# Final Level II 2013 Silver Fire BAER Monitoring Report
# Year Three

# Gila National Forest, Region 3

# March 2017


**Prepared by: Mike Natharius Forest Soil Scientist, Gila National Forest**

## Final Silver Fire Burned Area Emergency Response Level II Monitoring Report

### Introduction

In June and July 2013, the 137,326 acre Silver Fire burned large, contiguous tracts of National Forest System Lands in the southeastern portion of the Gila National Forest. Extensive areas of the fire were within the Aldo Leopold Wilderness. The majority of the high severity burn (20,793 acres) and moderate severity burn (36,931 acres) was limited to mixed conifer vegetation type with a much smaller percentage occurring in the pine vegetation type of the extremely steep and rugged Black Range. The fire left several communities, many private properties and County, State and Forest Service infrastructure at risk from post-fire flooding, sedimentation and debris flows. The BAER team conducted an assessment of the fire and made recommendations to minimize negative post-fire effects. Recommendations included aerial application of certified weed free straw to 2,880 acres of high severity burn and aerial application of certified weed free seed to 12,900 acres of high severity burn. A three year Level II post fire treatment effectiveness monitoring plan was developed. This report outlines the objectives, data collection/analysis methodologies, monitoring results and conclusions of the three years of monitoring.

### Monitoring Objectives

The following are the objectives this monitoring plan is intended to address.

1. Evaluate effectiveness of seeding and seeding/mulching in increasing canopy and vegetative ground cover using an annual barley and native seed mix verses no treatment
2. Evaluate the effect that post fire seeding or mulching and seeding has on maintenance of site/soil productivity
3. Evaluate if these treatments were effective on steep slopes of between 40 to 65 percent
4. Evaluate the effects of these treatments on regeneration of woody species
5. Evaluate the effects of treatments on natural recovery and site diversity or species richness.
6. Determine if these treatments introduced invasive species

### Selection of Monitoring Sites

This study stratified monitoring plots based upon high burn severity, vegetation types of mixed conifer and ponderosa pine and the 3 treatment types of *seeded, seeded/mulched* and *non-treated*. Locations for establishment of monitoring sites were identified in the office with the aid of the burn severity map, BAER treatment map, Forests Terrestrial Ecological Unit Inventory and Midscale Existing Vegetation maps prior to site visits and plot establishment. Due to the remoteness, steep topography and lack of trail access, some treatment units could not logistically be sampled and were not considered. The design was intended to distribute monitoring plots throughout the treated and non-treated areas of the Silver Fire while attaining a fair representation of the treatment units in the burned area (*see appendix A for map of monitoring plot locations*). Elevation of monitoring sites ranged from 7,200 feet to 9,600

feet. A total of eighteen permanent plots were identified to be set up throughout the burn area. Only seventeen were established prior to the area receiving significant snow cover that prevented establishment of one of the plots. There were a total of twenty seeding units in the burned area, varying in size from 72 to 2,203 acres. Six of these treatment units had plots established in them resulting in 30% of the seeded treatment units being sampled. There were a total of eight mulch/seeded units in the burned area varying in size from 64 to 1,246 acres. Five of these treatment units had plots established in them resulting in 63% of the seeded/mulched treatment units being sampled.

### Data Collection Method

Data was collected using two monitoring protocols developed by the USDA – ARS Jornada Experimental Range, Las Cruces, New Mexico and can be found and described in the publication *Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems, Volume I and II.* http://www.ntc.blm.gov/krc/uploads/281/Monitoring%20Manual%20for%20Grassland,%20Shrubland%20and%20Savanna%20Ecosystems%20Vol.%20.II.pdf The protocol used to collect canopy cover and ground cover data was the Line-point intercept. Line-point intercept is a rapid, accurate method for quantifying the components of soil cover which include vegetation, litter, rock, biotic soil crusts and bare soil. These measured attributes are related to erosion, infiltration and the ability of the site to resist or recover from degradation. Line-point intercept is used for generating ground cover data which is essential for erosion prediction modeling and is also useful in determining plant cover and composition. At each monitoring plot three permanent 100 foot transects were established parallel with the contour of the slope. At the start of every transect photo points were established down the transect line, upslope, downslope and in the opposite direction of the transect line. Additionally vegetation canopy cover was also collected on a tenth acre circular ocular plot at each monitoring site. This was done to pick up or account for plant species and their associated cover values that were present on the site but not picked up on the Line-intercept transects. The other protocol used was a Gap intercept method which was used to measure the amount of regenerating shrub or tree canopy cover encountered along a transect.

## 2013 through 2015 Monitoring Results

### Monitoring Objective 1

**Evaluate effectiveness of seeding and mulching/seeding in increasing canopy cover and vegetative ground cover using an annual barley and native seed mix versus no treatment**

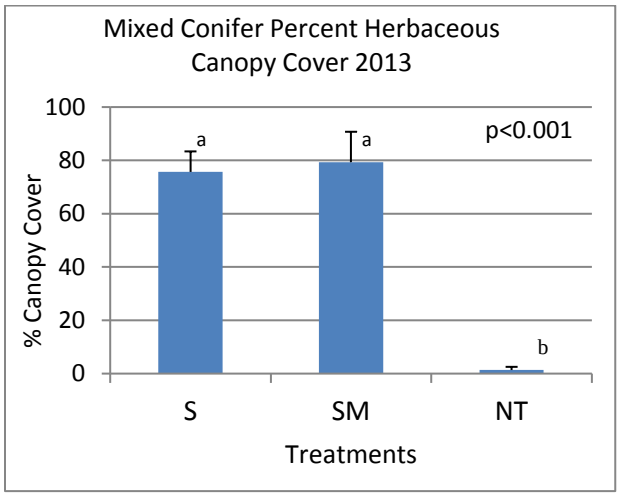
Aerial seeding occurred on 12,900 acres of high severity burn throughout the Silver Fire. Seed was applied at approximately 53 pounds per acre or 23 seeds per square foot. The seed mix consisted of annual barley (*Hordeum vulgare*) (15 seeds/ft2) and a smaller percentage of native grass species (8 seeds/ft2) common to the area. On the ground inspections of seeding application rates were monitored during aerial application, and application rates were fairly accurate at the sites monitored. Aerial

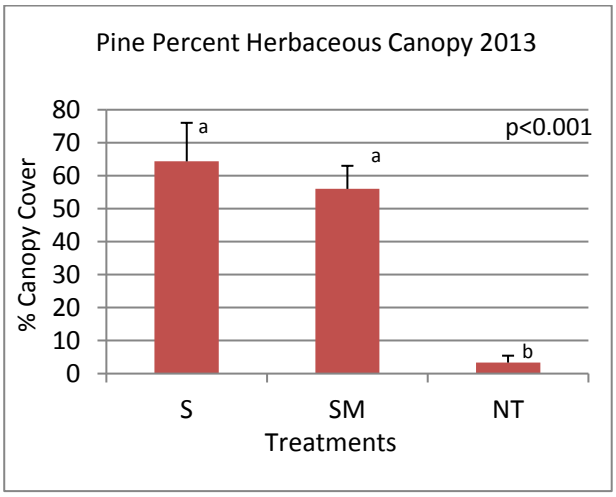
seeding of the fire was completed by July 26th 2013. Aerial straw mulching of the fire was completed August 2nd 2013. The burned area received precipitation prior to the completion of the seeding and mulching effort. Precipitation data from the McKnight SNOTEL site which is located in the Silver Fire burned area shows that between July 21st and October 30th the area received 14.7 inches of precipitation (http://www.wcc.nrcs.usda.gov/nwcc/site?sitenum=1048&state=nm). These dates correspond with the start of the seeding effort and the end of the growing season of the burned area. A total of seventeen monitoring sites were established throughout the burned area. These were tiered on pre-fire vegetation types of pine and mixed conifer and treatment types of seeded, seeded/mulched, and non-treated. Three plots were established in each vegetation and treatment type.

