

# **BAER Level II Monitoring Report Year Two**

## **Silver Fire**

### **Gila National Forest, Region 3**

**May 2015**



\*photo taken on Black Range Crest Trail Sawyers Peak

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# 2014 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 and first and second year monitoring results.

## Monitoring Objectives

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

1. Evaluate effectiveness of seeding and mulching/seeding 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. Determine if these treatments introduced invasive species
6. Evaluate the effects of treatments on natural recovery and site diversity or species richness.

The design of this monitoring plan incorporated a multiple year approach. Due to this design, not all of the above objectives will be fully addressed until monitoring has been concluded.

## 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 *mulched/seeded*, *seeded* 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 mulch/seeded 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.%20II.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. Data was collected during the months of October through December 2013 by Mike Natharius, Micah Kiesow, Nori Koehler and Jenny Natharius and September through November 2014 by Mike Natharius and Jenny Natharius.

## **2013 and 2014 Monitoring Results**

### **Monitoring Objective 1.**

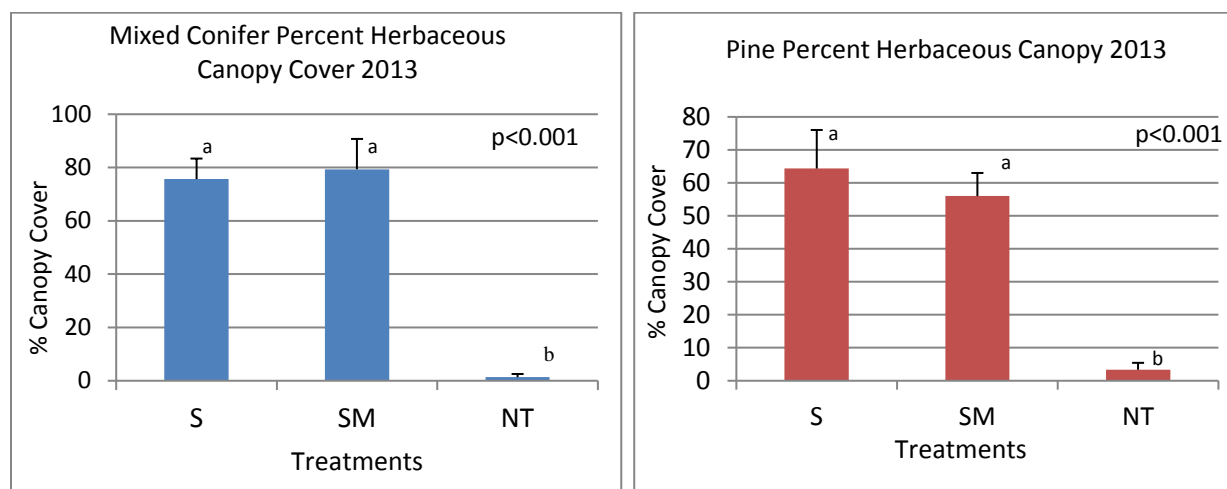
#### **Evaluate effectiveness of seeding and mulching/seeding in increasing canopy cover and vegetative ground cover using an annual barley and native seed mix versus no treatment**

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/ft<sup>2</sup>) and a smaller percentage of native grass species (8 seeds/ft<sup>2</sup>) 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 26<sup>th</sup> 2013. The burned area received precipitation prior to the completion of the seeding effort. Precipitation data from the McKnight SNOTEL site which is located in the Silver Fire burned area shows that between July 21<sup>st</sup> and October 30<sup>th</sup> 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 (S), seeded/mulched (S/M) and non-treated (NT) at the 5% significance level.

In 2013 there was not a significant difference between canopy cover values in the seeded and seeded/mulched plots in either of the two vegetation types. However, there was a significant difference in canopy cover between the treated and non-treated 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.

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.



