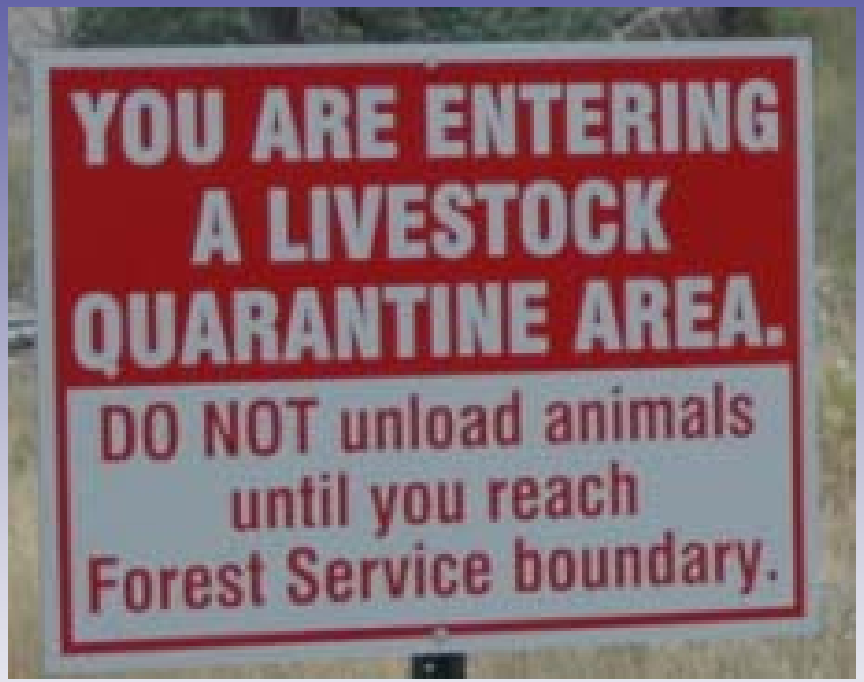
Modeling spatio-temporal, genetic, and environmental patterns of anthrax outbreaks in Texas and Montana



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Tuesday, 7 August 2012 (National Environmental Monitoring Conference)

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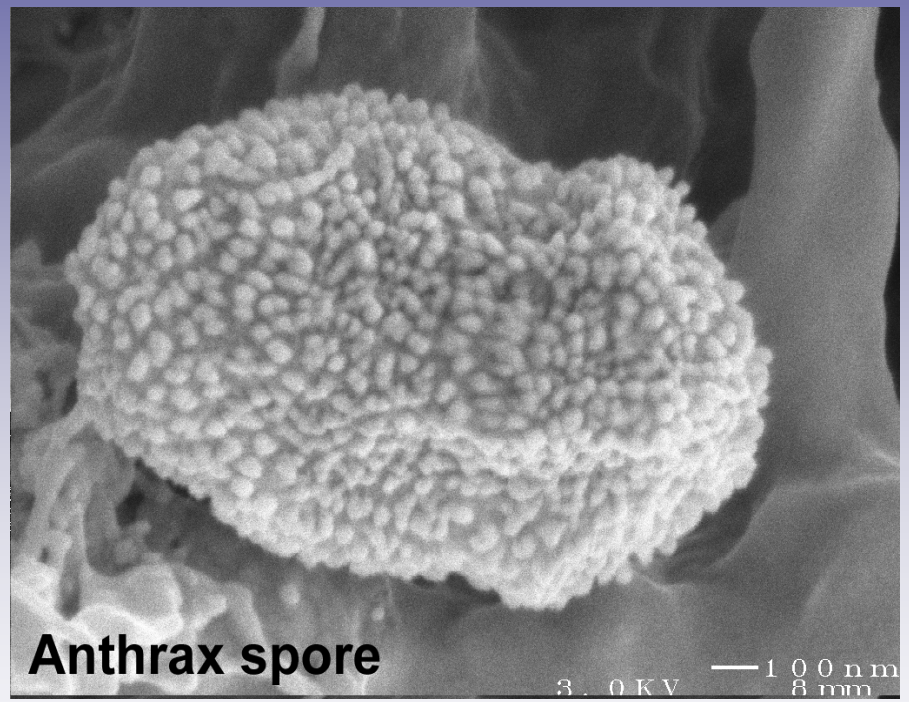
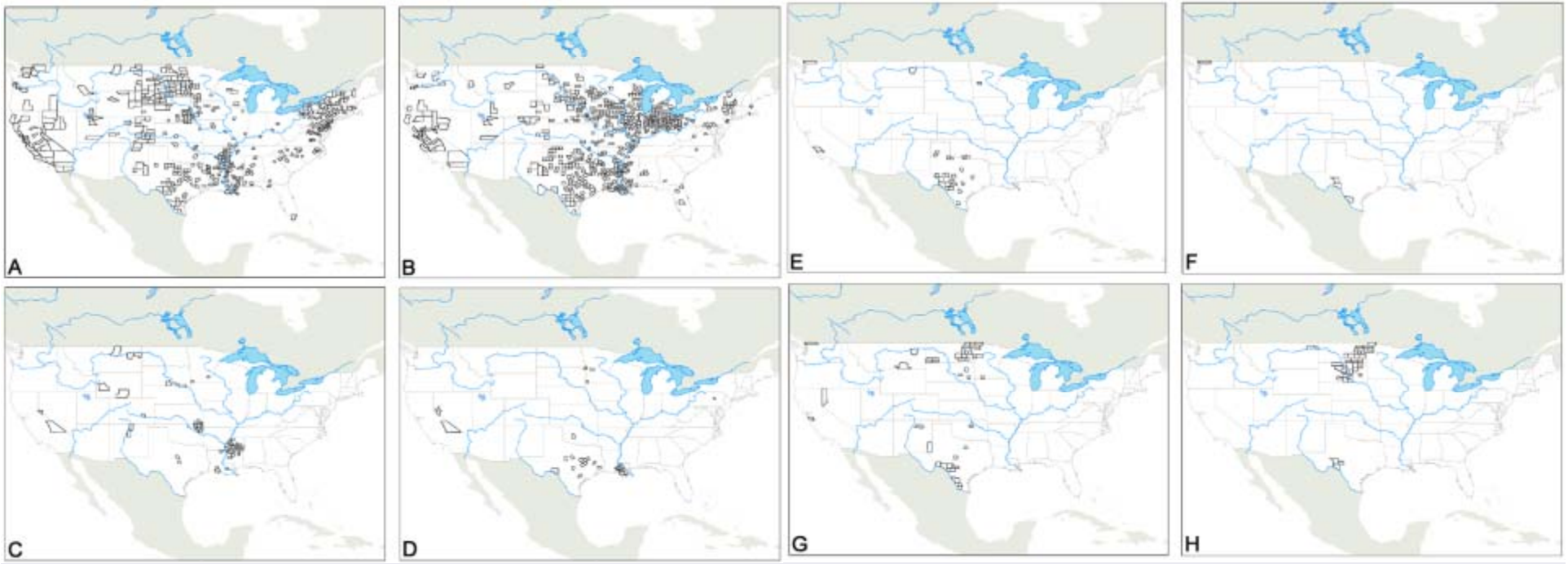
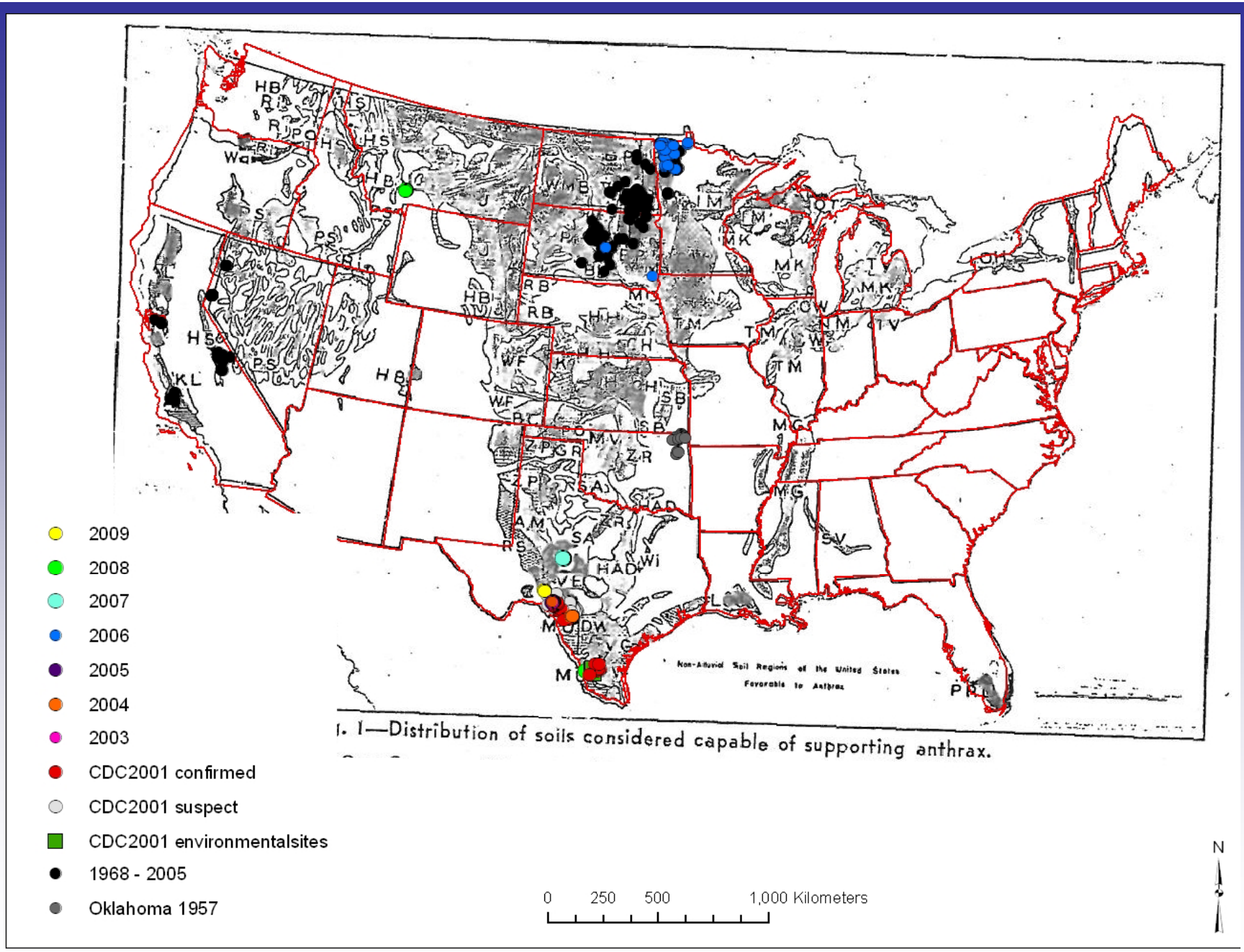
Two views of *Bacillus anthracis*