An ANOVA followed by Tukey's post-hoc test was performed on the mean cover values of the three treatment types of seeded, seeded/mulched and non-treated at the 5% significance level.

**Canopy Cover**

In 2013 there was not a significant difference between canopy cover values in the seeded (S) and seeded/mulched (SM) plots in either of the two vegetation types. However, there was a significant difference in canopy cover between the treated and non-treated (NT) plots in the two vegetation types. The following graphs display the differences.




Mean canopy cover of the plots were very similar in the seeded and seeded/mulched mixed conifer sites, with canopy covers of 76% and 79% respectively. Differences were larger in the seeded and seeded/mulched pine type with mean canopy covers of 64% and 56% respectively.

Production estimates of the annual barley were conducted throughout the monitoring in 2013 and it was estimated that mixed conifer sites produced between 1,500 to 3,000 pounds/acre and that pine sites produced from 750 to 2,000 pounds/acre. Both seeding and seeding/mulching treatments were deemed to be highly effective in providing beneficial canopy cover in 2013. Canopy cover provided by the annual barley had become well established one month after seeding, and was effective in providing for erosion control during the remainder of the 2013 monsoon season. *See appendix B for annual barley growth August –September 2013*. It was noted throughout the monitoring that generally the pine sites

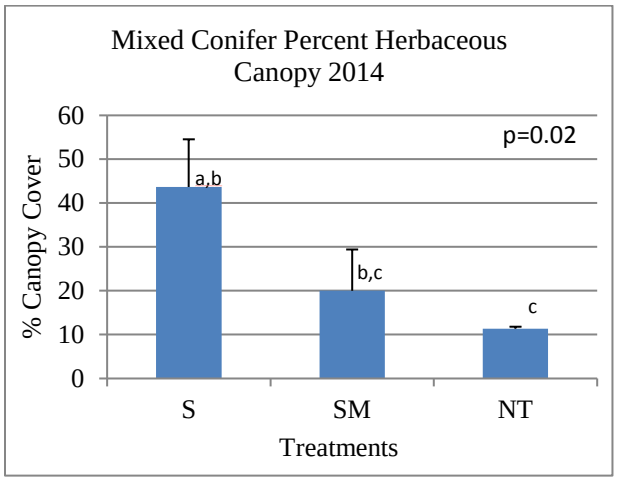
did not produce as much canopy cover or plant height (biomass) as the mixed conifer sites. This is likely the result of the pine type being warmer drier sites than the mixed conifer.

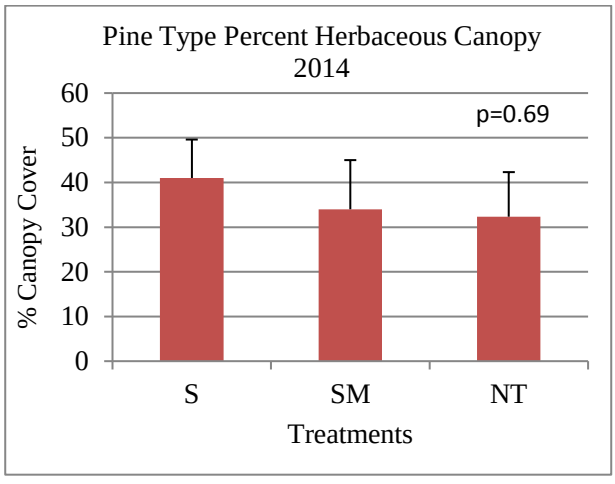
The following photos are of high burn severity mixed conifer sites, one seeded/mulched plot and one non treated plot, photos were taken during initial plot establishment 4 months after seeding and mulching was completed. The mean canopy cover in the seeded/mulched plot was 93% while there was no canopy cover present in the non-treated plot.


Mixed conifer non-treated, plot #3, November 2013

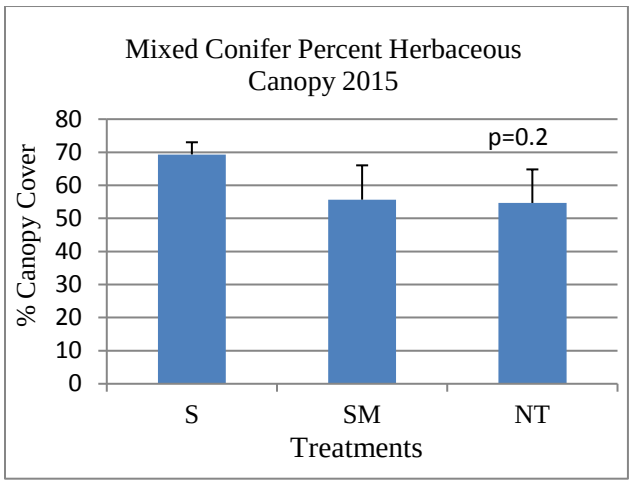

Mixed conifer seeded/mulched plot #2, November 2013

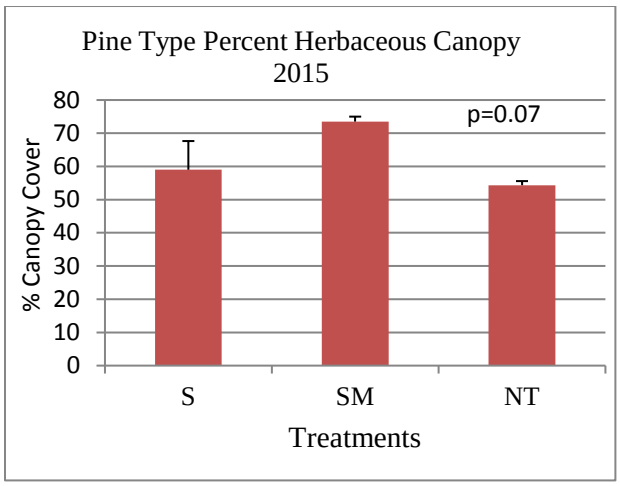
The following graphs display the mean differences in canopy cover between treatment types in 2014. In 2014 there was not a significant difference in canopy cover between the seeded and the seeded/mulched plots or the seeded/mulched and the non-treated plots though there was a significant difference between the seeded and the non-treated plots in the mixed conifer sites. In the pine type there was not a significant difference in canopy cover between the treated verses the non-treated plots.



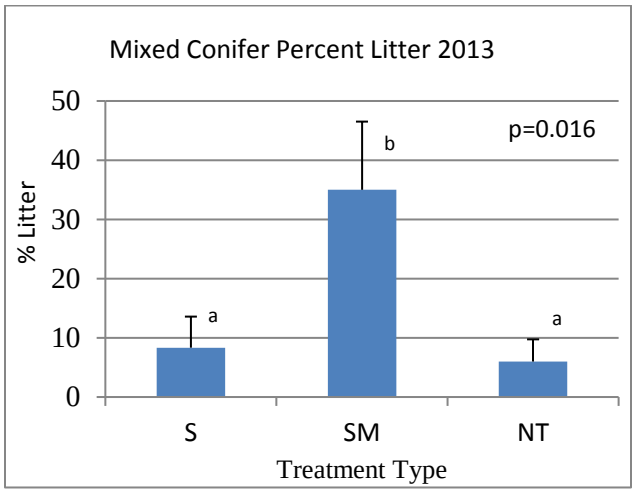
The following graphs display the mean differences in canopy cover between treatment types in 2015. There was not a significant difference in canopy cover by treatment type or vegetation type.

