Evaluating vegetation response subsequent to CRP mid-contract management across the western United States: Draft Project Report

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DRAFT PROJECT REPORT

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Introduction

It is impossible to explicitly state the degree to which mid-contract management (MCM) impacts the benefits that CRP enrollments provide due to the size of the program and variety of management prescriptions. But it is well documented that all native grasslands evolved with some type of ecological disturbance and the relatively good health of the grassland correlates with its disturbance regime. Concomitantly, all grassland bird communities have habitat requirements that evolved in conjunction with disturbance (primarily grazing).

While natural-disturbance regimes may be desirable from an ecological prospective, dependence on natural disturbances to meet specific conservation objectives is unrealistic. Management policies are needed to encourage efforts to preserve and enhance grassland habitat by managing for heterogeneity while offsetting principal threats such as invasion of noxious plant species and woody vegetation. The accumulation of dead vegetation (litter), in the absence of management, greatly retards growth in the spring, prevents the emergence of some plants, reduces flowering, decreases productivity and promotes monocultures. Perpetuation of diversity in grass-species composition is a fundamental goal for trying to sustain desirable habitat for grassland-dependent wildlife. In the absence of natural disturbance, this goal is only accomplished through some form of prescribed management. And while some types of management are superior at replicating historic disturbances (grazing, burning), other forms of management (haying, mowing, disking) accomplish at least some level of necessary disturbance.

Are there situations where MCM is unnecessary?

While the importance of natural disturbance in grasslands is well documented, differences in frequency and type of disturbance per bioregion must be understood to mimic historic events. For this briefing, and at the most simplistic level, disturbance (grazing) rarely occurred in dry, historically ungrazed regions commonly found in the southwest and west of the Continental Divide. The same is true for wet, historically ungrazed regions found east of the Mississippi River, where native grasslands evolved mostly with natural fire events. But even within a bioregion, such as the shortgrass steppe which historically was heavily grazed by bison are areas with unique vegetation types, such as the pinyon-juniper and sand-sage, that have soils that do not support the same level of grazing, if any at all. Although ecologically significant, small bioregions within larger ecoregions can confound the application of broad-brush management policies.

Annual management in areas that historically influenced the evolution of the ecosystem (e.g., grazing short-grass prairie) would tremendously benefit grassland ecosystems and grassland birds. Less frequent management, historically occurring in wetter ecoregions (mid-to-tallgrass prairie) would also benefit the health of these grassland ecosystems and suit the habitat requirements for grassland endemic birds (i.e., prairie chickens). But the mosaic of vegetation diversity and structure gained by frequent disturbances may not meet the requirements of game birds (e.g., pheasant, quail) in areas where local economies are dependent on them. Attentiveness to regional CRP plantings is also needed as they may not be representative of nearby native communities, and therefore management prescriptions may yield different results. For example, in eastern Colorado expanses of taller grasses have been planted where shortgrasses naturally occurred. These grasses maintain a much greater proportion of their plant material above ground. If grazed, they have a high potential to die out, causing extensive wind erosion.

Any management program must be based upon a definite goal. It is, therefore, important to craft a strategy that permits suitable management at the scale and frequency where historically critical to ecosystem integrity, but also considers local goals and objectives and guards against abuse.

Approach

I combined the data from the original surveys, where fields were observed to have management occurring in the current year or recent past, with data from the follow-up visits that occurred 2-3 years later for fields where this management had occurred. I included the 259 fields observed to be undergoing management in the current year as a visual reference point for graphs and figures, but these data were excluded from analyses because the current year's management obviously resulted in dramatic changes to vegetation (e.g., haying removes vegetation). This resulted in a dataset with a total of 340 data points for visualization but 81 points for analysis. The majority of these data points were recently-managed fields, with grazing, haying, and mowing as the most common management approaches (Table 1).

Table 1. Breakdown of data sample size by management type and number of years since management occurred. Data denoted as zero years since management implies management in the current year.