Spatial Epidemiology: Mapping Space-Time

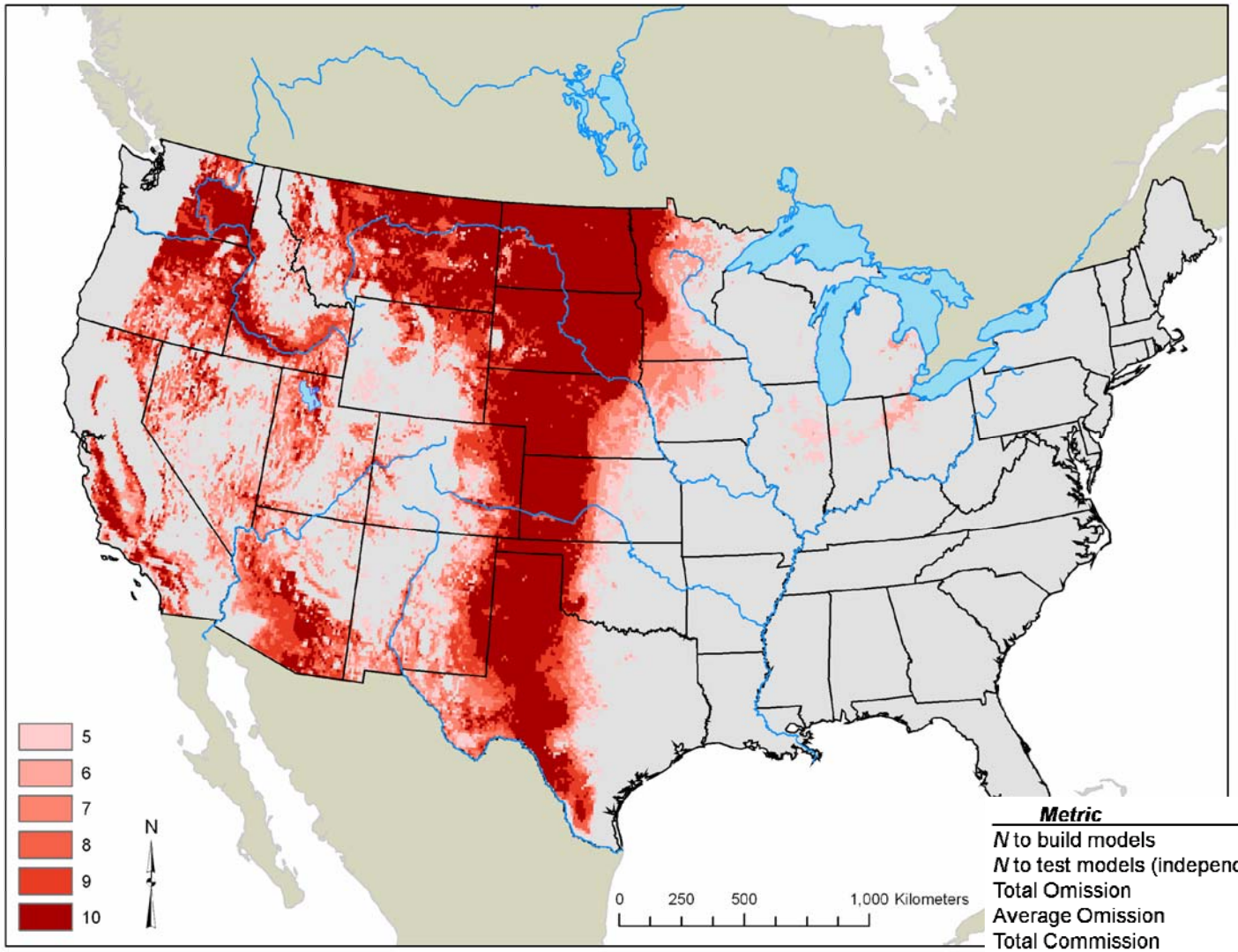


Blackburn (2006)



Base map from Van Ness and Stein 1956

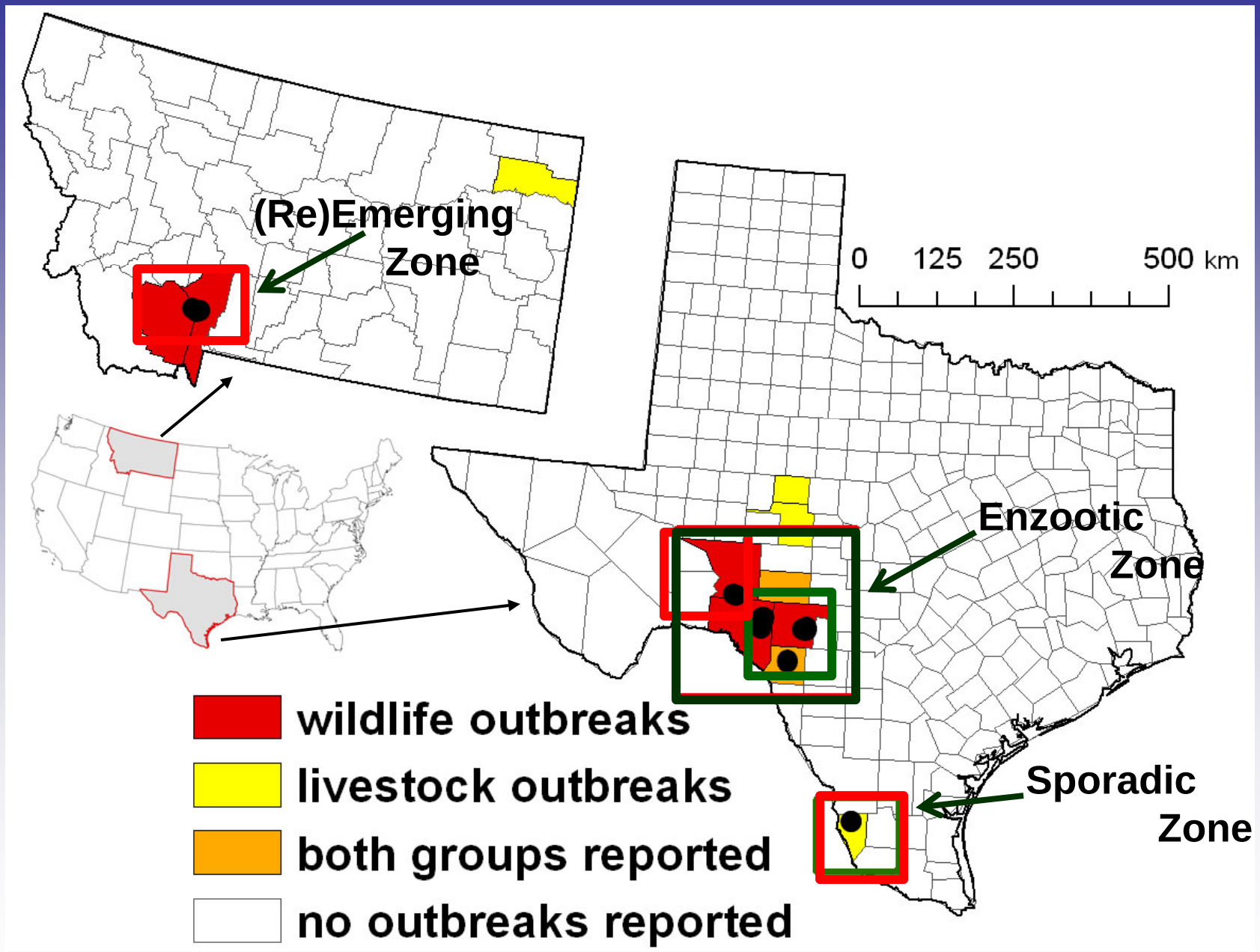
Predicted distribution of *B. anthracis*



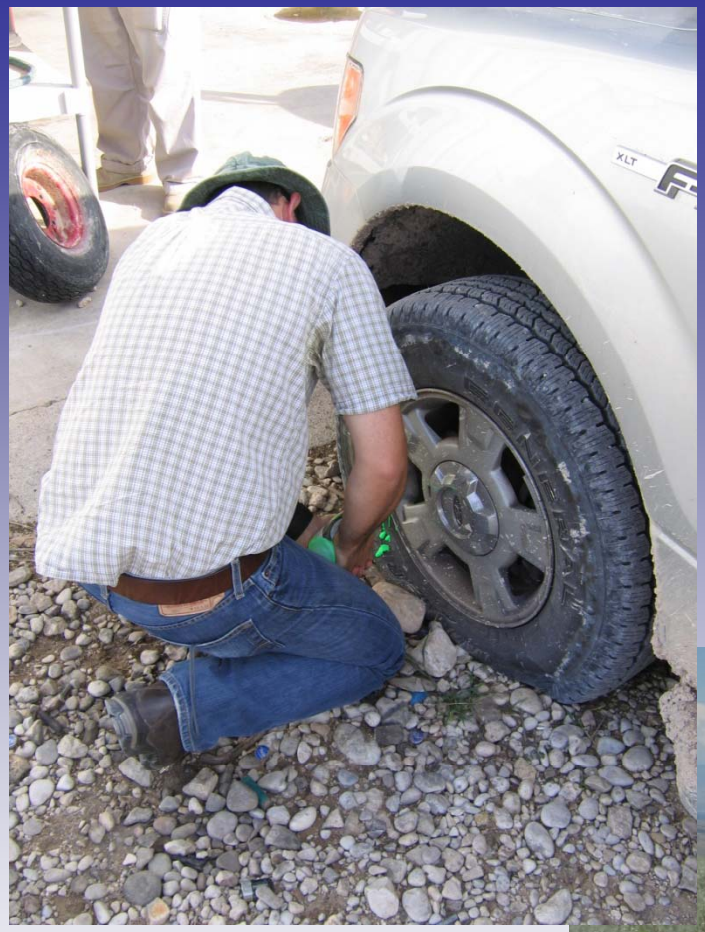
Metric	Model Specifications
N to build models	130†
N to test models (independent)	47
Total Omission	6.8%
Average Omission	23.2%
Total Commission	66.5%
Average Commission	41.6%
AUC	0.7916*‡

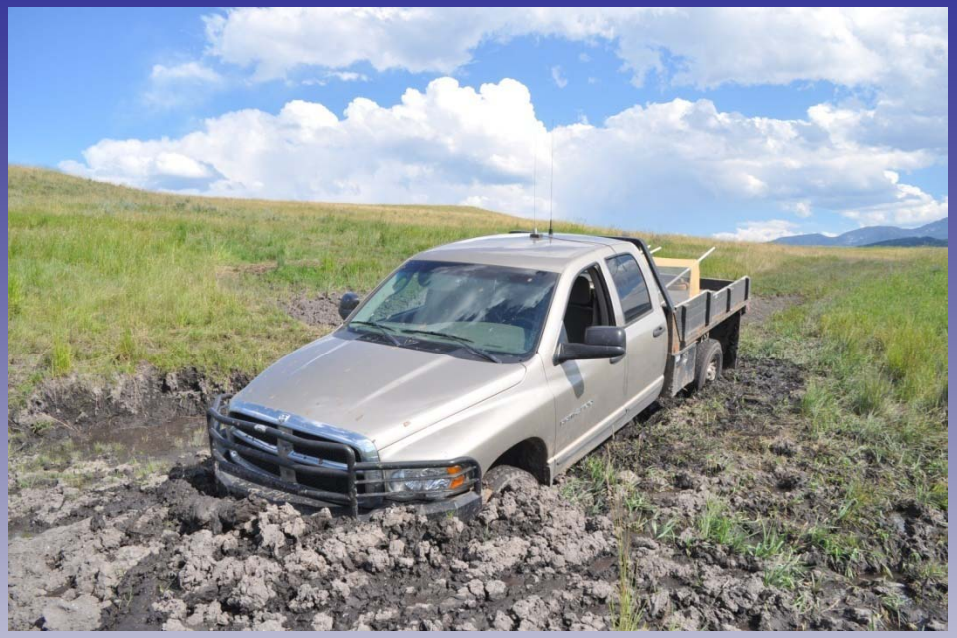
†*N* was divided into 50% training / 50% testing at each model iteration
*z=10.503 (p<0.01), ‡SE = 0.0394

Blackburn et al. (2007)



Blackburn et al. (In Prep.)





