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Session Topic Choices:
1. Emerging Technologies **2.** Conserving Native Plant Communities

Grass to Galaxies: Uncovering Vegetation Quality Patterns with Hyperspectral Methods in the Yellowstone Northern Range

Background:

Temporal variation in primary productivity is a major driver in spatial and temporal dynamics within a landscape, and yet is grossly understudied. Multispectral remote sensing, such as Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI), are often used to evaluate vegetation patterns in ecosystems. While multispectral methods can measure quantity directly, it can only infer quality. The recent development of hyperspectral imaging techniques may provide a higher resolution method of plant quality mapping over space and time. This progress provokes the questions: (1) How effectively can hyperspectral methods quantify forage quality? (2) Can hyperspectral methods provide more information about the abundance of high-quality forage than NDVI and EVI? (3) What are the spatiotemporal variations in the quantity of high-quality forage, and the potential drivers of these patterns? To answer these questions, spectral reflectances, environmental predictors, and vegetation samples will be analyzed and compared over the entirety of the summer growth season. There is a notable positive correlation between the start of season growth date (SOS) and elevation, with lower elevations exhibiting an earlier SOS date and class, while higher elevation areas show a later SOS date and class, indicative of the "Green Wave Hypothesis". This theory is of great importance to conservation managers as herbivores follow the new high-quality growth along the “Green Wave” making them extremely sensitive to vegetation seasonality, and availability.

Methods:

My research is distinctive, as it is in the relatively new field of plant quality mapping, implementing cutting edge hyperspectral technology to quantify the forage quality patterns across a landscape from the grass up. The study area is 322 km with 1,524 m elevation gain between the Paradise Valley and the high elevation grasslands, and will be split into three Start of Season (SOS) classes, based on average growth start date and the correlating elevations. For NDVI and EVI lab analysis each SOS class will have 10, 20x20 meter plots selected using Sentinel-2 data. The hyperspectral and vegetation sampling in the field will be 10 more 20x20 meter plots selected to represent a heterogeneous variety of vegetation for each SOS class every 14 days. The vegetation samples taken in the field will be used to estimate: nitrogen content, *In-vitro* dry matter digestibility (IVDMD), crude protein content, and chlorophyll A content. The vegetation samples will provide an accuracy baseline for the comparison of the three remote sensing method's spectral reflectance data.

Conclusions:

Data collection will start in May of 2024, so I will begin yielding results after this date. I hypothesize hyperspectral reflectance data will better capture plant quality pattern dynamics, than the NDVI and EVI analysis, and drivers like elevation, water, and nutrient availability will significantly impact phenological growth phases. This distinctive comparison of NDVI, EVI, and hyperspectral method's accuracy in mapping quality and phenology will allow landowners and conservation managers to develop simple and accurate protocols for monitoring ecosystem health, climate change effects, and population seasonal migrations.