	Years since management					
Management	0	1	2	3	4	5
Burning	3	0	0	0	1	0
Cropped	4	0	0	0	0	0
Disking	11	5	1	2	1	4
Grazing	57	23	2	0	0	5
Haying	101	18	1	5	0	0
Mowing	80	5	0	6	1	0
Other	5	1	0	0	0	0
Sum	261	52	4	13	3	9

Because most management approaches lacked sufficient replication to distinguish the effects of each management type, the data were instead visualized by the type of CRP practice (Grassland, Wetland, or Wildlife habitat, Table 2).

Additional variability in the data may be due to geographical differences in the effect of the different midcontract management practices, but data sparsity prevents analysis of these additional factors. In this analysis, I analyze only how time since management affects the measured variables.

Table 2. Breakdown of data sample size by Conservation Practice (CP) type and number of years since management occurred. Data denoted as zero years since management implies management in the current year.

	Years since management					
CP type	0	1	2	3	4	5
Grass	155	32	4	5	2	3
Wetland	31	9	0	0	0	1
Wildlife	75	11	0	8	1	5
Sum	261	52	4	13	3	9

Herbaceous Vegetation Cover

Fields in the year of management typically exhibited high grass dominance, but this dominance declined significantly ($p = 0.008$) in the years following management (Fig. 1). Conversely, forbs had relatively low dominance in the year of management, but this dominance showed a marginally significant increase ($p = 0.055$) in the years following management (Fig. 2). These concurrent shifts in dominance can be clearly seen in the declining grass : forb ratio following midcontract management (Fig. 3), which declined significantly following management ($p = 0.028$).

Fig. 1. Grass cover response to mid-contract management. Values are jittered on the x-axis in order to display all points.

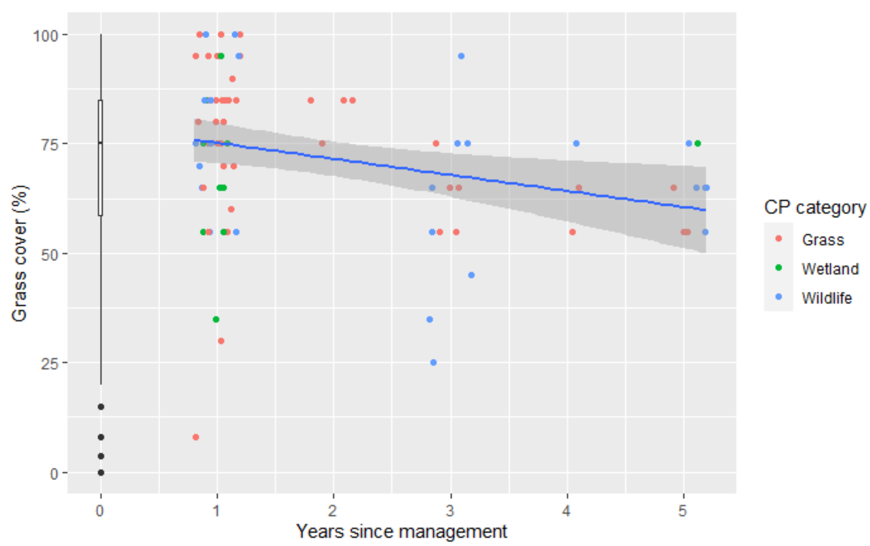


Fig. 2. Forb cover response to mid-contract management. Values are jittered on the x-axis in order to display all points.