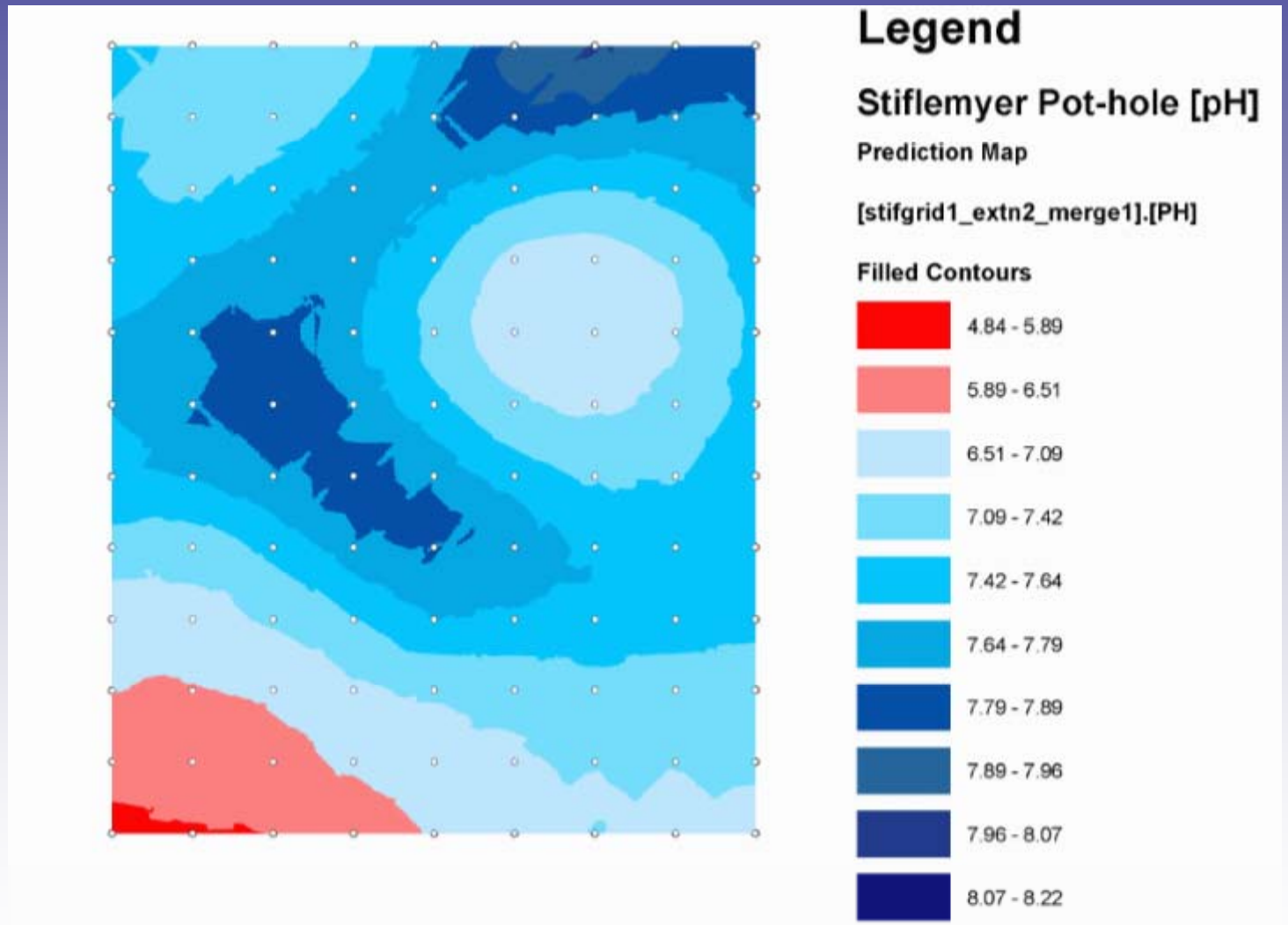

YAMAHA

Geography of the *Sporadic Zone*

Q: Are there landscape characteristics that differentiate the epizootiology of south and west Texas? Can we detect them?

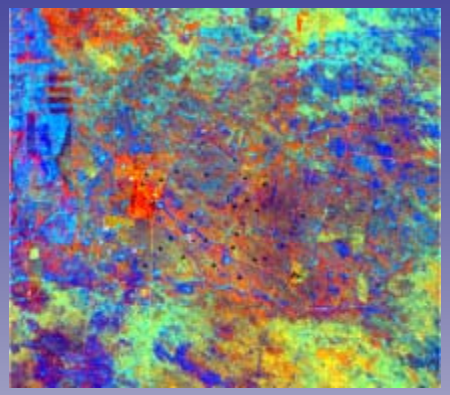
Photos: Deer © Jason Blackburn; Cows © M. Hugh-Jones

Mapping limiting factors to persistence



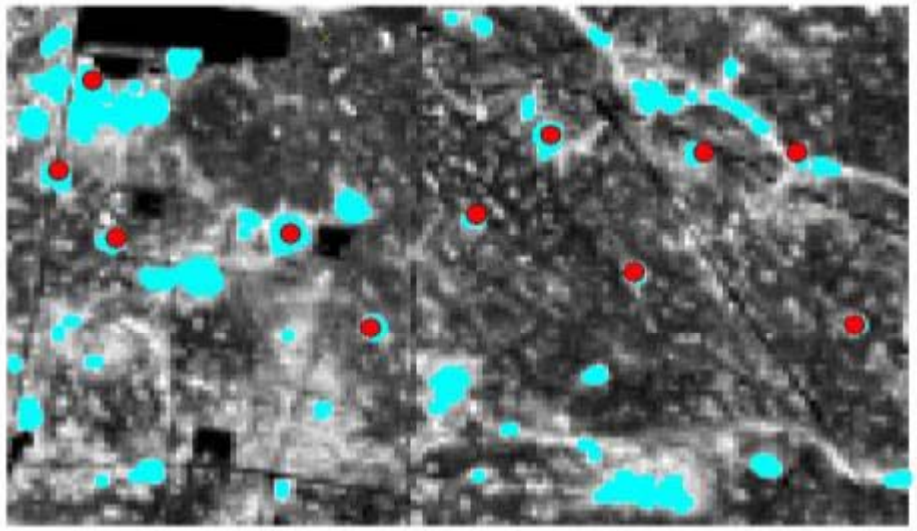
Blackburn et al. (2009 Bacillus ACT)

Defining local clusters: Getis' G statistic

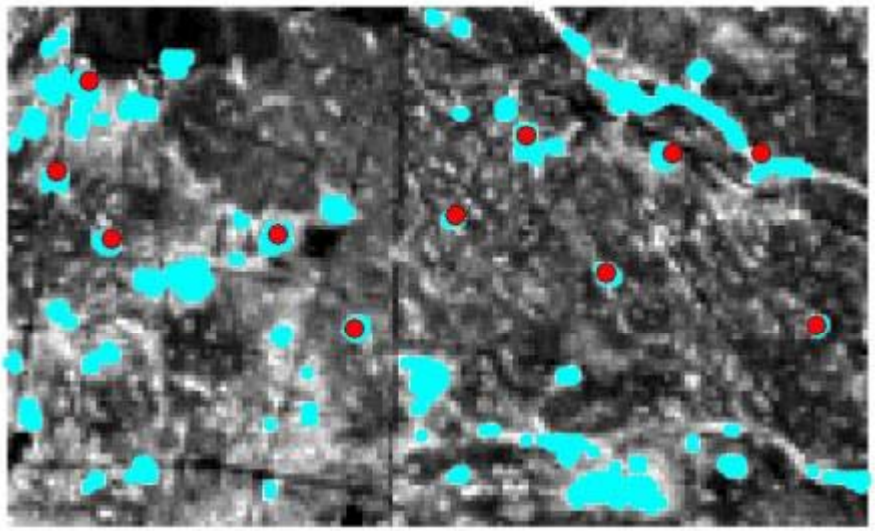


$$G_i^*(d) = \frac{\sum_j w_{ij}(d) \cdot x_j - w_i^* \cdot \bar{x}}{S \cdot \left\{ \left[\left(nS_{1i}^* \right) - W_i^{*2} \right] / (n-1) \right\}^{1/2}}$$

Can we detect the spectral signature of potholes? Do those values cluster on the landscape?