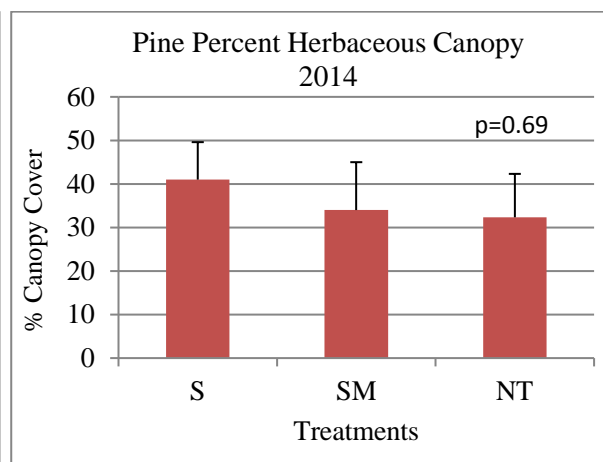
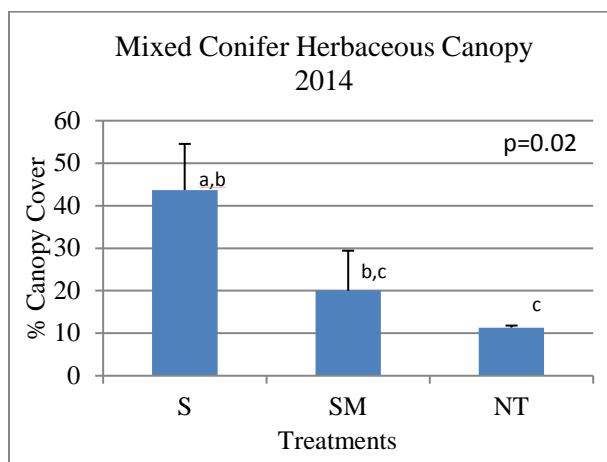


Mixed conifer seeded/mulched plot #2, November 2013



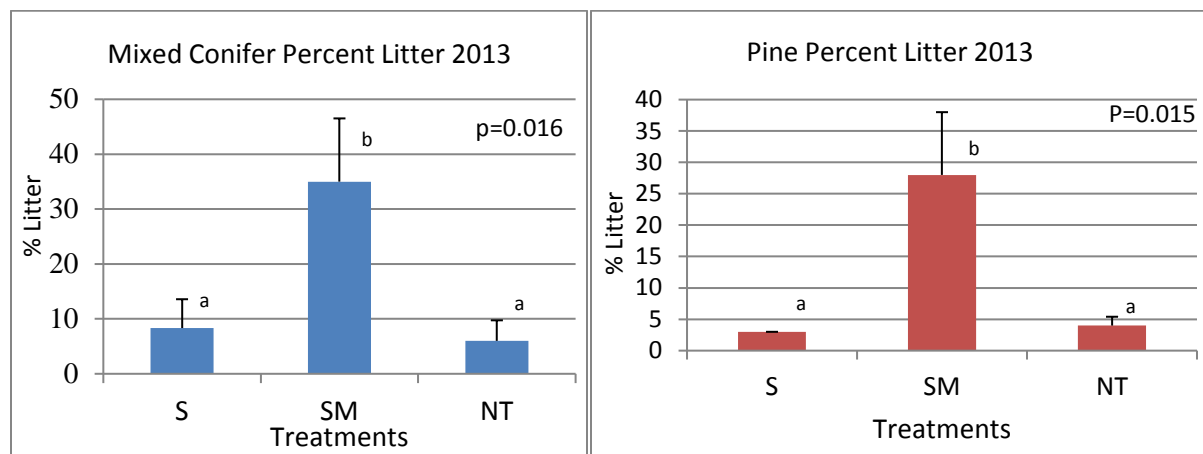
Mixed conifer non-treated, plot #3, November 2013

The following graphs display the 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 versus the non-treated plots.