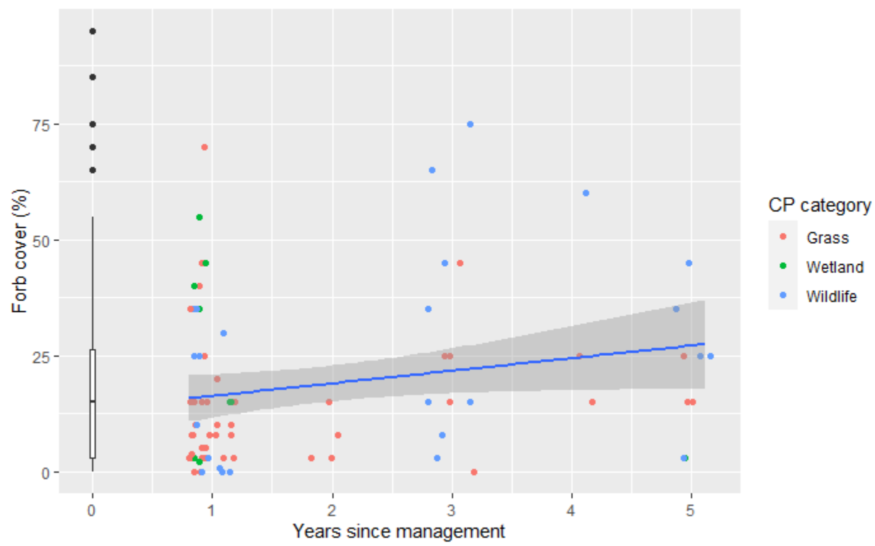
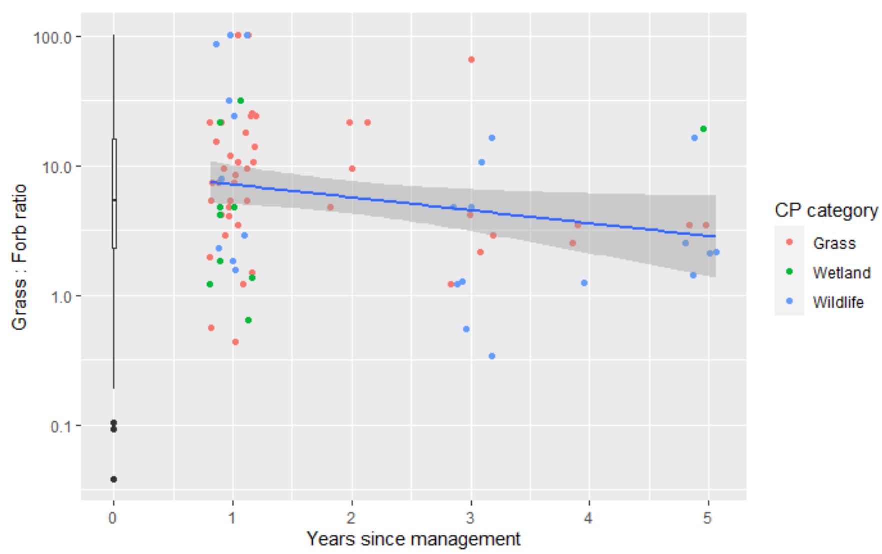


Fig. 3. Response of the grass-to-forb ratio following mid-contract management. Values are jittered on the x-axis in order to display all points.



In addition to the change in forb cover, there were changes in forb composition after management. There was a slight but non-significant increase in the number of forb species observed (Fig. 4), as well as a more dramatic and statistically significant increase in "pollinator-friendly" forbs ($p = 0.043$, Fig. 5).

Fig. 4. Response of forb richness following mid-contract management. Values are jittered on the x-axis in order to display all points.

