Domestic – Bighorn Sheep Research

American Sheep Industry/
National Lamb Feeders Association
Annual Convention
Charleston, SC
January 22-25, 2014

M. A. Highland, DVM, PhDc, Dipl. ACVP
PhD Veterinary Training Program
USDA-ARS ADRU
Morris Animal Foundation - Pfizer Animal Health Fellow
Veterinary Microbiology and Pathology
Washington State University
Pullman, WA
Bighorn pneumonia and the domestic sheep industry

- Captive commingling studies and anecdotal field reports → associated between interspecies contact and BHS pneumonia

- Captive experiments (bacterial inoculations, passive transfer, WBCs) → BHS are more susceptible to pneumonia-associated bacteria

**Profound economic and ecologic impacts**

- DS grazing restrictions on public land allotments
  - ~48% of DS in the U.S.A. spend time on public lands
  - $232M @ farm gate + $576M in supported economic activity
  (personal communication: Margaret Soulen Hinson, 2012)

- Resources invested in wild BHS herds & 3 decades of research
  → Pneumonic disease continues to impact wild BHS
What do we know about bighorn sheep pneumonia?

- Polymicrobial
  (more than 1 bacteria involved)

- Multifactorial
  (the presence of the bacteria in BHS alone does NOT = disease/death)

Incompletely understood disease phenomenon
DS and BHS pneumonia-associated bacteria

- **Mycoplasma ovipneumoniae (Mo, “M ovi”)**
  - Recently identified in very high prevalence in bighorn sheep pneumonia
  - Requires special media to culture (usually does not grow in/on standard culture media)

- **Pasteurellaceae**
  - Grow well in under standard culture conditions
    - *Mannheimia haemolytica* (Mh)
      - *Pasteurella haemolytica* biotype A (prior to 1999)
    - *Bibersteinia trehalosi* (Bt)
      - *P. haemolytica* biotype T and 3 (prior to 1990)
      - *P. trehalosi* (1990-2007)
    - *Pasteurella multocida*

- **Anaerobic bacteria**
  - Requires special culture conditions (will not grow in the presence of oxygen)

- **Other aerobic bacteria**
Complicating the matter....
Healthy bighorn sheep and domestic sheep carry the pneumonia-associated bacteria

- **M. ovipneumoniae**
  - Respiratory tract of sheep and goats
  - Healthy DS herds: 87% positive (453 tested)
    (National Animal Health Monitoring System-Sheep 2011; personal communication T. Besser)
  - Healthy BHS herds: 4 of 32 positive
    Pneumonic BHS herds (disease w/in last 10 yrs): healthy carriers present

- “Pasteurella” bacteria pathogens (*M. haemolytica, B. trehalosi*)
  - Nose and throat in both DS and BHS

In other words....infection does NOT equal disease
Captive commingling studies and anecdotal field reports → association between BHS and DS contact and BHS pneumonia

**Captive interspecies commingling studies**

<table>
<thead>
<tr>
<th>Species commingled</th>
<th>Bighorn sheep (died/total)</th>
<th>% death</th>
<th># of studies</th>
<th>Bacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS (39)</td>
<td>41/43</td>
<td>95%</td>
<td>7</td>
<td><em>Mh, Bt, Mo, A. pyogenes, Corynebacterium</em></td>
</tr>
<tr>
<td><em>Mo</em>-free DS (4)</td>
<td>1/4</td>
<td>25%</td>
<td>1</td>
<td><em>Mh, Bt</em></td>
</tr>
<tr>
<td>Goat (7)</td>
<td>2/10</td>
<td>20%</td>
<td>2</td>
<td><em>Mh</em></td>
</tr>
<tr>
<td>Horse (3)</td>
<td>1/6</td>
<td>17%</td>
<td>1</td>
<td><em>Pm, Strep zoo</em></td>
</tr>
<tr>
<td>Cattle</td>
<td>1/9</td>
<td>11%</td>
<td>2</td>
<td><em>Mh</em></td>
</tr>
</tbody>
</table>

