# The Road to Recovery: Soils and Vegetation of the Marfa Grasslands, 18 months after the Rockhouse Fire

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Marfa grass lands showing partial recovery in 2012. Forbs have become the dominant growth form. Dead grass is evident in the mounds of dead root crowns.

The year 2011 will be remembered in Texas as a year of extreme weather events. Most of Texas, including the Trans-Pecos region, experienced one of the driest years on record, and it was ravaged by some of the largest fires in its history. On April 9, the Rockhouse Fire began near the town of Marfa and burned across the plateau grassland and into the canyon and mountain country of the Davis Mountains. The fire continued to burn for 34 days, covering a total of 314,444 acres, making it the largest grass fire ever recorded in Texas.

The first ranch to be burned by the Rockhouse Fire was the Mimms Ranch, owned by the Dixon Water Foundation. Approximately 90 percent of the ranch was burned in the fire. The Borderlands Research Institute (BRI), in partnership with the Dixon Water Foundation, had been conducting research on the Mimms Ranch prior to the fire, which included long-term vegetation and soil erosion monitoring.

Timing and amounts of precipitation in years prior to and following the wildfire had a dramatic effect on the ecosystem. Average or above average precipitation from 2007-2010 led to an increased fuel load on the landscape. This, coupled with nearly six months of no recordable precipitation immediately preceding the fire, led to a heightened fire potential. Less than five inches of rainfall occurred within 12 months post-fire. The 2012 monsoon season began in mid-summer, and precipitation was average for 2012.

The BRI research project expanded in 2012 to look at the impacts of drought and fire on ecosystem recovery. Vegetation measurements continued following the fire and included the plant species, as well as the size of each plant. Soil erosion monitoring was also continued. Fire generally has a strong influence on soil's biological, physical and chemical properties near the surface, so measurements of soil microbial communities, microbial diversity, and soil nutrients were added to the study. Soils are

the basis for all life, and recovery of an ecosystem begins in the soil with soil microbes. Soil microbes are important in providing nutrients such as nitrogen to plants and in creating complex soil structure that increases water infiltration. Fire can damage microbes near the surface of the soil. Fewer microbes could cause a decline in water and nutrients available for plant growth and slow ecosystem recovery.

The landscape of the Marfa Plateau was significantly changed from a grassland dominated by blue grama to one dominated by forbs and bare soil. Six months after the fire, grass cover was 80 percent less than pre-fire, and 18 months later, was still 60 percent less. Annual forbs, on the other hand, increased dramatically in the fall and spring seasons following the fire, responding to very small amounts of rainfall. Once the monsoon rains began in 2012, the study site began to recover with a flush of grass and forb growth.

Following the fire, there was a shift in species composition of grasses across the landscape. Blue grama, which dominated the open flat landscape pre-fire, was one of the first species to return following the fire. Although this species had a quick comeback response from the disturbances, total number of plants decreased, and plants were much smaller. Three-awn, a grass with low forage and wildlife value, and Hall's panicum, a grass with high forage and wildlife value, increased significantly post-fire, and with the increase in forbs, filled much of the void left by the decrease in blue grama cover.

A more dramatic shift occurred on the rolling rocky igneous hills where a black grama monoculture existed prior to the fire. No recovery of black grama had occurred 18 months following the fire. Feathered pappusgrass, not recorded in pre-fire measurements, was one of the few grasses to grow on the igneous hills post-fire. Based on our data, grassland recovery was much slower on the rolling hills, as opposed to the flats.

Erosion is highly variable within the Marfa grasslands, but a distinct increase in soil movement was seen after the fire and during the monsoon season of 2012. This led to an increase in clay particles in some areas and a decrease in clay particles in others, since they are the smallest and easiest to move. Clays function in holding water and nutrients in the soil, so this movement impacts local productivity of rangelands and impacted microbial populations. Forb cover helped decrease the amount of erosion overall until grass recovery began with the rainfall in 2012. Thankfully, it does not seem that a large amount of soil was lost from the grasslands, so recovery to a grama grassland should occur.

The study of soil microbial communities focused on their important roles in nutrient (particularly nitrogen) cycles. Microbial functions are very important in providing nutrients for plant growth, which strongly relates to a rangeland's health. We collected microbe data from the flats, which was the most prominent ecosystem on the Mimms Ranch. We compared microbial communities and soil nutrients in three areas 1) burned, 2) unburned, and 3) grazed and unburned.

Mimms Ranch just after the Rockhouse Fire looking back toward Marfa. This photo shows the severity of the fire and the lack of any unburned patches within the vegetation.

Measurements were taken in early summer 2012, prior to any rainfall, and in late summer 2012 after the monsoon rains.

Measurements of soil properties indicated that soil pH became

Marfa grasslands prior to the Rockhouse Fire. Blue Grama is the dominant grass, and bare ground and forbs are not very prevalent.

more alkaline after the fire, because the ash left from the fire was high in calcium. The overall amount of nitrogen and carbon was lower in burned areas. Microbial activities responded to the change in the soil after the fire, and populations were almost half of what they were in unburned and grazed and unburned areas.

Microbes are vital to the nitrogen cycle. They are responsible for getting nitrogen gas into nitrate, a form that plants can use. In the nitrogen cycle, nitrogen gas is changed to ammonium, then to nitrite, then to nitrate. A different group of microbes is responsible for each step. Without a good population of microbes of each group, plants do not get nitrogen, growth rates slow down, and plant protein contents drop.

During the soil recovery process, the amounts of ammonium increased and then decreased, and the nitrates increased, as the microbes recovered from the drought and fire and began to work within the nitrogen cycle. The amounts of nitrate then decreased dramatically once plants started growing and using the nitrogen. It appears that the microbial community recovered more quickly than the plant community, and so was able to provide the nitrogen to the plants during the monsoon season.

This study also suggested that individual microbial groups had different paces of population recovery after the wildfire and drought. The population of microbes responsible for changing nitrogen gas to ammonium was much lower in burned areas, which clearly suggested that their recovery speed from fire was slower than other groups of microbes and slower than in areas impacted by just drought. In general, bacteria that were involved in the nitrogen cycle had the highest abundance in the grazed and unburned area both before and after the rains in 2012. This difference in recovery is not well-understood, but it does show that management decisions, such as grazing, can have positive impacts on microbial recovery following drought. Nitrogen content in plants, measured as protein, is very important for both livestock and wildlife production. This is dependent on the health of the soil microbial community.

Fire has been shown to be a natural part of maintaining grassland health in the Trans-Pecos. Both the increase in plant diversity following the fire, and the quick response and increase of many species reflects this fire tolerance. Precipitation, both in timing and amount, was found to be the most limiting factor in recovery of the vegetation and microbial community. With the late summer monsoonal system of the Trans-Pecos, recovery is limited and prolonged, due to lack of moisture during a large part of the growing season. Together, this shows that a natural fire regime would be based on late summer fires that are coupled with monsoon precipitation, enhancing recovery time, but still requiring multiple years for recovery, based on the low total precipitation amounts.

Overall, the Rockhouse Fire had a dramatic impact on the landscape, shifting both vegetative and microbial communities. Recovery has been delayed by extreme drought, and the full recovery of the landscape may take five or more years.