
Cirque Lake

Nutritional Carrying Capacity of Bighorn Sheep in the Teton Range

PROJECT OVERVIEW

Prepared by:

Ryan Martin, PhD Student, University of Idaho

Principal Investigator: Dr. Ryan Long, University of Idaho

NOVEMBER 2024


Hurricane Pass

Project Narrative

Bighorn sheep, particularly those in alpine environments such as the Targhee, Whiskey Basin, Jackson, and Absaroka herds, experience dramatic seasonal fluctuations in forage availability. At high elevations, forage quality peaks early in summer and begins to decline rapidly during autumn, creating a potential nutritional bottleneck as winter approaches. Despite the importance of nutrition as a factor limiting survival and reproduction in bighorn sheep, our understanding of their diet and the capacity of alpine habitats to sustain resident populations remain poorly understood.

Our project aims to help close this gap by estimating nutritional carrying capacity of bighorn sheep in the Teton Range, which, as the smallest and most isolated of Wyoming's four native core herds, is a priority for future conservation efforts. Nutritional carrying capacity is defined as the number of animals that a landscape can support based on availability and quality of forage, movement behavior, and dietary decisions of individuals. Historical accounts indicate that the Teton Range once supported a greater number of sheep than are currently present, and reasons for this trend could be related to nutrition. Teton sheep once had access to low-elevation winter ranges, but habitat fragmentation, fire suppression, and land use changes have now restricted their range to higher elevations year-round. Considerable resources have since been invested to accurately estimate population abundance, to protect wintering habitat, and to remove competing non-native mountain goats from the range. Quantifying nutritional carrying capacity is a critical next step in management of this population and will help managers establish realistic population objectives and develop strategies for sustaining or increasing the population.

To provide a science-based estimate of nutritional carrying capacity, our project combines intensive vegetation sampling, movement data, dietary analysis, and information on the nutritional requirements of reproductive ewes to model the nutritional landscape. Key variables such as the quality and

biomass of forage plants will be used to create dynamic maps that track variation in forage availability and quality in both space and time. These maps will allow for an assessment of forage availability during critical periods such as summer and autumn when the nutritional needs of lactating ewes are greatest, and when sheep accrue critical fat reserves to survive winter. Moreover, understanding how ewes, which drive population growth, use the nutritional landscape available to them is central to determining whether nutrition interacts with other factors such as predation risk to limit population performance.

Another key component of our project is quantifying diet composition of alpine bighorn sheep. Despite the critical role of diet in shaping the health and survival of bighorn sheep, little is known about their specific dietary choices in alpine environments. Fecal samples will be collected and analyzed using DNA metabarcoding to identify which plant species are consumed by sheep and in what proportions. These data will provide a detailed understanding of how diet shifts seasonally in response to changing forage availability and of how individual diets differ within the population. Linking diet composition to the availability and quality of forage will help wildlife managers better understand how bighorn sheep adjust their foraging strategies to meet their nutritional needs in the face of various constraints. This information is crucial for understanding how sheep navigate periods of nutritional scarcity and how diet impacts individual performance and population dynamics.

In addition to providing valuable information for managing the Targhee herd, the methods and tools developed during this project can be applied broadly to other alpine herds in Wyoming. For example, our models can be adapted for application to the Whiskey Basin, Jackson, and Absaroka herds, which occupy similar high-elevation environments and face comparable limitations in forage availability.

Finally, these tools can also be used to assess prior efforts by the Wyoming Wild Sheep Foundation to protect habitat and reduce the risk of disease in the Targhee herd. We plan to assess former grazing allotments in the western portion of the range to compare forage availability in areas that experienced historic overgrazing by domestic sheep relative to those that have been relatively protected.