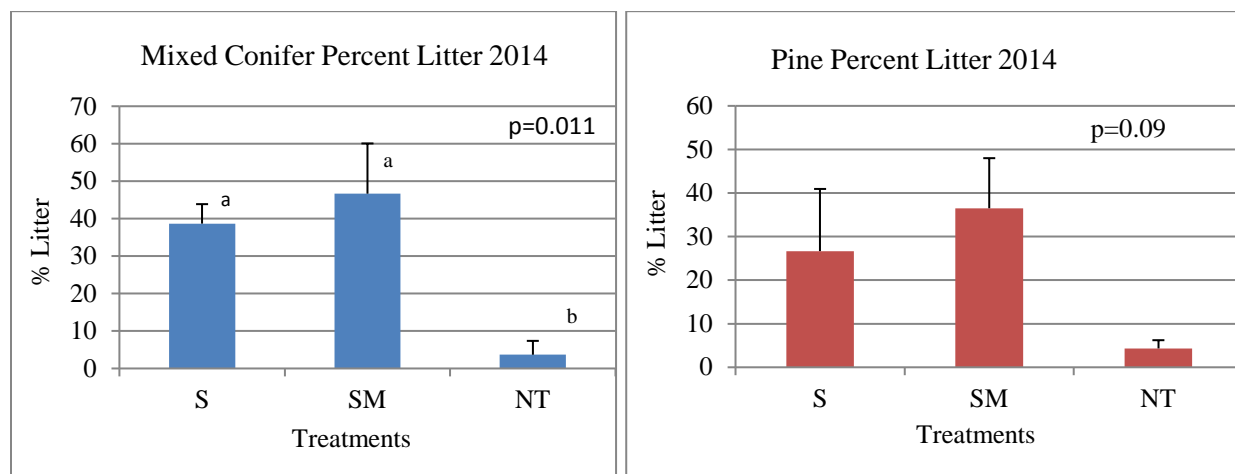
It was noted throughout the monitoring that generally the pine sites did not produce as much canopy cover or plant height (biomass) as the mixed conifer sites. This is likely the result of the pine type being warmer drier sites than the mixed conifer. Production estimates of the annual barley were conducted 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.*

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 inches 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.



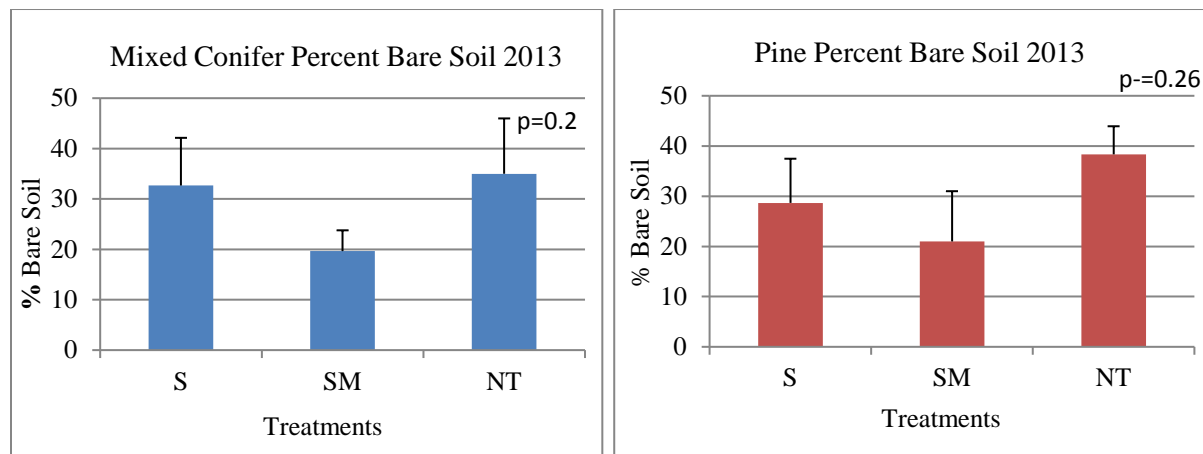
There was a significant difference in litter between the mulched/seeded sites and the seeded and non-treated sites. Seeding did not contribute to an increase in litter at the end of the growing season when the monitoring plots were established and read in 2013.

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.



