Twenty Years After the Dude Fire: Targeted Cattle Grazing of Weeping Lovegrass Through the Use of Protein Supplementation

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On the Ground

- The 1990 Dude Fire on the Mogollon Rim in Arizona and the following restoration resulted in an invasion of weeping lovegrass.
- Ecosystem restoration required successful collaboration between federal, state, and private individuals.
- We used protein supplementation to redistribute grazing pressure on the rangeland and to increase use of nutrient-poor old-growth weeping lovegrass forage.
- We observed that cattle hoof action worked in concert with targeted grazing to achieve the desired effect on weeping lovegrass. After 2 years of targeted grazing, we saw a short-term reduction in weeping lovegrass and increased competitive opportunities for native vegetation.

Keywords: weeping lovegrass, *Eragrostis curvula*, targeted grazing, cattle, protein supplementation, restoration, wildfire, Dude fire.

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Weeping lovegrass (*Eragrostis curvula*; WLG) is a warm-season bunchgrass that is native to southern Africa. It can grow 2–6-feet tall with long, narrow, drooping leaves; an inflorescence that extends beyond the crown; and a 4–6-inch, open panicle.[1,2] WLG was initially introduced into the United States in the 1930s in an effort to mitigate degraded rangelands and to reduce erosion.[3] It was chosen because of its documented rapid growth rate, prolific seed production, high germination rate, and extensive root system. It also germinates and grows earlier than native vegetation, stays greener longer, and was initially reported to be palatable to wildlife and domestic animals,[4] which is desirable in vegetation recovery. Because of these desirable characteristics, WLG was used in revegetation efforts in every southern state, on the east and west coasts, and along roads and other easily erodible surfaces. Today, WLG can be found in 32 states[1] and is readily available in seed and as adult plants in many nurseries.

For the most part, WLG stayed where it was planted. One Arizona study determined that 30-year-old plantings were merely present in semidesert grasslands and had completely died out in semidesert scrub, chaparral, and pinyon–juniper woodlands.[5] This passive reputation is illustrated by a Natural Resources Conservation Service fact sheet,[1] which provides seeding instructions and a description of WLG as a short-duration perennial requiring no maintenance. However, WLG has also been observed to persist and spread into neighboring landscapes in some locations, often displacing native vegetation.[6] The US Forest Service (USFS) currently lists WLG as invasive in eight states, including Arizona, and gives methods on how to eradicate it.[6] These somewhat contradictory perceptions may be due to the extensive range of WLG, covering a wide variety of climatic zones and soil types across the United States, and the genetic variety represented in the several WLG cultivars brought back from Africa. Although there may be some dispute as to the exact invasiveness of WLG, it became problematic and undesirable in the Tonto National Forest in Arizona.

WLG dominates the understory vegetation of more than 21,000 acres along the Mogollon Rim in the Tonto National Forest. Its prominence is the result of a vegetation restoration effort in the early 1990s that occurred after the 28,000-acre Dude Fire. As a monoculture, WLG impeded native vegetation and significantly reduced native forage for wildlife and domestic animals. In 2008, a diverse group of private, federal, and state rangeland professionals collaborated in an attempt to return biodiversity and productivity to this landscape through the use of targeted grazing. Our article describes the high level of collaboration that was established and the results of the research made possible because of that collaboration.

The Dude Fire

In June 1990, the Dude Fire burned more than 28,000 acres along the Mogollon rim.[7,8] Although considered a relatively small fire by today's catastrophic standards, the legacy of the Dude Fire taught some difficult lessons that have shaped modern fire policy and philosophy. The conflagration started as a simple lightning strike. As it spread, it was bolstered by the dense stands of ponderosa pines, the understory fuel accumulated from a century of fire suppression, and a combination of record high temperatures and extreme drought. The nation was captivated as Arizona fought what was, at that time, the largest wildfire in its recorded history. The response was dramatic, with thousands of firefighters and scores of fire engines, air tankers, bulldozers, water tenders, and helicopters all converging to protect the many homes and resources being threatened. The fire continued to grow, built upon itself, cascading into a firestorm with a monstrous plume extending into the atmosphere. When that plume cooled and collapsed, it generated a downdraft that blasted sustained 50–70 mph winds in all directions, causing fire to race downhill with 100-ft flame lengths. By the time the fire was contained, more than 36,000,000 board feet of timber had been consumed, 67 structures were destroyed, and six firefighters lost their lives in the effort to contain the fire.