(Mh = Mannheimia haemolytica, Bt = Bibersteinia trehalosi, Mo = Mycoplasma ovipneumoniae, Pm = Pasteurella multocida)

Captive experiments → BHS are more susceptible to pneumonia (and gaps in the data bolded below)

Passive transfer study indicating low transfer of antibodies
- Looked specifically at antibodies for one bacteria (*M. haemolytica*)
  also reported that the bighorn ewe had low/no *M. haemolytica* titers

Neutrophils (a type of white blood cell) from BHS & DS
- BHS neutrophils 4 – 8 x more sensitive than DS to toxin of “Pasteurellas”

Intranasal and intratracheal injecting 1 million to 1 billion live bacteria
- Multiple studies reported death in BHS and no disease in DS
  no or inconsistent reporting of the immune status of the animals
- BHS have “defective pulmonary clearance” of *M. haemolytica*
  BHS had significantly lower lung and blood antibody titers to bacteria so wouldn’t be able to defend themselves equally to the DS that have high levels of antibodies

Leading to a belief that bighorn sheep are “immunocompromised”
Work being done by ADRU-ARS-USDA
If domestic and bighorn sheep are raised equally, are their immune systems equally protective?

Domestic sheep and bighorn sheep were taken at birth
• No contact with the ewe or any other sheep
• Hand-raised (collected colostrum from ewe then milk replacer after)
• Separated by species
• Remain free of the bacteria associated with pneumonia

What we are investigating:
• Passive transfer of antibodies from ewe to lamb (completed, unpublished)
• Repeat toxicity assays on neutrophils from SPF animals (completed, unpublished)
• Neutrophils ability to kill bacteria (1/2 completed, unpublished)
• Intranasal immunization (scheduled for spring 2014)
heat killed Mycoplasma ovipneumoniae and Mannheimia haemolytica
(Bacteria from lung tissue of BHS that died from pneumonia)
Range Proposal

- GPS tracking of domestic grazing units
  - Herdsman
  - Protection and herding dogs
  - 10-20% of the flock

- Preferably in “at risk” areas (near bighorn habitat) where bighorns collared

- Locations – 2 under consideration
# Data Base for Broad Scope Risk Assessment
*(hopes of making sense of a multifactorial problem)*

## Land use
- GIS documentation or mapping of BHS herd locations and herd size
- Mapping of all public DS rangelands and flock size
- Survey all private lands within and surrounding known BHS herd ranges
  - Map locations of private lands that have DS and goats, flock size
- Domestic sheep straying events
- All known contacts with domestic sheep

## Human interactions with BHS
- Wildlife agencies (captures, flyovers)
- Other gov’t and private activities
- Hunting
  - Permits issued/# harvested

## Disease outbreaks
- Date
- Number affected/deaths
- Symptoms
- Pathogens identified and by whom

## Commensal bacteria screening in DS and BHS
- Performed by whom
- Results

## Environment
- Weather
- Feeding stations
- Natural disasters (ie. fire)
- Non-human predators
- Death due to other
How do we collect data/information from each state?

Forrest Service
BLM
State wildlife agencies
State veterinarians
ASI members from each state

Compiled information made available for all involved
Database would help to minimize this ambiguity and identify other possible disease associated factors.

(WAFWA June 22, 2010 report)

Table 1. Bighorn sheep pneumonia die-offs, winter 2009-2010, in 5 states (MT, NV, WA, UT, WY), as of 6/21/2010.
Conclusion

• Alternative approach to comparatively evaluating the immune systems of BHS and DS
• Advance the basic understanding of immune responses to pulmonary disease agents in both species
• Guidance for future research for improving the health of sheep
• Database: sort out the multifactorial component of BHS disease
• References for data/information within this presentation available upon request

• Questions, comments, feedback, suggestions, and constructive criticism welcomed

Contact information:

Maggie.Highland@ars.usda.gov