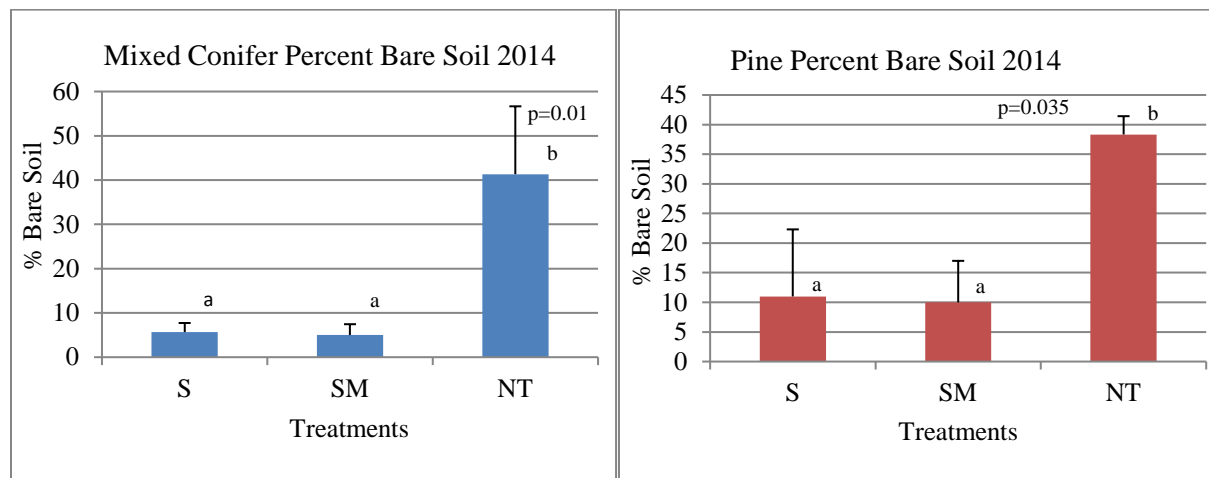
The increase in litter cover in 2014 in both of the treatment types was a result of the annual barley grown in 2013.

The following 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.

The following graphs display the differences in the amount of bare soil in 2014 in the two vegetation types by treatment.



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. Treated areas throughout the burned area have 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%, moss cover was 23% and bare soil was 3%. In the non-treated plot litter was 2%, bare soil was 58% and there was no moss cover.

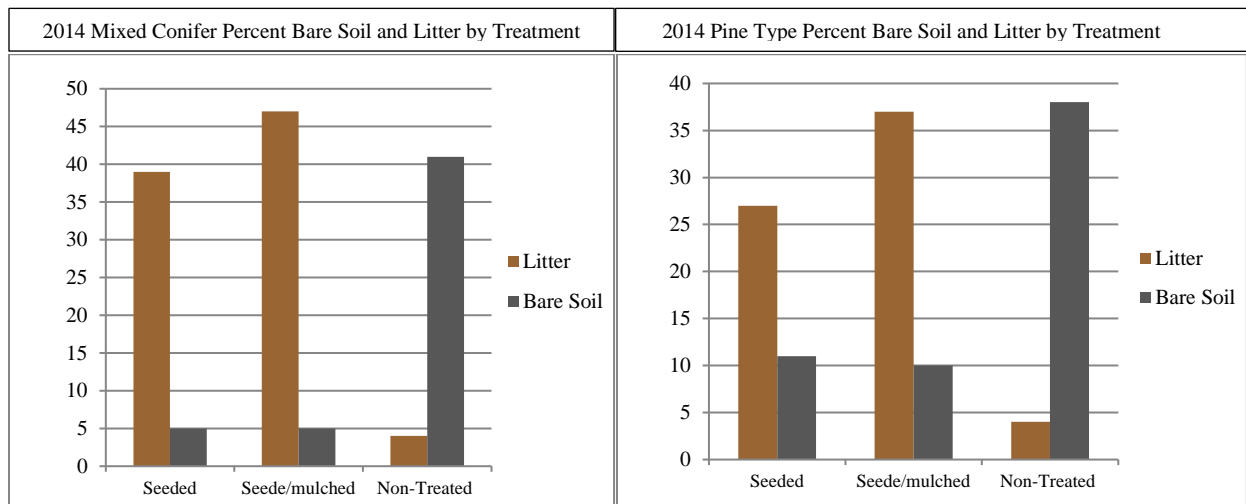


Mixed conifer seeded plot #3, September 2014



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.