Soon after the fire was contained, public and political pressure demanded aggressive ecosystem rehabilitation. The severity of the fire was extreme, leaving behind a charred, barren landscape that was vulnerable to massive erosion, especially with the fast-approaching monsoonal rains. There was a potential for devastating floods, threatening to scour drainages, choke out rivers, and wreck the remaining homes. An enormous reseeding effort took place with more than 210,000 pounds of seed spread aerially across the burned area. Native seeds were considered, but most native seeds were not readily available and had a reputation for poor germination rates in that area (S. L. Gunzel, Payson District Ranger 1986–1999, personal communication, 2007). The resulting seed mix included, by weight, 20% native western wheatgrass (*Pascopyrum smithii*), 76% nonnative grasses and forbs, and 3.3% WLG.

The Aftermath of the Dude Fire

Today, fire ecologists recognize and describe the plume-driven wildfire as an extreme class of fire behavior, better preparing those who fight it. Forest initiatives were created to thin ponderosa tree stands to reduce the severity of future fires and to restore the forests to a more historic and sustainable density. The 67 structures consumed and the nearly complete destruction of the community of Bonita Creek Estates led to the recommendation and development of buffer zones for homes located in the wildland–urban interface. The deaths of the six firefighters resulted in the creation of LCES (Lookouts, Communications, Escape routes, and Safety zones), a protocol now fundamental to firefighter safety and credited for saving the lives of countless firefighters.

Also included in the legacy is a cautionary tale of ecosystem restoration. The massive seeding did accelerate vegetation establishment and the eventual reduction of soil erosion. However, the seed mix failed to provide for biodiversity because WLG proved to be invasive. Today, WLG dominates the herbaceous understory over most of the Dude Fire area. This was partly due to the number of seeds applied to the landscape. Although WLG only composed 3.3% of the seed mix by weight, the small seeds meant that WLG was a much larger percentage of the total number of seeds applied. More than 55.6 billion seeds were aerially sprayed or 52 seeds per square foot. The seed mix, by the total number of seeds, was 11% western wheatgrass, 66% other grasses and forbs, and 23% WLG.

Unfortunately, the competitive advantage of WLG in the Mogollon Rim was severely underestimated. A 1993 USFS survey of the recovering landscape determined that 47% of the herbaceous cover was WLG; by 2005, that estimate rose to 89%.[9] As a monoculture, WLG has outcompeted native vegetation and degraded habitat quality for wildlife and domestic animals. Today, tracts of WLG dominate the landscape with such low plant diversity that ecologists describe these areas as a biological desert (Fig. 1).

Collaboration and Research

The expanse of WLG is most pronounced on the Little Green Valley Complex of cattle-grazing allotments on the Payson Ranger District of the Tonto National Forest. In that allotment, WLG frequency on a 0.16-m^2 frame exceeds 90% in several pastures. Cattle within those pastures that subsist primarily on mature tussocks (the raised grassy mounds created by WLG) have experienced lower than expected weaning and reproductive performance. Ray Tanner, grazing permit holder and owner of the Cross V Ranch, recognized the ecological and economical deficit created by the WLG monoculture and was determined to restore biodiversity and productivity to the landscape. He contacted Dr Jim Sprinkle, Area Extension Agent and Regional Livestock Specialist at the University of Arizona (UA), and together, they surmised that targeted grazing could potentially reduce WLG frequency and increase the competitive opportunities for native species.

