EFFECTS OF FIRE IN SAGEBRUSH VEGETATION AT SELECTED LOCATIONS ON THE SHOSHONE NATIONAL FOREST, WYOMING

REPORT TO THE SHOSHONE NATIONAL FOREST

FROM

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ABSTRACT

We used a paired-sample study design (each burned sample paired with an unburned sample on the same substrate, slope, and aspect) to collect data on plant canopy cover, shrub density, and ground cover in nine burned areas on the Shoshone Forest. In 2008, we sampled in three prescribed-fire areas and one wildfire area at the northern end of the Forest (the Beartooth face and the Shoshone River), and in 2009 we sampled in four prescribed-fire areas and one wildfire area at the southern end of the Forest (in the Popo Agie River drainage). The ages of the burns ranged from less than one year to 12years before sampling. Because we lacked data from before the fires, we had to assume that the vegetation at each burned point before the fire was similar in structure and species composition to the vegetation at its paired unburned point.

Fire all but removed the shrub stratum from the vegetation, as shown by large differences between burned samples and unburned samples in percent canopy cover of shrubs and density of shrubs. Big sagebrush (*Artemisia tridentata*) dominates the shrub canopy in most of the study area, and most of the difference in shrub canopy cover was due to a reduction in sagebrush. Deciduous shrub cover (principally of antelope bitterbrush, *Purshia tridentata*) also was reduced by fire, but the burned-plot to unburned-plot difference was less than for sagebrush. The reduction in shrub canopy cover was still clear 12 seasons after the fire. In the oldest fire, shrub density varied the least between burned samples and unburned samples.

Effects of fire on the herbaceous component of the vegetation are more subtle. Canopy cover of all herbaceous species increased after being burned, but the increase was small enough that we were able to demonstrate it on only two of the individual fires and in groups of fires: herbaceous cover was less on burned plots than unburned plots in the Beartooth face and Shoshone River fires as a group, and in the Popo Agie fires as a group. Fire also seems to have slightly increased the proportion of the herbaceous canopy cover contributed by exotic species, but this effect is small.

The number of plant species in the vegetation seems to have increased after fire, but this effect also was small and inconsistent: it appeared only among the Popo Agie fires analyzed as a group, and among all the fires together. There was no significant difference between burned and unburned samples for the Beartooth face and Shoshone River fires as a group. Similarly, fire may have increased the proportion of exotic plant species in the vegetation, but only slightly. Fire seems to have had no effect in changing the overall composition of the herbaceous component of the vegetation, expressed as the relative amount of canopy cover contributed by each herbaceous species. Finally, fire seems to have slightly increased the amount of bare ground, and slightly decreased the amount of plant litter and lichen.

In our sampling program, we opted to collect data from as many different burned areas as possible, and so obtained only three to five sample pairs from individual areas. Many of the vegetation parameters varied enough within individual areas that, with our small number of samples per area, only rarely were we able to show significant fire effects in individual burned areas. Rather, most fire effects were significant only when sample pairs from several fires were pooled for analysis.

Comparison of the burned areas with one another showed significant differences among them in amount of herbaceous plant canopy, the amount of that canopy contributed by exotic plants, the number of plant species present, and the proportion of exotic plant species in the flora. Unfortunately, due to the small numbers of samples per area, we were unable to show which burned areas differed from the others for these parameters. Reconnaissance in all of the burned areas, though, showed that exotic plants (especially cheatgrass) were more common in some of the burned areas than in others.

The paired-sample design strengthens the analysis of the effect of fire relative to other factors, such as weather and climate, that also influence the vegetation. Combined with collection of data before and after fire, from burned areas and unburned control areas, this design provides managers with a powerful way of studying the effects of fire on the vegetation.

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INTRODUCTION

In 2008, representatives of the Shoshone National Forest in northwestern Wyoming and biologists at the University of Wyoming's Natural Diversity Database entered into a cooperative agreement to study the effects on the vegetation of fires in sagebrush steppe and sagebrush shrubland. During the summer of 2008, Natural Diversity Database biologists conducted field sampling in the northern part of the Forest, in the North Fork of the Shoshone River, the South Fork of the Shoshone River (both in the Wapiti Ranger District), and along the Beartooth face (in the Clark's Fork Ranger District) (Figure 1). In 2009, the agreement was extended for an additional year, and Natural Diversity Database biologists collected data from lands in the Popo Agie River drainage (in the Washakie Ranger District) at the southern end of the Forest.

The intent of the study was to document the changes that fire (prescribed fire and wild fire) cause to the vegetation, in such features as plant species richness, abundance of different plant species, number and abundance of exotic species, and density and canopy cover of shrubs; and to estimate the longevity of such changes. In addition, we sought to test a study design and sampling procedure that might efficiently yield information from future studies of fire in sagebrush vegetation.

The information that we collected from the Shoshone National Forest in this study will, we hope, prove useful to Forest Service fire-program managers and biologists in predicting what will happen to the sagebrush vegetation in the Forest when they burn it. Beyond that, we hope that the study design that we have demonstrated and the information that we have collected will encourage the collection of similar information from future studies in sagebrush vegetation elsewhere in Wyoming. As the body of such information grows, it will provide an increasingly useful resource in light of the emphasis on prescribed fire as a vegetation management tool in state.

METHODS

SAMPLING DESIGN

This project is based on a paired-sample design, in which each plot in burned vegetation was paired with a plot in unburned vegetation on the same geologic substrate; on similar slope, aspect, and landscape position; and, in all but one case, in the same pasture. For any feature of interest, such as percent shrub canopy cover, the estimate on one plot is subtracted from the estimate on the other plot, to give a difference between the two. The plot-to-plot differences are the data points used in the analysis.

The strength of this paired-sample design is that it maximizes the influence on the vegetation from the factor of interest – fire – and minimizes the influences from other factors such as slope, aspect, and substrate. Consequently, the difference at a given time between burned plots and unburned plots (and between burned vegetation and unburned vegetation in general) can be attributed largely to fire. Unfortunately, we lacked data from the vegetation before the fires, and so have to assume that, for every pair of plots, the vegetation in the burned plot before the fire resembled very closely that in the unburned plot. Absence of pre-treatment data weakens any study of treatment effects, but pairing the plots as we have done here at least strengthens the assumption that the burned vegetation would closely resemble the unburned vegetation were it not for fire.

