Rio Grande Trail Vegetation Monitoring

Goat Grazing Vegetation Management Study

GARFIELD COUNTY, COLORADO

DHM DESIGN
LANDSCAPE ARCHITECTURE
URBAN DESIGN + LAND PLANNING
ECOLOGICAL PLANNING

DECEMBER
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INTRODUCTION

As part of a three (3) year study, DHM Design Ecological Services was engaged to coordinate with Roaring Fork Transportation Authority (RFTA) to monitor the vegetative composition along established transects of the Rio Grande Trail to assess the effectiveness of utilizing goats to manage noxious and nuisance vegetation. 2021 will be the sixth consecutive year that RFTA has utilized goats to manage vegetation through the lower 20 miles of the Rio Grande Trail corridor. Through these efforts, it is RFTA's aspiration to shift the paradigm of weed control away from the use of herbicides, and instead utilize the goats to graze and maintain vegetation as a more holistic approach. To further guide the use and effectiveness of goats as a vegetation management strategy, this study has been commissioned to assess whether the current use of goats is providing the desired results based on this evaluation of native and non-native vegetation within the corridor.

The intent of these monitoring efforts was to observe how the use of goats is impacting the vegetation and to assess any observed trends in changing vegetation composition. This study does not consider any other variables that may be affecting the overall trend of vegetation composition throughout the corridor, including, but not limited to: climatic conditions, precipitation, seasonal variations, and pedestrian or natural disturbances. The assumption of this assessment is that the observed trends are correlated with the effects of the grazing goats with the understanding that additional factors contributing to the changing composition.

METHODS

Starting in 2019, DHM Design conducted four (4) vegetation monitoring surveys over a three (3) year time period on established monitoring transects. In the summer of 2019, three (3) 100-foot transects were established along Catherine Store Rd. (CR 100), in areas where goats would be regularly (on a yearly basis) grazed. Monitoring efforts were completed using the point intercept sampling method to collect data and help assess changes in plant species cover, species composition, and ground cover over time. The point intercept method uses a narrow diameter sampling pole or sampling pins, placed at systematic intervals along line transects to sample within plot variation and quantify statistically valid changes in plant species cover over time. Plant species or ground cover classes that touch the pin are recorded as "hits" along a transect (Caratti, 2006). As part of the monitoring protocol, data was collected every 1 ft. over the 100-ft length of the transect, for a total of 100 sampling points per transect. Plants were identified and recorded to the species level.

Vegetation monitoring occurred each year, prior to the movement of goats through the sampling areas. Timing of monitoring was variable as it was dependent on the grazing schedule. The initial observed effects of goats on vegetation was extensive, with goats aggressively defoliating and eliminating above ground herbaceous and leafy vegetation. Completing the monitoring prior to the goats grazing an area provides the best assessment of the existing vegetation within an area. One (1) additional follow up monitoring effort in August of 2020 was completed to assess establishment following the grazing activities. Monitoring dates included:

1. September 4, 2019 (Before 2019 goat grazing)
2. June 9, 2020 (Before 2020 goat grazing)
3. August 13, 2020 (two months following 2020 goat grazing
4. September 8, 2021 (Before 2021 goat grazing)