Ray Tanner and Dr Sprinkle designed and presented a research project to Ms Christine Thiel, Rangeland Management Specialist and Staff Officer for the Payson Ranger District on the Tonto National Forest. Approval was secured for the project from the District Ranger, Mr Ed Armenta. The collaborative proposal suggested using high-intensity graz-

Figure 1. Weeping lovegrass–dominated landscape along the Mogollon rim, Arizona.

ing to increase use on WLG to 60%. This was a dramatic departure from the USFS guidelines, which typically calls for use of 40% on this vegetation type in this area. Project implementation depended on Ray Tanner's ability to radically change his grazing schedule and on the adaptability of the USFS on upland use levels. The USFS was not only receptive to the project but was completely supportive and enthusiastic. The support of its personnel was integral in the continuation of the project.

As the details of the study design were being developed, Dr Doug Tolleson, a UA Cooperative Extension Range Management Specialist, was contacted for additional research resources. The final collaborative research team included personnel from the Cross V Ranch, the USFS, and the UA Cooperative Extension. The team's objective was to determine whether targeted grazing through the use of protein supplementation could improve cattle productivity, reduce WLG frequency, and increase the competitive opportunity of native plant species.

What We Did

To test the effectiveness of targeted grazing on WLG, our collaborative team set up research plots on the Cross V Ranch with a herd of 300 beef cows and 50 yearlings. In 2008 and 2009, two supplement stations (WLG1: lower elevation = 6,150 feet; WLG2: upper elevation = 6,450 feet) were established in the 3,900-acre Roberts Mesa North pasture and were grazed from June till August. Protein (28% crude protein) supplement consisted of eight pressed blocks (approximately 40 pounds each) per site, replenished as dictated by consumption. In September 2008, these supplement stations were paired with two controls of similar WLG cover, elevation, aspect, and distance from water. Use was measured before grazing and then approximately monthly until September (after grazing) each year to observe both seasonal and end-of-season use. To determine use, we employed pace transects running parallel to the supplement stations at distances of 150, 300, 600, and 900 feet in two opposing directions from each supplement station (Fig. 2).

The data-collection method in the control plots was the same as that for the supplement stations. We calculated use with the USFS Forage Utilization Gauge height–weight

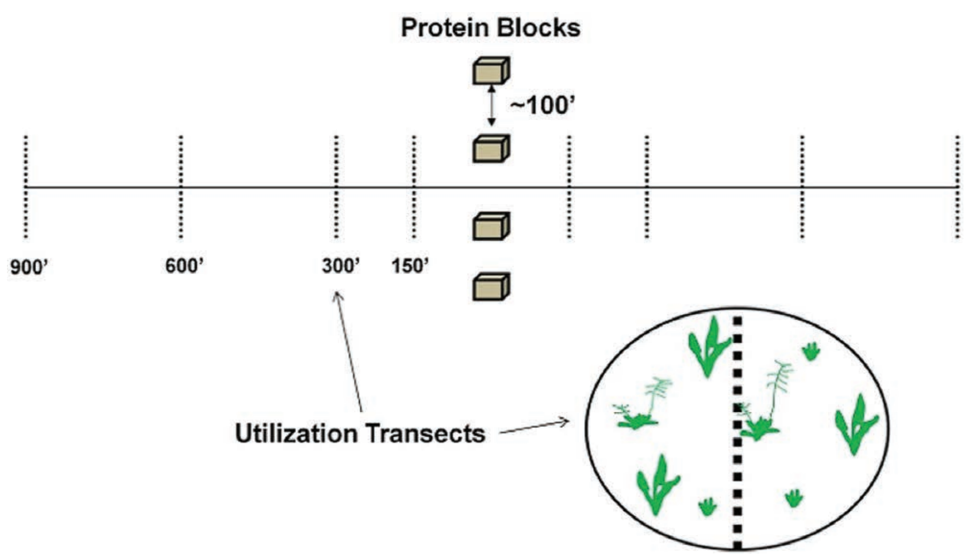

Figure 2. Protein block placement and forage use transect design for weeping lovegrass study in central Arizona.