SELECTION OF STUDY SITES AND SAMPLING POINTS

Fire management officers on the Shoshone National Forest identified for us burned areas where we might find suitable study sites and provided information about each area, including digital files with fire boundaries for most of the areas and paper maps or photographs showing the boundaries of the older fires. For each area, the boundary line showed the limit of the area within which a fire had burned, but the entire area within a boundary line had not necessarily burned. Many of the boundary lines included forest or woodland vegetation as well as sagebrush shrub vegetation or sagebrush steppe.

2008 Sites (Shoshone River and Beartooth face)

To implement our study design, we needed to (1) eliminate forest and woodland vegetation from consideration, (2) sub-divide each burned area into parts homogeneous for slope, aspect, and geological substrate or soil type, and then (3) randomly locate sampling points within burned areas and also within unburned areas having the same environmental features.

We added the digital files of burned-area boundaries to a geographic information system project along with the landcover-type layer from the 1996 Wyoming Gap Analysis Project (Merrill *et al*. 1996) and true-color aerial photographs. With those two layers, we were able to eliminate woodlands, wetlands, and riparian zones. For many of the areas, the aerial photographs also apparently allowed us to discern burned vegetation from unburned vegetation inside the boundary line or immediately outside it. To sub-divide each area into different physical environments, we used the digital Wyoming bedrock geology map (U.S. Geological Survey and Wyoming State Geological Survey, 1994) for substrate, and digital raster graphic layers (i.e., digital topographic maps) for general slope and aspect. We identified substrate, slope, and aspect classes informally and did not attempt to characterize them quantitatively.

For the 2008 field season, we anticipated sampling at up to 10 points per burned area, so we digitized at least 5 points in the burned vegetation, distributed among the combinations of substrate, slope, and aspect. For each point in the burned vegetation, we digitized a point in a similar physical environment in the nearby unburned vegetation. We placed each point well away from the line between the burned and unburned vegetation, but did not use any formal randomization procedure. For each point, we recorded the UTM coordinates.

During reconnaissance early in the 2008 field season, we used a geographic positioning system receiver (etrex Legend, Garmin Ltd.) and topographic maps to navigate to the potential sampling points at some of the burned areas, and discovered that the aerial photographs were less useful than we had thought for showing burned vegetation. Consequently, for the remainder of the season, we used each potential sampling point to get us to a general area, and then selected the final sampling point in the field. We selected a burned point first, and then selected an unburned point on the same substrate and on similar slope and aspect. In some areas (discussed below), we were unable during reconnaissance to find unburned sagebrush vegetation on slopes and aspects that matched the burned vegetation, and abandoned sampling in those areas.

2009 Sites (Popo Agie drainage)

In preparing for the 2009 field season, we again used GIS to examine the substrate types, slope, and aspect in each burned area, and digitized potential sampling points. During early-season reconnaissance, we selected the actual sampling points in the field. In each area, a burned point was selected first, and then a point was selected in nearby unburned vegetation to match the substrate type, slope, and aspect of the burned point. We abandoned only one burned area due to our inability to find unburned sagebrush vegetation on similar slope and aspect.

DATA COLLECTION

Final Selection of Sampling Points

For each burned area, the field crew had a list of potential sampling points, some predicted from the GIS review to be in burned vegetation and some in unburned vegetation. Crew members used a GPS receiver (etrex Legend, Garmin Ltd.) to navigate to the first burned point on the list, and if the point met four criteria (Table 1), it was chosen as the first burned sampling point. If the point failed to meet all of the criteria, the crew members moved to the nearest location where the criteria were met and established the burned sampling point there.

For each burned sampling point, the crew members selected a point in nearby unburned vegetation that matched the burned point in type of substrate, slope steepness (to within approximately 5^o, and aspect (to within approximately 10^o), and that met six criteria (Table 2). For some pairs, the unburned point lay outside of the boundary of the burned area.

Collecting Data and Information

At each sampling point in both years, a two-person field crew used a macroplot (10 m x 25 m) containing 3 shrub-density plots (1 m x 5 m), 5 nested microplots (0.5 m x 1 m), and a 25-meter long line-intercept transect (divided into five 5-m segments) to estimate percent canopy cover of all plants and percent of the ground covered by various materials, to record shrub vigor, and to document signs of disturbance. In 2009, we added a 50-meter long transect with twenty-five 1 m x 1 m plots to estimate the abundance of cheatgrass at each sampling point. The arrangement of the sampling units is shown in Figure 2. Detailed instructions for collecting information in the 2009 season are given in Appendix I.

One corner of the macroplot (usually the lower, right-hand corner when looking up the slope) was designated as the starting corner. The coordinates of that corner (UTM Zone 12N, NAD83) were recorded with the GPS receiver, and the corner was marked permanently with a 3.8 cm (1 ½ in.) diameter aluminum survey cap atop a piece of re-bar pounded into the ground so that the cap is within approximately 8 cm of the ground surface. The plot number was stamped into the survey cap. From the starting corner, the crew measured the azimuth in degrees from true north of the right-hand, long side of the macroplot, and of the short end of the macroplot. The measurements were made with a sighting compass (Brunton Type 16 or Silva Ranger) with 2^{o} graduations on the compass dial. The magnetic declination had been set to the value obtained in June of the sampling year from the National Geophysical Data Center's declination calculator (http://www.ngdc.noaa.gov/geomagmodels/Declination.jsp) for the nearest location with a postal zip code, so compass readings were from true north.

The perimeter of the 10 m x 25 m macroplot was marked with a measuring tape held in place with pins at the corners, with the tape tightened as much as possible without pulling loose the corner pins. The crew marked the mid-line of the macroplot with a fiberglass surveyor's rope stretched tight and straight between pieces of re-bar pounded into the ground at the mid-points of the macroplot ends.

Measurements on Shrubs

Shrub canopy cover was estimated along the right side of the surveyor's rope with the line-intercept technique (Canfield 1941). For every canopy that intersected the right side of the rope, we recorded the length of the intercept (measured with a metal tape to the nearest centimeter), the species name of the shrub, and whether the shrub was alive (any live leaves in the canopy) or dead (no live leaves present). We adopted Daubenmire's (1959) concept of the canopy as the above-ground part of the plant within the line drawn around the ends of the the outermost leaves or branches.