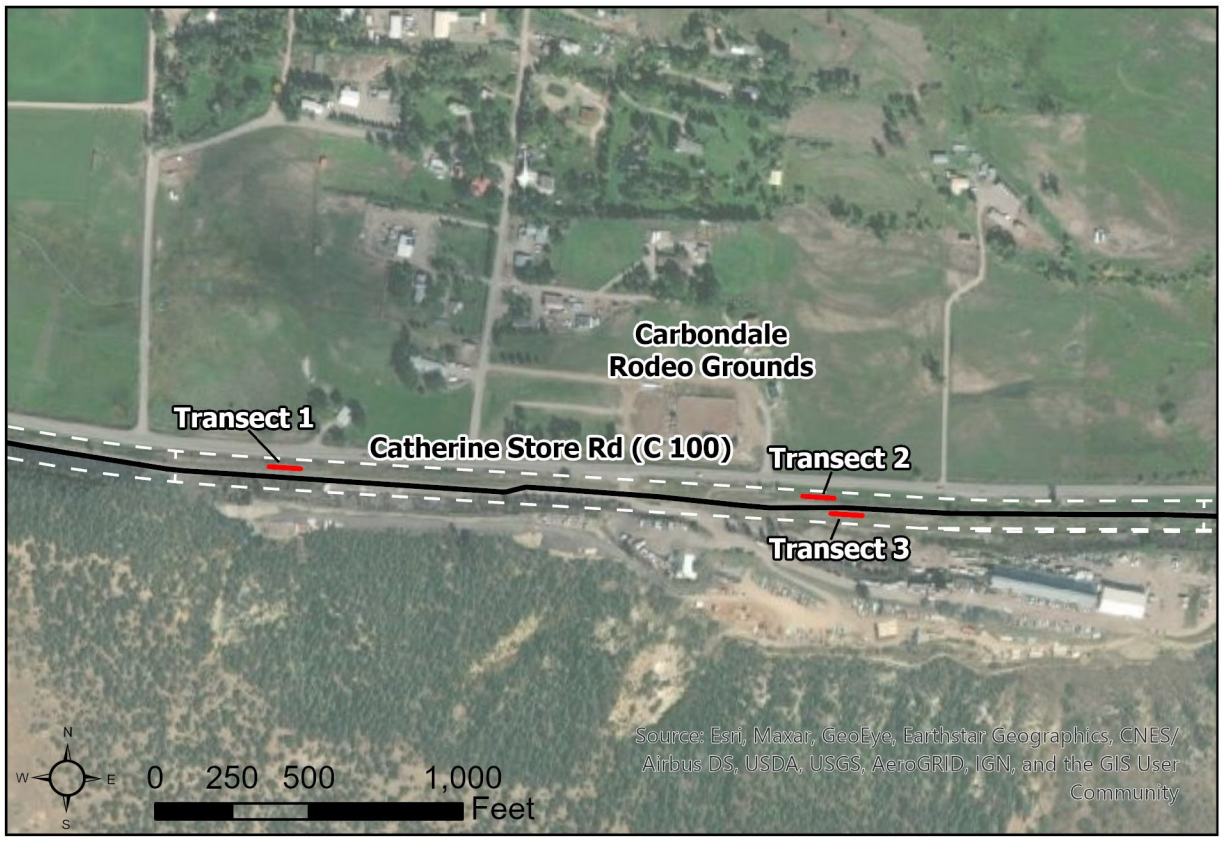

Figure 1: Transect Location Map

In 2020, the goat grazing took place in June and follow up monitoring was completed two (2) months post grazing to allow for vegetation growth and establishment. Minimal growth occurred during the two-month timeframe and therefore monitoring data collected was skewed and was not used as part of the study. In 2019 and 2021, grazing did not occur until late (September) in the growing season, and follow up monitoring efforts were not as feasible. Monitoring for these years occurred prior to goat grazing.

SUMMARY OF DATA

Following the completion of the three (3) year monitoring effort, DHM compiled and analyzed the data to assess any trends in changing vegetation composition in response to the goat grazing activities. Four (4) primary vegetation characteristics were used to assess the effects of the goats utilizing the vegetation data compiled through the monitoring efforts. These characteristics are outlined in detail in *table 1*, and include assessment of total ground cover, and composition of noxious, weedy, and native plant species.

Table 1. Rio Grande Trail Goat Monitoring Vegetation Characteristics Assessment table

VEGETATION CHARACTERISTICS ASSESSMENT	BASIS FOR ASSESSMENT	SUCCESS METRICS
1. VEGETATIVE GROUND COVER VS. BARE GROUND	Maintaining vegetative ground cover is important for managing a healthy ecosystem. Additionally, This metric is important as a basis for the following metrics, as decreased noxious and weedy vegetation, resulting in more bare ground and less vegetation cover – would indicate a degraded vegetative community.	Increased or stable vegetative cover over time
2. NOXIOUS VEGETATION COMPOSITION	Noxious species are highly competitive and indicators of degraded/un-healthy vegetative communities. One of the primary objectives of goats is to create a healthy community with low densities of noxious vegetation.	Decrease in noxious vegetation composition and cover
3. ANNUAL NON-NATIVE WEEDY SPECIES COMPOSITION	In addition to the noxious species, there are many annual non-native species found throughout. These species reproduce solely by seed, and are indicators of degraded/unhealthy vegetative communities.	Decrease in non-native weedy species composition and cover
4. NATIVE PERENNIAL SPECIES COMPOSITION	The main objectives of the goats are to create and maintain healthy vegetative communities. The native plants found within a community, and their composition is the best indicator of a healthy community. Establishing and maintaining these native species will inhibit the establishment and success of the noxious and weedy species targeted for control.	Increase of native perennial species composition and cover