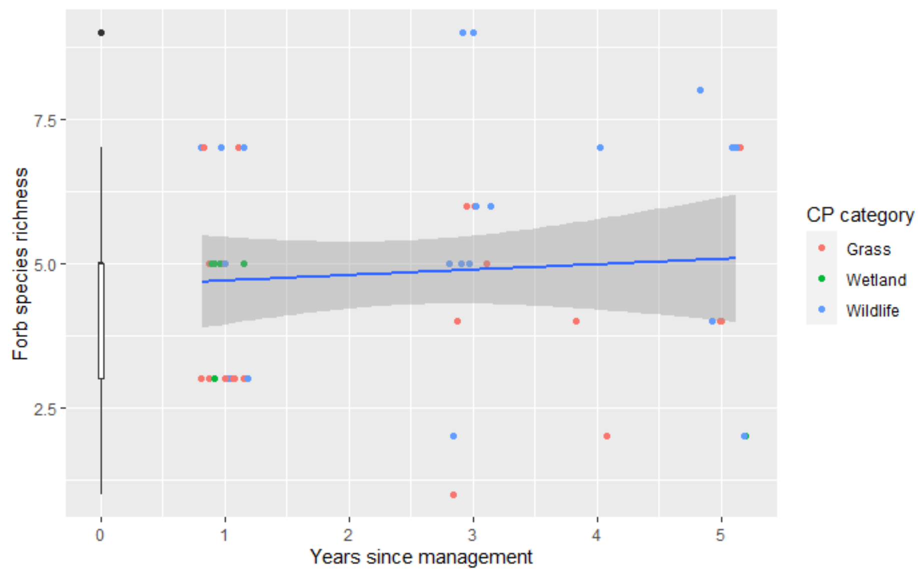
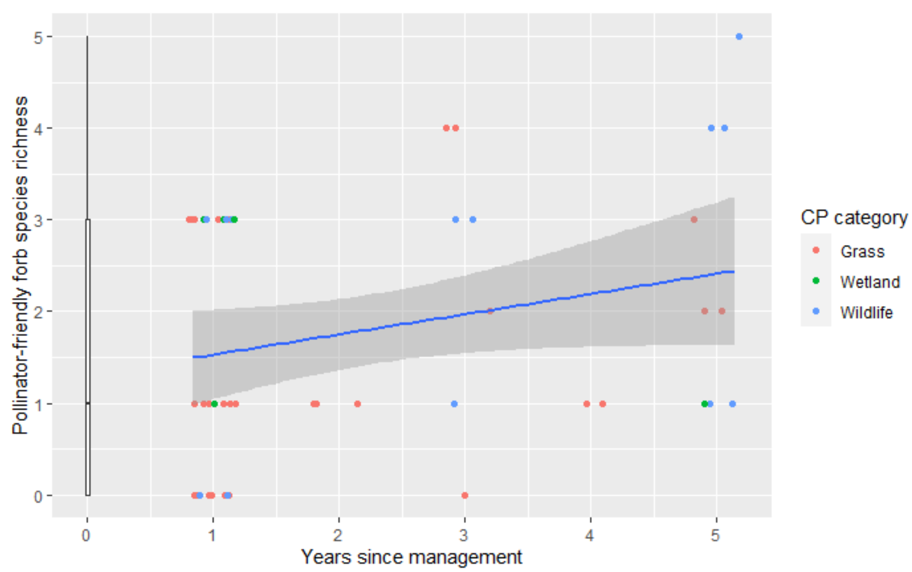


Fig. 5. Response of the number of pollinator-friendly forbs to mid-contract management. Values are jittered on the x-axis in order to display all points.



Woody Vegetation Cover

Shrub cover was highly variable prior to management, with cover ranging from 0% to >40%. While the majority of fields had very low shrub cover, the data were very skewed because a minority of fields had high shrub cover. In the years following mid-contract management, this skew and the overall average shrub cover showed a marginally significant decline ($p = 0.075$, Fig. 6). Tree cover followed a very similar pattern, showing a significant shift in dominance in the years following management ($p = 0.043$). While initially many fields had low but measurable tree cover (and some had very high tree cover), in years 2-4 following management none of the fields had any observable tree cover. However, tree cover actually increased again slightly by 5 years post-management, demonstrating a measurable degree of re-invasion by trees (Fig. 7).

Fig. 6. Response of shrub cover following mid-contract management. Values are jittered on the x-axis in order to display all points.