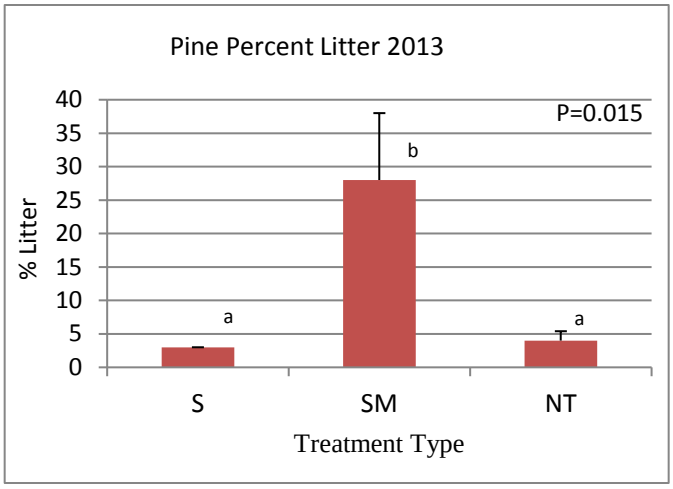



**Litter Cover**

The following graphs display the differences in the mean percent litter in 2013 in the two vegetation types by treatment. As would be expected there was very little litter found in the seeded and non-treated plots in 2013 and the litter present was comprised of unconsumed branches, roots and logs. It should be noted that litter was defined as being 0.5 inch thick. This depth was considered capable of being effective in reducing raindrop impact and soil detachment, assisting in infiltration and slowing overland flow on steep slopes that experience high intensity rainfall events.

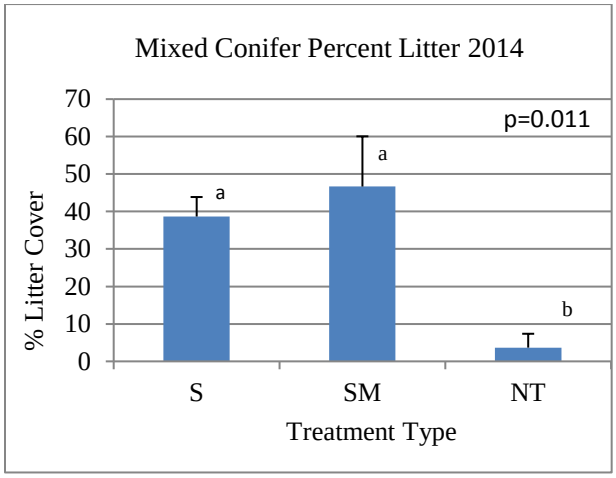


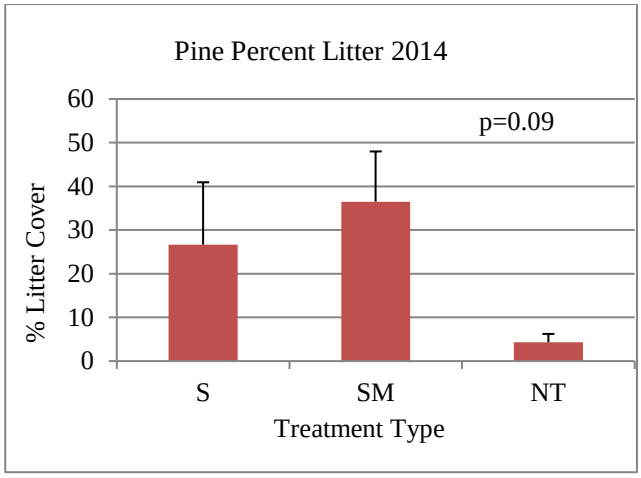




There was a significant difference in litter between the seeded/mulch (SM) sites and the seeded (S) and non-treated (NT) sites. Seeding did not contribute to an increase in litter near the end of the growing

season when the monitoring plots were established and read in 2013. The annual barley was still actively growing at a majority of the plots when plots were read.

In 2014 there was a significant difference in the amount of litter present in the treated verses the non-treated plots in the mixed conifer sites. In the pine type there was not a significant difference between treatments though mean litter values in the treated plots were higher than in the non-treated plots.

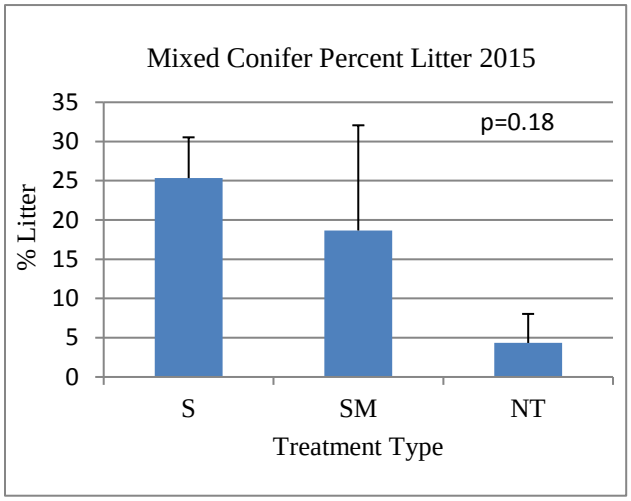


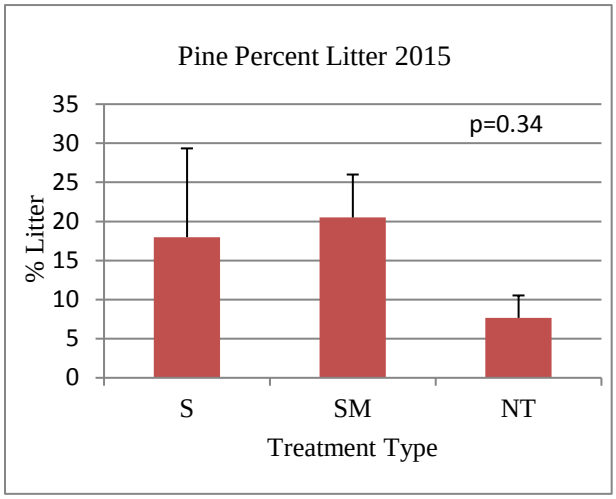




The increase in litter cover in 2014 in both of the treatment types was a result of the annual barley grown in 2013.

The following photos were taken in June 2014 prior to the monsoons, they are of a seeded watershed in the mixed conifer type. The annual barley grown in 2013 provided for exceptional ground cover in the form of litter and assisted in maintenance of soil/site productivity in 2014.