1. Vegetative Ground Cover

Across all three transects, the current trend is that the vegetative ground cover has stayed relatively stable over the course of the three-year goat grazing monitoring efforts (*Figure 2*). This is excluding the data from the August 13, 2020 monitoring efforts, two months after goat grazing occurred (*8/13/2020*) as it is expected that these numbers will be significantly lower with the initial grazing of goats naturally leading to a decrease in vegetative cover. Results from the 2019 and 2021 monitoring efforts provide the most reliable data, as these were completed during the same growing season and timeframe at the beginning of September. The calculated vegetative ground cover is provided in *Table 2*, with an overview of the observed changes from 2019 to 2021 within the transects provided below.

Table 2. Calculated Vegetative Ground Cover Transect Data (in Percentage)

	Monitoring Date			
	9/04/2019	***6/09/2020***	***8/13/2020***	***9/8/2021***
Transect 1	83	76	50	79
Transect 2	89	83	46	89
Transect 3	84	93	65	83

- ***Transect 1*** Transitioned from **83%** to **79%** for a total change of **4%** decrease in vegetation ground cover.
- ***Transect 2*** Was in stasis at **89%** with zero change in vegetative ground cover
- ***Transect 3*** Transitioned from **84%** to **83%** for a total change of **1%** decrease in vegetative ground cover.

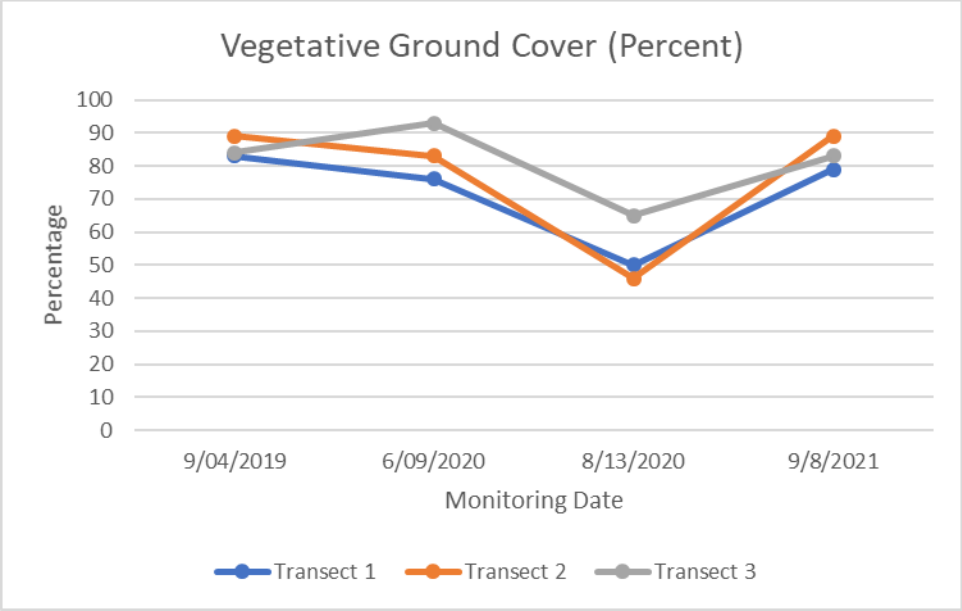

Figure 2: Vegetative Ground Cover Transect Data

2. Noxious Vegetation

Following the three years of monitoring, the percentage of noxious vegetation composition was varied, but as a general trend, it has decreased (*Figure 3*). The general trend of decreased noxious vegetation is a good sign of the effectiveness of the goats, and additional data and continued monitoring will help confirm this success. The calculated composition of noxious vegetation over the course of the monitoring activities is provided in *Table 3*, with an overview of the observed changes within the transects provided below.