Gaps < 10 cm long were included in measurements of the canopy, but gaps $\geq$ 10 cm were considered openings and were not included in measurements (Figure 3). Overlapping canopies of two shrubs were counted as one canopy when the shrubs were of the same species and both were alive or completely dead, and as two canopies when the shrubs were of different species or when one was alive and the other completely dead. The 25-meter long mid-line was divided into five 5-meter long segments, and the intercepts from the different segments were recorded separately from one another.

At five points on the mid-line (5 m, 10 m, 15 m, 20 m, and 25 m from the 0 end), we recorded size and vigor of the shrubs. Measurements were made on the four shrubs closest to each point, one shrub in each quadrant formed by the mid-line and a perpendicular line. Height of the top of the vegetative canopy, length of the canopy, and width of the canopy (i.e., the longest horizontal dimension of the canopy and the dimension perpendicular to it) were measured to the nearest centimeter with a measuring tape, and the percent of the canopy that was alive was recorded.

For estimating shrub density, we counted the shrubs rooted in each of three 1 m x 5 m plots (marked with parachute cord) on the left side of the mid-line rope, at 0 to 5 m, 10 - 15 m, and 20 - 25 m from the 0 end. We also recorded, for each shrub, the species name, the height of the top of the vegetative canopy (in four classes: < 5 cm, 5 - 25 cm, 25 - 50 cm, and > 50 cm), and whether the shrub was alive or completely dead.

Finally, we counted sagebrush seedlings in each of the five 0.5 m x 1 m microplots (described below).

Measurements on Herbaceous Plants

Canopy cover of herbaceous plants was estimated in five 0.5 m x 1 m microplots on the right-hand side of the mid-line rope, following the method of Daubenmire (1959). We marked out the microplots with a frame made of 1.27 cm (1/2") diameter PVC pipe, placed five times along the rope, at 3 - 4 m, 7 - 8 m, 11 - 12 m, 15 - 16 m, and 19 - 20 m from the 0 end of the rope. Each time we placed the frame, we recorded the canopy cover of each species that overlapped the frame, using seven canopy-cover classes: < 1%, 1 - 5%, 5.1 - 15%, 15.1 - 25%, 25.1 - 50%, 50.1 - 75%, 75.1 - 100%. The crew member estimating cover used two plastic squares (equal to 1% and 5% of the microplot area), and marks on the microplot frame, to make better estimates.

After recording information from the microplots, one crew member searched the macroplot for 10 minutes for plant species that had not been noted in the microplots, along the shrub intercept line, or in the shrub density plots. We collected specimens of unidentified plants for identification later.

Measurements on Ground Cover

In each of the five microplots, we estimated the percent of the ground surface covered by 12 kinds of biotic or abiotic materials (Table 3), using the same seven cover-classes as for plant canopy estimates. Categories of lichens are from Rosentreter *et al.* (2007). We also noted the presence of four types of animal droppings (pellets, cattle droppings, horse droppings, sage-grouse droppings) but recorded cover only for all droppings together, not for the individual types.

Measurements on cheatgrass transects (2009 samples only)

Canopy cover of cheatgrass was estimated, by seven cover classes (< 1%, 1 - 5%, 5.1 - 15%, 15.1 - 25%, 25.1 - 50%, 50.1 - 75%, 75.1 - 100%) in each of the twenty-five 1 m x 1 m plots along the 50-meter transect.

Miscellaneous Information

For every macroplot, we recorded the following:

-- signs of disturbance (roads, trails, recent grazing or browsing, cut stumps), including the number of mammal burrows and the number of ant mounds in the macroplot;
-- type of bedrock;
-- type of surface material (residual, alluvial, colluvial, aeolian);
-- aspect in degrees from true north., with a sighting compass (Brunton Type 16 or Silva Ranger) graduated in 2-degree increments, and corrected for magnetic declination;
-- slope steepness in degrees, with a clinometer on the sighting compass or with a separate clinometer (Brunton Clino Master) graduated in 1-degree increments;
-- slope shape (straight, concave, convex, mixed).

We also took at least one photograph of the macroplot with a digital camera (Canon PowerShot A590), usually looking up-slope from the starting (i.e., lower right-hand) corner.

DATA ANALYSIS

<u>Data Summary</u>

For each sampling point, the measurements or estimates of a vegetation feature (such as canopy cover) from the sub-samples in the macroplot were averaged to give a single value for the sampling point, as follows:

Shrub canopy cover

For each species, the lengths in centimeters of the intercepts in a given 5-meter segment of the mid-line were summed, and the sum was divided by 500 to give percent cover for that segment. This calculation of percent cover was repeated for all five segments, and the five percent cover values for the segments were then averaged to give an estimate of percent cover for the species at the sampling point. Live shrubs were analyzed separately from dead shrubs.

Shrub density

For each species, the number of shrubs in a given 1 m x 5 m plot was divided by 5, to give the number of shrubs / square meter. This calculation was done for each of the three plots, and the resulting values were averaged to give a single estimate of shrubs / square meter for the sampling point. Live shrubs were treated separately from dead shrubs.

Cover of herbaceous species

The cover for each species encountered in a 0.5 m x 1 meter microplot was recorded in the field as an integer value for the appropriate cover-class (Table 4). Each integer value was later converted to the mid-point of the percent cover range (Table 4). For each species, the mid-points were summed for all five microplots, and the sum was divided by 5 to give a single estimate of percent cover at the sampling point. Each species that had not been recorded in a microplot but was encountered in the macroplot was assigned a value of 0.05% cover for the sample point.

Ground cover

The cover of each ground-cover type in each microplot was recorded in the field as an integer value for the appropriate cover class (Table 4), and each of these integer values later was converted to the mid-point of the appropriate cover-range. For each type, the mid-points were summed for the five microplots, and the sum divided by 5 to give a single estimate of percent cover for the type at the sampling point.

Cheatgrass transects

The canopy cover of cheatgrass in each of the 25 plots had been recorded as an integer value for the appropriate cover-class (Table 4). In calculating percent cover, we converted each integer to the mid-point of the range (Table 4), summed the mid-points for the 25 plots, and divided by 25 to give a single estimate of percent canopy cover for the sampling point. To calculate frequency of occurrence of cheatgrass on a transect, we summed the number of plots in which cheatgrass had been encountered and divided by 25 to express the frequency as a proportion, from 0 to 1.

