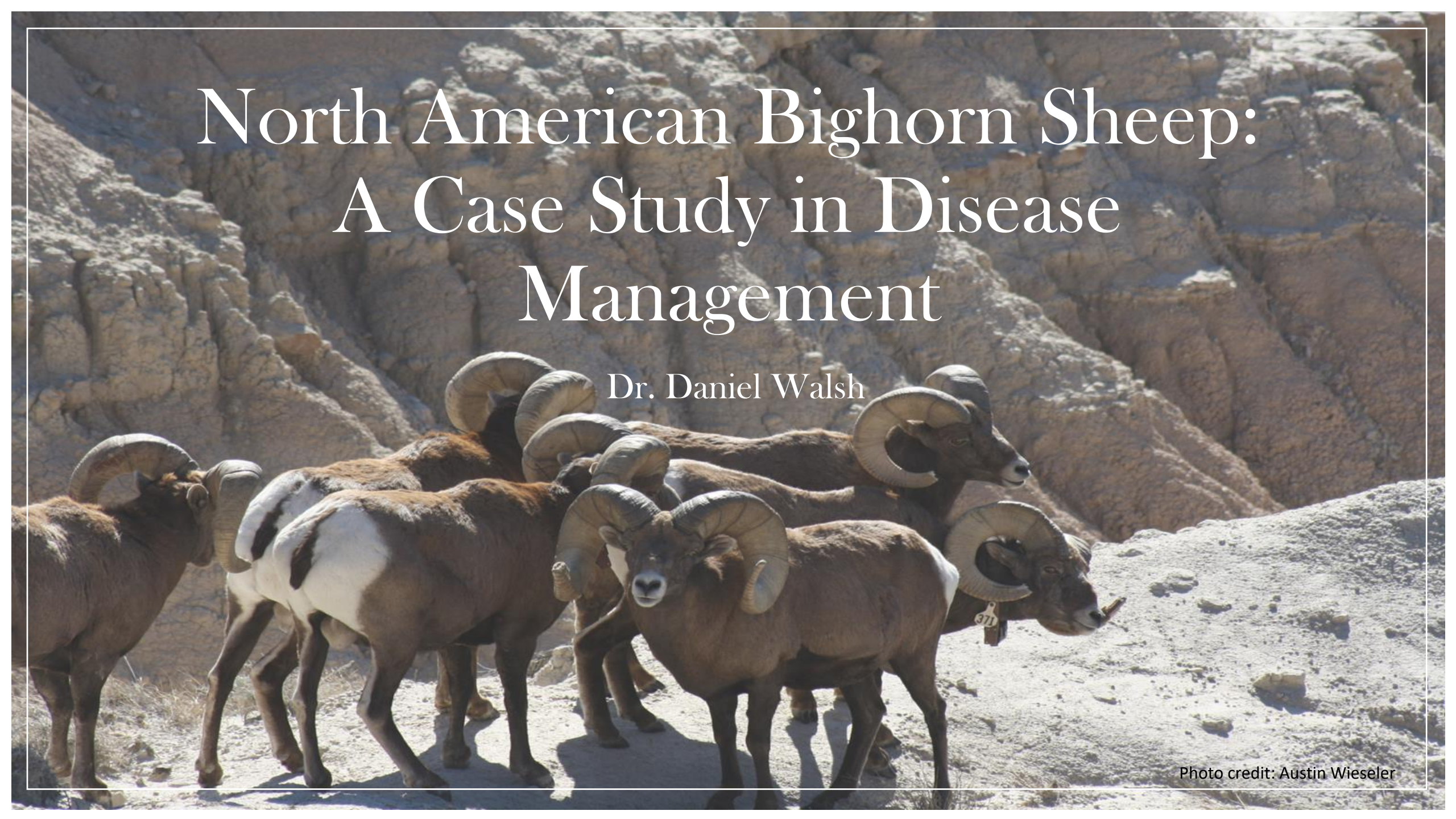


North American Bighorn Sheep: A Case Study in Disease Management

Dr. Daniel Walsh

Photo credit: Austin Wieseler



Habitat

- Bighorn sheep inhabit a wide range of habitats
 - Including river canyons, foothills and mountains
 - Occupy ranges from 450m to 3300m in elevation
 - Generally one commonality is that there is proximal escape cover
 - Steep rocky areas sheep use to avoid predators and to lamb
 - Some of the most productive bighorn sheep range is found in alpine meadows
 - Often areas desired by domestic sheep producers for the high quality forage that lasts late into the year











