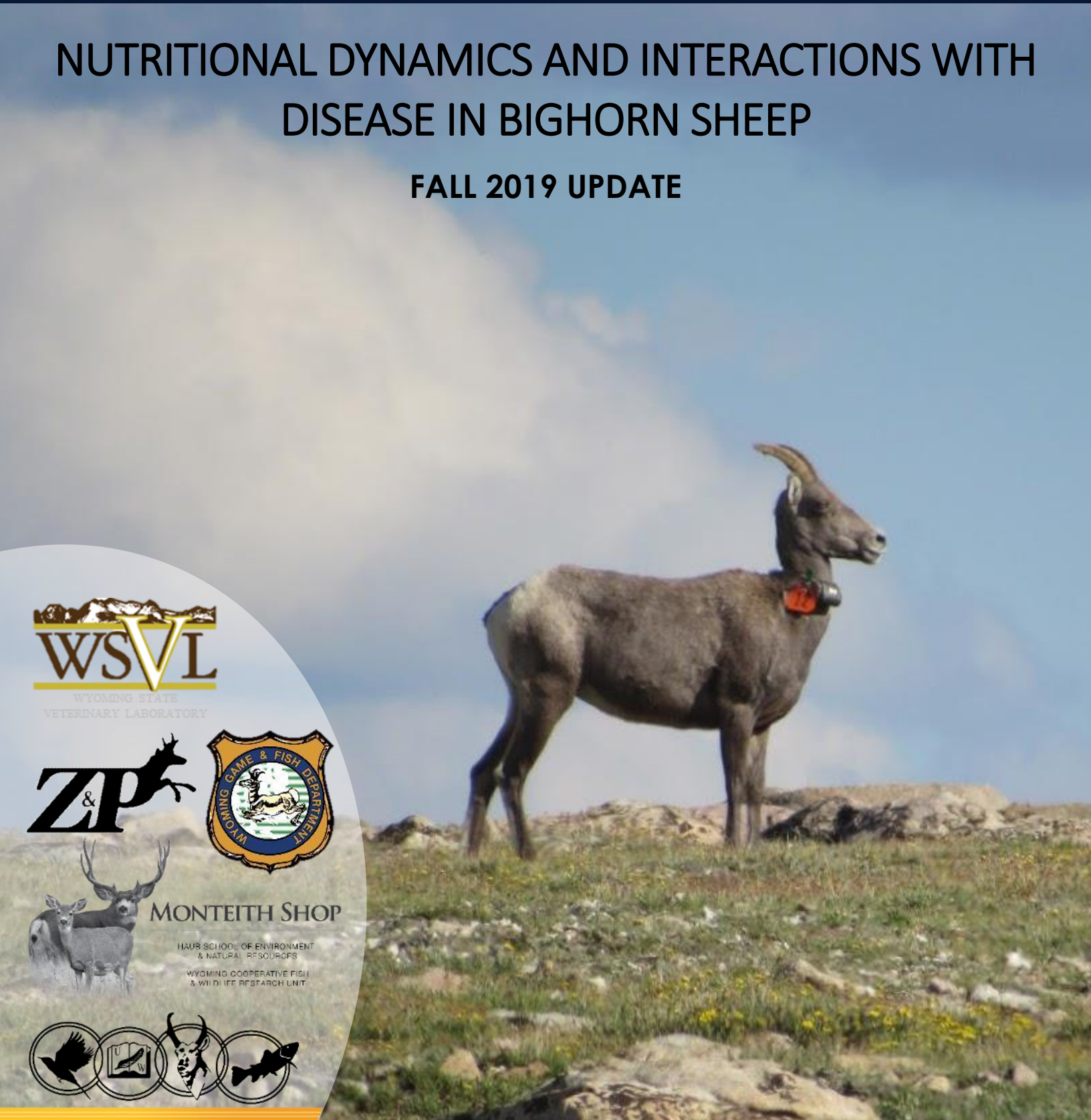
HAUB SCHOOL OF ENVIRONMENT AND NATURAL RESOURCES

NUTRITIONAL DYNAMICS AND INTERACTIONS WITH DISEASE IN BIGHORN SHEEP

FALL 2019 UPDATE



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Project Background

The presence of epizootic pneumonia to bighorn sheep populations muddles the already complicated processes underlying population dynamics and is often the culprit for massive crashes of sheep populations. Although pneumonia caused by bacterial respiratory pathogens is known to be the underlying driver of massive mortality events, the frequency and intensity of die-offs are inconsistent, and infections are not always manifested in disease. Therefore, die-offs may be dependent upon certain ecological or environmental conditions—the understanding of which could yield management alternatives to help reduce the frequency of outbreaks. Identifying how disease, nutrition, and population densities interact is critical in developing management options for and improving our understanding of pneumonia in bighorn sheep.

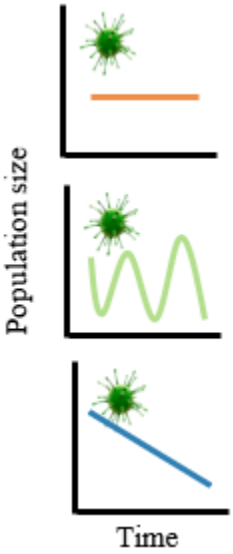


Figure 1. Varying population dynamics in bighorn sheep populations in Wyoming, despite many populations having the same pathogens.

In Wyoming, the Statewide Bighorn Sheep Disease Surveillance Program, led by the Wyoming Game and Fish Department, has documented many bacterial pathogens in herds across the state. While some herds continue to do well, others have undergone repeated pneumonia outbreaks and recoveries, and others have never recovered from die-offs. By adding long-term research on bacterial pathogens, nutritional condition, reproduction, predation, lamb survival, and forage conditions sheep from three herds over time to the ongoing Disease Surveillance Program, we hope to disentangle the relative roles of each of those components on crashes and recoveries of bighorn sheep populations throughout the state.