Pairwise Comarisons of Burned Plots to Unburned Plots

To investigate the effects of fire on the vegetation, we depended largely on pairwise comparisons of the burned plot in each pair to the unburned plot. We made these comparisons with one of two types of paired-sample tests, either paired-sample t-tests or Wilcoxon's signed-rank tests. In both types of tests, the statistic of interest is the difference between the value in the burned plot and the value in the unburned plot in each pair. Paired-sample t-tests were performed with the Minitab statistical software, release 12.21 (Minitab Inc., 1998). Wilcoxon's tests were done with the S-PLUS statistical software, version 6.1 (Insightful Corp, Seattle WA).

An understanding of the statistical basis for the t-test helps in interpreting the results. Suppose the the number of plant species per plot is the vegetation parameter being tested. In statistical terms, if fire has no consistent effect on the number of plant species present, then all of the plots (burned and unburned) are said to come from the same population. The number of species per plot varies among the plots, due to a number of factors acting randomly. Fire may be one of the factors, but its effect is inconsistent and can be considered random. In contrast, if fire has a consistent effect on the number of plant species present, then it is not a random factor (as are the other factors) and the plots are said to come from two different populations, one of burned plots and the other of unburned plots. The strength of a paired-sample study design is that pairing plots that are similar in topographic position, substrate, and management history minimizes many of the factors that influence the number of species present, and thereby maximizes the relative influence of fire.

Each t-test looks at a set of plot pairs, with the composition of the set depending on the analysis of interest: the plot pairs may come from individual fires, or from some combination of fires. For each set, the mean plot-to-plot difference in number of plant species is calculated. The mean difference is then adjusted to account for the amount of variation in the plot pairs being analyzed. This adjustment makes sense because a very large mean difference is more likely to come from a population with much variation than from a population with little variation. The adjustment is accomplished by dividing the mean difference by its own standard error (the standard error of the mean), to yield the t-value. A t-value is negative when the mean plot-to-plot difference is negative, and positive when the mean difference is positive.

The standard error of the mean is a function of both the number of plot pairs used in the test (the more pairs used, the smaller the standard error of the mean) and the amount of variation among those pairs in plot-to-plot difference in number of plant species (the less the variation, the smaller the standard error of the mean). So, the t-values with the greatest magnitude (i.e., farthest from 0) come from large sets of plot-pairs that have mean plot-to-plot differences far from 0 and little variation among the plot-to-plot differences.

The hypothesis being tested each time is that the t-value = 0, meaning that fire has no consistent effect on number of species and all of the plots come from the same population. The t-value has a probability (a p-value) associated with it, that shows the probability of obtaining a t-value of the observed magnitude or larger even if the hypothesis is true. The probability value can be thought of in this way: suppose that one runs 100 t-tests, each using a set of plot pairs drawn at random, and all of the sets have the same number of plot pairs. If all of the plots come from the same population, then the plot-to-plot differences usually will be small and very rarely will the t-values be far from 0. It will sometimes happen that one gets a t-value far from 0 because sometimes, just by chance, the plots drawn for the test are those with greatest differences in numbers of species. How often that happens depends on the amount of variation in number of species present in each plot in the population, and the number of plot pairs used in the tests. In contrast, if one draws the burned plot in each pair from one population and the unburned plot from a different population, then the plot-to-plot differences consistently will be large and the t-value will often be far from 0.

Whether a given t-value suggests that the plots are drawn from a single population (and fire has no consistent effect) or that the burned plots come from one population and the unburned plots from another (because fire has a consistent effect) can be judged by looking at the probability value. A probability value of 0.05, for example, means that, if the plots are drawn from the same population, then one will get a t-value as far from 0 as the observed t-value in only 5 of the 100 tests, as long as the tests use the same number of plot pairs and those pairs have the same amount of variation in the plot-to-plot differences.

In the customary interpretation of statistical tests, a result with a probability of 0.05 or smaller is considered statistically significant, and other results are dismissed as not statistically significant and therefore indicating no effect. The rationale, though, for saying that a result likely to be obtained only 5 times out of 100 indicates a real effect while a result likely to be obtained 7 or 8 times out of 100 does not, is unclear. The arbitrary cut-off for statistical significance sometimes is raised to a probability of 0.1, which allows for a more meaningful interpretation of test results. Even so, consideration of the actual probability value for a test result is more meaningful than simple focus on whether the probability value is larger or smaller than some arbitrary value.

Wilcoxon's signed-rank test (also known as Wilcoxon’s paired-sample test) also calculates the differences between two samples. The differences are ranked, and the sum of the ranks is calculated and compared to a critical value for a given sample size and probability of occurrence (Zar 2010).

For each of the vegetation parameters, we first tested for significant effects among the plots in each of the fires individually. We then pooled the plot-pairs from the four north zone fires (Line Creek, Littlerock-Bennett, North Fork, and Legg Creek) into a group and tested for significant differences for all those fires combined, and then did the same for the five Popo Agie basin fires. Finally, we pooled the plot pairs from all the fires into a group to look for significant fire effects in all of the fires together. Combining plot pairs from several fires into a group for analysis increases the sample size for the statistical test, and (other things being equal) the larger the sample size, the more likely a statistical test is to find a significant effect. So, by analyzing groups of plot pairs, we were able to look for significant fire effects that were too subtle to appear in the individual fires.

For investigating possible effects of fire on pattern in overall species composition, we had to rely on other techniques. Standard statistical techniques such as paired-sample tests look for differences in only one variable at a time, and so are unsuitable for investigating patterns in overall species composition of the vegetation, where each species is a variable. Species composition can be examined, though, with ordination, a class of multivariate techniques that examine similarity in the species composition of many stands or plots. We used non-metric multidimensional scaling, one type of ordination, to see if the burned plots differed from the unburned plots in terms of their species composition. For the ordination, we used the PC-ORD statistical software, version 5.31 (McCune and Mefford 2006).

Comparisons of Burned Areas With One Another

In making the pairwise comparisons, we calculated mean values of vegetation features for the burned plots and the unburned plots in each fire. Those means differed from one fire to another, giving some idea of how percent herbaceous plant cover, numbers of plant species per plot, and other vegetation features varied among the fires. Our sampling design allows us to compare the fires with one another more directly, though, and we did that with the Kruskal-Wallis test, a non-parametric analogue of the single-factor analysis of variance (Zar 2010). The Kruskal-Wallis test compares medians of groups; in our case, each group consisted of the plots from a fire. We compared the groups of burned plots separately from the groups of unburned plots. A Kruskal-Wallis test shows only that some medians in the groups being compared differ from one another, but does not show which specific medians differ from the others.