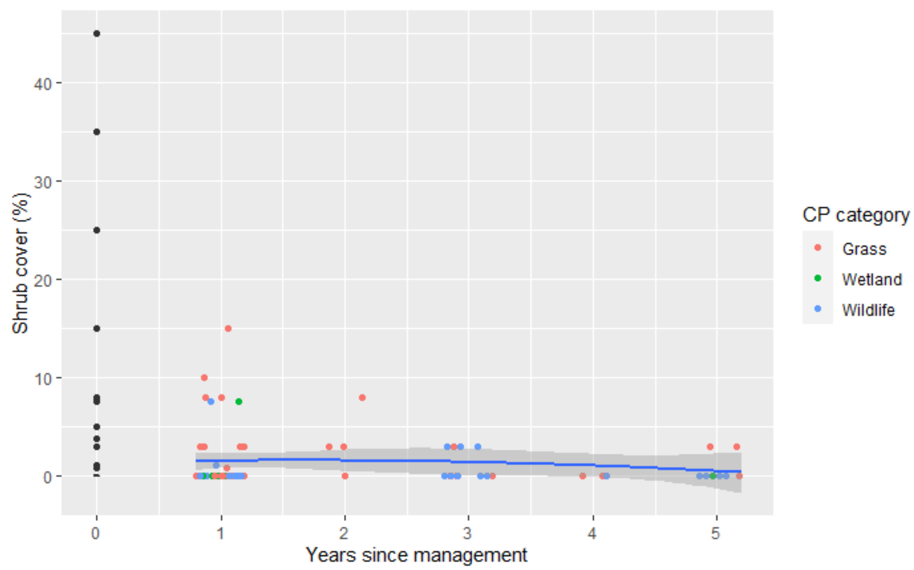
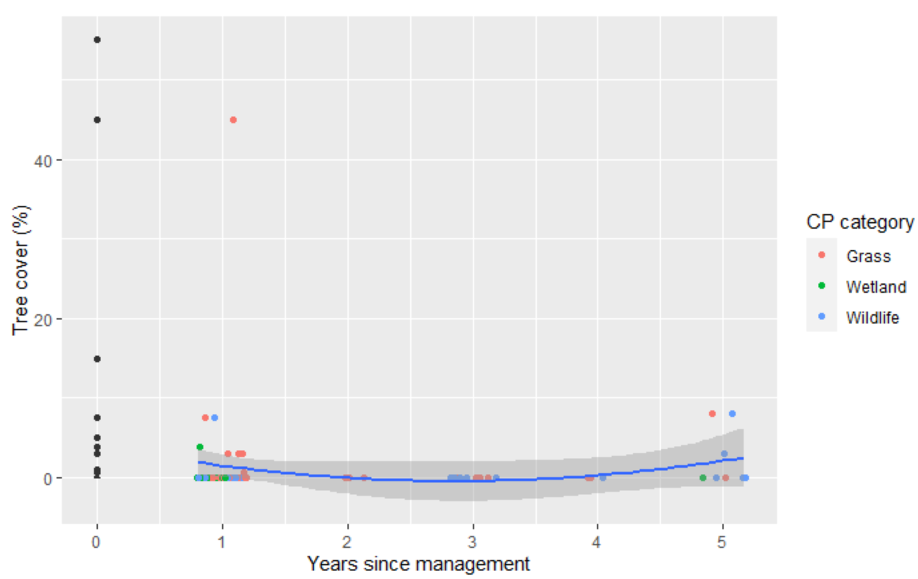


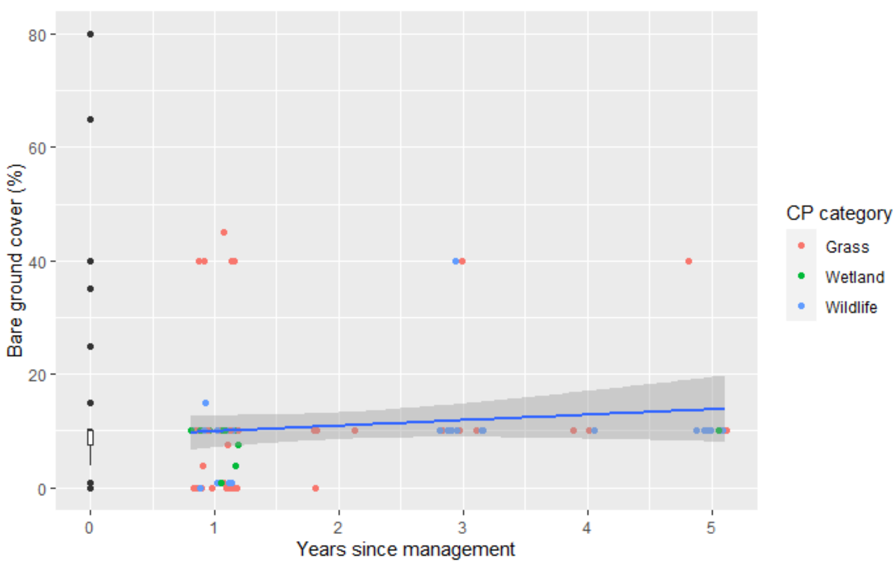
Fig. 7. Response of tree cover following mid-contract management. Values are jittered on the x-axis in order to display all points.