Moose Basin


Ranger Peak

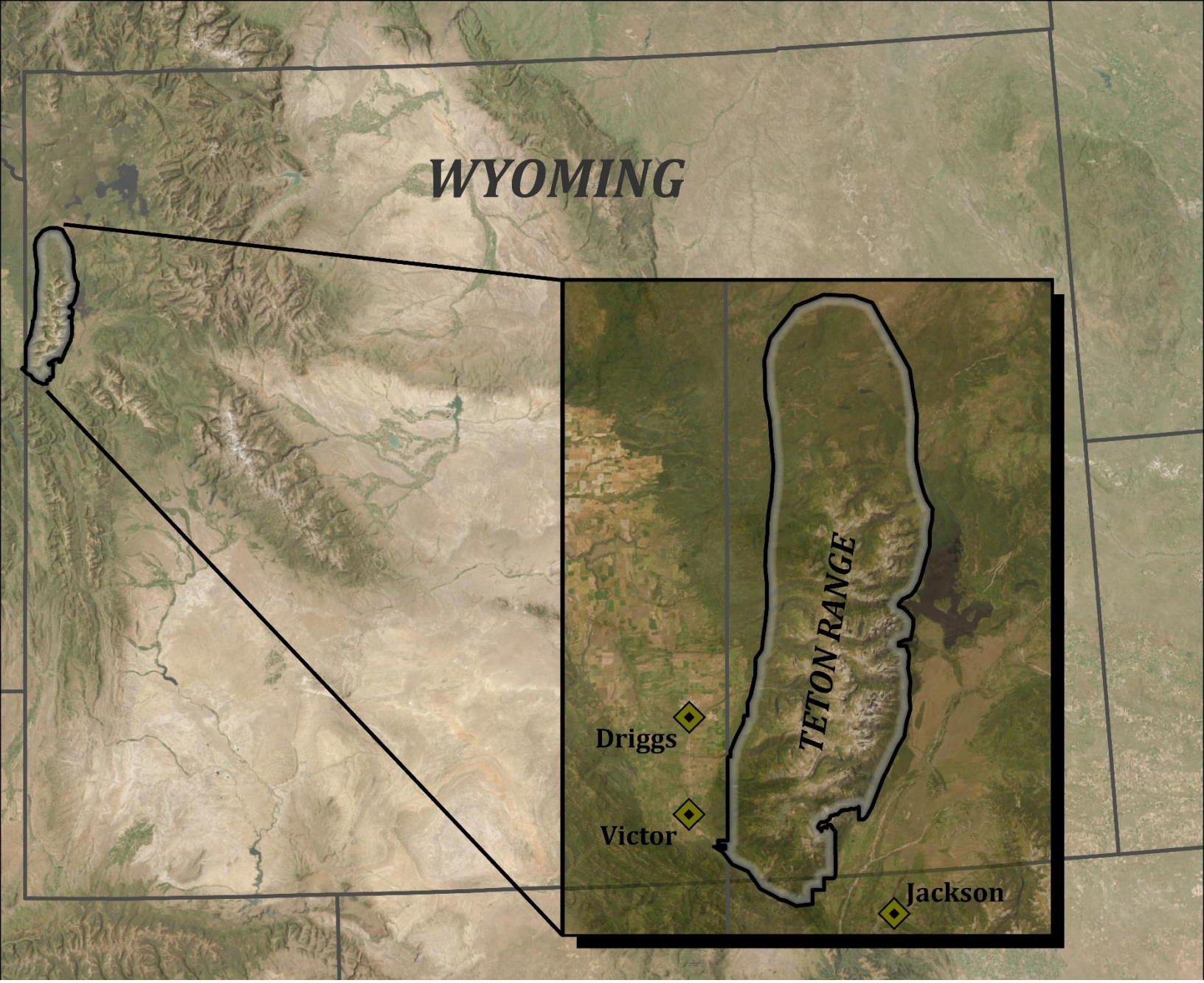
Project Objectives

Assess the nutritional carrying capacity of bighorn sheep in the Teton Range and provide collaborators with tools necessary to map forage resources under past, current, and future conditions.

Assess and compare the forage habitat quality of previously closed sheep grazing allotments to forage habitat in Grand Teton National Park.

