Risk Assessment of exporting brucellosis infected breeding cattle from the Designated Surveillance Areas

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The interim rule 75 FR 81090 requires States with a known wildlife reservoir to develop a brucellosis management plan to prevent the spread of brucellosis outside of these geographic areas.

State rule in Texas (2013) requiring post-entry monitoring and testing of DSA-origin breeding cattle, regardless of DSA testing.

ID, MT, and WY requested a risk assessment from VS.
The Risk Analysis Process

Hazard Identification

Risk Assessment
- Entry
- Exposure
- Consequences

Risk Communication

Risk Management
The Risk Analysis Process

Hazard Identification

- What could go wrong

Risk Assessment

- Pathways of introduction
- How likely is the event
- What are the consequences

Risk Management

- What are the mitigations
- What is the cost of mitigations, relative to consequences

Risk Communication

Transparency

- Stakeholder input
- Convey results
- Risk ≠ probability of event
- Risk = probability of event in context of risk management and consequences
**Brucella abortus** infected and undetected breeding cattle leaving the DSAs of Idaho, Montana, and Wyoming

- Focus is on interstate introductions
- 22 affected herds 2002-2013 within current DSA boundaries
  - 18 direct link to infection from wildlife
  - 4 linked to cattle traces from affected herds with most likely wildlife source
What is the benefit vs. cost of post-entry tests by receiving states?

• **Benefit** = avoiding introduction of *B. abortus*, weighted by the probability of exposure and effectiveness of the destination mitigation

• **Cost** = paying for post-entry testing and monitoring

• Livestock and trade issue: *economic objective*
What is the probability of a DSA herd having infected cattle (apparent herd prevalence)?

Entry pathways to estimate source herd infection rate and prevalence:

- Elk
- Purchased cattle

Pathways not evaluated:

- Bison: intensive management, no known transmission events
- Commuter grazing herd: timing of spring-summer entry overlaps with <5% of elk abortion events
What is the probability of a DSA herd having infected cattle (apparent herd prevalence)?

Entry pathways to estimate source herd infection rate:

• Elk
• Purchased cattle

Data: apparent herd prevalence and within-herd prevalence at detection 2002-2013.

Reflects interface ecology that has resulted in observed infection

Assumption: Conditions that have resulted in observed infection events are constant
Entry is limited to within current DSA boundaries
No statistical difference in apparent herd prevalence among states
Data: Within-Herd Prevalence, 2002-2013

No statistical difference in within herd prevalence among states
What is the probability of infected breeding cattle leaving the DSAs, undetected?

Exposure pathways:

• Breeding animals destined for breeding herds

• Feeding animals: test-eligible (sexually intact) removed from feeding chains post-movement (~4% NAHMS Feedlot)
Risk Assessment: Exposure

What is the probability of infected breeding cattle leaving the DSAs, undetected?

Data:

- **State brand inspection data** – number, size, and composition of shipments; number of DSA herds
- **NAHMs cow-calf survey** – supplement state shipment data, where necessary
- **DSA reviews** – number of DSA herds, testing regulations and compliance
- **Epidemiological reports** – apparent herd prevalence and within-herd prevalence
Risk Assessment: Exposure

What is the probability of infected breeding cattle leaving the DSAs, undetected?

Data:
• State brand inspection data
• NAHMs cow-calf survey
• DSA reviews
• Epi reports

Affected Herd prev → Within-herd prev → Out-shipments → Diagnostic testing

Sensitivity of:
RAP → FPA → CF
Test in series
What is the probability of infected breeding cattle leaving the DSAs, undetected?

Data:
- State brand inspection data
- NAHMs cow-calf survey
- DSA reviews
- Epi reports

Affected Herd prev $\rightarrow$ Within-herd prev $\rightarrow$ Out-shipments $\rightarrow$ Diagnostic testing

Output:
rate of shipments leaving DSAs undetected with infected breeding cattle
What is the probability of infected breeding cattle leaving the DSAs, undetected?

