NitroDrone: Are Drones the Future of Agricultural N Management?
Steamboat Springs (Routt County)

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Project Introduction

- In an agricultural settings, Nitrogen (N) is often a major concern because it is a common fertilizer and an even more common pollutant.
- Monitoring for N in large fields can be costly and time consuming, so many are exploring other options, like drones.
- Drones have been shown to accurately estimate N content in other systems but not yet in mountain hay meadows, which can be complex.
- Colorado has a large ranching community that relies on these hay meadows to feed cattle, so an improved method of N management would benefit ranchers and the environment.

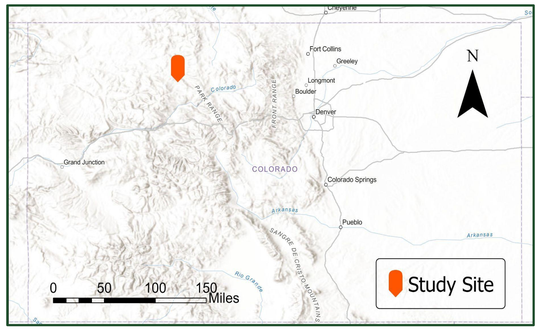

Figure 1. Map showing the location of the study site in the Yampa Valley.

Research Question and Hypothesis

Can multispectral drone data be used to accurately predict plant N content in a mountain meadow hay system?

Drone-derived multispectral imagery can serve as a proxy for N concentrations in living plant tissue,and potentially identify management zones for future, more precise N fertilizer applications.

Project Goals

- Collect data to determine if there is a statistically significant correlation between drone spectral data and N in mountain meadow hay grasses found at the study site.
- Use correlations to create N management zones for precise fertilizer application, and potentially reduce nonpoint source pollution.

Methods

Workflow

Conduct a Multispectral Drone Flight

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Stitch NDVI/NDRE images in Pix4d to create a high-resolution map

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Use NDRE values to determine sampling locations based on spatial and NDRE variances

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Sample top 12” of soil and 1 sq ft of plant biomass at determined locations, species ID

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Create quantitative relationships between NDRE, NDVI and N content using tested soil and biomass

Drone Imagery Collection

Figure 2. DJI M3M drone used to create high resolution, multispectral maps.

These drones use the near infrared, red edge, red, green, blue light spectra to calculate vegetation indices that can characterize crop health, and in this case, plant N:

- **NDVI:** Normalized Differential Vegetation Index.
- **NDRE:** Normalized Differential Red Edge Index.

Sample Collection

- The study site is a privately owned ranch in the Yampa River Valley.
- Statistical software determined our sampling points based on drone data. We would sample plant and soil N at these 12 locations.
- Plant samples would then be dried and ground for nutrient analysis using a C:N Analyzer.

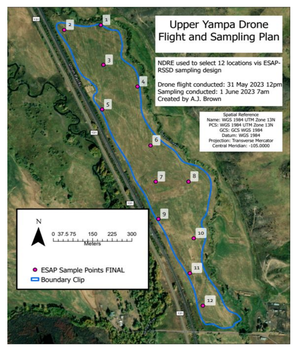


Figure 3. Map showing the sampling points throughout the hay meadow.

Results

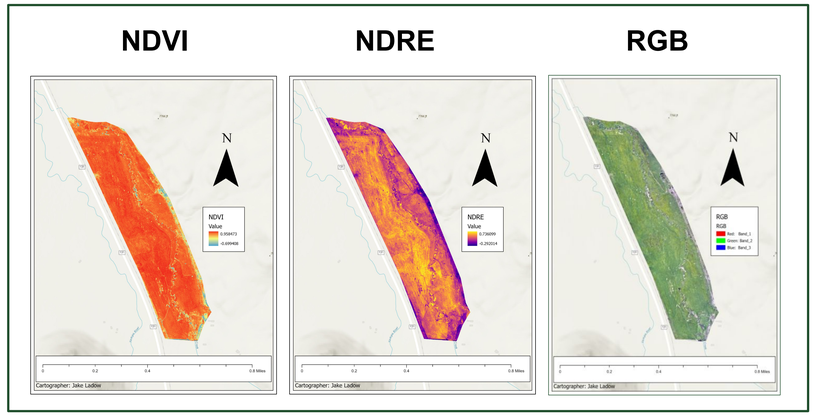


Figure 4. Three maps generated using the drone data collected in the hay field on July 10th 2023. Each shows a different type of map that can be created using the drone imagery.

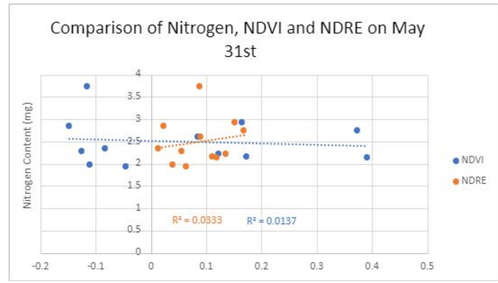
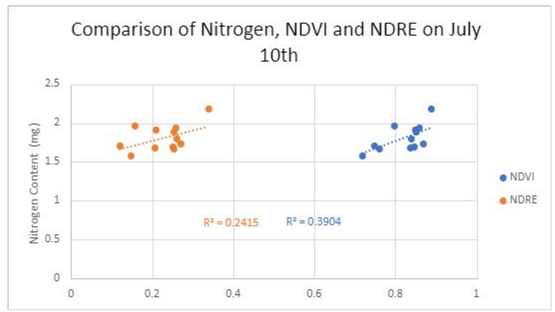


Figure 5. A chart showing the correlations between the N Content, NDVI, and NDRE values early in the season.

Figure 6. A chart showing the correlations between the N Content, NDVI, and NDRE values in late summer.



Conclusions and Future Work

- Preliminary data suggest that significant correlations do exist between plant N, NDVI, and NDRE but the nature of that relationship is highly dependent on the time of year.
  - Additionally, these relationships are “noisy” and require further investigation as to what other factors are at play.
- The data from this summer and future years will be used to create N management zones for precision fertilizer application recommendations.