Quantify seasonal variation in the composition of bighorn sheep


Avalanche Divide

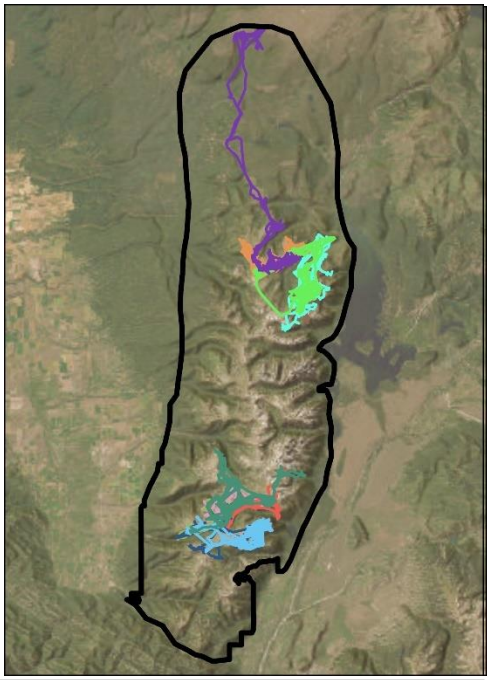


Data Collection

STUDY AREA

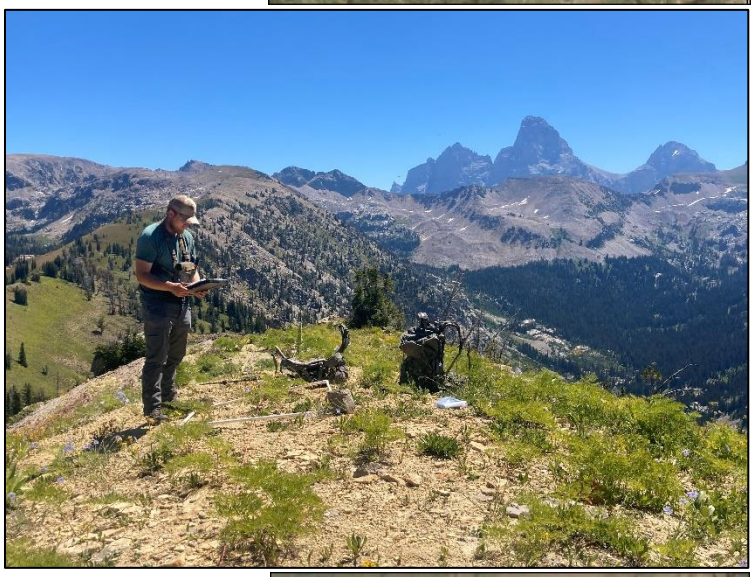
The 613 square-mile study area is comprised solely of federally managed land under four different jurisdictions. It makes up portions of Grand Teton National Park, Caribou-Targhee National Forest, Bridger-Teton National Forest, and Yellowstone National Park within the Greater Yellowstone ecosystem. Relative to other sheep populations in North America, Targhee sheep reside in highly seasonal and relatively forb dominated habitats. Bighorn sheep within the Tetons form two disjunct subpopulations in the south-central and north-central portions of the range, totaling approximately 125 individuals. Due to migration loss, Targhee herd sheep inhabit high-elevation (8000-12000 ft) range year-round.

