649	0,0128
60	culture	79,17%	24	19	20	6	0,593	0,6246	0,7176	0,7762	0,8283	0,8899	0,9064	0,7692	0,7917	0,0811
65	serology	99,90%	1000	999	1000	2	0,9944	0,9953	0,9973	0,9983	0,999	0,9996	0,9998	0,998	0,999	0,0014
70	culture	75,45%	167	126	127	42	0,6838	0,6953	0,7296	0,7525	0,7744	0,8043	0,8135	0,7515	0,7545	0,0331
76	serology	96,08%	153	147	148	7	0,9171	0,9246	0,9449	0,9568	0,9669	0,9785	0,9815	0,9548	0,9608	0,0166
79	serology	99,64%	562	560	561	3	0,9872	0,9889	0,993	0,9953	0,9969	0,9985	0,9989	0,9947	0,9964	0,0031
	Summary		5086	4961			0,9581	0,9610		0,9741		0,9835	0,9850	0,9734	0,9754	0,0069

=(0.9119*174/5086)+…

Article	Standard	Se	n tested	n positive	Alpha value	Beta value
9	culture	95,40%	174	166	167	9
10	bayesian	88,00%	25	22	23	4



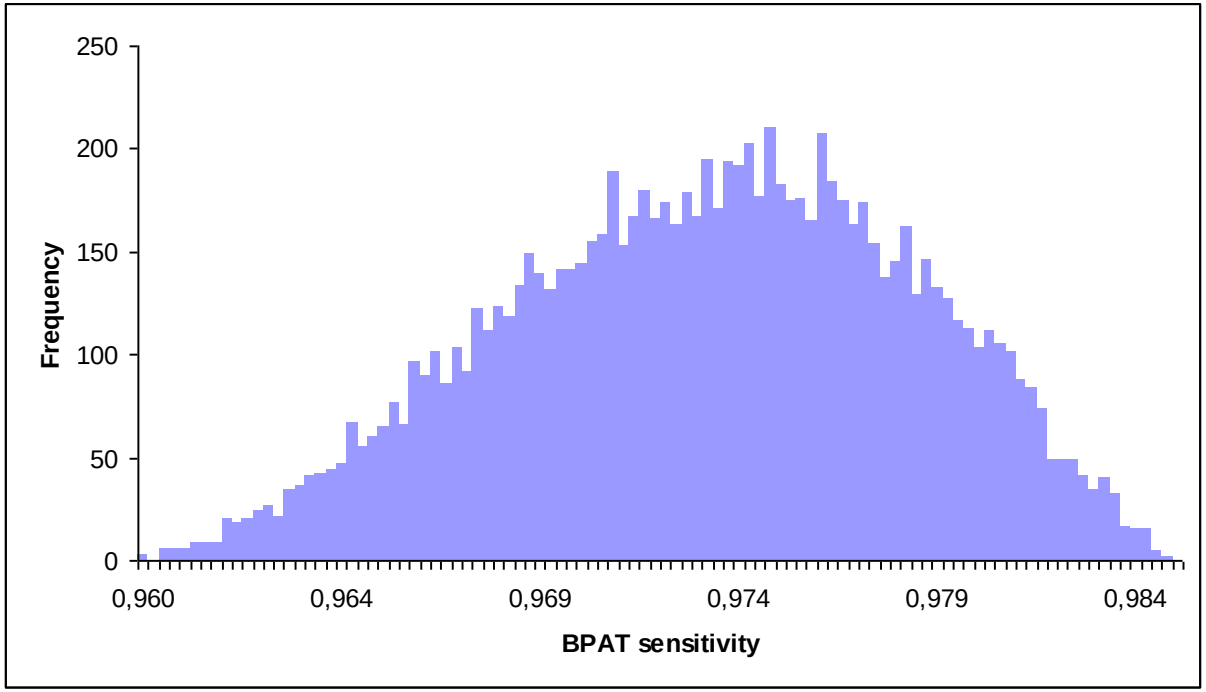



BPAT Sensitivity data
Estimated sensitivity
1
0,9
0,8
0,7
0,6
0,5
9
10
40
42
43
48
50
60
65
70
76
79
Article #

Summary Se for BPAT

Pert distribution: (0.96, 0.97, 0.98)

- Minimum: 0.96
- Most Likely: 0.97
- Maximum: 0.98



Diagnostic Tests available – Estimating sensitivity

Test	Min	Most Likely	Max
TAT	0.69	0.76	0.81
CF	0.89	0.92	0.94
BPAT	0.96	0.97	0.98
FPA	0.93	0.95	0.97
cELISA	0.96	0.97	0.98

Conclusion

Method presented appeared to be appropriate for pooling multiple sensitivity estimates into one estimate.

Method provides data necessary to build a probability distribution that will account for uncertainty around the sensitivity point estimate, for use in scenario tree modeling.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