February 14, 1999 (WINTER)



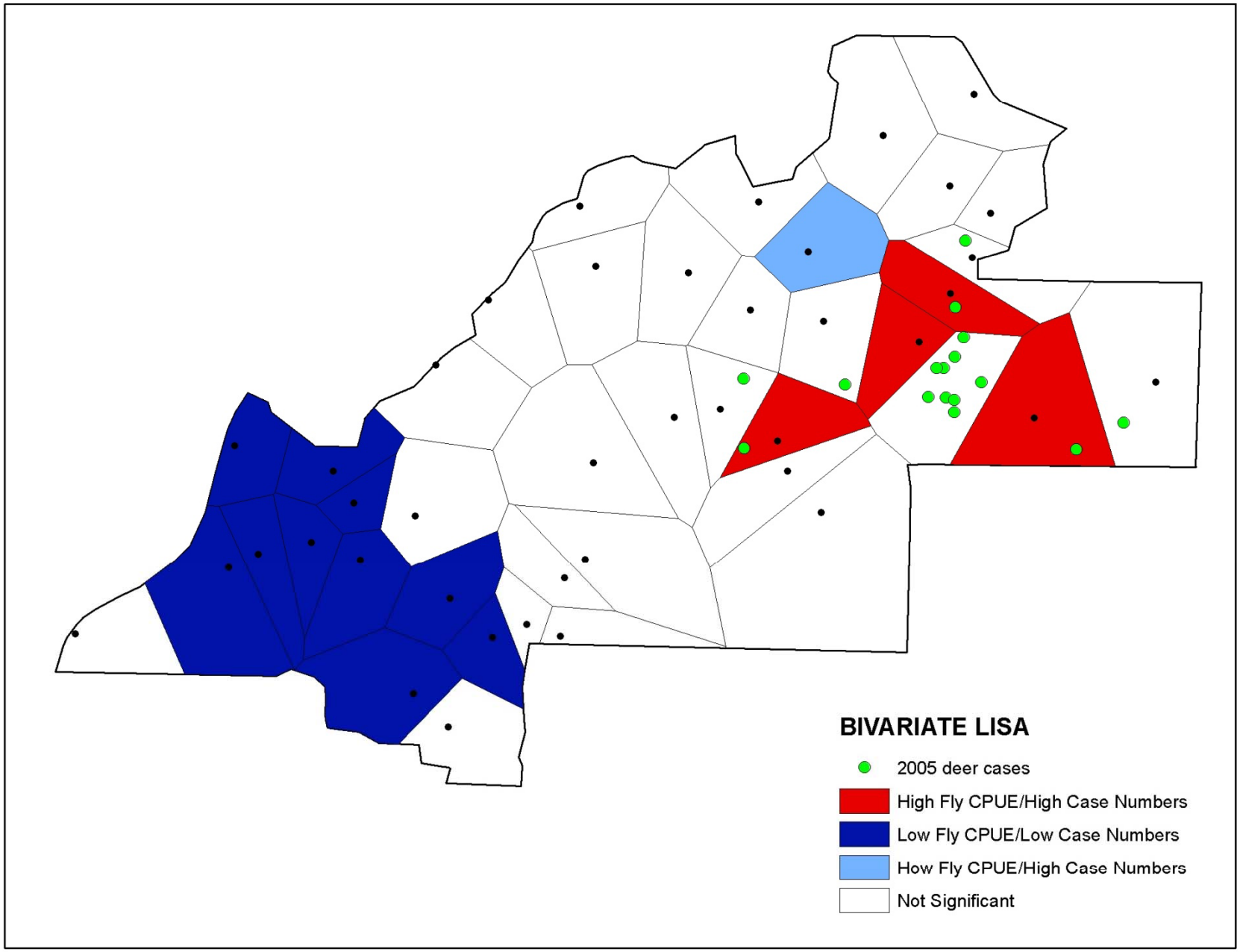
November 13, 1999

Blackburn et al. (2009 Bacillus ACT)

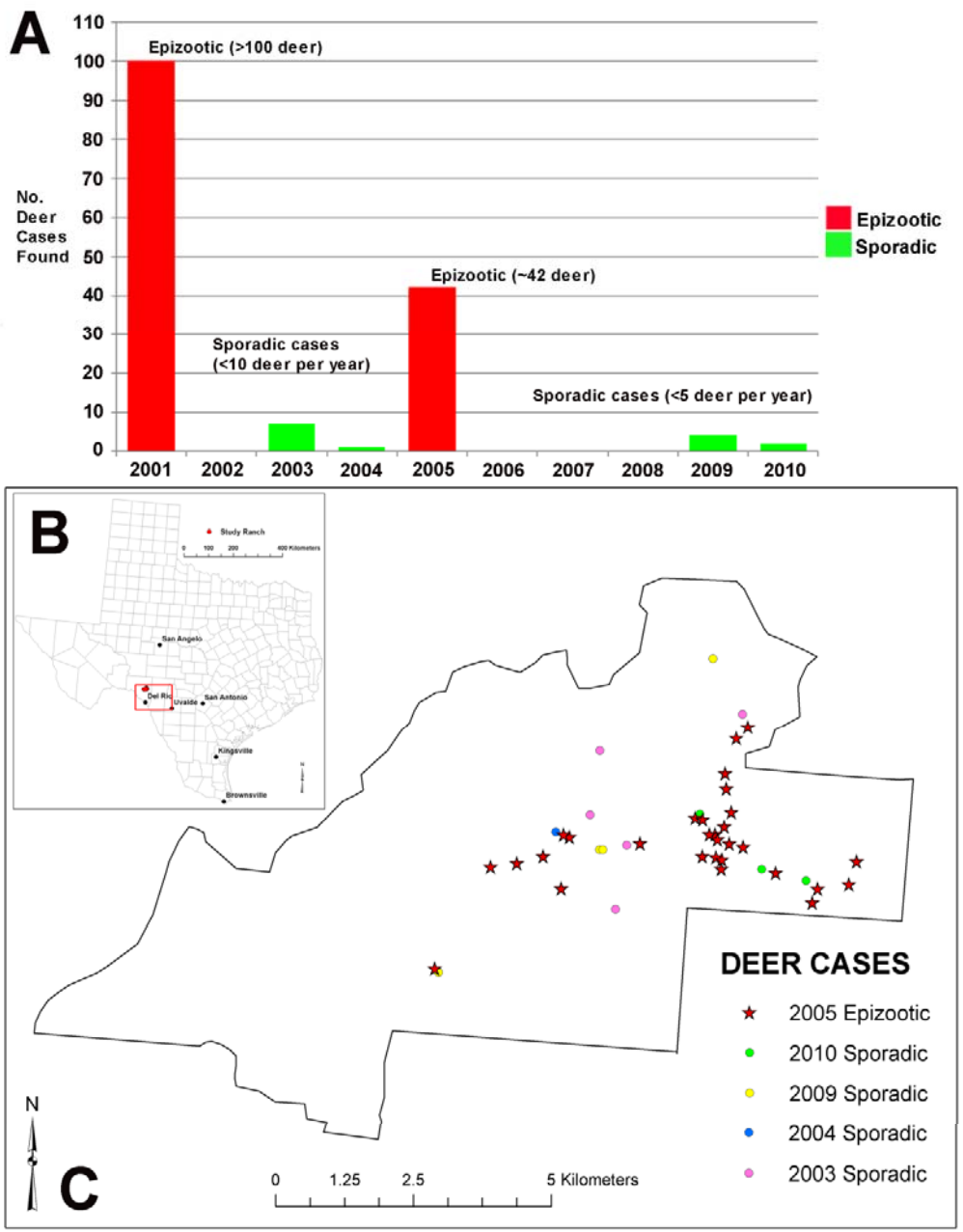
Geography of the *Enzootic Zone*

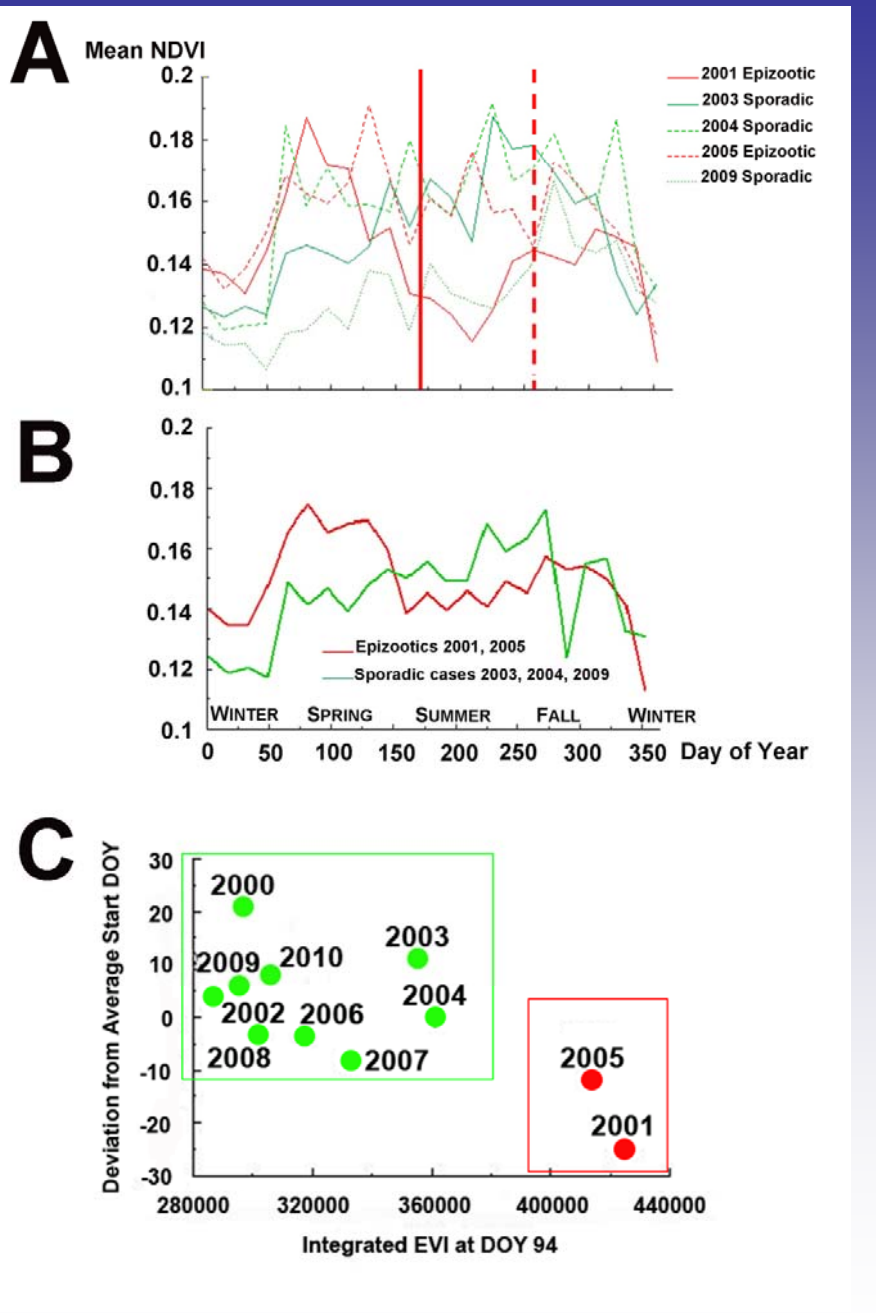
Q: What is the *Enzootic Zone* and how does it differ from the *Sporadic Zone?*

Epizootic	Mortality	Prevalence
TEXAS 2009		
White-tailed deer	30	~10.0
TEXAS 2005		
White-tailed deer	49	~3.2
TEXAS 2001		
White-tailed deer	~100	~7.7
ITALY 2004		
Red deer	8	~17.7



Blackburn et al. (In Review)