Table 3. Calculated Noxious Vegetation Composition Transect Data (in Percentage)

	Monitoring Date			
	9/04/2019	***6/09/2020***	***8/13/2020***	***9/8/2021***
Transect 1	26.28	23	19.28	21.57
Transect 2	29.41	31.03	7.69	8.92
Transect 3	49.68	58.82	59.18	38.85

- ***Transect 2*** has seen the greatest decrease in noxious vegetation composition, with an overall decrease by **20.5%** from 2019 to 2021.
- ***Transect 3*** was trending towards a continual increase in noxious vegetation composition, with an overall increase of **9.5%,** but saw a significant decrease in 2021, dropping **20.3%** from 2020 to 2021 and overall **10.83%** from 2019 to 2021.
- ***Transect 1*** was relatively stable, with a slight decrease over the years from **26.28%** in 2019 to **21.57%** in 2021 for an overall decrease of **4.7%**

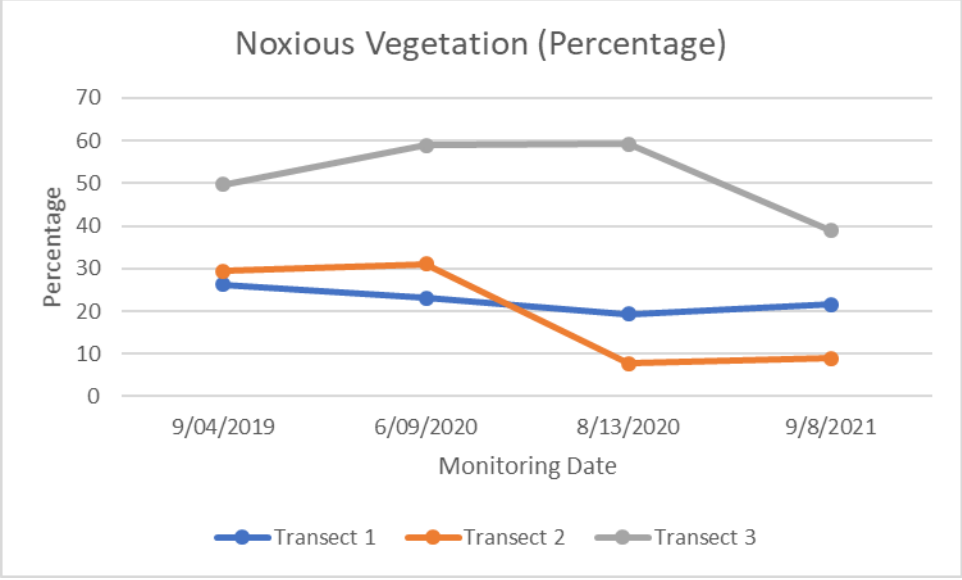

Figure 3: Noxious Vegetation Composition Transect Data.

3. Annual Non-Native Weedy Species

Transects 2 and 3 contained a significant amount of non-native annual species at the beginning of the monitoring efforts, with Transect 1 containing a very minimal amount (only 0.73 percent of total species composition) (*Figure 4*). No annual weed species were recorded in transect 1 during the latest monitoring efforts on August 13, 2020 and September 8, 2021. In the transects where annual weeds were an issue, there was a noticeable decline in annual weed composition over the course of the monitoring activities. The calculated composition of annual non-native weed species over the course of the monitoring activities is provided in *Table 4*, with an overview of the observed changes within the transects provided below.

Table 4. Calculated Annual Non-Native Weedy Species Composition Transect Data (in Percentage)

	Monitoring Date			
	9/04/2019	***6/09/2020***	***8/13/2020***	***9/8/2021***
Transect 1	0.73	0	0	0
Transect 2	45.1	30.17	3.08	15.92
Transect 3	25.48	26.8	18.37	8.63

- ***Transect 2*** saw the biggest decrease in annual weed composition in August 13th, 2020 monitoring results following the 2020 grazing efforts. With a **27%** decrease from June 9th, 2020 to August 13th 2020 and total vegetation composition consisting of only **3.08%** annual weed species. Annual species increase slightly from August 2020 to September 2021, with a **12.84%** increase. The net decrease in transect 2 from 2019 to 2021 was **29.18%.**
- ***Transect 3*** saw no major changes in annual weed species composition from 2019 to June 9th, 2020. Following the 2020 goat grazing, there was a consistent decrease in annual weed species composition, with 16.85% total decrease in annual weed species composition.