Words From the Rancher, Ray Tanner

The lead taken on this study by the University of Arizona and the participation by the US Forest Service has been very much appreciated. I believe it has given us all a much better understanding of how to use weeping love grass (WLG) on public lands where cultivation and fertilization is not permitted. WLG is not normally very palatable to cattle, and elk will hardly touch it, but I believe this study has helped our cattle to better adapt to WLG to make better use of it. Although WLG is not very high in nutritional value and is even lower when it is dormant, we find our cattle are even using the dry WLG in addition to more desirable species in the winter time. It has been interesting to see the changes that have occurred on the ground as species that are more desirable have increased when competition from the WLG has decreased. I think the next step may be to try to supplement some of these areas with native seed that is not currently present and try to get even more species diversity. I do believe the study and our on-the-ground experience show that WLG needs to be grazed very intensely and at higher use rates than normally permitted by the Forest Service, perhaps as high as 60–80% and should be grazed every year to avoid the return of a dense canopy of old, mature WLG that shades out more desirable species. It would seem the best grazing strategy would be a high-intensity, short-duration one that would allow the more desirable species time to recover each year. I believe the experiment has been a very successful one and appreciate the flexibility of the US Forest Service, Payson Ranger District in permitting the higher-than-normal use rates that were required to maintain some management control over the WLG. All this being said, I would not recommend planting WLG on public lands. For those who have it, targeted grazing is something that can be done to improve use and species diversity that works better than cussing it.

method,[10] using 20 plants along each pace transect for a total of 160 plants measured per station. In addition to use, in September of each year, we measured distance to the closest perennial plant (fetch), plant species frequency, and point basal cover with a 0.16-m^2 frame.[11] These forage measurements were also conducted in 2010, after we ended the supplementation trials, to follow any possible short-term residual effects from the grazing treatments. Differences between dates and treatments were determined using analysis of variance procedures and/or the general linear model in SAS software.

What We Found

In 2008, there were no effects[i] on percentage of grazing use in the experimental site (29% ± 2 SE and 32% ± 2 SE for WLG1 and WLG2, respectively) or distance from supplement (28% ± 3 SE, 30% ± 3 SE, 32% ± 3 SE, and 33% ± 3 SE for 150–900 feet, respectively). Thus, grazing was evenly distributed within 900 feet of the protein supplement locations. Month was significant[ii] in both 2008 and 2009, and as expected, use increased with time during the grazing period, then decreased afterward as plants recovered (Fig. 3). In 2009, we observed a greater[iii] overall percentage of use in the protein supplement-treated sites (49% ± 1 SE) vs. control sites (45% ± 2 SE). Grazing was again evenly distributed[iv] around the supplement sites in 2009 (50% ± 3 SE, 54% ± SE, 47% ± 3 SE, and 44% ± 3 SE for 150–900 feet, respectively).

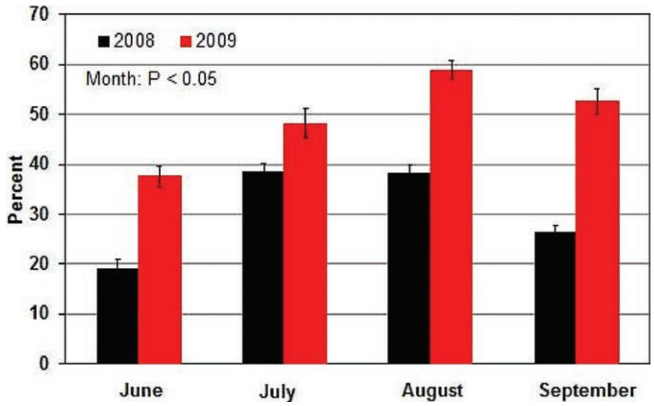

Figure 3. Effect of year and month on use in weeping lovegrass–dominated sites in central Arizona, treated with targeted grazing.

Timing and pattern of grazing use on the two protein-supplemented sites were not identical. In 2008, WLG1 peaked at approximately 36% in midsummer, compared with approximately 42% for WLG2. Both sites peaked at just under 60% seasonal use in 2009; however, by September, WLG1 had recovered to approximately 45%, whereas WLG2 remained at approximately 60%.