All Kruskal-Wallis tests were performed with the Minitab statistical software, release 12.21 (Minitab Inc., 1998).

RESULTS

BURNED AREAS AND POINTS SELECTED FOR SAMPLING

In two field seasons, we sampled 29 pairs of plots and a single burned plot, 12 plot pairs and the single plot in four areas at the northern end of the Forest and 17 pairs in five areas at the southern end (Figure 1, Table 5). Each of the burned areas is described briefly below. Detailed information about each plot is contained in Tables 6 through 14, and photographs of the plots and of other aspects of the burned areas are contained in Appendix II.

2008 Sites (Shoshone River and Beartooth face)

In 2008, we examined three prescribed-burn areas and one wildfire-burned area on the north end of the Forest (Figure 1). After reconnaissance, we selected parts of each of these areas for study. Our selection of the areas in which to locate sampling points was constrained in part by our inability to find suitable unburned sagebrush vegetation in parts of one of the areas (Lower North Fork).

In the Lower North Fork prescribed-burn area, our sampling was limited to the lower slopes of the north valley wall (Figure 4). We were able to sample only one pair of plots and a single additional burned plot; despite extensive search, we were unable to find a place in unburned sagebrush vegetation that matched the second burned plot in slope, aspect, and landscape position. The single unburned plot (Table 6, plot 45UN08; Figure 5) indicates that the unburned sagebrush vegetation on slopes with a southerly aspect had a stratum of mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) above a herbaceous stratum dominated by bluebunch wheatgrass (*Elymus spicatus)* and containing a variety of forbs. Data from the unpaired burned plot (46BU08) suggest that vegetation on east-facing slopes is less strongly dominated by bluebunch wheatgrass; Idaho fescue (*Festuca idahoensis*) appears to co-dominate, and the vegetation contains more graminoids and forbs.

In the Legg Creek Fire burned area, in the valley of the South Fork of the Shoshone River, we sampled four pairs of plots (Figure 6). (One of the burned plots was outside the boundary of the fire area as shown in the digital file.) The sagebrush vegetation in this area grows on the lower slopes of the northwestern side of the valley (Figure 7). The shrub stratum is patchy, with some areas dominated by tall basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) and others by shorter Wyoming big sagebrush (*A. tridentata* ssp. *wyomingensis*) (Table 7). The herbaceous stratum generally is dominated by bluebunch wheatgrass, needle-and-thread grass (*Hesperostipa comata*), and needleleaf sedge (*Carex duriuscula*), and contains a variety of forbs in lesser amounts.

The Line Creek Fire at the far northern end of the Forest burned across a wider foothill zone of sagebrush than did the other fires, and we sampled four pairs of points there (Figure 8). The sagebrush vegetation is diverse in the area. Dwarf-sagebrush steppe of black sagebrush (*Artemisia nova*), threadleaf sedge (*Carex filifolia*), bluebunch wheatgrass, and a forb component with with a number of cushion-form species (Table 8, plot 28UN08) grows on the upper parts of wide slopes (Figure 9), and covers much of the area. Taller sagebrush steppe and shrub stands of Wyoming big sagebrush also cover much of the area and grow on slopes in broad draws and valleys (Figure 10); the herbaceous component in this vegetation is more sparse and contains a relatively large amount of western wheatgrass (*Elymus smithii*) and Sandberg bluegrass (*Poa secunda*) (Table 8, plots 90UN08 and 91UN08). Stands of mountain big sagebrush grow on slopes in the upper part of the foothill sagebrush zone (Figure 11) and appear to cover less of the area; the herbaceous stratum in this vegetation contains a substantial amount of bluebunch wheatgrass (Table 8, plot 92UN08).

In the last of the burned areas sampled in 2008, which we refer to as the Littlerock-Bennett Fire, we sampled at three pairs of points in the upper part of the foothill sagebrush zone (Figure 12). The vegetation (Figure 13) is a mix of mountain big sagebrush stands with a herbaceous undergrowth rich in Idaho fescue and bluebunch wheatgrass on rolling hills (Table 9, plot 101UN08), and mountain big sagebrush with black sagebrush and various amounts of bluebunch wheatgrass, threadleaf sedge, and needle-and-thread grass on broader, flatter slopes (Table 9, plots 100UN08 and 102UN08).

2009 Sites (Popo Agie drainage)

During the 2009 field season, we examined four prescribed-burn areas and one wildfire area at the southeastern end of the Shoshone Forest (Figure 1). We initially planned to sample in a fifth burned area, the Middle Fork 1999 prescribed burn in Sinks Canyon, but could find no unburned sagebrush vegetation on sites that matched those in the burned area.

In the Fairfield Hill Fire, we were able to place three pairs of sampling points in and around the burned area (Figure 14). Like most fires in the Popo Agie drainage, this fire burned a south-facing slope (Figure 15), in vegetation with a shrub stratum co-dominated by mountain big sagebrush and antelope bitterbrush (*Purshia tridentata*), and a forb-rich herbaceous component dominated or co-dominated by bluebunch wheatgrass and spikefescue (*Leucopoa kingii*) (Table 10).

The Freak Mountain Fire burned in an area similar to the area burned by the Fairfield Hill Fire, and we placed three pairs of sampling points at Freak Mountain as well (Figure 16). Mountain big sagebrush dominated the shrub stratum here (Figure 17), and antelope bitterbrush co-dominated in places (Table 11). The herbaceous stratum was rich in forbs and graminoids; several grasses (bluebunch wheatgrass, spike fescue, and Cusick's bluegrass) contributed substantial cover. Our data suggest that this area had the smallest number of exotic plant species of all the areas we sampled.