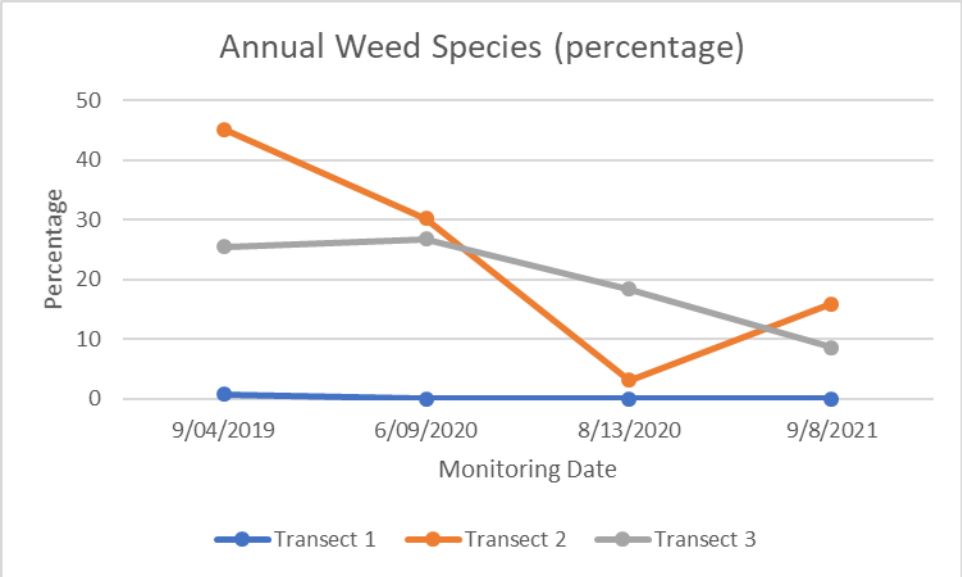

Figure 4: Annual Non-native Weed Species Composition Transect Data

4.Native Perennial Composition

Across all three transects, the current observed trend is that native perennial vegetation composition has increased over the course of the three-year goat grazing monitoring efforts (*Figure 5*). The primary native perennial species found in the transect areas are rubber rabbitbrush (*Ericameria nauseosa*) and western white clematis (*Clematis ligusticifolia*). The increase in the native perennial composition is largely attributed to two (2) factors: 1.) A decrease in noxious and annual weedy species composition, and; 2.) An increase in western white clematis populations. Observed rabbitbrush density has varied slightly, but in general their populations have stayed relatively the same. The calculated composition of native perennial species over the course of the monitoring activities is provided in *Table 5,* with an overview of the observed changes within the transects provided below.

Table 5. Calculated Native Perennial Species Composition Transect Data (in Percentage)

	Monitoring Date			
	9/04/2019	***6/09/2020***	***8/13/2020***	***9/8/2021***
Transect 1	54	53	68.67	64.71
Transect 2	3.92	6.04	23.08	59.87
Transect 3	23.57	15.03	31.52	32.41

- ***Transect 1*** increased from **54%** in 2019 to **64.71%** in 2021 for a total increase of **10.71%** over the three-year monitoring period.
- ***Transect 2*** increased from **3.92%** in 2019 to **59.87%** in 2021 for a total increase of **55.95%** over the three-year monitoring period.
- ***Transect 3*** increased from **23.57%** in 2019 to **32.41%** in 2021 for a total increase of **8.84%** over the three-year monitoring period.