MOVEMENT DATA



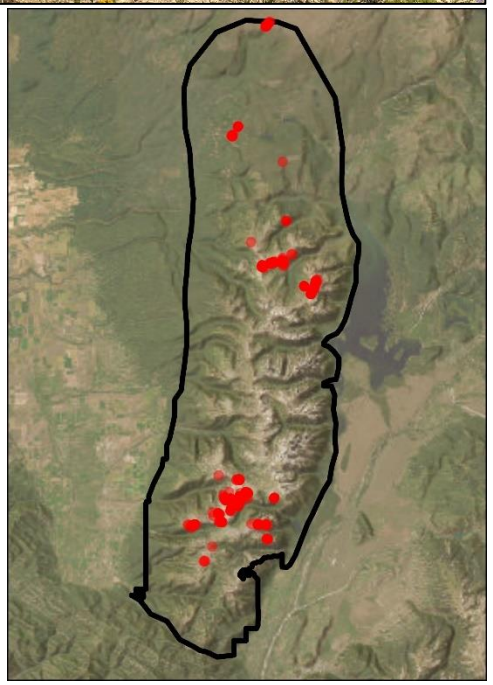
From November 2023 – November 2027, we will use GPS collars to monitor movements and space-use behavior of up to 30 adult ewes within the Teton Range. We will use a net-gun to capture sheep (around 15 per year) from a helicopter during early winter of 2024 and 2025. During capture and handling, we will fit GPS collars to each sheep that are programmed to collect hourly locations from July 1 – October 31, coinciding with sheep presence on summer and autumn ranges. GPS collars will be programmed to detach from the sheep remotely after approximately 2 years due to battery-life constraints. In late November 2023, we collared 14 ewes, split evenly between the northern and southern subpopulations. We plan to collar up to 16 additional ewes in mid-November 2024, targeting areas where we do not currently have collared individuals. The figure in the upper-right panel shows the movement of collared ewes from July – October of 2024.

VEGETATION SAMPLING



To create spatiotemporally dynamic maps of forage availability for bighorn sheep, we have intensively sampled sheep habitat throughout the Teton Range. At each sampled location, we classified ground cover and phenological stage (newly emergent, budding, flowering, fruiting, mature, cured) of each plant species and clipped corresponding biomass and quality samples to provide the basis for predicting suitable forage biomass in the rest of the range. We sampled vegetation from July – October 2023 and 2024, a period when ewes are provisioning their lambs and accruing critical fat reserves to survive the winter. The picture in the center right shows a researcher sampling vegetation on an alpine ridge in the Teton Range.