Erosion and Bare Ground

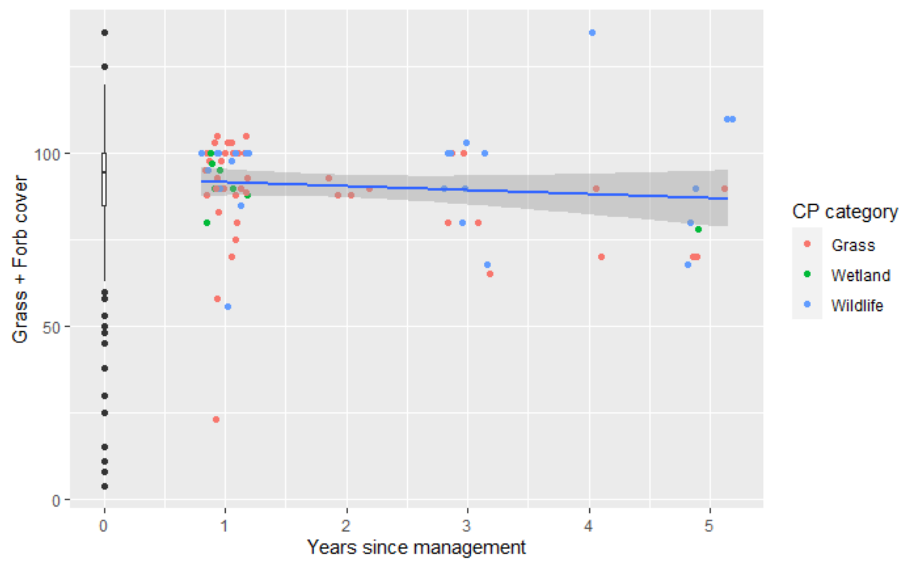
Evidence of erosion was seldom encountered. Of the 340 fields, 6 exhibited rills, 3 had gullies, and 13 had evidence of pedestaling. Almost all of these fields were in active management (i.e., a portion of the field was disturbed). No one type of disturbance (e.g., mowing, grazing) had a disproportionate number of these instances, but because so few fields exhibited evidence of erosion it is difficult to draw any inferences from these data. Most fields did have some measure of bare ground, however, and occasionally the cover of bare ground was very high, especially in the year of active management. In the years following management, bare ground cover rarely exceeded 20%, and remained steady at an average of around 10% (Fig. 8).

Fig. 8. Response of bare ground cover following mid-contract management. Values are jittered on the x-axis in order to display all points.



Similarly, the total native cover was occasionally very low in the year of active management, but on average was very high (~90%) and remained high in the years following management (Fig. 9). A slight decline in the total grass and forb cover over the 5 years after management occurred was not statistically significant ($p = 0.345$).

Fig. 9. Total native cover following mid-contract management. Values are jittered on the x-axis in order to display all points.



Noxious Weeds

Noxious grasses occurred on 19% of post-management fields, and noxious forbs occurred on 53%. The presence of noxious grasses and forbs was significantly related to the type of disturbance used (grasses: $p = 0.002$; forbs: $p = 0.001$). Fire was seldom used, so its effect on the presence of noxious species cannot be determined from these data, but noxious grasses were more commonly found in mowed or disked fields (Table 3), while noxious forbs were more commonly observed in grazed and mowed fields (Table 4).

Table 3. Number of fields under different management approaches with noxious grasses either present or absent.

	Burning	Disking	Grazing	Haying	Mowing
Present	1	8	22	13	24
Absent	3	23	101	137	60
%	25.0%	25.8%	17.9%	8.7%	28.6%

Table 4. Number of fields under different management approaches with noxious forbs either present or absent.