The Pass Creek Fire was the largest of the fires that we sampled, and we placed five pairs of sampling points there (Figure 18). This large fire burned over entire south-facing slopes that appear to have supported heterogeneous sagebrush vegetation (Figure 19). In most of the area, the vegetation before the fire apparently had a shrub stratum dominated by mountain big sagebrush (sometimes co-dominant with antelope bitterbrush), and a herbaceous stratum containing a large number of forbs (most widespread and contributing little cover), but dominated in terms of canopy cover by several grasses, especially bluebunch wheatgrass, Sandberg bluegrass, Cusick's bluegrass, and prairie junegrass (*Koeleria macrantha*) (Table 12). Idaho fescue and cheatgrass (*Bromus tectorum*) contributed substantial cover in some places. We also encountered patches of dwarf black sagebrush steppe (Table 12, plot Eco2-047). The dwarf Wyoming threetip sagebrush (*Artemisia tripartita* ssp. *rupicola*), present in most of the burned areas at this end of the Shoshone Forest, was more common here than in the other areas. This short sagebrush sprouts after fire.

We sampled four pairs of plots in the Middle Fork 2002 Fire area (Figure 20). The vegetation in that area also had a shrub stratum of mountain big sagebrush with antelope bitterbrush in places (cover of the two shrubs was highly variable from plot to plot) and a herbaceous stratum with numerous widespread (but mostly sparse) forbs and generally dense grasses (especially bluebunch wheatgrass, Sandberg bluegrass, prairie junegrass, and cheatgrass) (Table 13). Exotic plants were common in the Middle Fork Fire area, and cheatgrass formed dense patches in both the burned and unburned vegetation (Figure 21).

We placed only two pairs of points in the Homestead Fire area (Figure 22). The vegetation in much of area had a shrub stratum strongly dominated by mountain big sagebrush, and a herbaceous stratum dominated by a mix of bluebunch wheatgrass, Sandberg bluegrass, prairie junegrass, and cheatgrass (Table 14, Figure 23). Wyoming three-tip sagebrush apparently dominated patches of vegetation in the burned area but we did not sample them.

EFFECTS OF FIRE ON THE VEGETATION: PAIRWISE COMPARISONS OF BURNED PLOTS TO UNBURNED PLOTS

<u>Vegetation Structure</u>

Shrub Canopy Cover

Mean live shrub canopy was unambiguously less on burned plots than unburned plots: in every one of the 29 plot pairs, the burned plot had far less percent live shrub canopy cover, and in 20 of the pairs, we measured no live shrub canopy at all along the line-intercept transect (Table 16). Paired-sample t-tests for seven fires individually showed a statistically significant mean unburned-to-burned difference on every fire. (The North Fork and Homestead Fires were not tested individually because of insufficient numbers of plot pairs.)

The difference in cover between burned and unburned plots can be put into useful perspective by relating it to the amount of cover in the unburned plots. Consider these two cases: in the Fairfield Hill Fire, the mean cover of all live shrubs was 9.65% in the burned plots and 57.75% in the unburned plots, for a mean absolute difference in cover of 48.1%. In the Freak Mountain Fire, mean cover of live shrubs was 1.53% in the burned plots and 37.05% in the unburned plots, for a mean absolute difference in cover of 35.52%. The 48.1% burned-to-unburned difference at Fairfield Hill might seem more impressive than the 37.05% difference at Freak Mountain, but the difference at Fairfield Hill is 83% of the amount of cover in the unburned plots, while the difference at Freak Mountain is 96% of the amount of cover in the unburned plots.

On the fires individually, mean cover of all live shrubs on burned plots is at least 72% less than the mean cover on unburned plots. Mean burned-to-unburned plot differences in cover of all live shrubs are large even in the two oldest burned areas: the Legg Creek Fire burned 10 years before the sampling season and mean cover of all live shrubs on the burned plots was 72% less than on the unburned plots, and the Fairfield Hill Fire burned 12 years before sampling and mean cover of all live shrubs on the burned plots was 83% less than on the unburned plots.

Because the shrub component of the vegetation throughout the study area is strongly dominated by sagebrush, nearly all of the reduction in live canopy cover came from a reduction in the amount of evergreen shrub cover; the cover of live deciduous shrubs (the second component of total live shrub canopy cover) was minor on most fires (Table 6). As is true for canopy cover of all live shrubs, paired-sample t-tests on live evergreen shrub canopy cover alone in the seven individual fires showed statistically significant differences in mean cover between burned plots and unburned plots in every fire.

Deciduous shrubs were far less common than evergreen shrubs, occurring in 14 of 29 unburned plots and 16 of 29 burned plots (Table 16). Only in the plot pairs from the Fairfield Hill Fire and the Middle Fork 2002 Fire did we find consistent and substantial mean burned-to-unburned differences in the amount of deciduous shrub cover. In both fires, the burned plots had little deciduous shrub cover compared to the unburned plots, and the differences were statistically significant. Antelope bitterbrush (*Purshia tridentata*) was by far the most common deciduous shrub at Fairfield Hill, with canopy cover of 20% to over 30% in the unburned plots (Table 10). Antelope bitterbrush was the major deciduous shrub in the Middle Fork 2002 plots as well, but it had substantially less cover than at Fairfield Hill (Table 13).

Differences in deciduous shrub cover were apparent in plot pairs from other fires as well, but they did not reach the level of statistical significance. In at least one plot pair at Freak Mountain and at least one pair at Pass Creek, the burned plot had substantially less deciduous shrub cover than did the unburned plot, but the differences were not consistent in all of the pairs at those fires, and consequently the probability values from the t-tests were high. Antelope bitterbrush was the major deciduous shrub in those plot pairs (Table 11 and Table 12). In contrast, on the Legg Creek Fire, the burned plots consistently had slightly more deciduous shrub cover than did the unburned plots. Line Creek and Littlerock-Bennett plots had virtually no deciduous shrub cover.

As expected given the results of the analyses on the individual fires, the analyses on groups of fires also showed large and statistically significant differences in live shrub cover. Both the cover of live evergreen shrubs and the cover of all live shrubs were significantly less on burned plots than unburned plots on the northern fires, the Popo Agie-area fires, and all fires together. In the Popo Agie-area fires and in all fires together, the burned plots also had significantly less cover of deciduous shrubs than did the unburned plots. The northern area fires had virtually no deciduous shrubs, though, and we found essentially no differences between the burned plots and the unburned plots.

Canopy cover of dead shrubs was more common on the northern fires than the Popo Agie-area fires (Table 16). Dead shrub canopy was measured on 11 of the 12 unburned plots on the northern area fires (and was $\geq$ 5% on eight of them) and on 10 of the 12 unburned plots (on which it seldom contributed more than approximately 5% cover). Cover of dead shrubs was substantially less than cover of live shrubs on all of the unburned plots, but many of the burned plots (on which cover of all shrubs was sparse) had more cover of dead shrubs than of live shrubs. The mean burned-plot cover of dead shrubs was significantly less than the mean unburned-plot cover only on the Line Creek Fire. When the four northern fires were analyzed as a group, mean dead shrub canopy cover was significantly less on the burned plots than the unburned plots.

