



# Bighorn Sheep Nutrition- Disease Project

Exploring how nutrition and disease affect western Wyoming's bighorn sheep.

Large herds of bighorn sheep were once common across the rugged landscapes of western North America, but today's populations are far smaller and more restricted. Pneumonia, a respiratory disease originally introduced by domestic sheep and goats over a century ago, contributed to the population decline of bighorn sheep and remains one of the greatest conservation challenges for bighorn sheep across their range.

The effects of pneumonia, however, are far from uniform. Some herds decline rapidly and fail to ever recover, others cycle through variable crashes and recoveries, while some can tolerate infection with little loss. At the individual level, too, unique traits of the animal may shape how a sheep experiences disease. Bighorn sheep in high-quality habitats that are able to gain a lot of fat are more likely to clear their infections than animals who live in low-quality habitat and aren't able to pack on as much fat. Untangling the complex web of ecological factors that drive these differences is essential for developing effective management strategies and advancing our understanding of disease in complex wildlife systems.

Through collaboration with our partners at the Wyoming Game and Fish Department, US Fish and Wildlife Service, and Shoshone and Arapaho Fish and Game, we are investigating how nutrition, sociality, and disease interact to influence population dynamics.

## Project goals

Understand how ecological factors including nutrition, habitat quality, and social behavior influence the effect of pneumonia on bighorn sheep populations.

Work with collaborators to understand the impact of management strategies aimed at combating pneumonia.

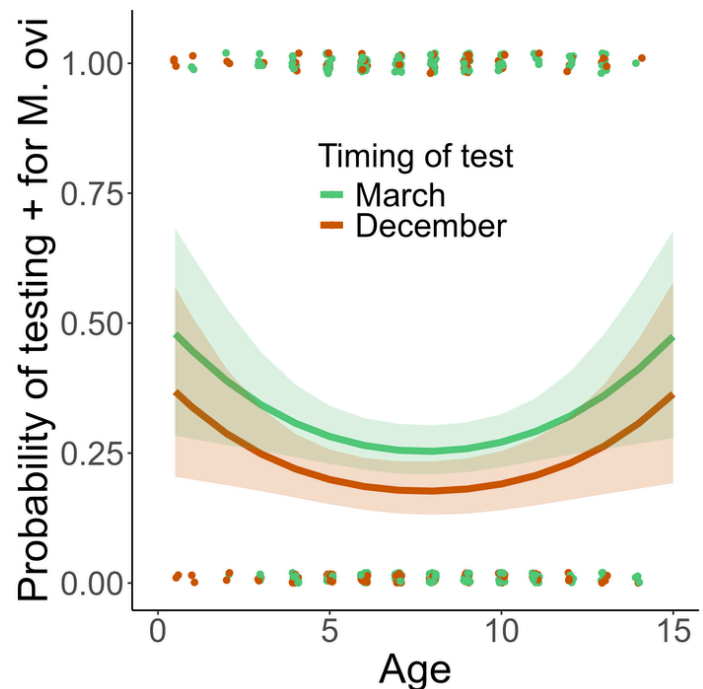
## Approach

We use GPS collars, remote sensing, and intensive fieldwork to study bighorn sheep behavior, life history and the habitats they depend on. Our monitoring strives to span the lifetime of each sheep, tracking disease status, nutritional condition, survival of both adults and lambs, and causes of mortality. By following individuals throughout their lives, we gain insights into how bighorn sheep persist in the face of disease and how this knowledge can guide management efforts.

## Research finding 1: Pathogen prevalence is seasonal and has implications for management.

Wildlife managers across the West combat the devastating effects of pneumonia by judiciously removing chronically infected bighorn sheep, a strategy commonly known as “test and remove.” This strategy has been a promising tool to mitigate pneumonia, but more information will help managers implement the most effective test and remove strategies.

Using our long-term dataset of pathogen prevalence that was collected from multiple populations across Wyoming in both spring and fall, we learned that pathogen prevalence was seasonal. Bighorn sheep were over 1.5 times more likely to test positive in the spring than in the fall. Although, an animal that tested positive in the spring was less likely to test positive again the next season than an animal that tested positive in the fall. These findings show that timing is an important consideration in test and remove programs, which can limit removals of animals that may be likely to clear their infections.



The u-shaped curve shows that younger and older animals are more likely to test positive for *Mycoplasma ovipneumoniae* (M. ovi; a pathogen strain that causes pneumonia), than animals in their prime. Across all ages, animals are more likely to test positive for M. ovi in March than in December.