Full Testing per DSA plans: 100% testing of test-eligible animals
All breeding shipments, ~40% of feeding shipments

Assumption: Compliance with movement testing regulations is at (or very close to) 100%
<table>
<thead>
<tr>
<th>State</th>
<th>Estimated number of breeding shipments per year</th>
<th>Average exposure per year [99% IQR]</th>
<th>Years per 1 average exposure</th>
<th>Average exposure per 1000 shipments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idaho</td>
<td>~250</td>
<td>0.006 [0-0]</td>
<td>167</td>
<td>0.024</td>
</tr>
<tr>
<td>Montana</td>
<td>~1000</td>
<td>0.009 [0-0]</td>
<td>111</td>
<td>0.009</td>
</tr>
<tr>
<td>Wyoming</td>
<td>~850</td>
<td>0.012 [0-1]</td>
<td>83</td>
<td>0.014</td>
</tr>
<tr>
<td>Combined DSAs</td>
<td>~2100</td>
<td>0.027 [0-1]</td>
<td>37</td>
<td>0.013</td>
</tr>
</tbody>
</table>

**Assumptions:** Exposure per state is independent Entry conditions are constant
Risk Assessment: Exposure

- Idaho DSA
- Montana DSA
- Wyoming DSA
- Combined DSAs

**Frequency of infected and undetected shipments per year (proportion out 1000 simulations)**

- Idaho DSA: 0.994, 0.001
- Montana DSA: 0.991, 0.007
- Wyoming DSA: 0.987, 0.008
- Combined DSAs: 0.973, 0.018

**Average infected and undetected shipments per year**

- Idaho DSA: 0.994
- Montana DSA: 0.991
- Wyoming DSA: 0.987
- Combined DSAs: 0.973
## Risk Mitigation

How much does post-entry testing and monitoring reduce exposure?

<table>
<thead>
<tr>
<th></th>
<th>Average exposure per year</th>
</tr>
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<tbody>
<tr>
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<td>Exposure assessment</td>
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<tr>
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<td>Full testing per DSA plan</td>
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</table>
How much would an outbreak have to cost to equal $$ spent on post-movement testing?

\[
\text{Exposure rate} \times \text{Post-entry detection} \times \text{Outbreak cost} = 1
\]

Benefits (outbreak costs avoided)

Cost of maintaining post-entry testing

Risk Estimation & Consequences

Accounting based on TAHC rules

Serological testing with pre- and post-calving health monitoring
How much would an outbreak have to cost to equal $$ spent on post-movement testing?

Exposure rate $\times$ Post-entry detection $\times$ Outbreak cost

Break-Even value of mitigation (not expected consequences)

$\frac{benefits \ (outbreaks \ costs \ avoided)}{cost \ of \ maintaining \ post \ entry \ testing} = 1$

Accounting based on TAHC rules
How much would an outbreak have to cost to equal $$ spent on post-movement testing?

\[
\text{Exposure rate} \times \text{Post-entry detection} \times \text{Outbreak cost} = 1
\]

Break-Even value of mitigation (not expected consequences)

\[
\frac{\text{benefits (outbreaks costs avoided)}}{\text{cost of maintaining post entry testing}} = 1
\]
Risk Estimation & Consequences

How much would an outbreak have to cost to equal $$ spent on post-movement testing?

Assumption:
• All breeding animals out of DSA are subject to post-movement mitigations
• No destination is more or less likely to receive infection = break-even value is the same for any receiving state

\[
\text{Cost of maintaining post entry testing} = \text{Exposure rate} \times \text{Post entry detection} = \text{benefits}
\]
How much would an outbreak have to cost to equal $$ spent on post-movement testing?

$100M’s

- $4.6M year\(^{-1}\) to test all breeding animals out of DSA
- Testing all DSA breeding animals = 40-60 years
How much would an outbreak have to cost to equal $$ spent on post-movement testing?

Perspective…

• A hypothetically big outbreak (100 affected herds with 100k breeding head subject to GYA DSA-like response and testing) ~$20-30M cost¹

• 1976: Economic cost of $120M (2014 dollars)
  1% nation-wide herd infection rate (2012 NASS ~7000 herds)
  0.7% animal infection rate (2012 NASS ~ 480k head)

• USDA slaughter surveillance goal is 1 in 100k

¹ 2008 MT economic assessment of DSA and Wilson (2011)- UWyo upper estimate of cost to producer of brucellosis in 400 head breeding herd test and slaughter
Information Gaps and Limitations

Entry and Exposure

• Undetected herds or time to detection
• Can’t explicitly account for variation owing to vaccination, elk dynamics, herd management, spatial location etc.
  – but we don’t need to under the objectives of the RA
• Can’t account for risk outside DSA boundaries
• Assumes relatively constant conditions
• Limitations on movement data to
  – Number of herds in DSA?
  – Link shipments to herds?

Consequences

• Epidemiological consequences- prospective modeling
• Impact of reduced national surveillance
Questions?

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Risk Assessment Working group
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Idaho Department of Agriculture
Montana Division of Livestock
South Dakota Animal Industry Board
Texas Animal Health Commission
Wyoming Livestock Board
USDA VS District 5: ADD’s, Field Personnel, and Director’s office