On four of the Popo Agie-areas fires (Fairfield Hill, Freak Mountain, Homestead, and Pass Creek), the burned plots had slightly more mean cover of dead shrubs than did the unburned plots, but none of those minor differences was statistically significant. On the Middle Fork 2002 Fire, in contrast, the burned plots had greater mean cover of dead shrubs than did the unburned plots, and the difference (although small) was statistically significant. Analysis of the plots from the Popo Agie-area fires together showed no significant mean burned-to-unburned difference in dead shrub canopy cover. When the plot pairs from all fires were analyzed together, the burned plots had slightly less mean cover of dead shrubs than the unburned plots, and this small difference was statistically significant.

In summary, the data show that the burned plots in all the fires individually and in all the fires together had substantially less canopy cover of live evergreen shrubs (that is, sagebrush) and of all live shrubs than did the unburned plots. Deciduous shrubs contributed substantially less canopy cover to almost all of the plots, and most of that cover came from antelope bitterbrush. Consistent burned-plot-to-unburned-plot differences in cover of live deciduous shrubs were apparent only in the Fairfield Hill Fire and the Middle Fork 2002 Fire, where the burned plots had less cover than the unburned plots. The Popo Agie-area fires as a group had less deciduous shrub cover on the burned plots than the unburned plots, but in the northern fires (where we encountered very little deciduous shrub cover), the burned plots and unburned plots differed hardly at all. The difference on the five Popo Agie-area fires was large enough to produce a statistically significant difference for the nine fires overall.

The paired-sample design reduces the effects of slope, aspect, and the like on the amount of shrub canopy cover present and maximizes the effect of fire. Consequently, we are confident that the burned-to-unburned plot differences illustrate a reduction in shrub cover by fire, which has greatly reduced the cover of sagebrush and of all shrubs, and has had a smaller effect on deciduous shrubs. This large reduction in shrub canopy cover persists for at least 10 years.

Herbaceous Canopy Cover

In contrast to shrub canopy cover, the burned plots generally had more canopy cover of herbaceous plants than did the unburned plots. Mean burned-plot herbaceous cover was at least one-third greater than mean unburned-plot cover on seven individual fires (Legg Creek, Littlerock-Bennett, North Fork, Fairfield Hill, Homestead, Middle Fork 2002, and Pass Creek), and paired-sample t-tests indicated statistically significant differences on four of the fires (Legg Creek, Fairfield Hill, Middle Fork 2002, and Pass Creek) (Table 17). Mean burned-plot herbaceous cover was substantially greater than the mean unburned-plot cover on the Littlerock-Bennett Fire (by 34.8% of the unburned plot mean), but the differences for the individual pairs showed considerable variation and the mean difference for the fire was not statistically significant. The Line Creek Fire, which had burned the previous year, was the only fire on which the burned plots had less mean herbaceous cover, and the small difference there was not statistically significant. When plot pairs were analyzed in groups, herbaceous plant cover was significantly greater on the burned plots on the northern fires (by 26% compared to the unburned-plot mean), the Popo Agie-area fires (by 58%), and all of the fires considered together (by 45%).

For canopy cover of graminoids, the burned-plot-to-unburned-plot differences were more subtle than the differences in total herbaceous plant cover. Mean graminoid cover was greater on the burned plots than the unburned plots on eight of the fires (Legg Creek, Littlerock-Bennett, North Fork, Fairfield Hill, Freak Mountain, Homestead, Middle Fork 2002, and Pass Creek), but due to the great variation among plot pairs on most fires and the small sample sizes, the differences were statistically significant only on the Middle Fork 2002 and Pass Creek Fires (Table 17). On the Line Creek Fire, mean cover of graminoids was less on the burned plots than on the unburned plots (as was cover of all herbaceous plants), but the small difference was not statistically significant. When the plot pairs were analyzed in groups, mean graminoid cover was significantly greater on the burned plots in the five Popo Agie-area fires (by 62% of the unburned plot mean) and on all of the fires together (by 42% of the unburned-plot mean). Mean graminoid cover was slightly greater on the burned plots than the unburned plots on the four northern fires as a group, but the difference was not statistically significant.

Forbs were the second type of herbaceous plant for which we examined canopy cover. Mean burned-plot cover of forbs was greater than mean unburned-plot cover on all of the fires (Table 17), but although the differences were generally substantial when expressed as a percentage of the mean unburned-plot cover, they were statistically significant only on the Freak Mountain and Pass Creek Fires. When plot pairs were analyzed in groups, mean burned-plot forb cover was significantly greater than mean unburned-plot cover on the four northern fires, on the five Popo Agie-area fires, and on all nine fires together.

In summary, canopy cover of herbaceous plants showed the opposite response to fire than did cover of shrubs: cover of herbaceous plants generally increased, while cover of shrubs decreased markedly. This increase in herbaceous cover was seen in both graminoids and forbs, although it was less for either plant-type than for all herbaceous plants together. And the increase in herbaceous plant cover was variable enough among plot pairs that it was statistically significant on few fires individually (four fires for herbaceous cover, compared to all fires for shrub cover). The Popo Agie-area fires showed a greater increase in herbaceous canopy cover than did the northern fires.

Canopy Cover of Exotic Plants

We analyzed two sets of estimates of exotic plant canopy cover, both with Wilcoxon signed-rank tests instead of paired-sample t-tests. The first data set consisted of the canopy-cover estimates from the nested microplots within each macroplot, and come from all of the fires except the Homestead Fire (where we were uncertain of the species identifications). Mean exotic plant cover was greater in the burned plots than the unburned plots in all of the fires except the Littlerock-Bennett Fire, but none of the Wilcoxon tests on the individual fires showed a statistically significant difference (Table 18). Mean cover differed little (up to 2.57%) except in plots from the Middle Fork 2002 Fire, where mean cover was over 9% greater in the burned plots. Even this large mean difference was not statistically significant, because the variation was substantial among the four plot pairs.