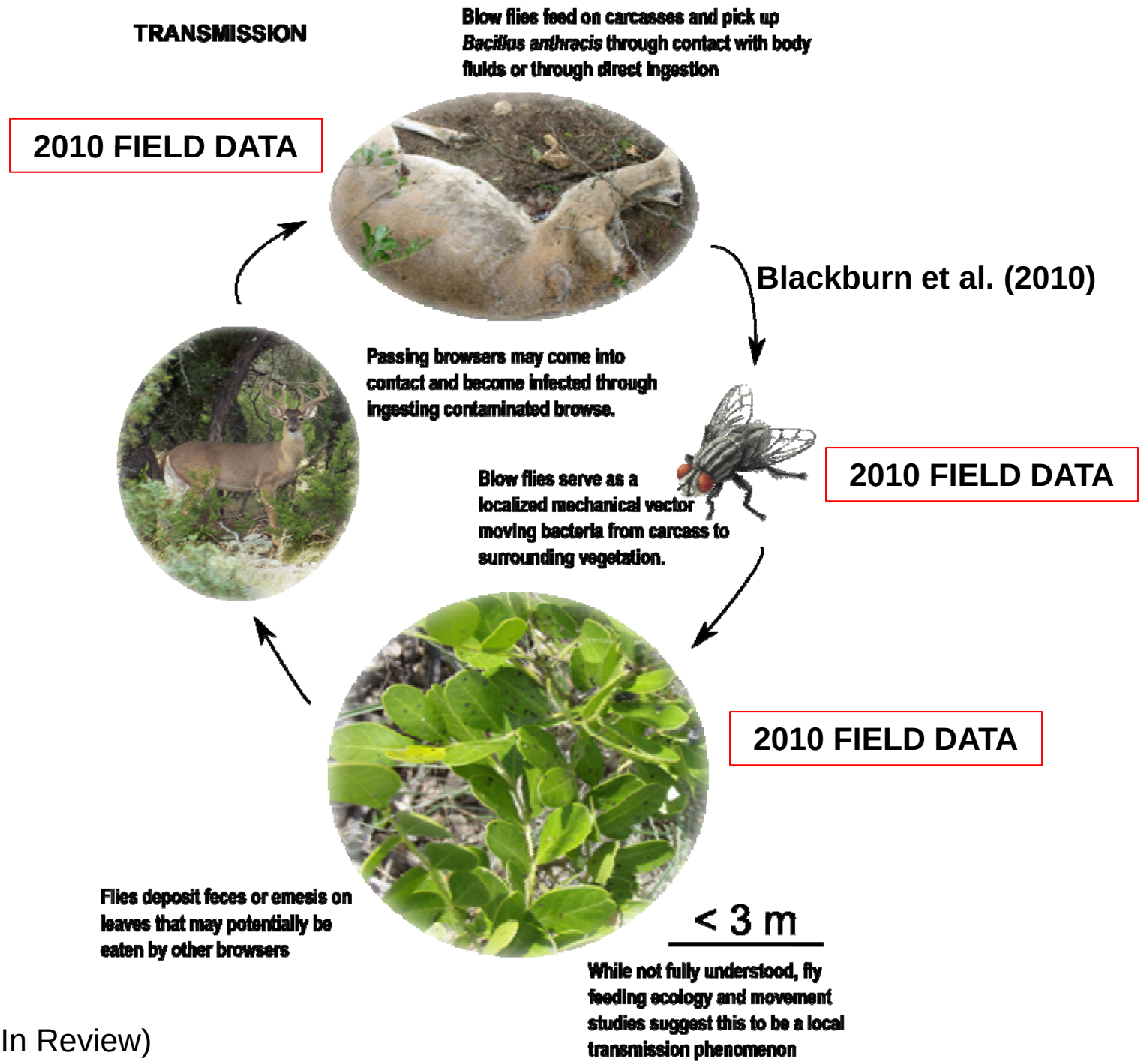




Blackburn and Goodin (In Review)

CASE MULTIPLIERS
NECROPHILIC FLIES IN OUTBREAKS

Q: Is there evidence for flesh eating flies moving contamination from carcass to the surrounding environment (browse, graze, etc)?



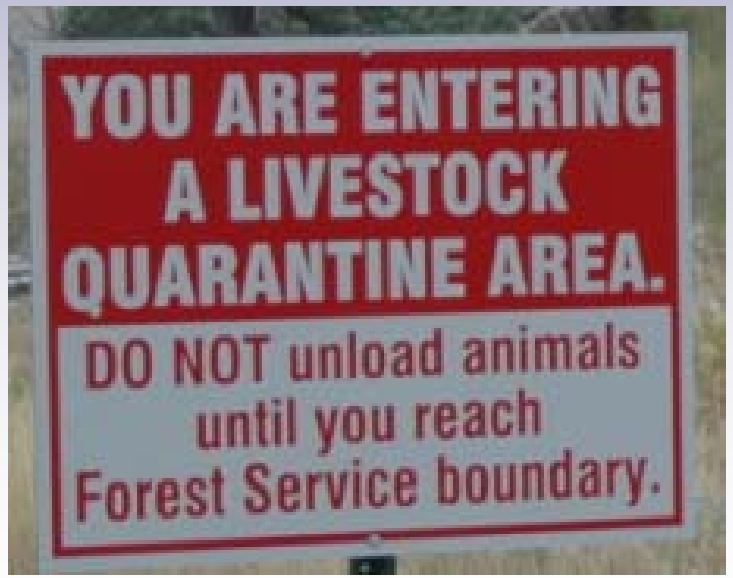
Blackburn et al. (In Review)

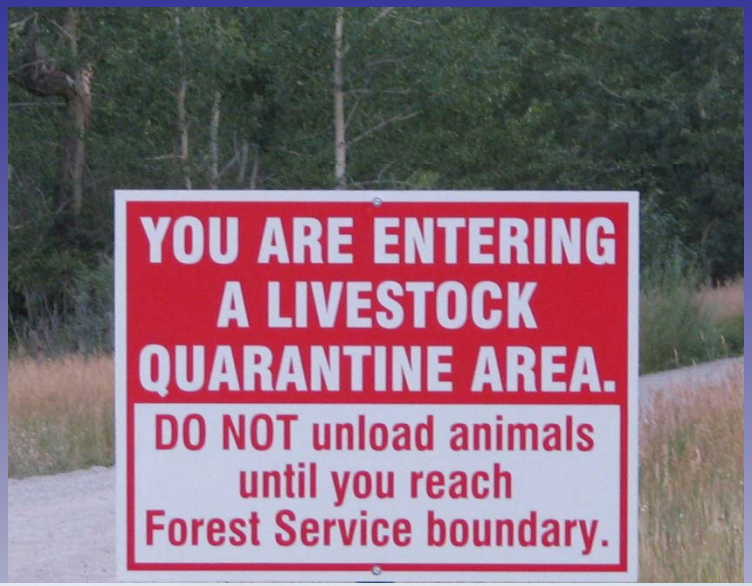
PERSISTENCE IN THE ENVIRONMENT

Q: What do we know about persistence?

The *(Re) Emerging Zone* in Western Montana

Q: How long has the disease been here? Can we study “Spillover”? What is the host system? What are the genetics?




YOU ARE ENTERING
A LIVESTOCK
QUARANTINE AREA.
DO NOT unload animals
until you reach
Forest Service boundary.

Bison (sex)	Mortality	Prevalence
Mature cows 3+ (F)	208	10.25
2006 born cows (F)	1	0.18
herd bulls 6+ (M)	*74*	*27.41*
2007 stocker & born replc (M)	15	2.23
Calves (F, M)	0	0

FEMALE TOTALS PREVALENCE

8.11

MALE TOTAL PREVALENCE

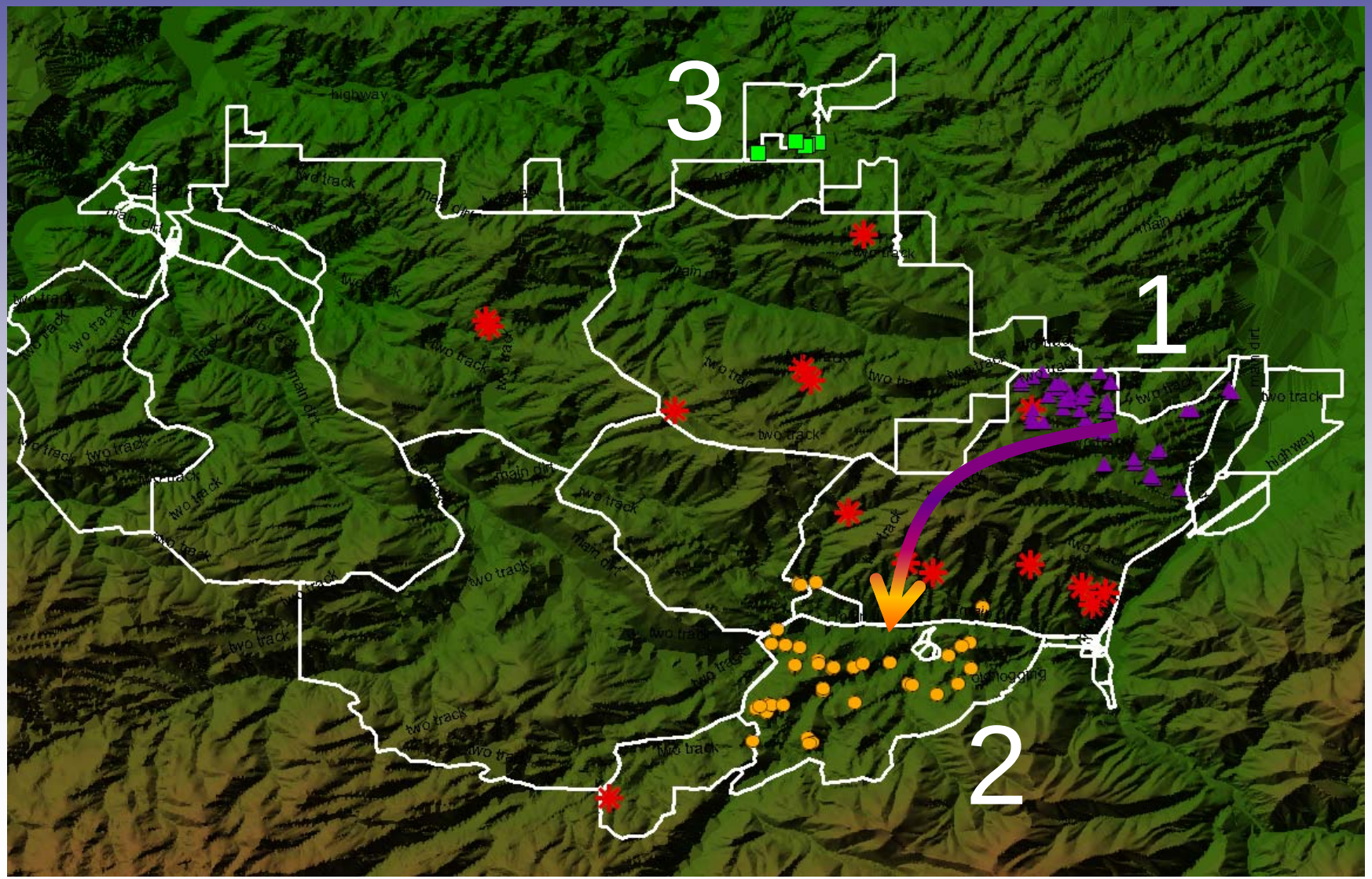
9.44

BISON HERD TOTAL PREVALENCE (excluding calves)