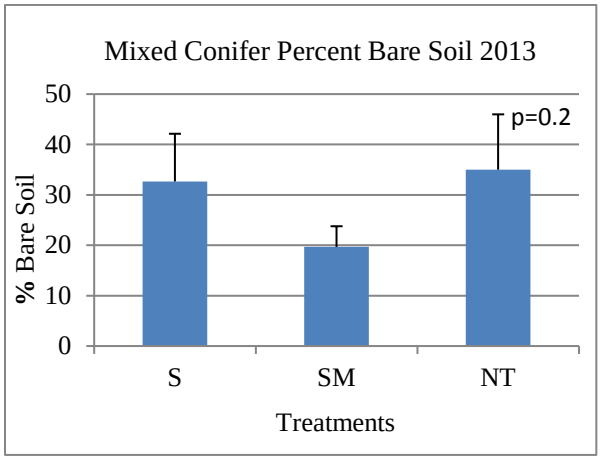

The following graphs display the mean differences in litter cover between treatment types in 2015. There was not a significant difference in litter cover by treatment type or vegetation type though treated plots had more litter associated with them than the non-treated plots

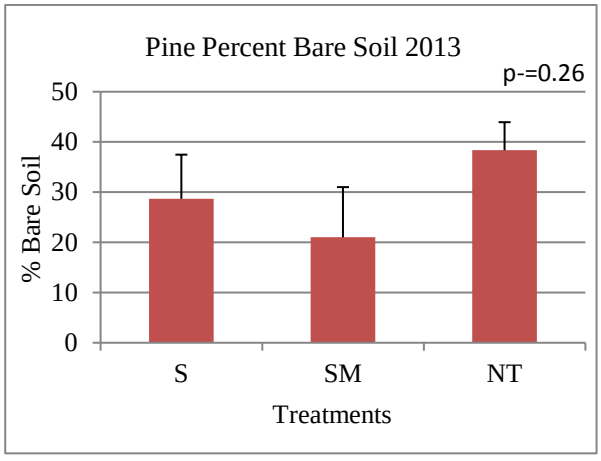



**Bare Soil**

The following graphs display the differences in the amount of bare soil in 2013 in the two vegetation types by treatment.

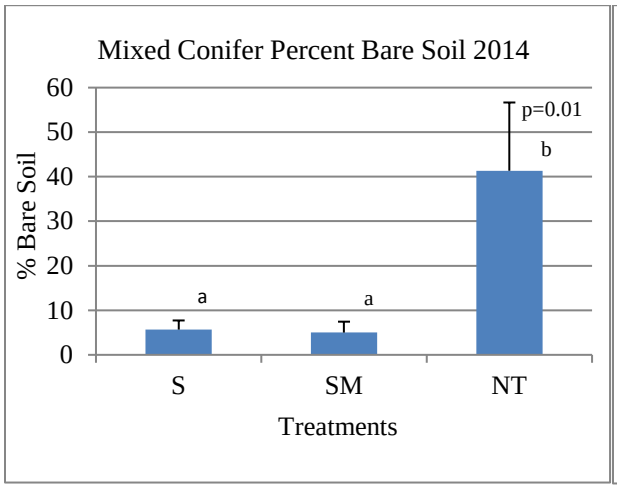


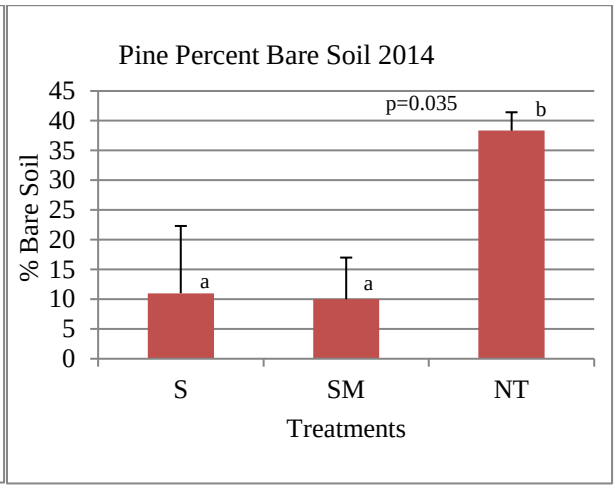




There was not a significant difference in percent of bare soil between the treated and non-treated sites in 2013, though the seeded/mulched sites did have less bare soil than the seeded and non-treated sites.

In 2014, treated sites in both of the vegetation types had significantly less bare soil than in the non-treated sites. Mean bare soil percentages in the treated mixed conifer and pine type sites were 5% and

10% respectively. The annual barley grown in the 2013 season provided exceptional litter cover in 2014 reducing the amount of bare soil present. Treated areas throughout the burned area experienced increased litter cover and reduced amounts of bare soil as compared to those areas not treated.



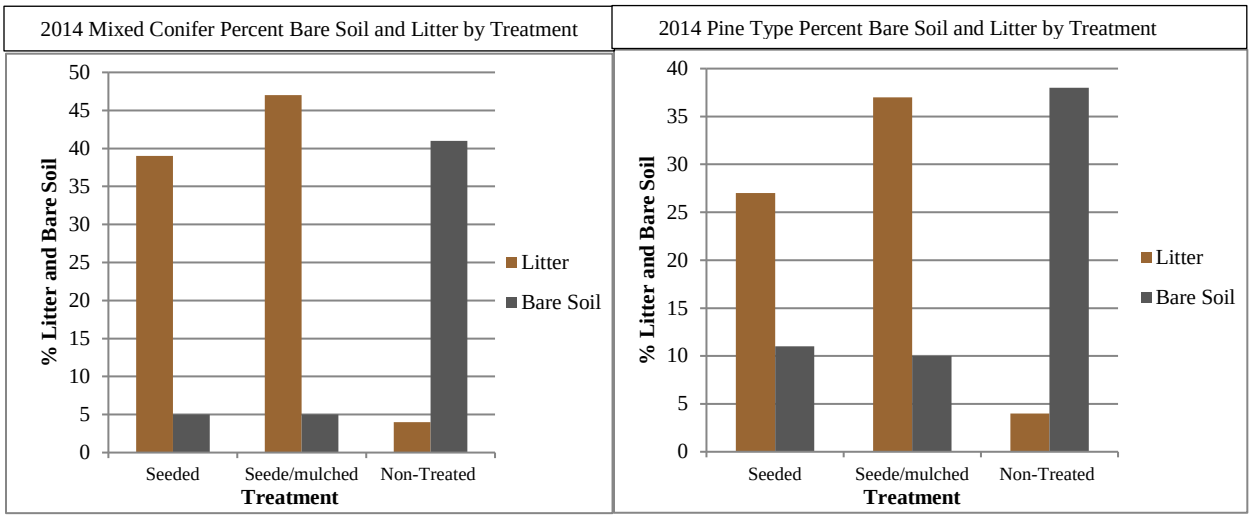




The following photos are of high burn severity mixed conifer sites, one seeded plot and one non-treated plot, photos were taken approximately 13 months after seeding. In the seeded plot litter cover was 35% (annual barley from 2013), moss cover was 23% and bare soil was 3%. In the non-treated plot litter (burned branches and logs) was 2%, there was no moss cover, and bare soil was 58%.