Captures and Disease Sampling

Starting in March 2015, the Haub School of Environment and Natural Resources, Wyoming Cooperative Fish and Wildlife Research Unit, and the Wyoming Game and Fish Department, in collaboration with the US Fish and Wildlife Service, the Shoshone and Arapaho Tribes of the Wind River Indian Reservation, and the National Elk Refuge captured adult female bighorn sheep in the Jackson, Cody, and Whiskey herds of northwest Wyoming. Each December and March thereafter, our objective was to recapture those same adult females to monitor how their recruitment status, disease status, nutritional condition and reproduction status varies seasonally.

During captures numerous disease-related samples are collected from each animal including nasal and tonsil swabs, feces, and blood following protocols established through the Statewide Bighorn Sheep Disease Surveillance Program. Samples are analyzed by the Wildlife Disease laboratory to identify respiratory pathogens and macro-, and micro-nutrient levels. We specifically test sheep for *Mycoplasma ovipneumoniae (M. ovi), Leukotoxin of Bibersteinia trechalosi, Manneheimia haemolytica*, other *Manneheimia* species, *and Pasteurella multocida*, all bacterial pathogens associated with symptomatic pneumonia. Based on test results from our 2015 – 2017 samples, although the Cody, Jackson, and Dubois herds possessed a similar suite of pathogens, their prevalence varied depending upon pathogen and season (Figure 2). Future work will seek to assess whether previous experiences of individual animals affect their probability of becoming infected, becoming symptomatic, and their subsequent effects on vital rates. Intriguingly, some pathogens (*M. ovi, B. trehalosi,* and *Manneheimia spp*) have lower detection rates in December than in March (Figure 2). Future work will also investigate seasonal patterns of detection rates.