In the time frame of this study, we were not able to affect perennial grass frequency. There were no consistent differences[v] in plant frequency between control and treated sites in 2008 and 2009. In particular, WLG frequency averaged approximately 90% across all experimental sites. We did, however, start to see changes in percentages of ground cover categories and in forbs or annual grasses. Bare ground (approximately 7%) and fetch (approximately 4.3 inches) were similar[vi] across sites in 2008. Bare ground was greater[vii] on treated sites (9.2% ± 2.2 SE) than control (3.5% ± 1.3 SE) in 2009. There was more[viii] litter on the control (82.6% ± 2.7 SE, 83.7% ± 2.2 SE) than treated (75.1% ± 3.2 SE, 77.1% ± 2.6 SE) sites in both years (2008 and 2009, respectively). Our interpretation is that we were able to break down the lovegrass thatch and litter that was pervasive at the beginning of the experiment in 2008. As the cattle were attracted by the sup-

[i] $P > 0.1$.

[ii] $P < 0.05$.
[iii] $P < 0.05$.
[iv] $P > 0.1$.
[v] $P > 0.1$.
[vi] $P > 0.1$.
[vii] $P < 0.05$.
[viii] $P < 0.05$.

Table 1. Effect of targeted cattle grazing via protein supplementation on plant frequency* and ground cover attributes on weeping lovegrass–dominated sites in central Arizona, 1 year after last grazing treatment (i.e., 2010)

Species/Functional Group or Attribute	Control	Treated
Weeping Lovegrass	93.3[a] ± 1.8	86.0[a] ± 10.0
C_4 Perennial Grasses	4.0[a] ± 4.0	0.5[a] ± 0.5
C_3 Perennial Grasses	17.0[a] ± 11.0	23.0[a] ± 5.0
Perennial Forbs	35.0[a] ± 2.0	62.0[b] ± 2.0
Annual Grasses	6.0[a] ± 1.0	39.5[b] ± 26.5
Bare Soil (%)	7.3[a] ± 1.0	12.3[b] ± 2.7
Litter (%)	84.3[a] ± 2.6	72.8[b] ± 3.6
Fetch[2] (inches)	4.0[a] ± 0.8	5.0[a] ± 1.0

*Occurrence of plant species or group within 200 placements of a 0.16-m^2 frame; thus, values per year will not sum to 100.
†Distance to nearest perennial plant.
‡Means within a row with different superscripts differ ($P < 0.05$).

plement and frequented those sites, litter was broken down and, most likely, was incorporated into the soil.

In 2010, 1 year after grazing treatments, WLG was not different[ix] between overall control and treatment sites but was only 76% on WLG2, as compared with more than 90% on all other sites. There were higher frequencies of perennial forbs and annual grasses as well as more bare ground and less litter on treated vs. control sites[x] in 2010 (Table 1). Although the treatment did not dramatically decrease WLG or increase native perennial grasses, there was a general increase in herbaceous biodiversity. This increase was more pronounced at the upper-elevation site (WLG2) and was likely due to a combination of timing and distribution of grazing and precipitation. We propose that to affect WLG-dominated sites with targeted grazing, a longer combination of moderately high to high use would need to be employed, perhaps, an every other year or two-on, one-off cycle of ~60% seasonal use until monitoring data indicate a desired reduction in weeping lovegrass and/or increase in perennial grasses occurs.

[ix] $P > 0.1$.
[x] $P < 0.05$.

The Forage Value of Weeping Lovegrass

There is a common perception among many land managers that WLG is of poor forage value. In fact, the forage value of WLG has been recognized as being superior to some native vegetation.[4] However, the increased forage value comes with the stipulation of a high-maintenance, domesticated pasture, as opposed to a typically managed rangeland. This is because WLG evolved under constant grazing pressure that maintained young, palatable forage. As WLG leaves mature, they rapidly become unpalatable.[4,12] A 1970 symposium on WLG recommended that, to be profitable, a manager would need to remove old-growth forage, harvest any unused new growth every 40 days to prevent a transition to old growth, add fertilizer, and avoid planting WLG on acreage too large for this high-maintenance pasture strategy.[12] These are unrealistic objectives for a rangeland setting. The result is an overabundance of low-quality forage that is detrimental to both ranching practices and wildlife.