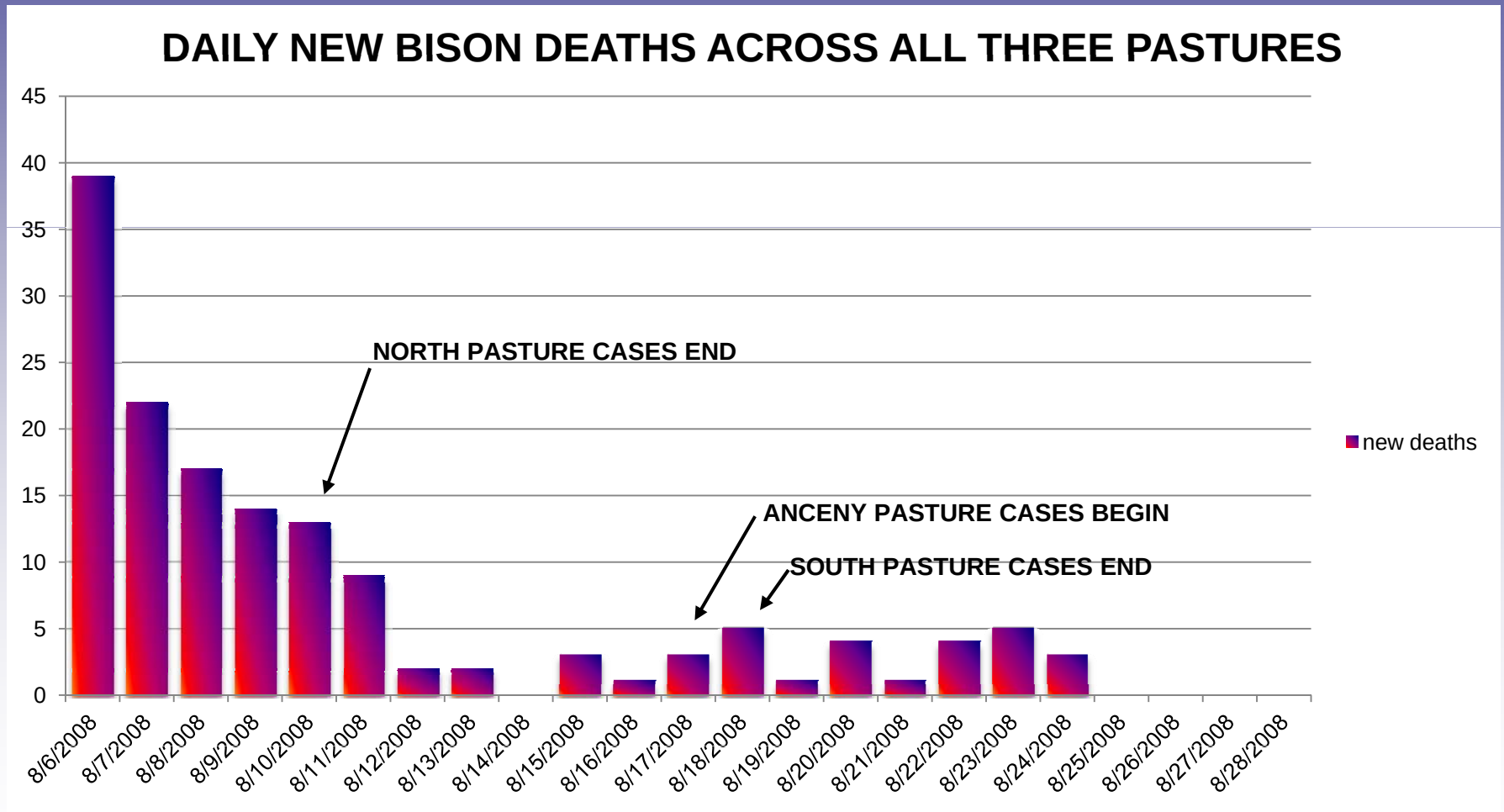
8.47

Elk	Mortality	Prevalence
Found during epizootic	18	13.95
Found during 2009-2010	27	
Total	*45*	*34.88*
Deer		
Buck	1	1.54
Doe	1	1.18
Total	*2*	*1.33*

Spatial patterns of bison cases

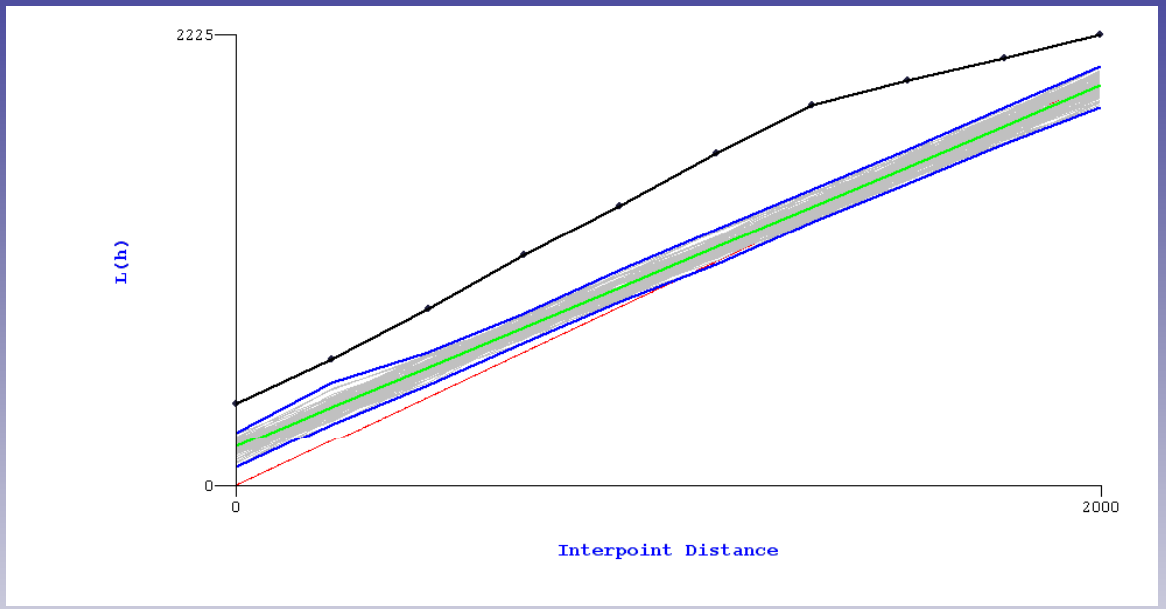


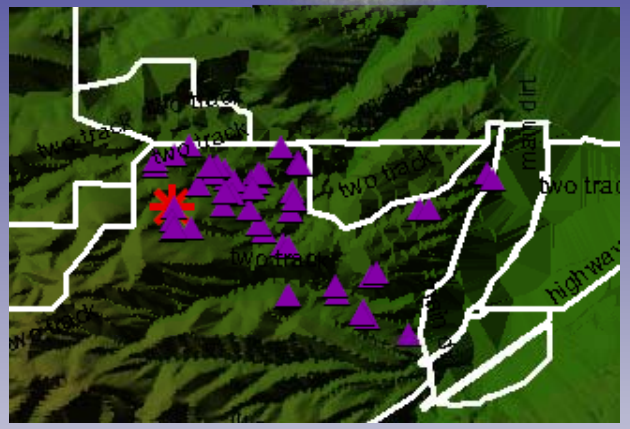
Daily deaths of bison across the pastures

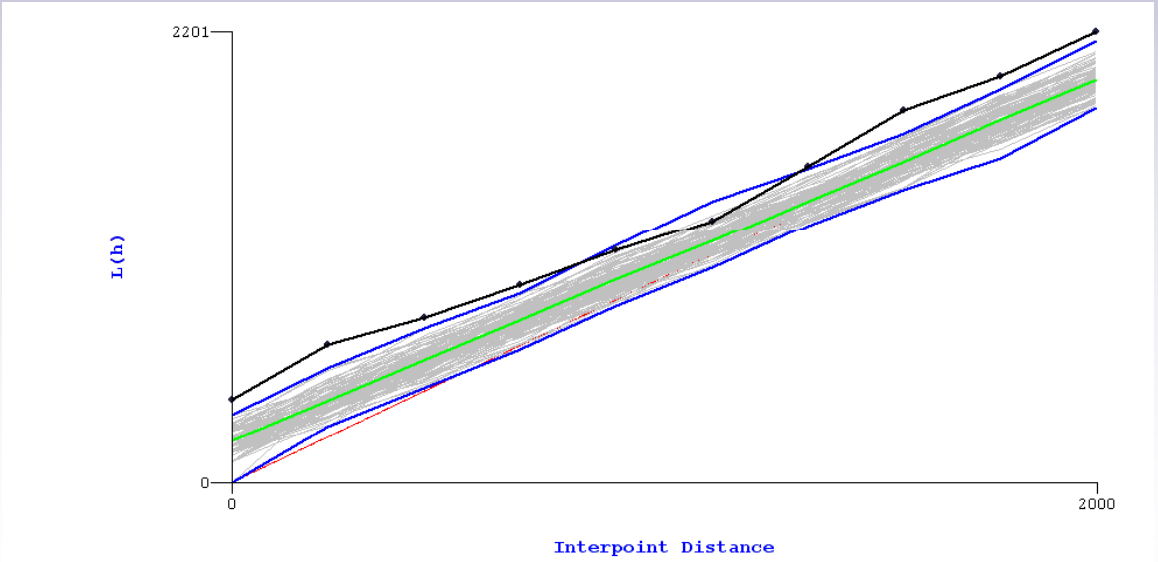


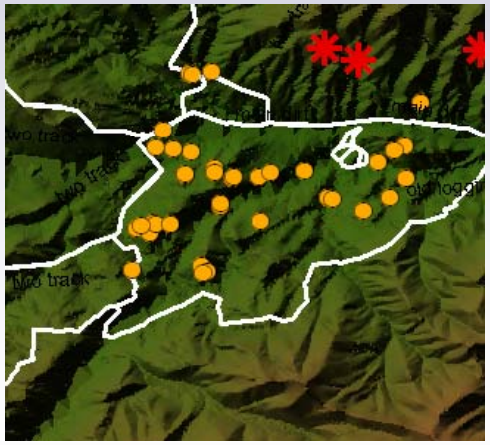
Blackburn et al. (In Review)