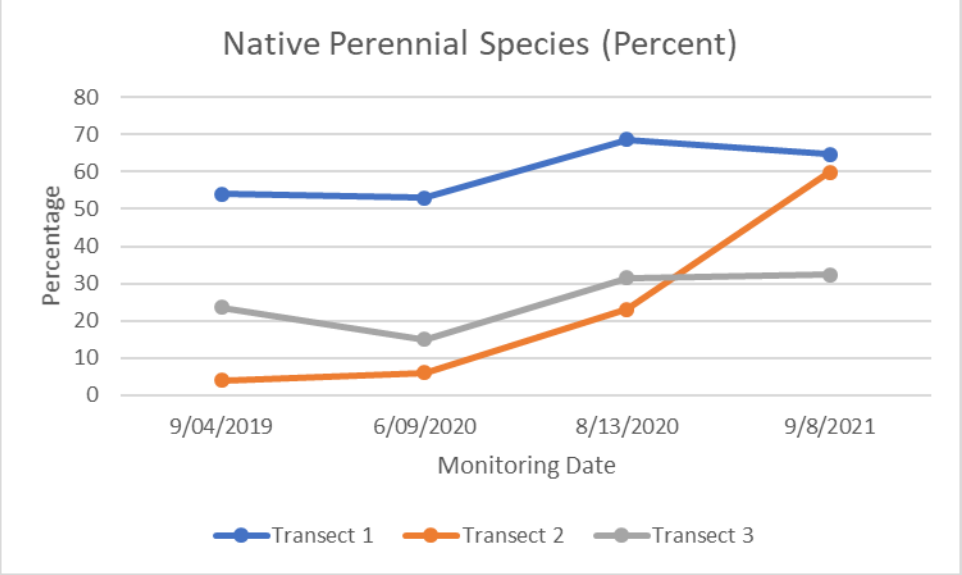

Figure 5: Native Perennial Species Composition Transect Data

SUMMARY OF FINDINGS

Given the focus of these monitoring efforts and the criteria established for success in *table 1*, it has been assessed that the implementation of goats in the Rio Grande Trail Corridor has been successful at managing the vegetation as intended. This is based upon the assessed data and results provided in *table 6*, below.

Table 6. Established monitoring criteria success results

1. Vegetation ground cover has stayed relatively stable through the course of monitoring.
2. Noxious vegetation composition has decreased over the course of the monitoring.
3. Annual non-native species composition has decreased over the course of the monitoring.
4. Native perennial species composition has increased over the course of monitoring.

It is expected that additional variables have also influenced the vegetative trends observed, and without directly accounting for these additional variables in the study, the extent of these outside influences is unknown. That being said, the assessment team can confidently conclude that the observed vegetative trends over the three (3) year monitoring time period showed a positive overall trend in correlation to the presence of goats. Alternatively, we can concur from these results that there have been no drastic strains on the vegetation due to the goats. It is recommended that further studies occur in which control locations are utilized to fully understand the short- and long-term impacts of goat grazing.

The extent of the goats impacts on the vegetation is strongly dictated by the foundational vegetative composition of the transects, with herbaceous vegetation being much more responsive to the goats than woody vegetation. Transect 1, which is comprised of a relatively intact rubber rabbitbrush community, was more static throughout the three-year monitoring, with the high densities of the shrub layer and low-density herbaceous layer showing less fluctuations in changes, as shown in *figure 5* below.

Alternatively, transects 2 and 3, which are comprised largely of herbaceous forbs and graminoids, were much more responsive to the goat activity, with higher fluctuations and changes in vegetative composition throughout the three-year monitoring period, as shown is *Figures 7* and *8* on the following page.

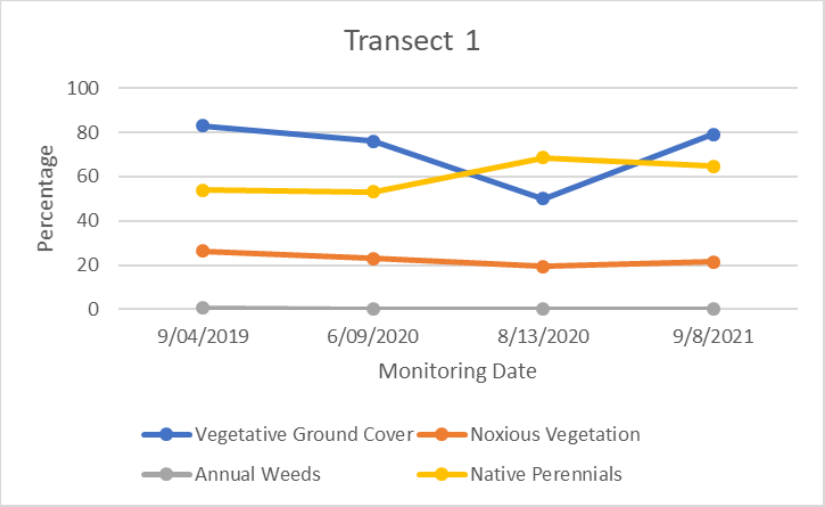

Figure 6: Transect 1 Vegetative Composition Data. Showing relatively stable conditions, with higher densities of rubber rabbitbrush and containing a more intact vegetation community.