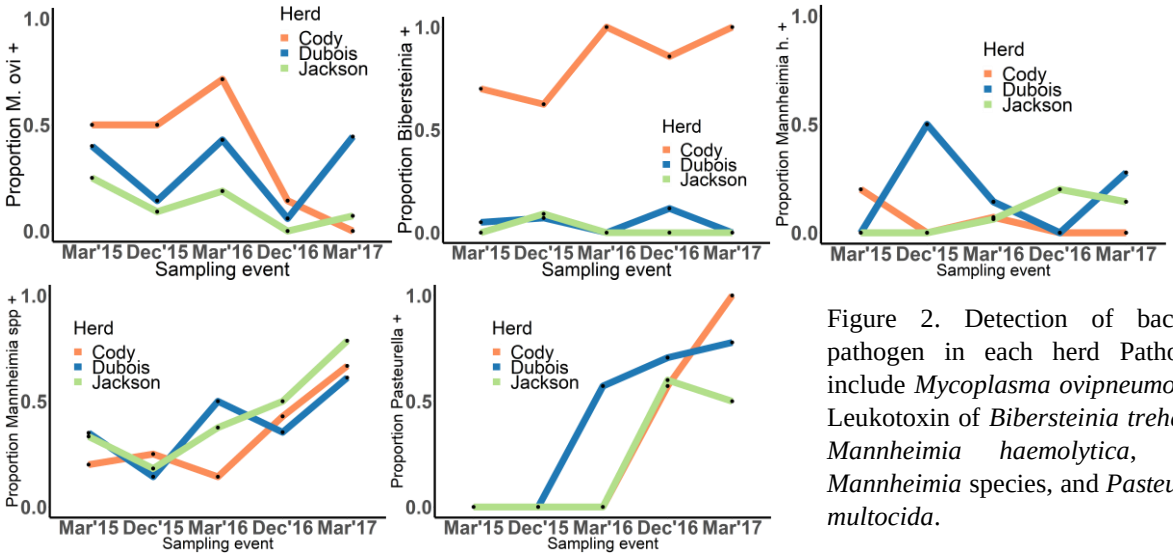


Figure 2. Detection of bacterial pathogen in each herd Pathogens include *Mycoplasma ovipneumoniae*, Leukotoxin of *Bibersteinia trehalosi*, *Mannheimia haemolytica*, other *Mannheimia* species, and *Pasteurella multocida*.

Recruitment and nutritional condition

Each spring, we determine pregnancy of captured females. Interestingly, pregnancy rate of the Dubois herd has remained relatively constant across the five years of this study, while pregnancy rates of the Cody and Jackson herds have fluctuated over time (Figure 3). During autumn captures, we also assess lactation status of females, which can provide corroborative evidence of recruitment (if a female is still lactating), or if she lost her offspring earlier in the summer or fall (if she is no longer lactating). Lactation rates and thus, lamb recruitment was particularly poor for sheep in Dubois during summer 2016 and 2018 (Figure 4).

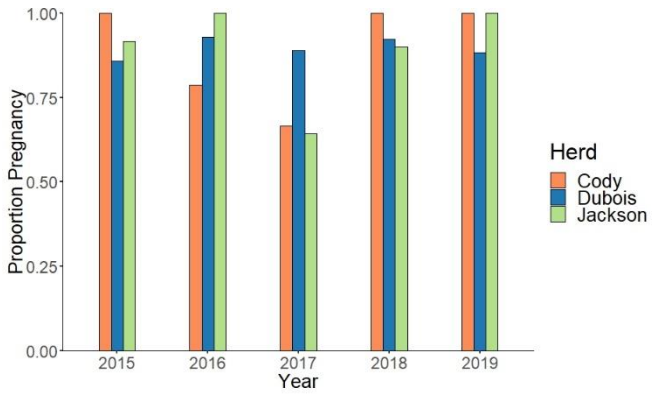


Figure 3. Proportion of pregnant adult female bighorn sheep in March 2015 -2019 in the Cody, Dubois, and Jackson herds of northwest Wyoming.

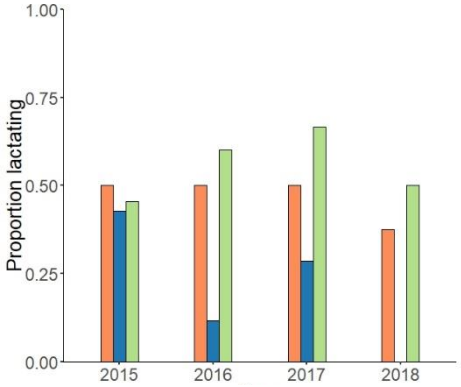


Figure 4. Proportion of adult female bighorn sheep that were lactating in December 2015 – 2018 the Cody, Dubois, and Jackson herds of northwest Wyoming.