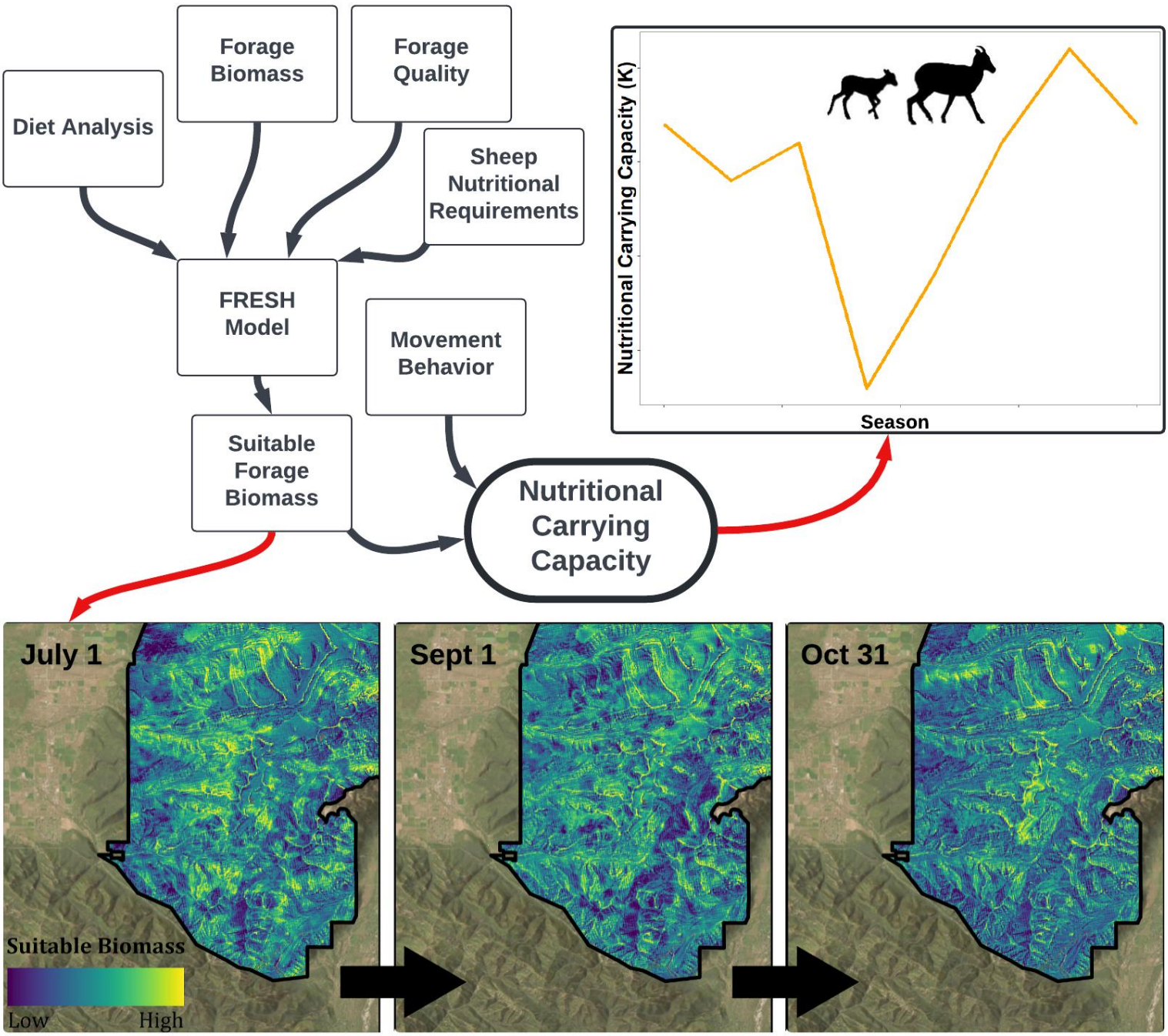
FECAL COLLECTION



To quantify the diet of alpine bighorn sheep, we collected fecal samples in bighorn sheep habitat from July – October 2024. Samples were collected from areas used by collared individuals. Our team collected 550 fecal samples spread evenly across the field season. Diet of bighorn sheep will be quantified via DNA metabarcoding of each sample. This analysis will estimate the proportion of each plant species present in the diet as well as seasonal changes in diet from July – October. Our team plans to continue collecting additional fecal samples from July – October 2025. The figure in the lower right-hand panel shows areas of fecal sample collection in the 2024 field season.