Mixed conifer seeded plot #3, note litter cover, September 2014

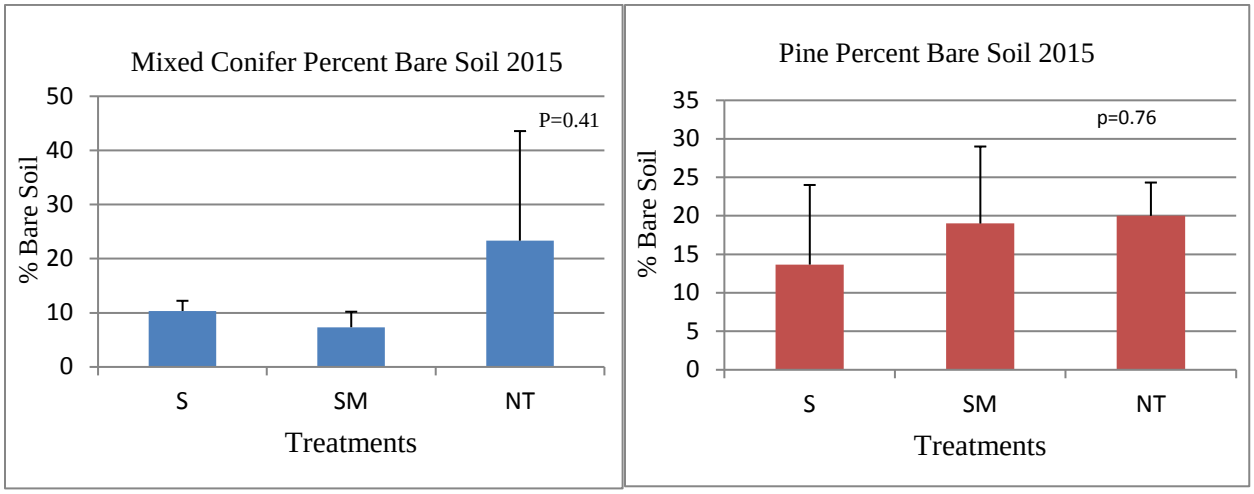

Mixed conifer non-treated, plot #3, October 2014

The following graphs display the mean litter and bare soil percentages from the 2014 data.




Note the inverse relationship in litter and bare soil between the treated verses non treated sites.

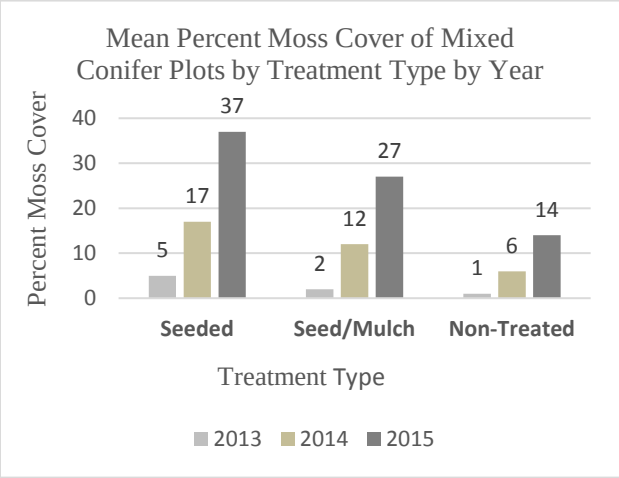
The following graphs display the differences in the amount of bare soil in 2015 in the two vegetation types by treatment. There was not a significant difference between the treated and non-treated sites.

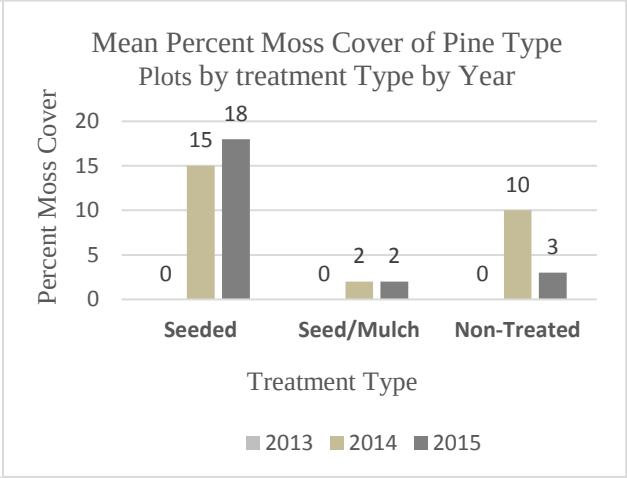



**Moss Cover**

The following graphs display the differences in the amount of moss cover in 2013 through 2015 in the two vegetation types by treatment type. There was not a significant difference in moss cover in any of the years by vegetation type or treatment type. When plots were initially read in 2013 moss was becoming established on the mixed conifer plots but only trace amounts were documented on the pine plots. By 2014 moss cover had increased on all sites and was providing for varying amounts of ground

cover. Moss cover continued to increase in 2015 except in the Pine seeded/mulched and non-treated plots. The data indicates that overall the cooler, moister mixed conifer sites had more moss cover than the warmer drier pine sites. It also shows that seeded sites in both of the vegetation types had greater percentages of moss cover than the seeded/mulched or the non-treated sites in the second and third year.




The first photo is plot #1, a mixed conifer seeded/mulched site in October 2013. In 2013 this plot had 6 percent moss cover. The second photo shows moss cover at plot #1, a mixed conifer seeded site in October 2015. Moss cover at this site was 55 percent while bare soil was 13 percent. The moss provided additional ground cover greatly reducing the amount of bare soil at this site.

## Monitoring Objective 2

**Evaluate the effect that post fire seeding or mulching/seeding has on maintenance of site/soil productivity**

Post-fire soil erosion is of considerable concern because of the potential decline in site productivity and adverse effects on downstream resources and infrastructure (Benavides-Solorio J, MacDonald LH 2005) . Erosion rates typically increase by several orders of magnitude from areas burned at high severity because of the loss of protective ground cover and increase in surface runoff (Inbar *et al*. 1998; Robichaud *et al*. 2000; Benavides-Solorio and MacDonald 2001, 2002). Soil productivity is associated with the top soil horizons (topsoil) where the highest concentration of organic matter, microbial activity and nutrients are located. When erosional processes remove these surface layers, soil or site productivity is diminished. Soil formation is an extremely slow process which may take hundreds of years to form 1 inch of soil. It was determined that comparing relative differences in modeled erosion rates would assist in addressing this objective. All erosion models require similar inputs of soil texture, slope percent's, slope lengths, number of slope segments, cover values and precipitation data or runoff volumes. The Rangeland Hydrology Erosion Model (RHEM) (http://dss.tucson.ars.ag.gov/rhem) was used to model erosion for the Silver Fire using cover values collected at the monitoring sites. A Cligen station was developed by personnel at ARS in Tucson for the modeling using an elevation of 8,400 feet and a Latitude of 32.912598 and a Longitude of 107.765676. Input values of soil texture, slope and slope length were held constant for all model runs. ***It should be made clear that the intent of the erosion modeling was not to come up with absolute erosion rates but rather to display relative differences in modeled erosion rates from the 3 treatment types of mulched/seeded, seeded and no treatment.***

### 2013 Results

Incorporating the cover data collected at each of the treatment plots read in 2013 into the RHEM model, percent differences in erosion rates were calculated between treatment types. Mixed conifer sites show yields of 147% less erosion in the seeded/mulched areas when compared to the no treatment areas. Seeded areas in the mixed conifer sites show yields of 120% less erosion when compared to the no treatment areas. In the pine type the seeded/mulched areas yielded 119% less erosion compared to the no treatment areas. Seeded areas in the pine type yielded 103% less erosion compared to the no treatment areas.

### 2014 Results

Incorporating the cover data collected at each of the treatment plots read in 2014 into the RHEM model, percent differences in erosion rates were calculated between treatment types. Mixed conifer sites show yields of 90% less erosion in the seeded/mulched areas when compared to the no treatment areas. Seeded areas in the mixed conifer sites show yields of 116% less erosion when compared to the no treatment areas. In the pine type the seeded/mulched areas yielded 61% less erosion compared to the

no treatment areas. Seeded areas in the pine type also yielded 61% less erosion compared to the no treatment areas.