As of the summer of 2019, some of the most interesting results stem from nutritional dynamics across the different populations. The Dubois herd appears to be nutritionally limited on their summer ranges, while experiencing adequate winter conditions. Conversely, the Jackson herd appears to have robust summer ranges, but experience poorer conditions when on winter ranges than the Dubois herd. Finally, the Cody winter and summer ranges appear to fall somewhere in between those in Dubois and Jackson (Figure 5). The Dubois herd often has the lowest nutritional condition, despite having less energetic demands associated with lactation because recruitment has been so poor.

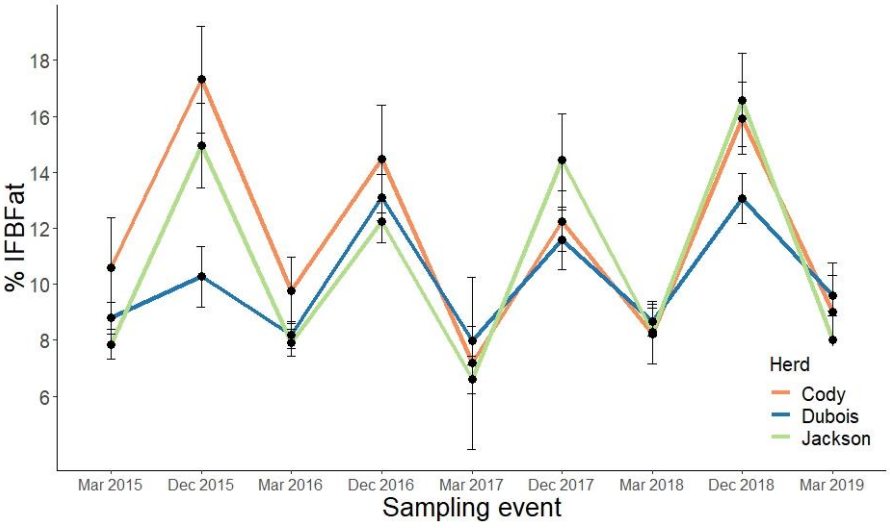
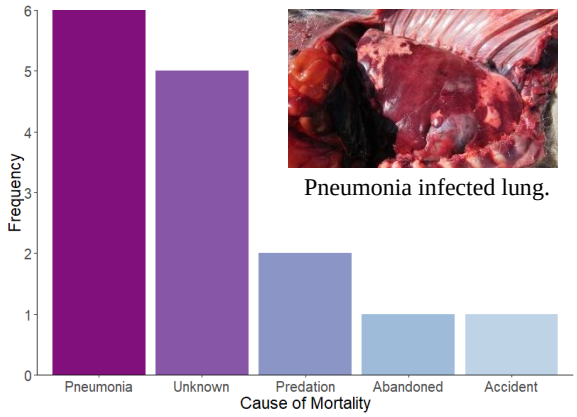


Figure 5. Ingesta-free body fat (%±SE) of adult female bighorn sheep from March 2015 to March 2019 in the Cody, Dubois, and Jackson herds.

Nutritional condition of an animal is a product of its environment and therefore, represents the energetic gains and deficits experienced by an animal, as well as the nutritional reserves it carries into the upcoming season. Assessing nutritional condition of an animal is a critical step in understanding how disease, the environment, pregnancy and recruitment interact to affect bighorn sheep populations throughout the state.

Lamb survival

In March 2019, we fit pregnant ewes with vaginal implant transmitters (VITs) in order to capture and collar their lambs. During May – June 2019 we fit 14 lambs with GPS collars in the Dubois herd and 4 in the Jackson herd. When we capture a lamb, we take morphometric measurements, nasal swabs, and draw blood. The average weight of all lambs was 9.8 pounds.



Pneumonia infected lung.

Figure 6. Cause-specific mortality of the lambs captured in 2019.