Targeted Grazing

Targeted grazing has been used to create fire breaks, decrease shrub density, and reduce the presence of invasive species. One targeted grazing tactic is the use of protein supplementation, which has been shown in studies to restore nutrient deficits in herbivores, increase use of poor-quality forage, and adjust the grazing distribution of herbivores on the landscape.[13] In addition, cattle tend to congregate and rest around supplementation stations and, in large enough densities, could apply an additional treatment on grass tussocks in the form of mechanical hoof action.[14] Strategically placed, the protein-supplementation tactic may reduce WLG frequency and create competitive opportunities for native plants. Increased biodiversity would improve ecosystem health and function for wild and domestic animals.

Conclusion

The legacy of the 1990 Dude Fire and subsequent catastrophic wildfires continues to teach us new lessons. Perhaps the most important addition to this legacy is the experience that a collaborative team of federal, state, and private individuals can accomplish great things when working together. This study was made possible through several individual professionals. Ray Tanner recognized an environmental problem and was willing to experiment on his allotment, purchase the protein blocks, and potentially reduce cow performance by promoting nutritionally deficient feed. He was willing to make an economic sacrifice and take on additional short-term economic risk in the hopes of enhancing biodiversity and long-term economic gain. Extension specialists agreed that there was a problem that was worth studying and experimenting. They were willing to explore the area, assist in designing a research plan, and commit to conduct the experi-

Figure 4. Weeping lovegrass supplement station 1 (WLG1) before targeted grazing (left) and after 1 year of targeted grazing (right).

ment over several years. Furthermore, the USFS acknowledged the problem and saw the potential of the proposal to increase biological integrity in the ecosystem. They were willing to be flexible and accommodate the needs of the experiment, despite use rates exceeding policy guidelines. Without this level of cooperation and collaboration, it is likely that this study would never have moved beyond discussion.

The collaboration allowed for the study to add to the Dude Fire legacy. We found that a 2-year, targeted grazing trial using protein supplementation can reduce WLG frequency (Fig. 4). Protein supplementation adjusted the grazing distribution of the cows in the pasture and increased the use of the lovegrass from a low of 15% to a high of 60% (Fig. 5). The frequency of perennial forbs and annual grasses increased, but no change was recorded in perennial grasses. The lack of perennial grass response may be due to the short duration of the study. The end-of-season use did not differ between experimental and control sites; however, bare ground increased and litter decreased in the treatment sites. This suggests that the mechanical hoof action associated with cows concentrated around the protein supplementation is important for breaking up lovegrass tussocks and incorporating litter into the soil. In addition, it seems that the foraging behavior on WLG was a little more aggressive than expected. As the cows forage, they pull up entire tufts of tussocks, an act that may increase the magnitude of the treatment on the lovegrass. The overall decrease in WLG frequency was modest and was largely negated after a year of rest. To be effective, both the 60% use and mechanical damage to the tussocks need to be applied for a longer duration, both in the season of grazing and in treatment years, than was performed in this study. The reduction of WLG, the increase in bare ground, and the decrease in litter all increase the potential for perennial vegetation to increase in diversity and abundance in that area. Additional treatments could include applying native seed before removing cattle, which could promote seed planting by hoof action and may aid in the accelerated recovery of the native grass community. Future research on the number of years required for ecologically significant effects from long-term, targeted grazing would be valuable.

Figure 5. Protein supplementation increased use of weeping lovegrass from a low of 15% to a high of 60%.

Afterword

There have been some interesting observations since the completion of this study in 2010. It seems that the cows on the ranch now use WLG regularly and without protein supplementation directing them. Ray Tanner compares the behavioral change to priming a pump, that is, that the study "primed" the cows by getting them used to the idea of eating WLG. Once acclimated to that new diet, they simply continued the behavior into the following years.[15] It would be worth exploring this observation in greater detail in the future. How long will the WLG use behavior last in the herd and what is the long-term response of the native vegetation to that change in behavior? The answers to these questions could have long-lasting implications for rangeland management.

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