**2015 Results**

Incorporating the cover data collected at each of the treatment plots read in 2014 into the RHEM model, percent differences in erosion rates were calculated between treatment types. Mixed conifer sites show yields of 50% less erosion in the seeded/mulched areas when compared to the no treatment areas. Seeded areas in the mixed conifer sites show yields of 36% less erosion when compared to the no treatment areas. In the pine type the seeded/mulched areas yielded 25% less erosion compared to the no treatment areas. Seeded areas in the pine type also yielded 8% less erosion compared to the no treatment areas.

## Monitoring Objective 3

**Evaluate if treatments were effective on steep slopes of between 40 to 65 percent**

The Silver Fire occurred in the steep mountains of the Black Range, over eighty percent of the burned area occurred on slopes of greater than 40 percent. The following table shows slope classes and acres of treatments by treatment type and number of monitoring plots by slope class by treatment type.

| Slope Classes | Seeded Acres and *Number of Plots | Percent of Total Acres | Seeded/Mulched Acres and *Number of plots | Percent of Total Acres |
|---|---|---|---|---|
| **0 to15%** | 412 Acres *(0) | 4% | 62 Acres *(0) | 2% |
| **15 to 40%** | 3,389 Acres *(0) | 34% | 617 Acres *(1) | 22% |
| **41 to 50%** | 2,311 Acres *(3) | 23% | 583 Acres *(2) | 21% |
| **51 to 65 %** | 3,970 Acres *(3) | 39% | 1,577 Acres *(2) | 56% |

From evaluating the plot data and from personal field observations it appears that both the seeding and the seeding/mulching were highly effective on steep slopes of 40% to 65%. There were no plots established on slopes greater than 65%, although there were some treatments applied to slope slightly greater than 65%. There was variability in canopy cover, ground cover and plant heights noted between treatments on similar slopes and aspects and variability also occurred within the individual transects at the plots. Site factors such as geology type, soil type, depth of soil, surface and internal rocks and inherent soil productivity appeared to have a much greater influence on treatment effectiveness and success than slope did.

This photo is looking up Drummond Canyon on the east side of the Black Range off of Highway 152. This watershed was seeded and mulched. Photo was taken in September 2013 two months after seeding and mulching operations. The majority of the slopes in this watershed range from 40 to 65 percent.

## Monitoring Objective 4

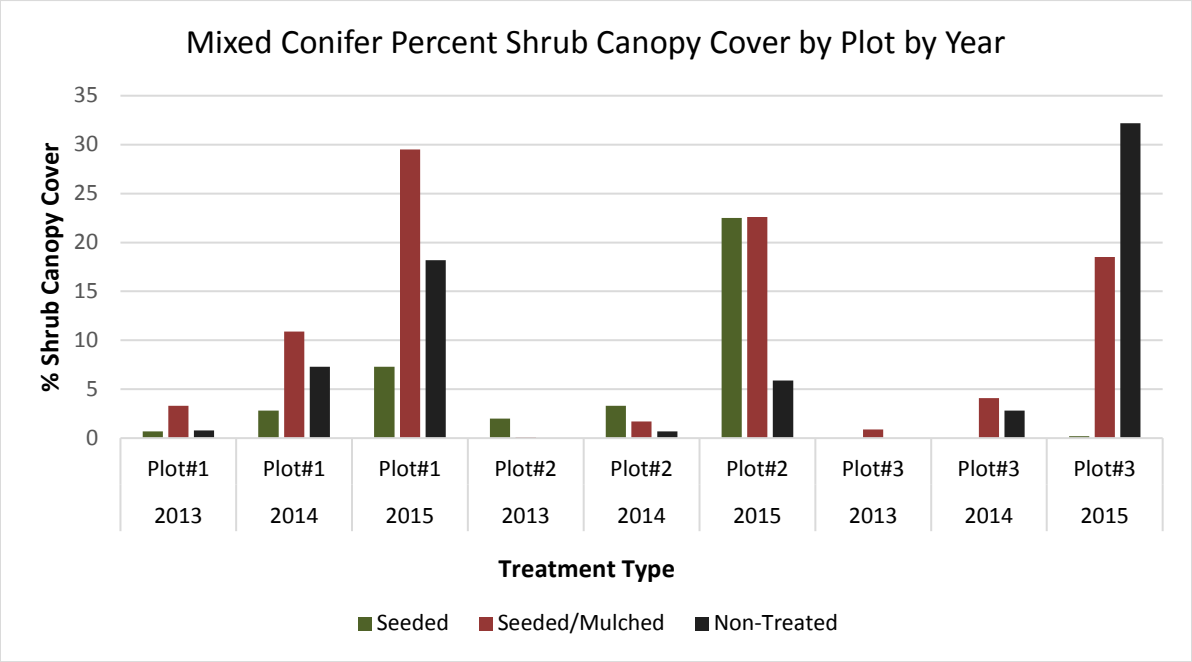
**Evaluate the effects of treatments on regeneration of woody species.**

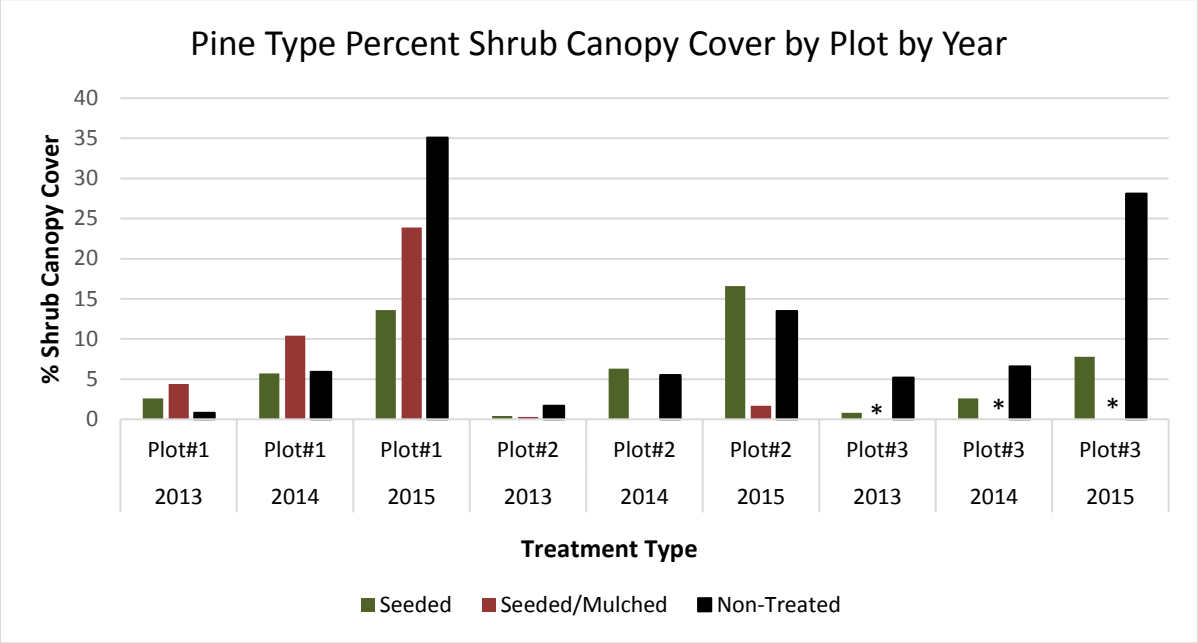
In conjunction with the line point intercept data collected at the monitoring sites a Gap intercept method was also done on transects in the plots to measure the amount of regenerating shrub and tree canopy encountered along the transects. It should be noted that all sites are not created equal and that some sites have a higher potential than others for regeneration of woody species. Pre-fire stand composition and species frequency influence post-fire figures. Site factors such as soil type, geology type, soil depth and inherent soil productivity can also influence growth rates. The intent of this vegetation monitoring method was to capture change in canopy over time.