History

- Historically wild sheep were common across western North America
 - Valdez (1998) – Estimated wild sheep numbers were ½ million across N.A.
 - Seton (1929) – Estimated around 4 million
 - Buechner (1960) – Estimated 15000-20000 remained
- Dramatic declines – have been attributed to a combination of unregulated hunting, **diseases**, competition with non-native species, and anthropogenic factors.
- Recent estimates - ~ 185,000 wild sheep, but many populations are small and fragmented
- Increases since 1960 – regulated harvest, habitat management and vigorous translocation programs (i.e., >1400 projects)

Distribution



Distribution of Bighorn Sheep in North America



1850

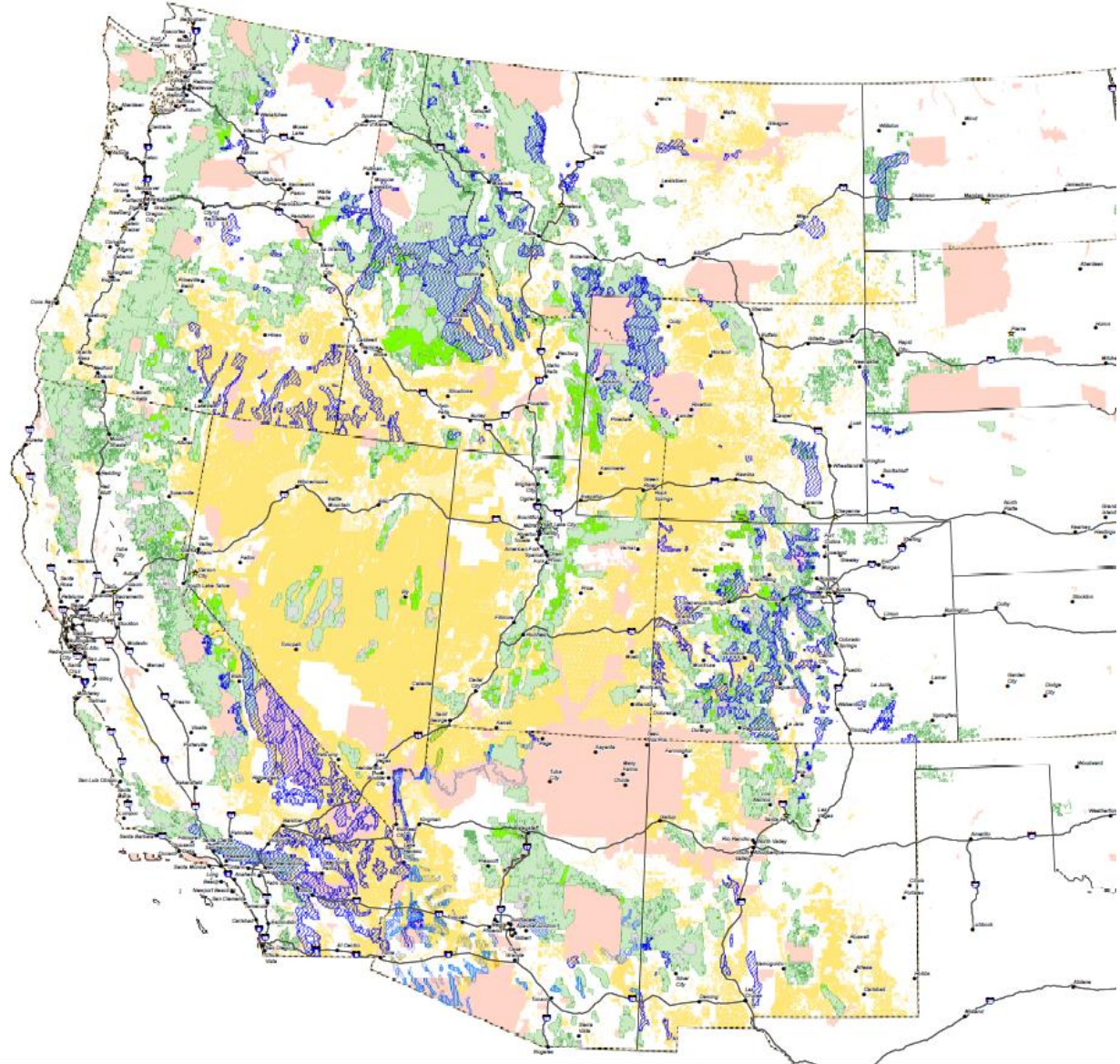


1960



2012

Bighorn habitat and domestic sheep/goat grazing allotments



Bighorn Sheep Respiratory Disease

- Other diseases that affect bighorns – EHD, sarcoptic mange, etc.
- Respiratory disease is by far the most impactful
 - Example: 2009-2010 and estimates 1600-1700 animals died across 5 western states (1% of population)
- Symptoms: nasal discharge, coughing, lethargy, abnormal stance, drooping ears, head shaking, inappetence
- **Population-level impacts:** epizootic can cause loss of 35 – 95% loss of the adult population
- Post die-off –low lamb recruitment for years (preventing rebounding of the population) with lambs dying between 6 – 11 weeks of age
- Can be difficult to detect disease



Evolving Suspects as Etiologic Agents

- Originally – lungworms (*Protostrongylus spp.*)
- Pasteurellaceae – *Manheimmia haemolytica*, *Pasteurella multocida*, *Bibersteinia trehalosi*
 - Leuktoxin producing - *Pasteurellaceae*
- Currently – *Mycoplasma ovipneumoniae* = *primary agent*
 - Inhibits ciliary action of the respiratory cells necessary for bacterial clearance and suppress lymphocytes
 - *M. ovi.* and other bacterial pathogens invade the lungs
 - *Domestic sheep pathogen*