Ripley's K Plots of Bison Cases

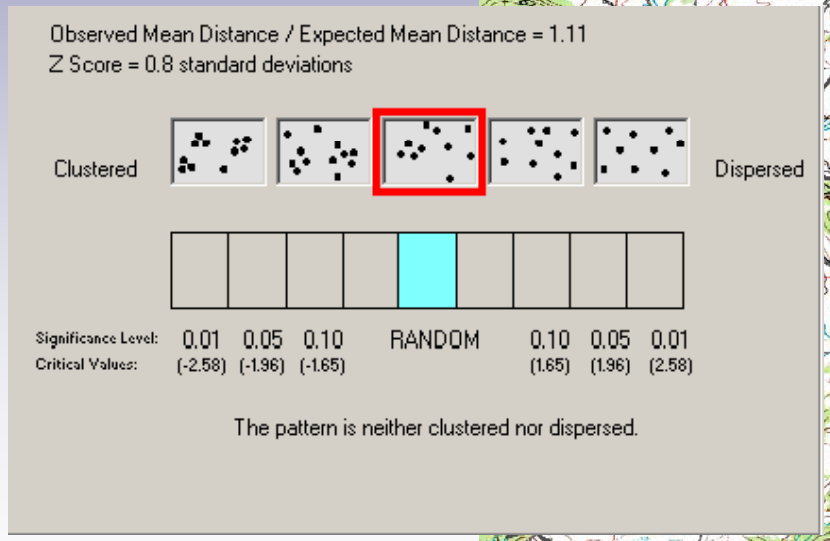


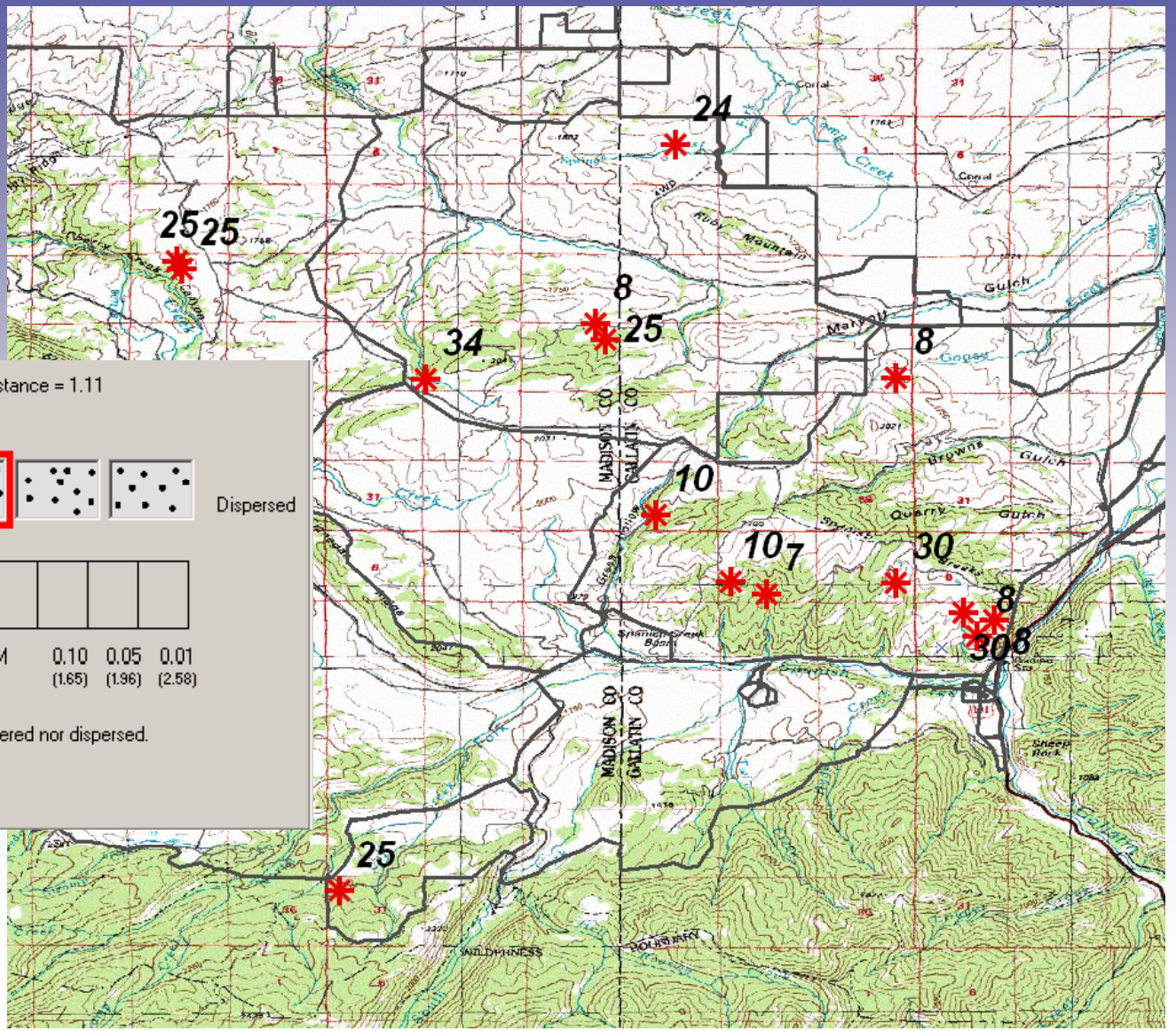




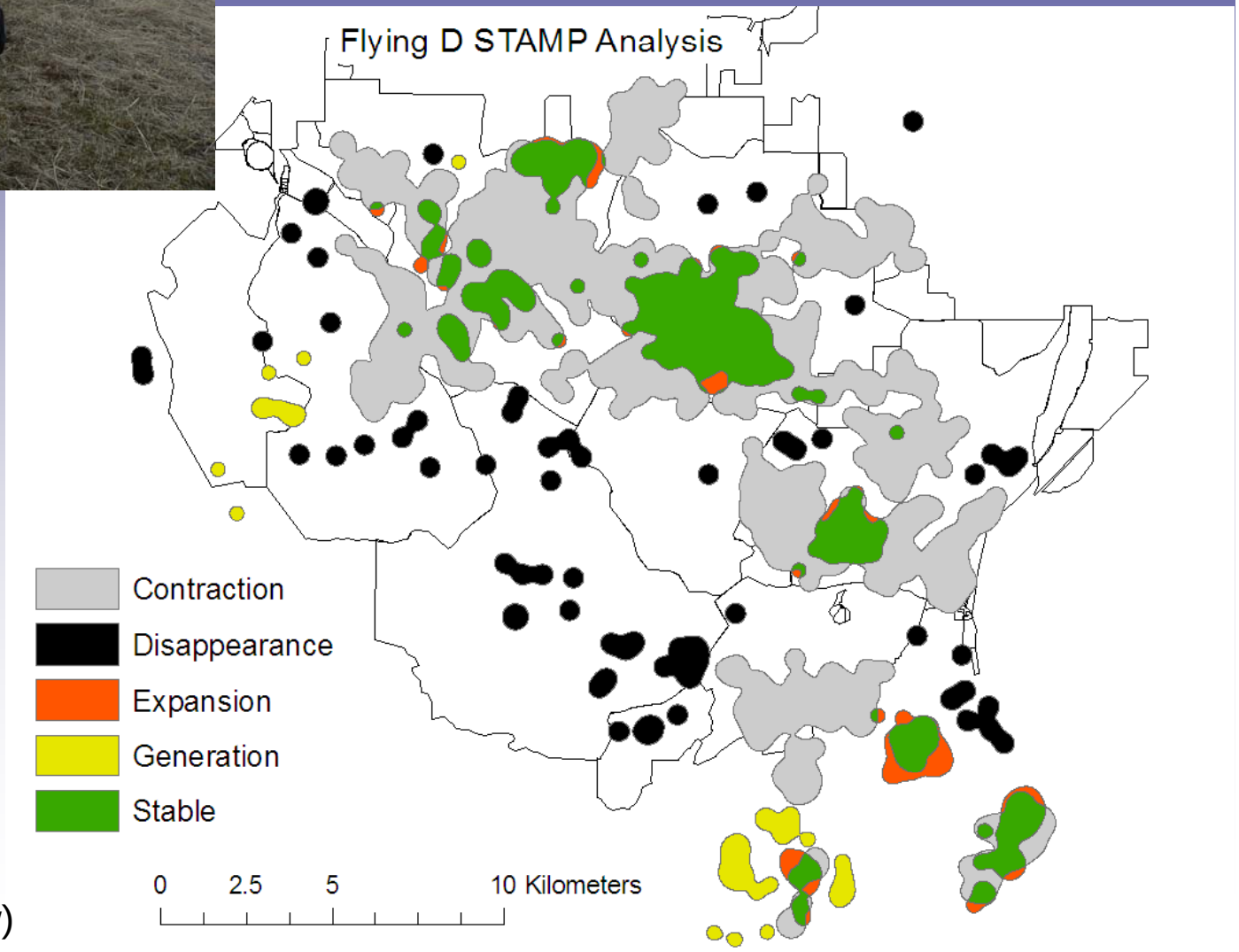


Elk spatial-temporal distribution and ANNI





Elk spatial-temporal changes in home range during anthrax risk period



Blackburn et al. (In Review)

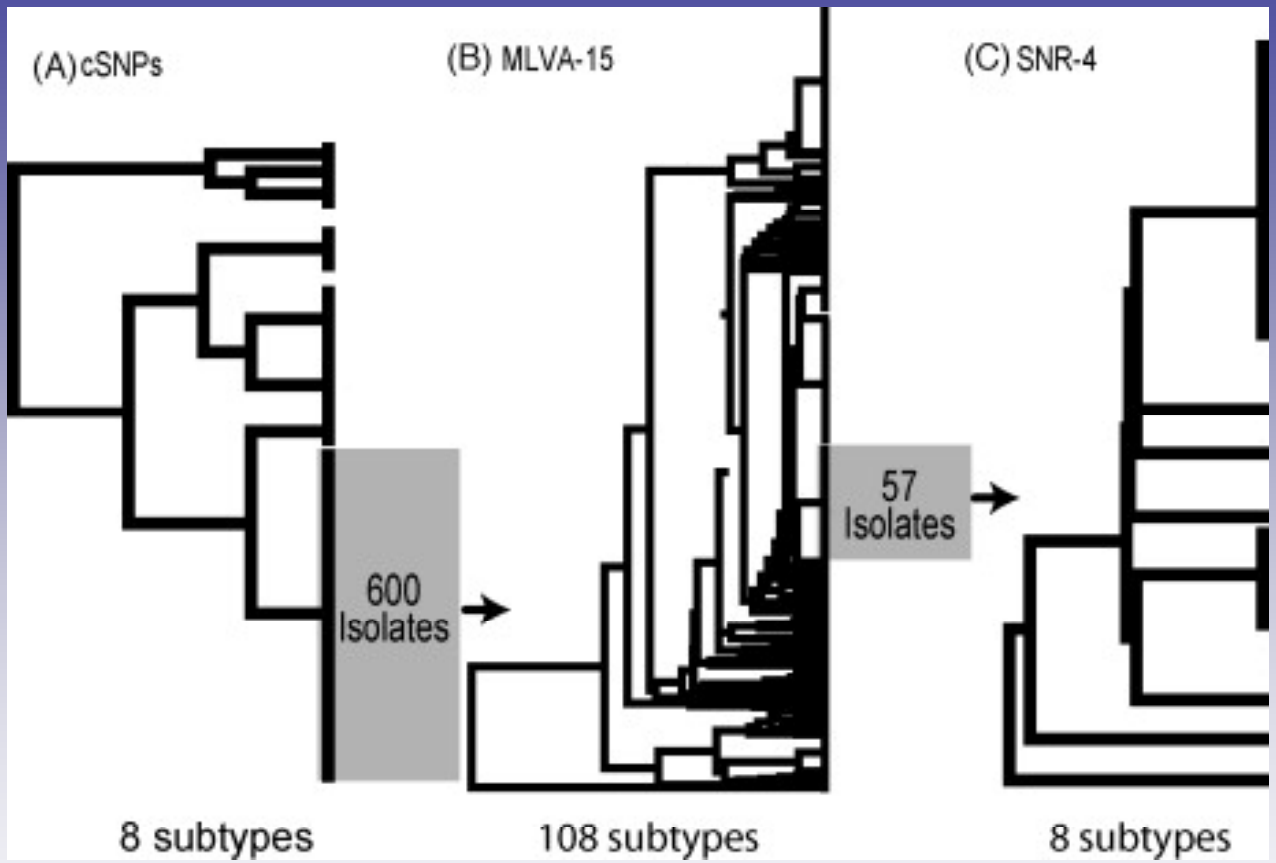
What about genetics? Do they matter?