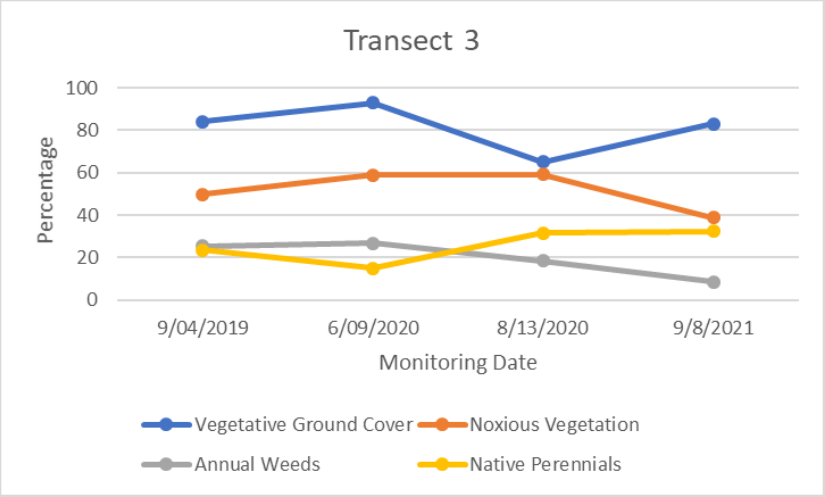

Figure 7: Transect 3 Vegetative Composition Data. Comprised of higher densities of noxious and non-native species, displays more variation in vegetative change over the course of the monitoring.

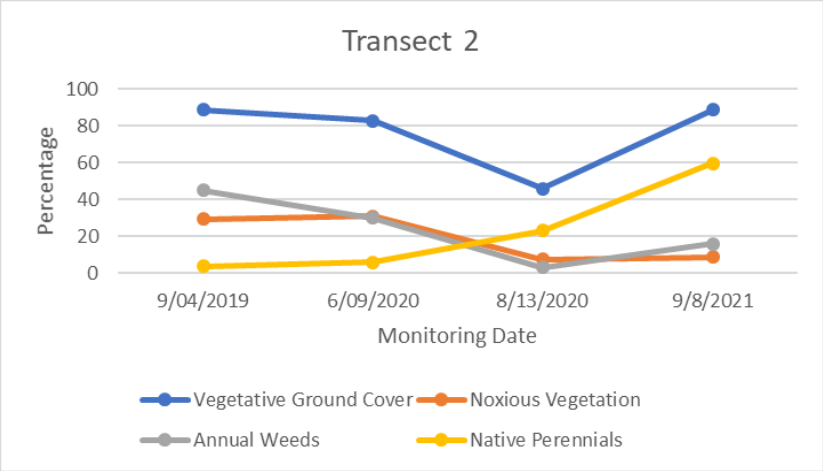

Figure 8: Transect 2 Vegetative Composition Data. Comprised of higher densities of noxious and non-native species, displays more variation in vegetative change over the course of the monitoring, with significant increase in western white clematis (perennial species).

The evidence supported through these monitoring efforts provides insightful information to help guide the continued use of goats for vegetation management activities for the Rio Grande Trail, but until further investigation details the influence on other variables influencing vegetation, these results are partial. If further justification for goat use is needed, it is recommended that studies testing the other variables influencing the vegetation be tested in conjunction with the goat transects.

SOURCES

Caratti, John F. 2006. Point Intercept (PO) Sampling Method. USDA Forest Service Gen. Tech. Rep. RMRS-GTR-164-CD

Colorado Department of Agriculture. 2000. Creating an Integrated Weed Management Plan: A Handbook for Owners and Managers of Lands with Natural Values. Colorado Department of Agriculture, Caring for the Land Series, Volume IV.

View looking West at Transect 1. September 4 2019 vegetation monitoring data collection.

View looking West at Transect 1. June 9 2020 vegetation monitoring data collection.

View looking West at Transect 1. August 18 2020 vegetation monitoring data collection.

View looking West at Transect 1. September 8 2021 vegetation monitoring data collection.

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View looking East at Transect 2. September 4 2019 vegetation monitoring data collection.

View looking East at Transect 2. June 9 2020 vegetation monitoring data collection.

View looking East at Transect 2. August 18 2020 vegetation monitoring data collection.

View looking East at Transect 2. September 8 2021 vegetation monitoring data collection.

View looking West at Transect 3. September 4 2019 vegetation monitoring data collection.

View looking West at Transect 3. June 9 2020 vegetation monitoring data collection.

View looking West at Transect 3. August 18 2020 vegetation monitoring data collection.

View looking West at Transect 3. September 8 2021 vegetation monitoring data collection.

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