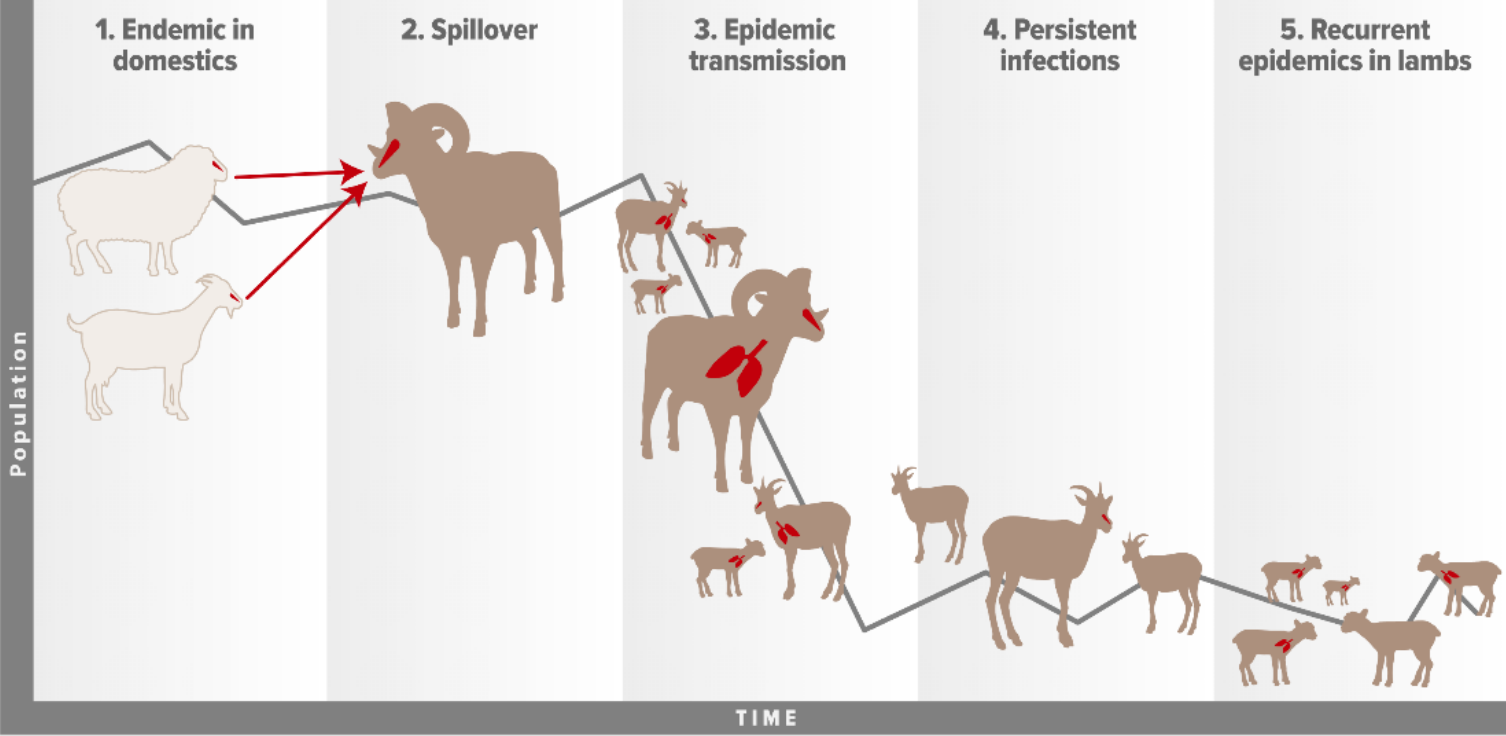




Domestic Sheep Respiratory Disease

- Impacts are less severe
- Still has significant economic impacts
 - In 2009 USDA estimated 4.8% of non-predator losses of adult sheep = respiratory disease
 - 12.6% of non-predator lamb losses = respiratory disease
- In 2011 USDA surveyed 453 operations for Movi
 - 88.5% of operations were PCR positive
 - 85.3% were sero-positive via ELISA

Epidemiology of Bighorn Sheep Respiratory



Domestic sheep and goats carry *M. ovipneumoniae* within their nasal passages.

M. ovipneumoniae is transmitted to bighorn sheep through contact with infected domestic sheep and goats. Once bighorn sheep populations are infected, bighorn sheep can also spread *M. ovipneumoniae* among populations.

M. ovipneumoniae damages the clearance system within the respiratory tract, leading to polymicrobial pneumonia caused by inhaled opportunistic pathogens. Mortality rates after pathogen invasion can be very high.

Survivors return to health, but a proportion of them persistently carry *M. ovipneumoniae* within their nasal passages. Ewes carrying *M. ovipneumoniae* pass the bacteria to their lambs.