Assessing Nutritional Carrying Capacity

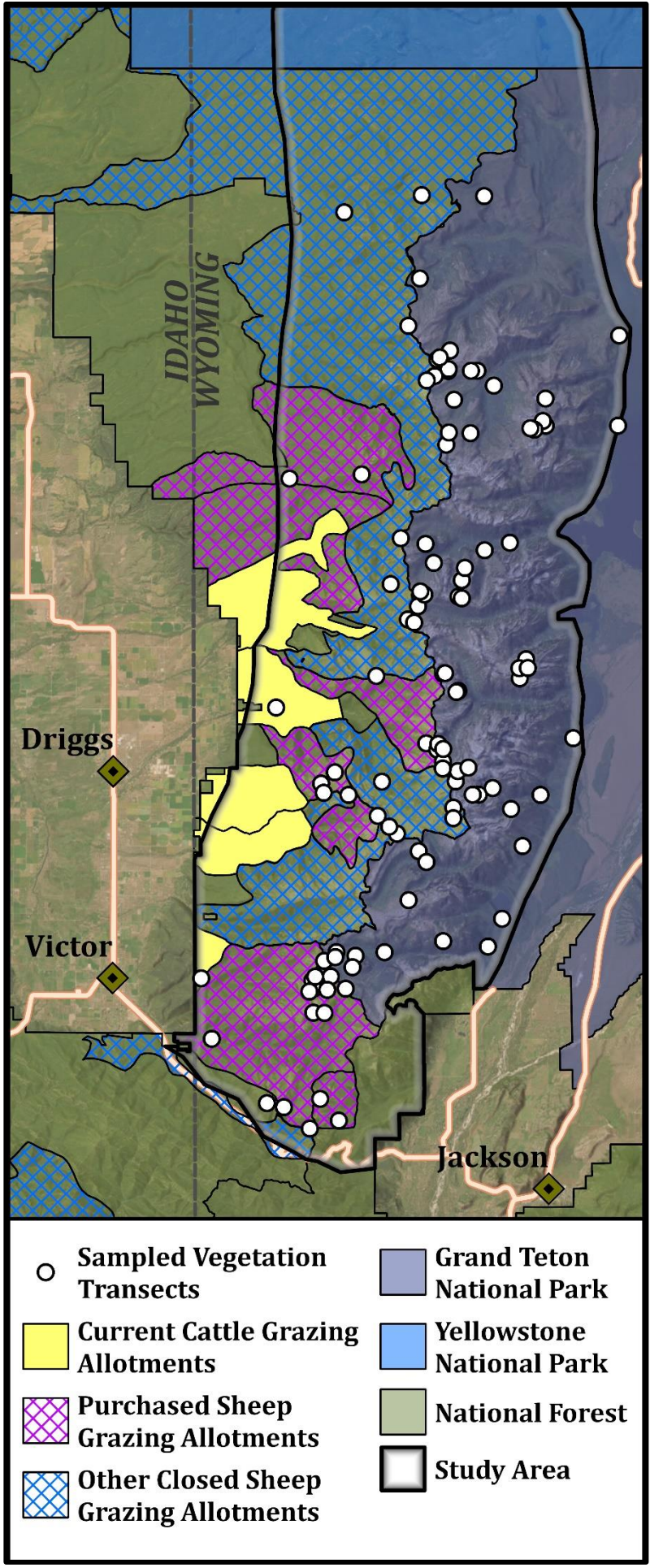
Data on diet, forage biomass, and forage quality will be combined with the seasonal nutritional requirements of reproductive ewes to produce estimates of suitable forage biomass at each sampled point throughout the range. These point estimates will then be used to build a predictive model of suitable biomass across the rest of the landscape (see maps below). These spatiotemporally dynamic maps quantify the forage base (foodscape) available to bighorn sheep. After establishing this forage base, nutritional carrying capacity can be estimated by constraining maps of available forage by the behavioral tendencies of bighorn sheep. For instance, bighorn sheep spend most of their time close to escape terrain to avoid predation, so not all forage on the landscape is equally available to be consumed. Incorporating these behaviors will provide a more realistic estimate of how many animals the range can support based on both forage availability and behavior. We will provide the finished software tool to our collaborators and other interested parties to estimate forage resources and carrying capacity, and to aid in the development of management objectives. The figure below provides a visual illustration of estimating nutritional carrying capacity.