*See appendix C for comparison of individual plot cover data, species richness and photos of individual monitoring sites for 2013 and 2014.*



## 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.

As would be expected modeled erosion rates were significantly less in the treated verses the non-treated areas of the fire. Results from this modeling exercise indicate that treatments of seeding or seeding /mulching were more effective in maintaining soil/site productivity than no treatment. Plot cover data will be collected and evaluated for one more year.

### **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 80 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.

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

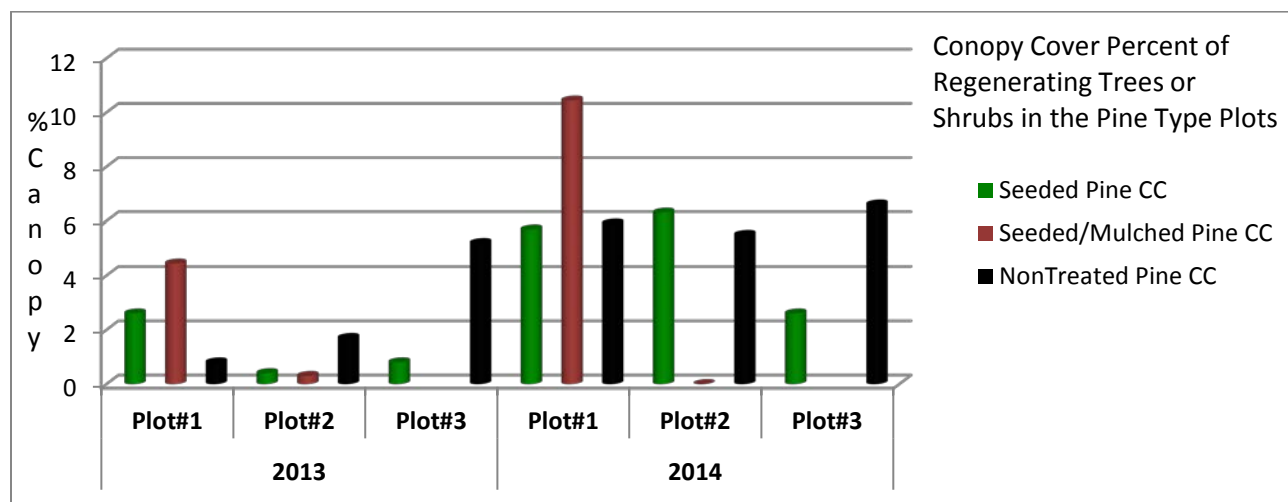
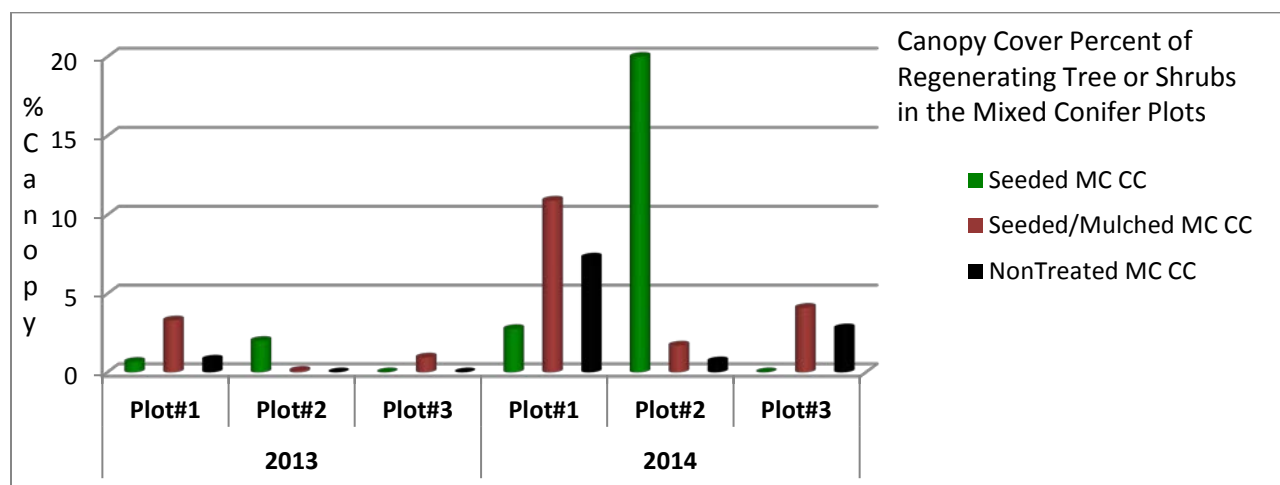
### **Monitoring Objective 4.**