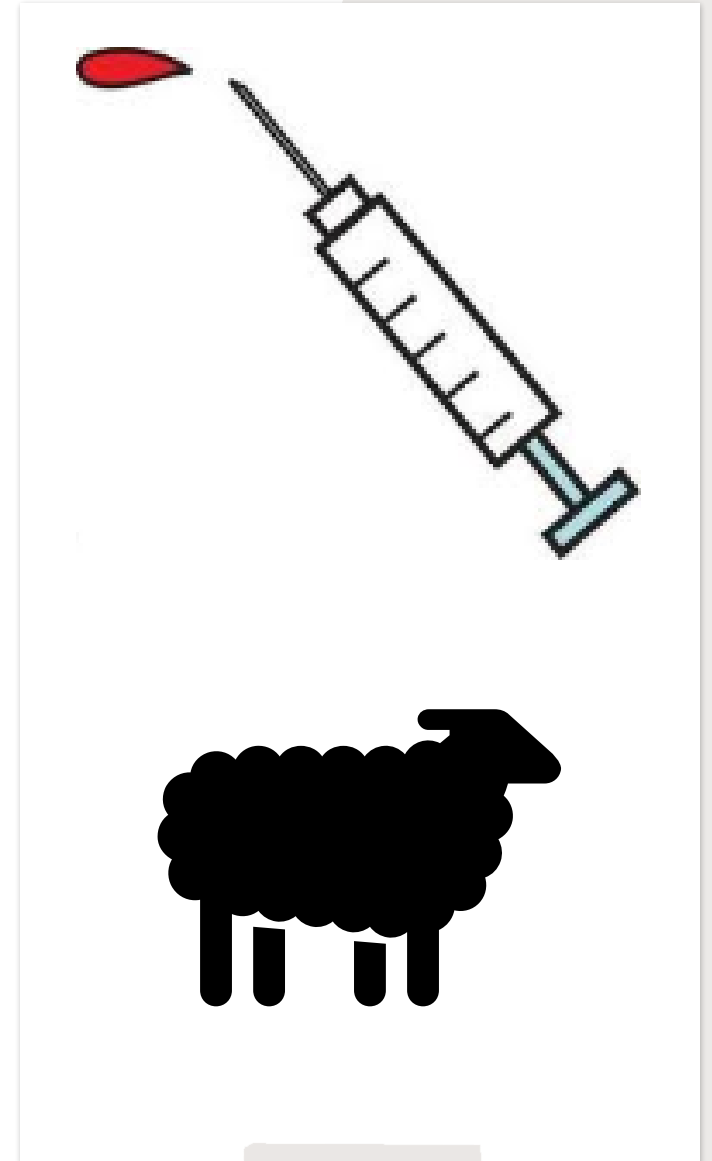
Acutely infected lambs then transmit *M. ovipneumoniae* to the entire lamb cohort, leading to pneumonia outbreaks in lambs. Lack of recruitment becomes the major constraint to population recovery.