Assessing Former Sheep Grazing Allotments

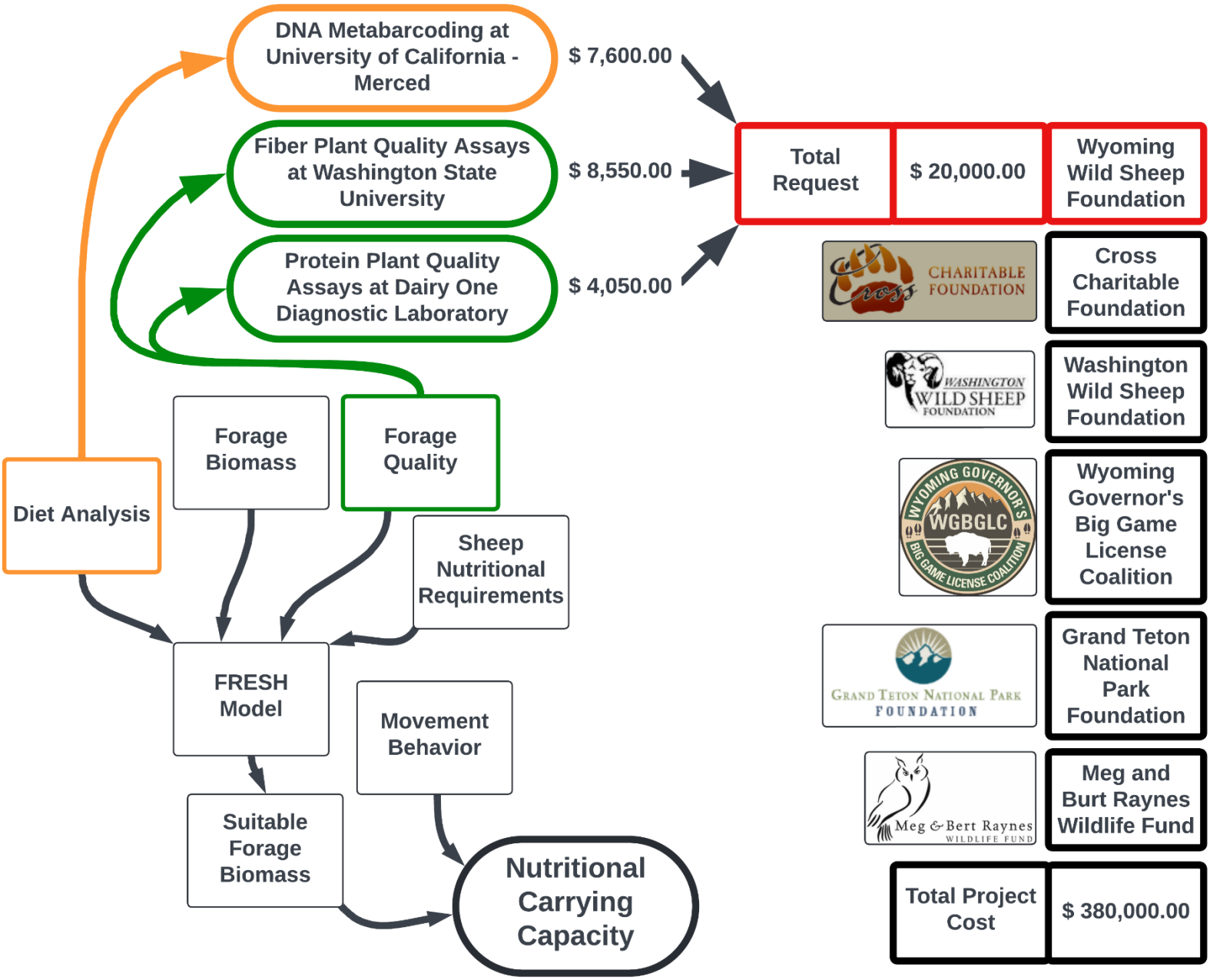
In the late 19th and early 20th centuries, the Teton Range experienced intense rates of overgrazing by domestic sheep, cattle, and horse herds. This intense grazing continued after the establishment of the Caribou-Targhee National Forest in 1908 and began to be gradually reduced in response to overgrazing from the 1920s onwards. However, these previously overgrazed areas were subject to erosion and flooding. Prior research by Michael Whitfield in the late 1970s and early 1980s identified areas of poor forage quality due to previous overgrazing in areas such as upper Game Creek and Andy Stone Creek over 30 years after grazing by domestic sheep had ceased. In the 1990s, the Wyoming Wild Sheep Foundation made considerable investments to facilitate the purchase of several sheep grazing leases (red hatched areas) in the Teton Range to protect foraging habitat and reduce the risk of epizootic disease within the Targhee herd. This effort added to previous efforts by the Forest Service to administratively close other domestic sheep grazing leases (blue hatched areas). Collectively, these retired allotments overlap with bighorn sheep summer range as well as bighorn sheep winter range.

Our project is interested in evaluating forage habitat in these former grazing allotments and drawing comparisons to similar areas within Grand Teton National Park, which has experienced comparatively less overgrazing. To accomplish this objective, we will use the foodscape mapping tools being developed under the other objectives of the project to build area-specific foraging maps that would facilitate easy comparison. Qualitative comparisons can also be made with areas with high levels of historic grazing. Former lease areas are well represented by the intensive vegetation sampling that we completed in 2023 and 2024. Of the 118 transects that we have sampled, 45 fall within former domestic sheep grazing areas.

