The Application Benefits of Drone Technology on Rangeland Restoration

BY

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Introduction

The evaluation of land in New Mexico is imperative to the success of our agricultural industries. From cattle production to chile products, all agricultural systems ultimately depend on the health and productivity of the land. Through my internship with the Sierra Soil and Water Conservation District, I gained hands-on experience evaluating rangelands and learned what is required to determine land needs and implement effective recovery and restoration projects. While traditional land evaluation methods remain widely used, there is a significant margin of error that is often overlooked due to limitations in efficiency and scale. With the introduction of drone technology, including infrared sensors, LiDAR, and high-resolution imagery, the accuracy of data collection has increased substantially. However, these advancements also come with increased costs associated with site evaluations. Recognizing the importance of accurate data for effective land management, I became interested in the growing use of drone technology and its applicability to real-world rangeland evaluations. Given the wide variety of rangeland types found across New Mexico, ranging from grasslands to desert and mountainous ecosystems, along with highly variable weather conditions, it is important to evaluate which method—traditional or drone-based—is most appropriate for collecting accurate and practical range data.

Objectives

The objectives of this project were to:

1. Determine which method, traditional or drone-based, is more efficient in collecting rangeland data.
2. Evaluate and compare the cost of operation for each method.
3. Compare the accuracy of the two methods while considering environmental factors and equipment limitations.
4. Determine which method is the most applicable, affordable, and accurate for meeting the needs of local landowners.

Background Information

The use of drones has increased rapidly across a variety of sectors, including healthcare, search and rescue, precision agriculture, rangeland science, and wildfire management. In rangeland monitoring specifically, drone technology has been utilized for approximately 20 years and has steadily advanced in both capability and availability. Despite this progress, widespread adoption has not occurred to the extent often assumed. My interest lies in the application of drone technology for land management and data collection related to rangeland and soil health. In smaller, rural communities such as those found in New Mexico, there is often skepticism surrounding the use of advanced technology on rangelands, particularly when artificial intelligence is used to identify target plant species impacting production and overall range condition (*T. Taylor, personal communication, March 12, 2025*). With guidance from advisors

and local private contractors, I researched the practical use of drone technology within the agricultural industry, focusing specifically on realistic applications in range management, restoration, and site evaluations. Drone technology is not always the most practical option due to the cost of operation and the conditions required for flight, including weather limitations, airspace clearance, proper equipment availability, and appropriate licensing (*L. Landlord, personal communication, May 3, 2025*). Additionally, flight restrictions vary depending on the drone's make, model, and manufacturer. Traditional range evaluation methods require in-person data collection and rely heavily on human observation. A limitation of this approach is that project sites are often represented by relatively small plots, commonly one-tenth of an acre, which may not accurately reflect conditions across an entire site (*T. Taylor, personal communication, March 12, 2025*). Larger project areas also require significantly more time to survey and are subject to human error. Because land management prescriptions depend directly on collected data, inaccuracies can result in ineffective or inappropriate management decisions.

Methods and Materials

The traditional method of range evaluation requires a minimum of two people establishing transects or plots that are believed to best represent the project site as a whole. Each plot typically measures approximately one-tenth of an acre. Data is collected by pacing, counting, and recounting target plant species within the plot. Once a count is determined, it is multiplied by ten to estimate plants per acre. This process is repeated across multiple plots throughout the project site. The values are then averaged to determine plants per acre (PPA), which is multiplied by the total acreage of the site. The drone-based method utilizes a combination of current and developing technologies to collect similar data. In the project site evaluated for this study, drone-based data collection required approximately four days for one individual to complete, compared to an estimated fourteen days using traditional methods. While drone technology demonstrated increased efficiency and improved data accuracy, it also resulted in a significant increase in operational costs. This comparison highlights the trade-off between time efficiency, accuracy, and affordability when selecting an appropriate land evaluation method.

Traditional Monitoring Method

The traditional monitoring method is the older and more trusted method of the two being compared. For this project I accompanied my advisor, Taylor Roberts, along with several other youth to the project site and began the process of selecting our first plot. The results of the walk took several hours to accumulate and while this doesn't seem like an issue, it is important to note that we did not walk the entirety of the project site, only several tenths of an acre. The traditional method allowed for the students to learn about the selected rangeland as well as interact with the

land owner in a more relaxed environment. The results and materials of the traditional monitoring method are shown below:

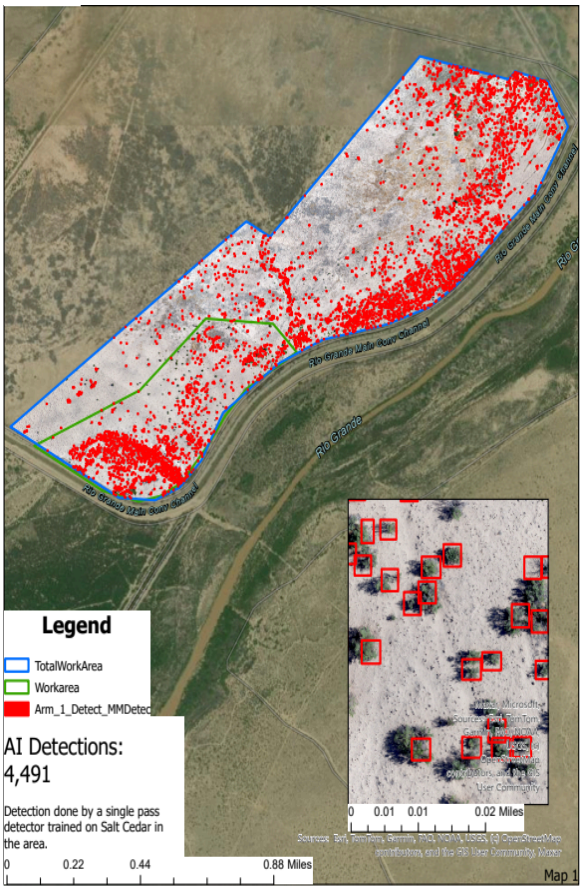
Plot Number:	Number of Plants:	Number per Acre:
1	8	80
2	2	20
3	4	40
4	10	100
5	3	30
6	15	150
7	6	60
8	3	30
9	7	70
10	5	50
Total: 10 Plots	Total *Tamarisk spp*: 63	Avg. per. Acre: 63



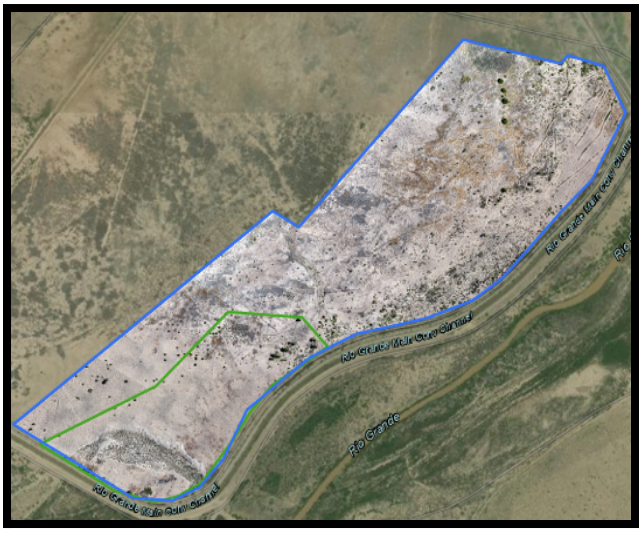
Materials used for traditional monitoring method.

Drone Monitoring

The same project site was monitored with a drone as it was with human eyes and estimates. When setting up the drone itself, it required a flight checklist, ensuring that all equipment was operational and responsive to the main controller and that the controller was receiving signals from both the drone and the GPS equipment. Once the checklist is filled out, the project map is uploaded onto the computer which converts it to a mission for the drone to complete on its own with human supervision. The batteries of the drone needed to be changed twice during the flight, causing the overall flight time to be roughly four hours. There were also times where the camera would fall out of sequence with the drone and there were several images lost due to this error. The camera was taking pictures of the land to run through a computer and artificial intelligence program as well as an overall converter later on. This eliminates the human error element to collecting data but still invites a degree of chance of lost information due to the amount of equipment and steps required to operate. The results, in map form, are shown below:



Artificial intelligence detection map.



Original map of project site with collected data.



Zoomed in picture of the project site.

All images taken from 350ft.

Results and Conclusion

The results of this project indicate that both traditional monitoring methods and drone-based monitoring methods are valuable tools for rangeland evaluation, depending on project size, objectives, and available resources. The traditional method is significantly less expensive and relies on minimal equipment, making it an accessible option for Soil and Water Conservation Districts and landowners, particularly on smaller project sites. This approach also allows for direct interaction with the land and landowners, providing educational benefits and practical field experience. However, traditional monitoring is limited by time constraints, plot size, and the potential for human error. Because only a small portion of large project areas is typically surveyed, data collected may not always represent site-wide conditions accurately. Drone-based monitoring demonstrated clear advantages in efficiency and spatial coverage. In this project, the drone was able to complete a full site flyover in approximately four hours, compared to an estimated fourteen days required to complete comparable coverage using traditional methods. High-resolution imagery and artificial intelligence-assisted analysis reduced reliance on human estimation and allowed for a more comprehensive evaluation of the entire project area. These benefits resulted in improved accuracy and reduced time requirements. However, drone operations required specialized equipment, trained operators, favorable weather conditions, airspace clearance, and significantly higher costs for smaller project sites. Additionally, technical issues such as lost imagery and equipment synchronization errors highlighted the ongoing challenges associated with emerging technologies.

Based on these findings, drone technology is not always the most practical option for small-scale projects, where traditional monitoring methods remain more cost-effective and

sufficient. However, for large or complex project sites where time efficiency and detailed spatial data are critical, drone-based monitoring may justify the increased cost. The results of this study suggest that the choice between methods should be determined by project scale, funding availability, agency capacity, and management goals rather than a preference for one method over the other.

The primary goal of this research was not to determine which method is superior, but to evaluate how each method can be applied effectively within real-world rangeland management. A combined approach that integrates traditional field observations with drone-based data collection may provide the most balanced solution, allowing land managers to maximize accuracy while remaining mindful of cost and logistical constraints. This research supports informed decision-making by conservation professionals and landowners seeking efficient, accurate, and practical strategies for managing New Mexico rangelands.

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