As of October 10th, 15 of the 18 lambs have died. Early in the summer there were a few predations, one mountain lion and one coyote, accidents, and unknown mortalities, however most of the mortalities have been due to pneumonia (Figure 6). After the first pneumonia death, that was the only cause of mortality we observed (Figure 7). *Pasturella multocida* has been associated with most of the pneumonia deaths. The pneumonia deaths have varied from slow to rapid progression. Lambs suffering from slow progression were very emaciated, while the latter were in relatively good body condition. The pneumonia deaths occurred between 29 and 78 days old (Figure 7). The two remaining lambs in the Dubois herd were the last two born.

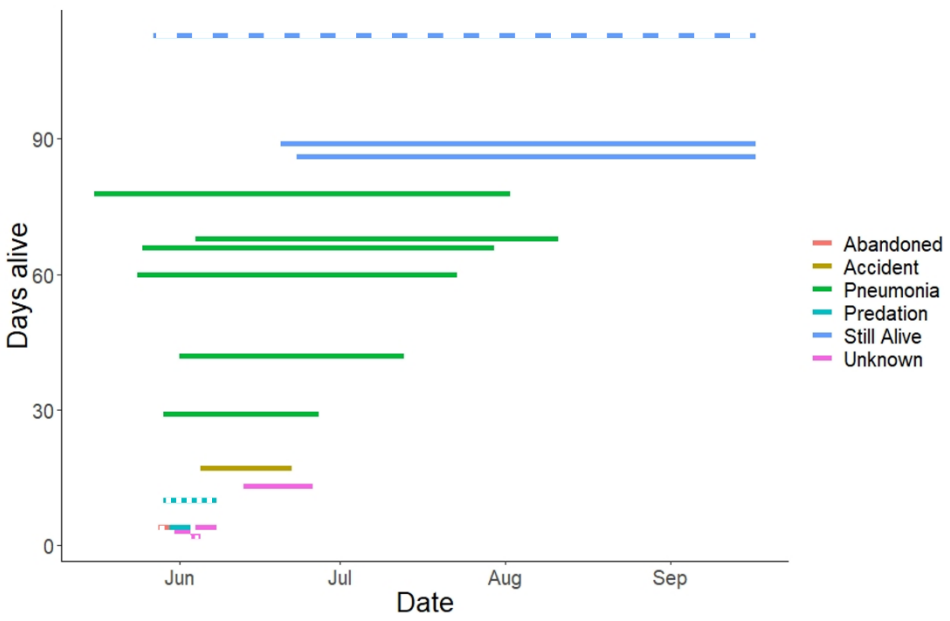


Figure 7. Timeline of birth and death dates for all lambs captured in 2019. Solid and dashed lines indicate the Dubois and Jackson herds, respectively.

Habitat assessment

We began habitat assessment of the Dubois and Jackson summer ranges in 2019. Our aim is to describe species abundance, species diversity, and nutritional quality of sheep core ranges. We also collect fecal samples for future diet and parasite load analyses and soil samples for trace mineral analyses. Our goal is to compare the summer ranges and sheep diets of the Jackson and Dubois herds, as the Dubois herd appears to be limited on summer range. Species diversity appears to be similar in the two ranges, however species abundance seems higher in Jackson (Figure 8).