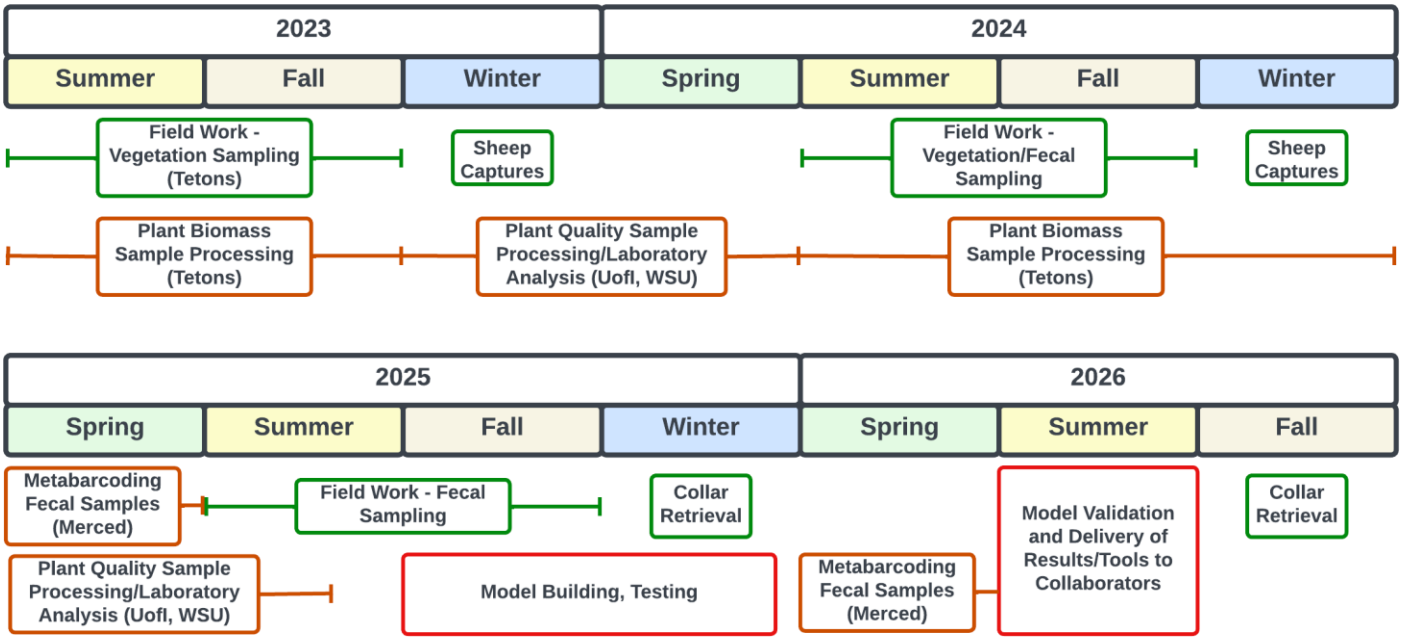


Funding Request

Producing a tool to accurately estimate nutritional carrying capacity requires combining several different data sources. Funding from the Wyoming Wild Sheep Foundation would benefit this project in two key areas. The first is analyzing bighorn sheep fecal samples for diet content. This analysis will be performed by the grantees in collaboration with the HERD Lab at the University of California – Merced. The other key component involves measuring the quality of forage plants available to bighorn sheep throughout the growing season. To accomplish this task, we will process plant tissue samples at the University of Idaho and send those samples to the Wild Herbivore Ecology Lab at Washington State University to be analyzed for fiber content. Additionally, plant tissue samples will be analyzed for protein content at Dairy One Diagnostic Laboratory. The remaining costs associated with each of these steps are outlined in the figure below.



Project Timeline




North Cascade Canyon