Sixteen of the seventeen monitoring plots showed regeneration of one or more of the following alligator juniper, silver leaf oak, grey oak, gambel oak, New Mexico locust, maple, snowberry, aspen, mountain spray, thimbleberry, elderberry, ribes, fendler ceanothus or raspberry. When transects were established and read in the fall of 2013 woody canopy cover was relatively low (< 5%) at all plots regardless of treatment. The 2014 data showed increased woody canopy over 2013 and canopy cover values were generally less than 10 percent. In 2015 woody canopy covers varied much more than the previous 2

years ranging from 5 to 35 percent. The two primary species that contributed to woody species canopy covers of greater than 20% in 2015 were Gamble oak and New Mexico locust.

The data indicates that regeneration or growth of woody species was not inhibited or suppressed in the treatment units. They showed similar leader lengths, vigor and leaf size as the non-treated areas. The following graphs display canopy covers by year of regenerating species by plot and vegetation type.




*It should be noted that there was not a Pine Type seeded/mulched plot #3.

The following photos are of high burn severity mixed conifer plots, one seeded/mulched and one non-treated. They both have regeneration of gambel oak with similar growth form, plant height and leaf sizes 13 months after treatment.

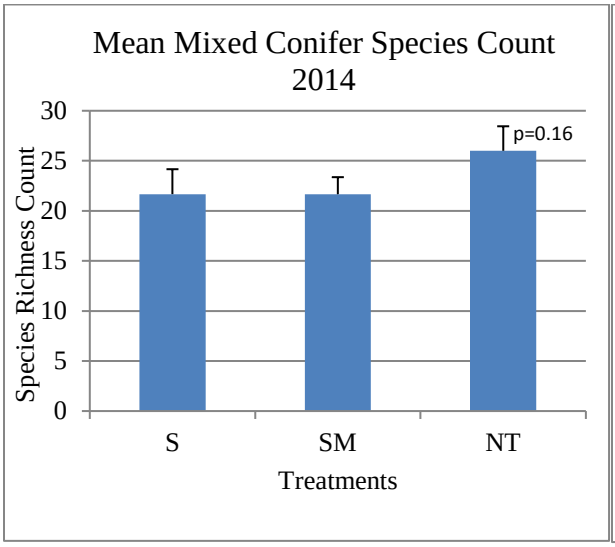

Gambel oak regeneration in a seeded/mulched plot, September 2014

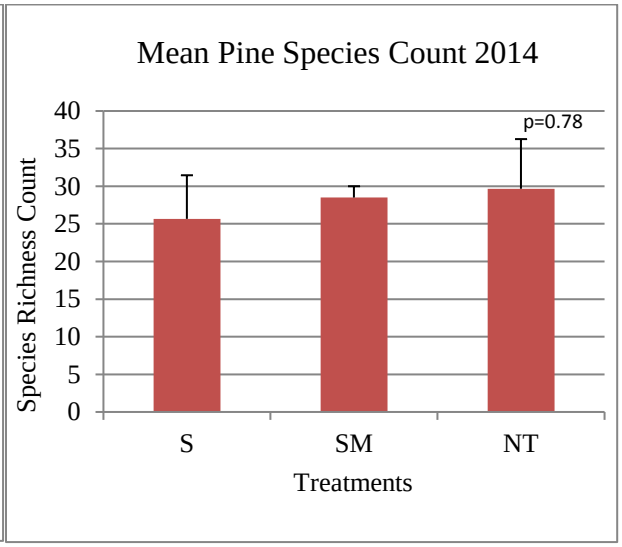

Gambel oak regeneration in a non-treated plot, September 2014

## Monitoring Objective 5

**Evaluate the effects treatments have on natural recovery, species richness and overall site recovery**

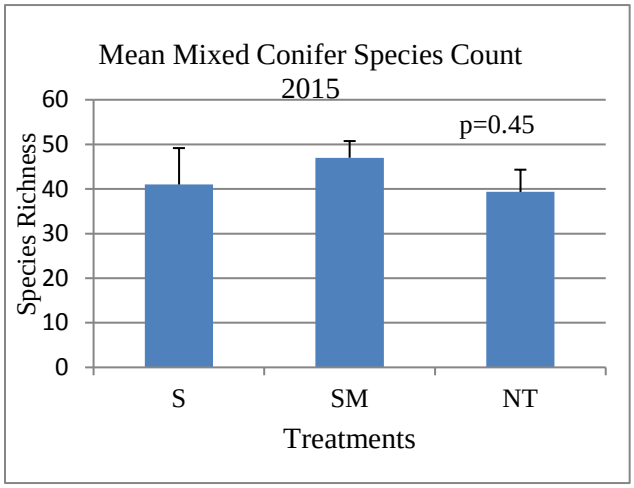
At all plots a list of the various species of trees, shrubs, forbs and graminoids present was recorded to obtain species richness of the plot. It should be noted again that all sites are not created equal and that some sites have a higher potential than others concerning site recovery and revegetation. Pre-fire stand structure and species present can influence post-fire figures. This only represents species found at the plots and does not look at the amount or abundance of a species at a site. The following graphs display the means of the species present in the 2014 plots by vegetation type and treatment type.

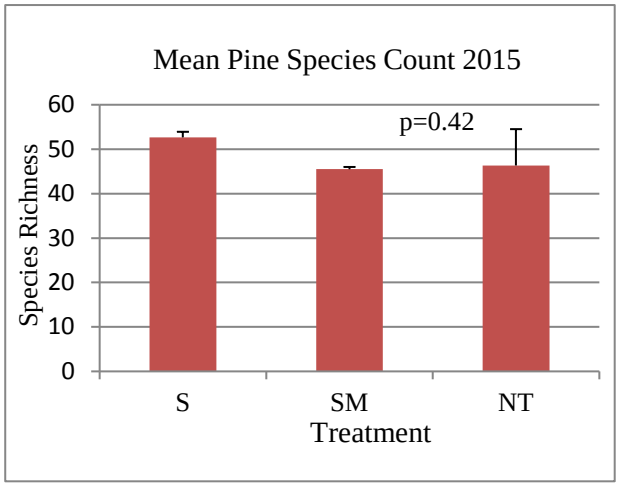


There was not a significant difference in species richness between the treated and non-treated plots in 2014. The non-treated plots do show a slightly higher number of species present than the treated plots.

The following graphs display the means of the species present in the 2015 plots by vegetation type and treatment type.




There was not a significant difference in species richness between the treated and non-treated plots in 2015.

Aspen establishment from seed throughout the burned area added to species richness at several of the monitoring plots in 2014. In the spring of 2014 an aspen bloom was noted in some aspen stands not burned by the fire in 2013. In 2014 plot readings, aspen seedlings were documented at 3 mixed conifer treated sites and 2 non treated sites. They were also documented in a pine treated site and a non-treated site. These plots had no aspen present in them pre-fire and ranged from 4 to 11 miles from the aspen stands that bloomed in 2014. This demonstrates how species spread and become established during post fire recovery of burned areas.