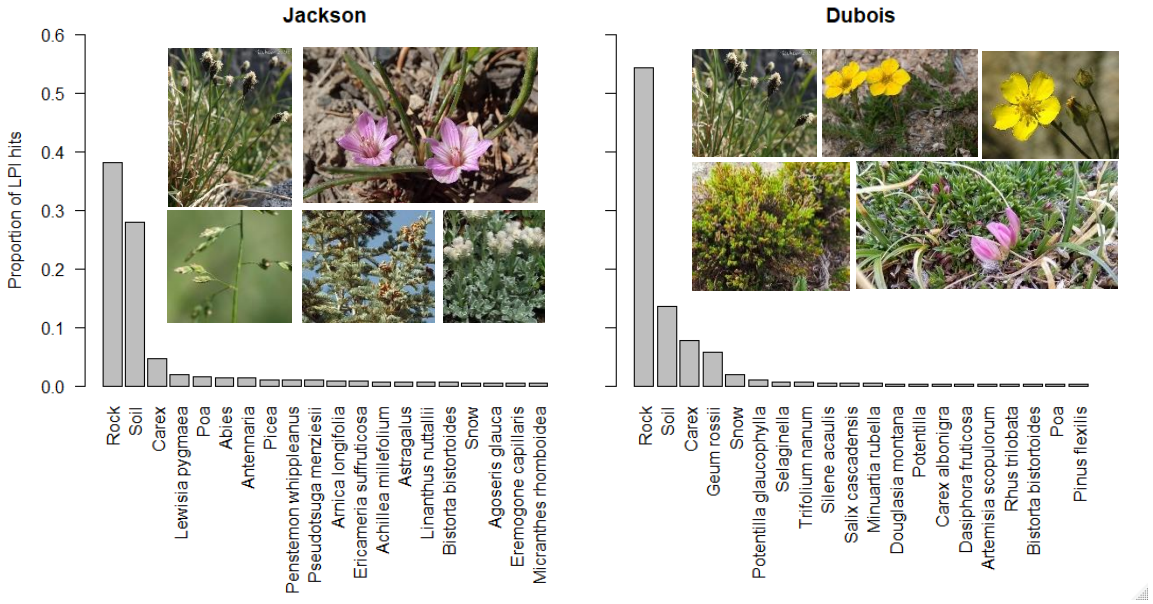


Figure 8. Proportions of the top 20 plant species or ground cover types from line-point-intercept transects in the Jackson and Dubois summer ranges.

Additionally, we have three habitat treatment plots on Dubois summer range in the Fitzpatrick Wilderness. Each plot contains grazed, ungrazed, and burned subplots, as well as combinations of these treatments. We simulated heavy grazing throughout the summer of 2019 and burned the plots and the end of August 2019. We will monitor species abundance, composition, and nutritional composition for the next two years.

Figure 9. Grazing exclosure on Middle Mountain (left) and Goat Flat (right). Right image image shows exclosure being prepared for fire treatment.

Looking forward

We aim to continue to recapture and monitor sheep in the Jackson, Cody, and Dubois herds until the winter of 2021, as well as cpautre lambs in Jackson and Dubois and assess summer ranges until the summer of 2021.

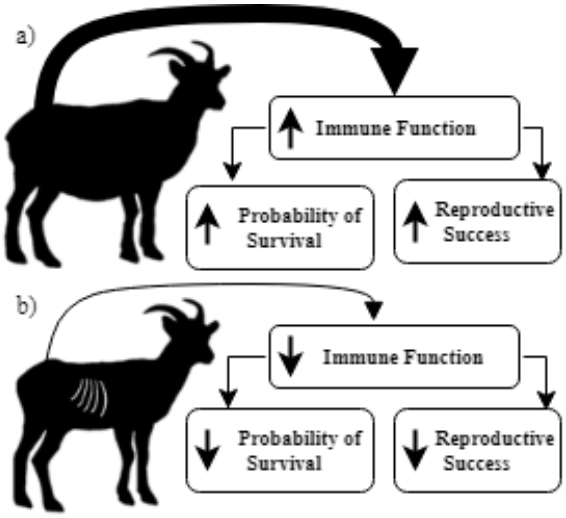


Figure 10. Potential relationship between nutritional condition, immune function, survival, and reproductive rates. Thickness of arrows indicates relative energy available to investment in immune function to sheep in (a) good and (b) poor nutritional condition.

The fundamental components underlying any large ungulate population (e.g., habitat quality and quantity, and density-dependent interactions) remain operational and yet, are commonly neglected when considering disease dynamics. We will piece together each females' history to describe how she interacts with her environment, understand her success to survive and reproduce or lack thereof, and how she fits within the population in which she resides. By piecing together the histories of each female we monitor, we hope to add an important piece to the puzzle of the complex interactions of environment, immune function, disease, and dynamics of our cherished bighorn sheep populations (Figure 10).

For more information, please don't hesitate to contact us.

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