#### **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 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 determine 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. In addition to the Gap intercept method a tenth acre ocular plot was done at the start of transect #2 at each plot. This was intended to capture species and associated canopy covers that may not have showed up in the Line Point intercept and the Gap intercept transects.

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



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.**

### **Determine if these treatments introduced invasive species**

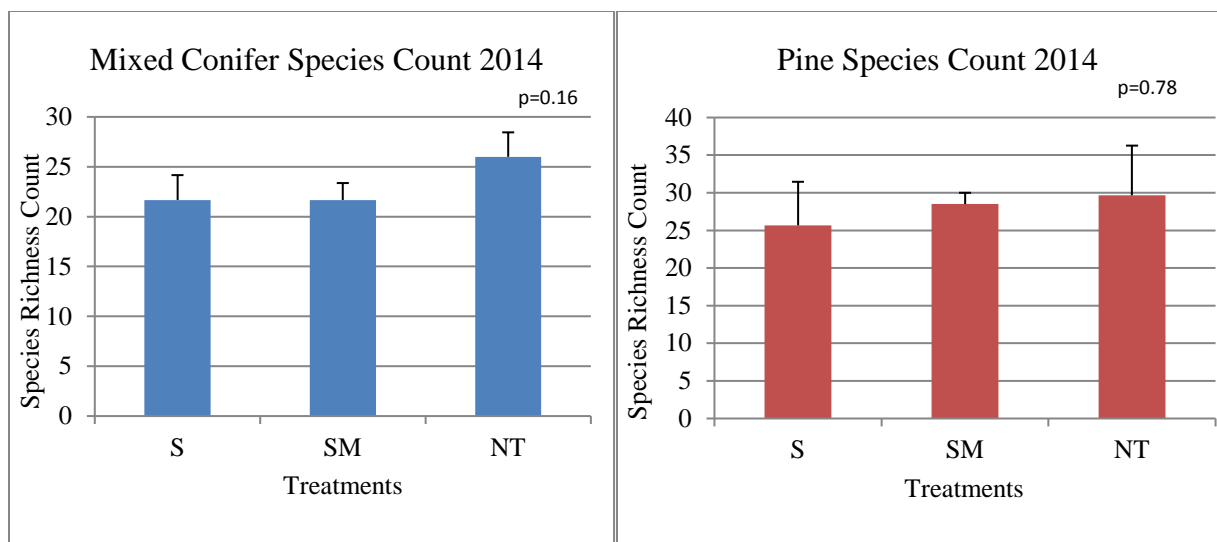
Wheat straw was used for mulching and was certified weed free of plants listed on the State of New Mexico's noxious weed list. Seed was also certified weed free. In the course of completing the treatment monitoring the past two years over 30 miles of trails were either ridden or hiked annually numerous 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 have been visually inspected. No invasive or noxious weeds have been detected as of the end of the 2014 monitoring. Inventories will continue into 2015.

## **Monitoring Objective 6.**

### **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. The following graphs display the means of the plots by vegetation type and treatment type.





There was not a significant difference in species richness between the treated and non-treated plots at the time the data was collected in the fall of 2014. The non-treated plots do show a slightly higher number of species present than the treated plots. At the end of year two's monitoring it does not appear that treatments have had much of an effect on natural recovery when compared to those areas of no treatment.