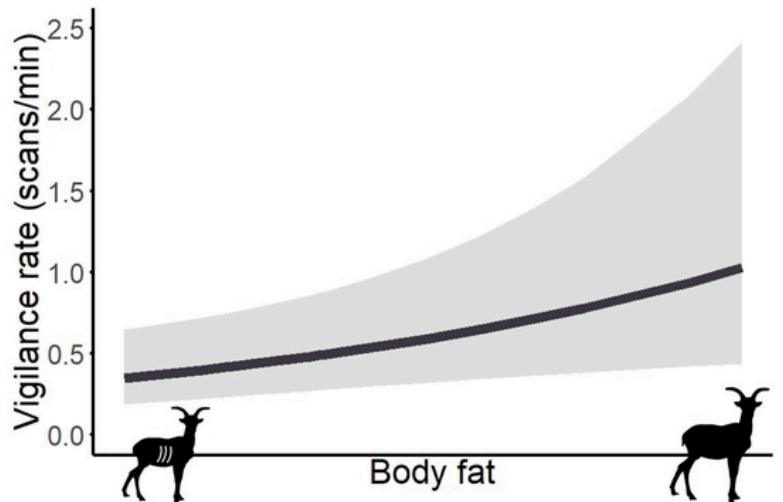


## Recent finding 2: Bighorn sheep adjust how they feed depending on their fat reserves.

When bighorn sheep and other large herbivores eat, they lift their head periodically to check their surroundings. This behavior, known as vigilance, helps bighorn sheep stay aware of any approaching threats, but it presents a tradeoff. If bighorn sheep never looked up they would be sitting ducks for nearby predators, but if they are always on the look out they won't eat enough to stay alive and raise their lambs.

Bighorn sheep adjusted their vigilance behavior depending on their energetic needs, which varied based on their nutritional condition. Bighorn sheep that entered summer with more body fat had higher vigilance rates, suggesting that they are able to devote more time to predator detection while still getting all the food they need. This finding highlights the flexibility bighorn sheep have in adjusting their behavior, which is an encouraging sign for populations that contend with disease.

We are excited to continue exploring the relationship between behavior and disease and whether or not bighorn sheep use behavior as a tool to cope with the burden of fighting off disease.



Bighorn sheep that start summer with greater fat reserves are more vigilant than skinny sheep. These fat sheep are able to devote more time to predator detection while still getting enough food.



These findings result from hours and hours of observing bighorn sheep from afar. The photo to the right shows a collared ewe and her collared lamb through a spotting scope!

## ⋮ Upcoming work.

Bighorn sheep undergo seasonal shifts in fat reserves driven by changing food resources and environmental conditions. Building on our previous work examining how summer-range habitat influences fat reserves, we now turn to the winter period, where far less is known about how forage, varying environmental conditions, and differences in winter ranges affect pathogen prevalence, fat reserves, and ultimately survival during this harsh time of year. To tackle this gap in knowledge, we are studying what food resources are available to sheep and how sheep use those resources over winter, coupled with how bighorn sheep navigate fine-scale habitat features such as snow depth. By examining fine-scale habitat features,

we aim to reveal how winter environments influence disease vulnerability, overall health, and resilience of both individual bighorn sheep and their populations.



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## Project leads



This project is led by master's student Jack Gavin (left) and master's student Ty Hults (right).

## Partners and collaborators

The Bighorn Sheep Nutrition Disease Project benefits from being highly collaborative in development, operations, and funding. We are fortunate to partner with the Wyoming Game and Fish Department, the Wyoming State Veterinary Laboratory, the US Fish and Wildlife Service, and the Shoshone and Arapaho Fish and Games, collaborations through which we can pull expertise from managers, disease specialists, and ecologists. Funds have been provided by the Wyoming Game and Fish Department, Wyoming Game and Fish Commission, Wyoming Wildlife and Natural Resource Trust, National Wild Sheep Foundation, Wyoming Wild Sheep Foundation, Wyoming Governor's Big Game License Coalition, Bureau of Land Management, Wyoming Animal Damage Management Board, Wyoming Wildlife Livestock Disease Research Partnership, Teton Conservation District, and Bowhunters of Wyoming Inc. Special thanks to the Wyoming Game and Fish Department, United States Forest Service, Wyoming State Veterinary Lab, Bureau of Land Management, National Elk Refuge, Pinto Ranch, Steve Kilpatrick, Sara Bridge, Steve and Kara Losik, and Des Brunette for assistance with logistics, lab analyses, field housing, and fieldwork.