Plowright et al. 2017

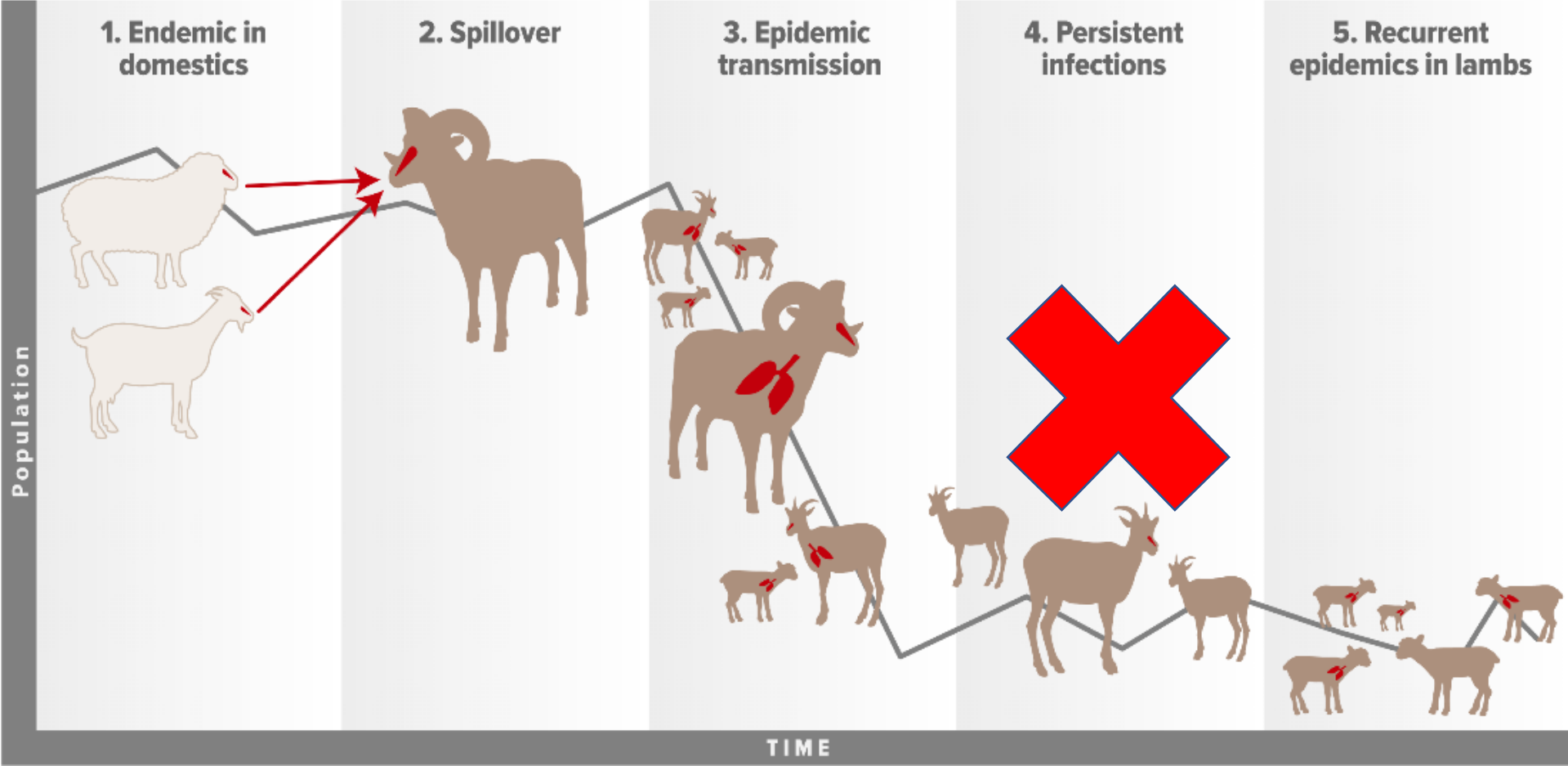
Figure 1 Epidemiology of *Mycoplasma ovipneumoniae* invasion and persistence in bighorn sheep populations.

Past Management/Research Efforts

- Anthelmintics – treat lungworms
- Focused large on application of various vaccines
 - Often targeting the wrong pathogen (i.e., Pasteurellaceae)
 - Difficult to administer as labeled in free-ranging bighorn sheep
- Broad-spectrum, long-lasting antibiotics
 - Also unsuccessful for similar reasons
- Mineral supplementation – selenium
 - Appear to be deficient...but this is based on domestic sheep standards
- Herd supplementation
 - Transplants die or do not integrate with the herd



Current Research



Captive and Free-Ranging Experiments - SD

Commingled known Chronic Shedders with non-Chronic Shedders

- Lambs commingled with shedders significantly higher mortality compared to those not commingled

Custer State Park – Removed chronic shedders from the population

- Rapid City – Chronic shedders not removed (Control)
- Adult survival higher : 94% annual survival rate (CI = 77%, 99%) in the treatment population and 88% (CI = 82%, 92%) in control
 - No pneumonia in treatment herd
- Lamb survival higher: 77% annual survival rate (CI = 26%, 96%) in the treatment population and 35% (CI = 12%, 62%) in the control
 - Pneumonia-caused mortality in the treatment population (probability = 6%, CI = 0%, 29%) ; control population (probability = 48%, CI = 24%, 73%)

Conclusion

- Understanding the ecological and epidemiology of the system – key to success
 - Chronic shedders – are the key link to improving herd health
- Challenges exist to operationalize
- Path to success