Seeded/Mulched site in 2014 with aspen establishment


Seeded site in 2015 with aspen establishment

## Monitoring Objective 6

**Determine if these treatments introduced invasive species**

Wheat straw was used for mulching and was certified weed free of plants listed on the State of New Mexico's noxious weed list. Seed was also certified weed free. Additional independent seed testing was not done prior to aerial seeding due to time constraints. In the course of completing the treatment monitoring in 2013 and 2014 over 30 miles of trails were either ridden or hiked annually numerous times within the Silver Fire and inventoried for invasive or noxious weeds. This occurred during the months of September - December of 2013 and September - November 2014. While not all treatment polygons were sampled with monitoring plots many were visually inspected. The staging area for the aerial mulching operation and straw storage at Emory Pass and Iron Creek Campground was also inventoried in 2013 and 2014 with no invasive or noxious species present. No invasive or noxious weeds were detected by the end of the 2014 monitoring season.

In June of 2015 while evaluating a seeded/mulched site adjacent to Highway 152, *Bromus tectorum* was noted on the site. Later in June and July the Crest trail south and north of Highway 152 was inventoried. Along the Crest trail to the south of the Highway *Bromus tectorum* was identified at numerous locations along the first mile of the trail from Highway 152. No *Bromus tectorum* was noted further out on the Crest trail to the south. The Crest trail to the north of the Highway was inventoried to Hillsboro Peak and two small populations of *Bromus tectorum* were inventoried one in a mulched polygon and one in a non-treated area. The staging area for the aerial mulching operation at Emory Pass and at Iron Creek Campground was inventoried and no brome was found.

During the 2015 fall plot monitoring, *Bromus tectorum* was inventoried in two of the mixed conifer seeded/mulched plots and one of the pine seeded/mulched plots. The one mixed conifer plot had been noted as having *Bromus tectorum* on it in June of 2015. A Siberian elm seedling was noted at a pine seeded/mulched plot and several Russian thistle were inventoried at a pine non-treated plot. A small population of *Cirsium vulgare* was inventoried in a non-treated low burn severity area while accessing a monitoring plot.


Seeded/Mulched mixed conifer site


Non treated area along the Crest Trail

# Summary of Monitoring Results

The summary addresses the monitoring objectives listed below

1. Evaluate effectiveness of seeding and seeding/mulching in increasing canopy and vegetative ground cover using an annual barley and native seed mix verses no treatment
2. Evaluate the effect that post fire seeding or mulching and seeding has on maintenance of site/soil productivity
3. Evaluate if these treatments were effective on steep slopes of between 40 to 65 percent
4. Evaluate the effects of these treatments on regeneration of woody species
5. Evaluate the effects of treatments on natural recovery and site diversity or species richness.
6. Determine if these treatments introduced invasive species

The monitoring results indicate that post-fire seeding of annual barley is very effective the first year in increasing canopy cover in areas of high burn severity in the pine and mixed conifer vegetation types. Monitoring indicated that annual barley was providing canopy cover and reducing raindrop impact and subsequent soil detachment in as little as two weeks after completion of seeding operations. The cooler moister mixed conifer sites produced more canopy cover and overall biomass in 2013 than the warmer drier pine type sites. When plots were established and read in 2013 mean canopy cover values on the mixed conifer treated plots were76% or greater and in the pine type 56% or greater. Cover values in the non-treated plots were less than 5%.

The annual barley grown in 2013 provided for increased ground cover in the form of litter in 2014 on the treated plots. The increase in litter cover in 2014 also resulted in reduced amounts of bare soil in the treated plots. Bare soil levels remained high on the non-treated plots. In 2015 litter levels remained higher in the treated plots with reduced amounts of bare soil as compared to the non-treated plots. Cryptogam or moss cover was also higher on seeded versus non treated sites in both the mixed conifer and pine type. In 2015 mean moss cover values were 37% in the mixed conifer seeded sites and 18% in the pine seeded sites as compared to 14% in the mixed conifer non treated sites and 3% in the pine non treated sites. Particularly in mixed conifer sites there appears to be a correlation between treatments and increased moss cover.

By incorporating the cover data collected at the monitoring plots in 2013 through 2015 into the Rangeland Hydrology Erosion Model, percent differences in erosion rates were calculated between treatments and no treatment. Modeled erosion rates were significantly less in the treated verses the non-treated areas of the fire the first 2 years. By the third year erosion rates were relatively similar, though non treated sites were still producing more sediment than the treated sites. Results from this modeling exercise indicate that treatments of seeding or seeding /mulching were effective in reducing soil erosion and consequently assisting in maintenance of soil/site productivity. This is consistent with the findings of Koehler and Kiesow on the BAER effectiveness monitoring conducted on the 2014 Gila NF Signal Fire.

Five of the eleven treated plots were located on slopes ranging from 41-50% and five others were located on slopes ranging from 51-65%, the remaining plot was located in a slope range of 15-40%. There was variability in canopy cover, ground cover and plant heights noted between treatments on similar slopes and aspects and variability also occurred within the individual transects at the plots. Site factors such as geology type, soil type, depth of soil, surface and internal rocks and inherent soil productivity appeared to have a much greater influence on treatment effectiveness and success than slope did. From evaluating the plot data and from personal field observations it appears that both the seeding and the seeding/mulching were highly effective on steep slopes of 40% to 65%.

The data indicates that regeneration and growth of woody species was not inhibited or suppressed in the treatment units. They showed similar leader lengths, vigor and leaf size as the non-treated areas. When transects were established and read in the fall of 2013 woody canopy cover was relatively low (< 5%) at all plots regardless of treatment. The 2014 data showed increased woody canopy over 2013 and canopy cover values were generally less than 10 percent. In 2015 woody canopy covers varied much more than the previous 2 years ranging from 5 to 35 percent. The two primary species that contributed to woody species canopy covers of greater than 20% in 2015 were Gamble oak and New Mexico locust. It should be noted that all sites are not created equal and that some sites have a higher potential than others for regeneration of woody species. Pre-fire stand composition and species frequency influence post-fire figures.

Species richness was not affected by treatments. In all three years of data collection there was not a significant difference in the number of species present at the treated versus the non-treated plots. In 2013 species counts were very low at all sites averaging around 5 species. By 2014 sites ranged from 20 to 30 species and by 2015 they ranged from 40 to 50 species. Species richness was slightly higher in all years in the pine type. At the end of the third year in 2015 the data indicates that treatments had not had an effect on natural recovery. Three years is a short period of time and it would be good to read plots again in years five and ten to evaluate treatments effects on longer term natural recovery.

In the first two years of monitoring no invasive species were documented at any of the plots or straw mulching staging areas. Bromus tectorum was first identified in June of 2015 in a seeded mulched site adjacent to the highway. Bromus tectorum is a class C noxious weed in the state of New Mexico. Class C noxious weeds are classified as being widespread and present statewide. Without pre-fire noxious or invasive species inventory of the burned area it is unknown if the burned area had noxious or invasive species present pre-fire. It is well documented that roads and trails can be vectors for the spread of noxious or invasive plants and many noxious and invasive species do well in disturbed areas such as those found under post-fire conditions. Populations of *Bromus tectorum* have been documented throughout the Gila National Forest dating back to the early 1980's. It is interesting though that no *Bromus tectorum* was found in the burned area during the monitoring until the summer of 2015. It is suspected that *Bromus tectorum* could have been introduced to some of the monitoring plots in the straw mulch due to the correlation of *Bromus tectorum* being found in three of the six seeded/mulched plots and not being found in the seeded and non-treated plots, though it was observed along the Crest trail in non-treated areas.