	Burning	Disking	Grazing	Haying	Mowing
Present	3	17	75	63	51
Absent	1	14	48	87	33
%	75.0%	54.8%	61.0%	42.0%	60.7%

Conclusions

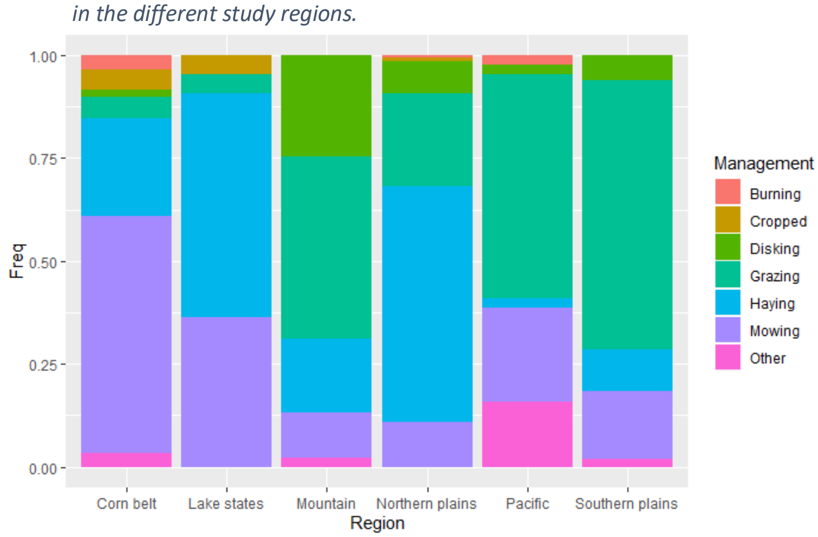
This study demonstrates several important observations about the effects of mid-contract management. First, following disturbance there is a vegetation shift toward stronger forb dominance and decreased grass dominance. In general, fields remained grass-dominated, but the grass-to-forb ratio fell from a mean of approximately 14:1 in the year of management to approximately 5:1 three years after management, and 3:1 five years after management. Notably, decreased grass dominance is compensated for by increasing forb dominance and generally does not result in higher bare ground cover or erosion. Total grass and forb cover was constantly high (~90%) and bare ground cover remained constant and low (~10%). Erosional features were rarely encountered, and did not show any measureable relationship to time elapsed since mid-contract management or to management method.

Second, mid-contract management is effective at reducing the cover of woody vegetation. Shrub and tree cover was rarely high even in the year of management, but high values did occur infrequently. These high values were greatly diminished very quickly (<2 years) after mid-contract management. As expected, this was especially true for tree cover, but was also true for shrubs. It is useful to note as well that this limited amount of data provides some insight into the timing of woody vegetation control; tree cover began to increase again in the fifth year after management suggesting a 5-year interval is a useful timeframe for woody vegetation control. The results also suggest that different approaches to mid-contract management provide varying degrees of opportunity for noxious weed invasion. Utilizing haying in particular appears to have the potential to reduce the occurrence of noxious grasses and forbs. Grazing slightly reduces noxious grass occurrences but increases noxious forbs, so its use should be limited to situations in which noxious grasses are a greater concern than forbs.

Several limitations of this study became apparent as well that might be addressed by future work. Mid-contract management is typically implemented only in a portion of a field in a given year. With the limited data collected and an experimental design that was focused on rapid whole-field assessment, the fact that only a portion of the field was disturbed represented an analytical limitation, introducing variance into the outcomes. In designing future research however, this feature can actually become a very strong asset to reducing background statistical noise if data are collected separately for the disturbed and undisturbed portions of the field. In this way, the data can be experimentally paired, dramatically increasing the power to detect management effects. This alteration in experimental design alone would enable even a modest sample size to distinguish effects of different management practices and regional differences in management effects.

The study also revealed regional differences in the dominant mid-contract management practices. For example, haying is very common in the Northern Plains and Lake states, while grazing is the dominant approach in the Mountain, Pacific, and Southern Plains states. Regionally differences in approach imply that in order to understand the effects of different approaches, caution is needed to ensure sufficient sampling of the approaches that are uncommon in some regions to prevent conflating regional differences with differences among management approaches. Any future studies should consider this in the experimental design and ensure large enough sample sizes to disentangle regional differences from differences among practices.

Fig. 10. Frequency of different mid-contract management approaches in the different study regions.



References

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