Qs:

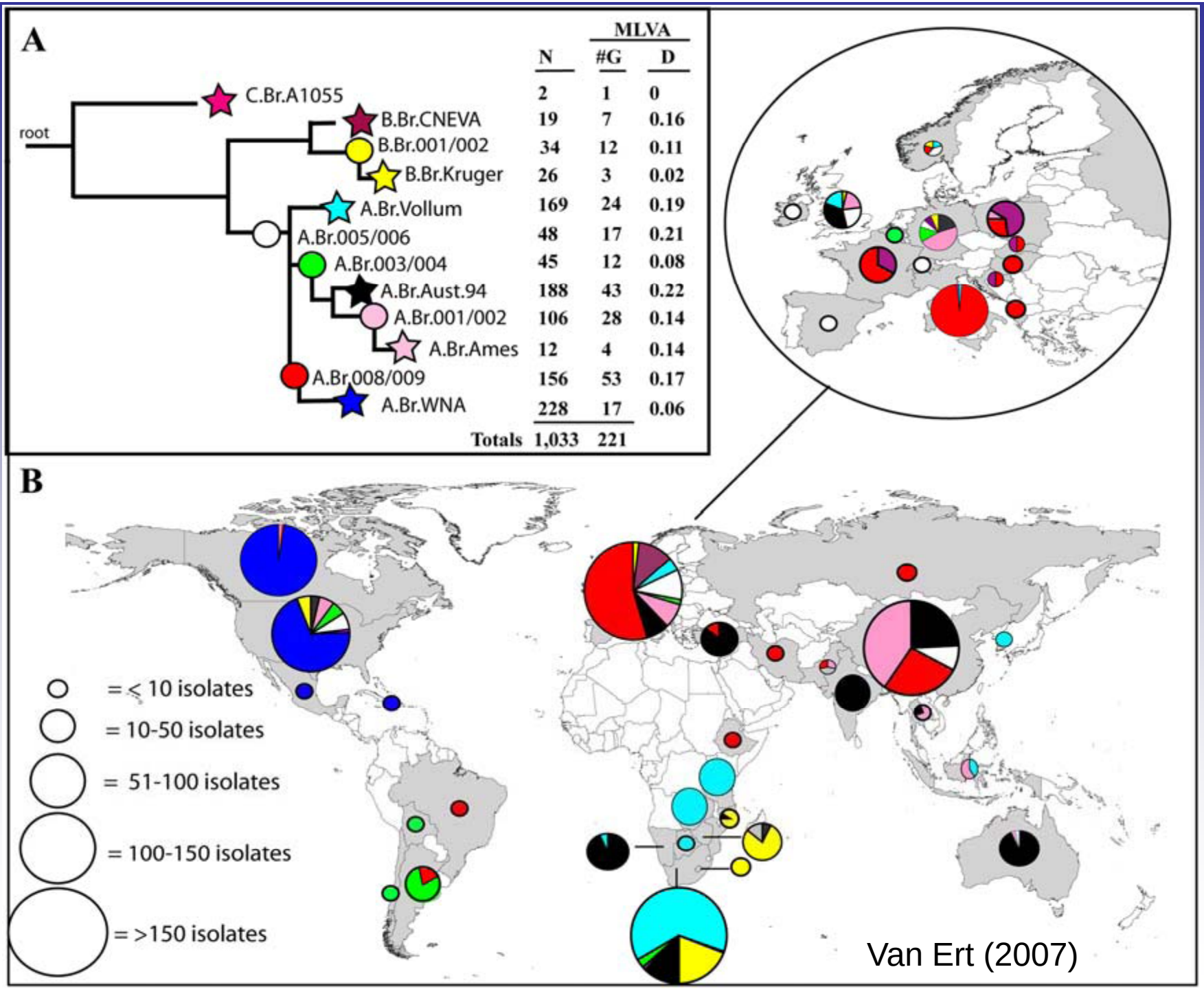
What strains are in the US?

Do the same strains always reoccur? Is there diversity per ranch, per outbreak, per situation?

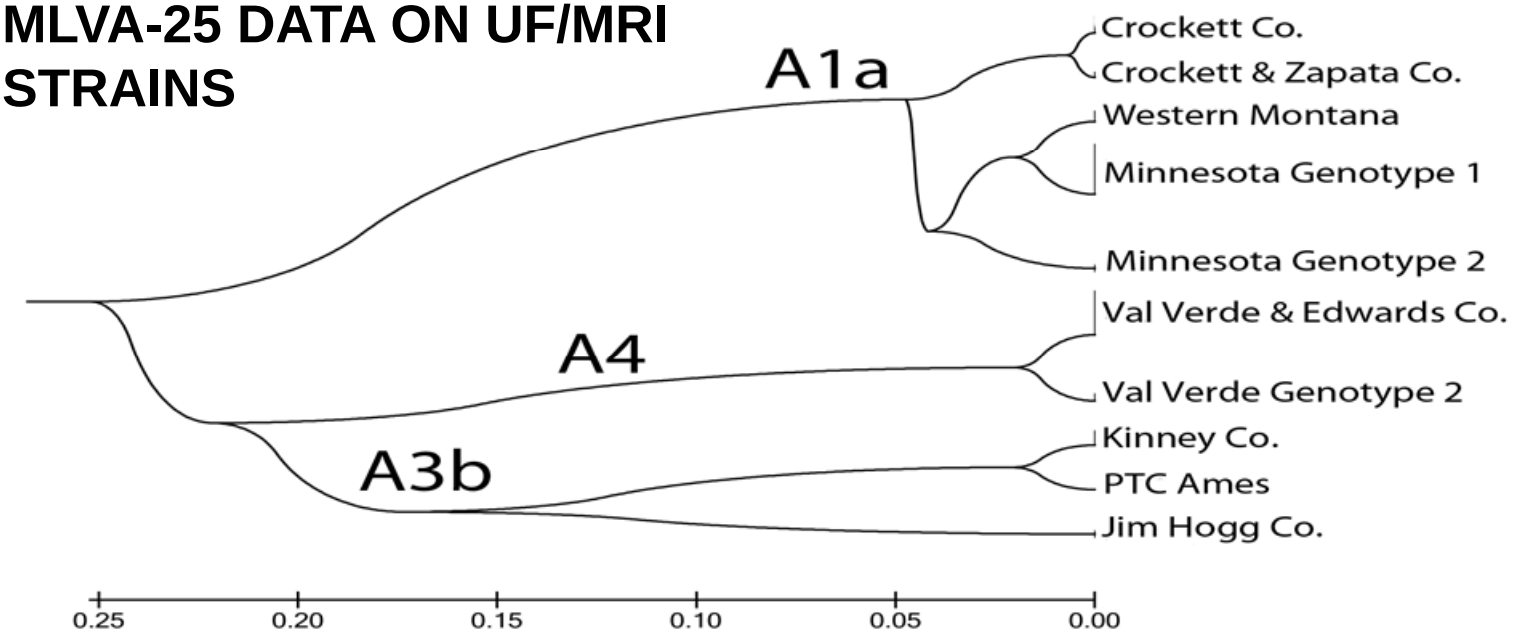
Which genetic marker? When? Why?

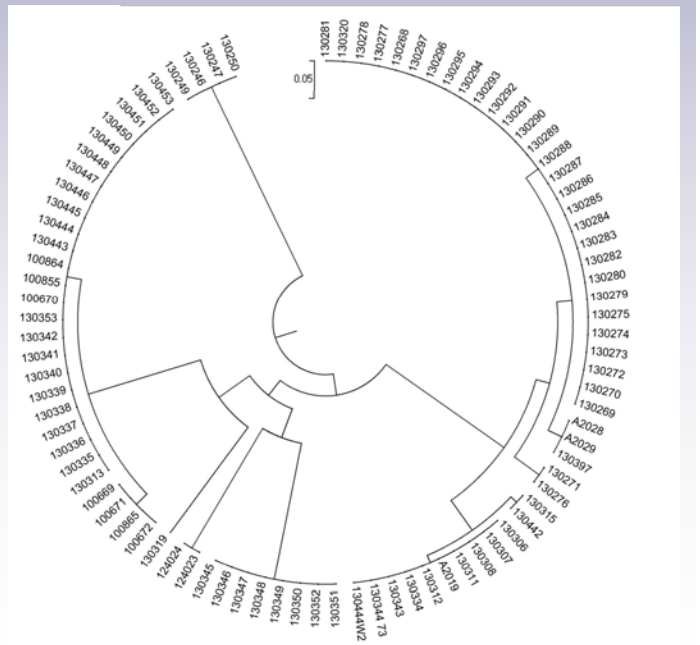


Keim et al. (2004)


A
root
C.Br.A1055
B.Br.CNEVA
B.Br.001/002
B.Br.Kruger
A.Br.Vollum
A.Br.005/006
A.Br.003/004
A.Br.Aust.94
A.Br.001/002
A.Br.Ames
A.Br.008/009
A.Br.WNA
MLVA
N #G D
2 1 0
19 7 0.16
34 12 0.11
26 3 0.02
169 24 0.19
48 17 0.21
45 12 0.08
188 43 0.22
106 28 0.14
12 4 0.14
156 53 0.17
228 17 0.06
Totals 1,033 221
B
= < 10 isolates
= 10-50 isolates
= 51-100 isolates
= 100-150 isolates
= >150 isolates
Van Ert (2007)

MLVA-25 DATA ON UF/MRI STRAINS





Blackburn et al. (In Prep.)

Acknowledgements

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