In contrast, the tests on larger groups of plot pairs did indicate statistically significant, but small, differences in canopy cover of exotics, with burned plots having greater mean cover than unburned plots. In the four northern fires, mean exotic cover was 0.55% greater (relative to the unburned plot average) in the burned plots than the unburned plots. In the four Popo Agie-area fires, the burned plots had 3.38% greater mean exotic canopy cover than did the unburned plots. And in all 8 fires together, burned plots had 2.12% more mean cover of exotics than did the unburned plots.

The second set of estimates, for cheatgrass only, comes from the cheatgrass transects that we added to the sampling method during the second year. Those estimates came only from the Popo Agie-area fires. On each of those transects, we estimated the amount of canopy cover of cheatgrass in each of 50 plots. From those data we calculated frequency of occurrence of cheatgrass along the transect (that is, the proportion of plots with cheatgrass) as an indicator of the extent of cheatgrass around the plot, and the mean canopy cover of cheatgrass in the plots to show the density of cheatgrass within the area around the plot.

We found almost no cheatgrass at the Fairfield Hill and Freak Mountain Fires (Table 19). Cheatgrass was more common in the Pass Creek Fire (occurring at 2 of 5 locations), but its frequency values generally were low and it contributed very little cover. Cheatgrass seems to be more widespread in the Homestead Fire, but the sample size in that fire was small. The Middle Fork 2002 Fire had far more cheatgrass than the other Popo Agie-area fires: we found it at every sampling location, where it occurred with maximum possible frequency on all but one transect, and contributed a large amount of cover. Even on the Middle Fork plots, though, we found no statistically significant difference between the burned and unburned transects in either frequency or percent canopy cover: frequency was slightly lower on transects in the burned area, and while mean cover was much higher on the burned transects, the variation among the burned transects was large.

Even when the data from all transect were combined for analysis, we found no statistically significant difference in mean frequency or mean cover of cheatgrass between burned transects and unburned transects.

In summary, we found some evidence (in the estimates from the nested microplots) that fire has very slightly increased the amount of canopy cover of exotic plant species, although the effect is so small and inconsistent that it appears only when large groups of plot pairs are examined together. In the smaller set of estimates from cheatgrass transects, though, our data had so much variation that we could perceive no significant effect of fire.

A comparison of the results from the two sets of estimates may illustrate something about the pattern of occurrence of cheatgrass in the fires. We can only make a rough comparison between the methods, because we have estimates from both methods from only four of the Popo Agie-area fires. (Because of uncertainty about species identifications in the microplots on the Homestead Fire, we did not examine cover of exotic plants there). Both data sets indicate that exotic plants are minor components of the vegetation in the Fairfield Hill and Freak Mountain Fires. In the Middle Fork and Pass Creek Fires, where exotic plants are more common, the microplots gave lower estimates of canopy cover of exotics than did the transects, even though the microplot estimates included all exotic species and the transects included only cheatgrass. At each sampling point, half of the cheatgrass transect lay along the edge of the macroplot only 5 meters from the microplots (Figure 2), and this result from the Middle Fork and Pass

Creek Fires suggests that cover of exotics varies greatly across distances as small as 5 meters. This patchy distribution of cheatgrass is obvious in photos from many of the plots (Appendix II).

Shrub Density

Mean shrub density was substantially less on the burned plots than the unburned plots in all of the fires (Table 20), with the mean difference ranging from a low of approximately 44% of the unburned-plot mean on the Legg Creek Fire to 100% of the unburned plot mean on the Freak Mountain Fire (where no shrubs were recorded on the burned plots). Paired-sample t-tests indicated that the differences were statistically significant on all of the fires except Legg Creek, the oldest of the fires and a very patchy fire. The significant mean differences resulted from the consistent plot-to-plot differences: in only two plot pairs out of 29 was shrub density higher on the burned plot than the unburned plot.

The reduction in shrub density from fire is expected, given the clear effect of fire in reducing shrub canopy cover.

<u>Plant Species Composition</u>

Numbers of Plant Species

Differences between burned plots and unburned plots in numbers of plant species were analyzed with paired-sample t-tests. We examined only 7 of the fires individually: the Homestead Fire was excluded because we were uncertain about the identities of the plant species, and the North Fork Fire was excluded because it contained only one plot-pair. The plots from the North Fork Fire were included when the northern fires were analyzed as a group.

The mean difference in number of species per plot (burned plots - unburned plots) ranged from -1.67 species / plot in the Littlerock-Bennett Fire to 5.5 species per plot in the Middle Fork 2002 Fire (Table 21). In five of the fires (Legg Creek, Fairfield Hill, Freak Mountain, Middle Fork 2002, and Pass Creek), the mean difference was positive, indicating that, on average, the burned plots had more plant species than did the unburned plots. The two remaining fires (Line Creek and Littlerock-Bennett) had negative mean differences, indicating fewer species (on average) in the burned plots than the unburned plots in the pairs.

Only in the pairs from the Line Creek Fire did we find a statistically significant difference. In every plot-pair in the Line Creek Fire, the burned plot contained fewer species than did the unburned plot, and there was little variation in the differences. On average, the burned plots contained 4.25 fewer species. In the Fairfield Hill Fire, the t-test produced a probability value of 0.15, suggesting that the mean difference of 5.33 more species in the burned plots may represent a consistent effect of fire. In all three plot pairs there, the burned plot contained more species than the unburned plots, although the magnitude of the difference varied rather widely among the plot pairs.

In each of the remaining 5 fires (Legg Creek, Littlerock-Bennett, Freak Mountain, Middle Fork 2002, and Pass Creek), the plot-to-plot differences in numbers of species were highly variable. For example, in the Middle Fork 2002 Fire, the burned plots in two of the four pairs had at least 15 more species than did the unburned plots, but in the other two pairs, the burned plots had fewer species than did the burned plots. This variation in the individual fires, combined with the small numbers of plot pairs, produced large standard errors and small t-values.

In analyzing the plot pairs from the four northern fires together (including the single pair from the North Fork Fire), we found no indication that fire has had an effect on number of plant species. The mean difference between the burned plot and the paired unburned plot was small (-1.25), and the t-value had a very high probability ($p = 0.368$). The plot-to-plot differences were inconsistent in the 12 plot pairs from these four fires: the burned plot had more species than the unburned in 9 pairs, but fewer species in 3 pairs.

For the Popo Agie-area fires, in contrast, fire appears to have increased the number of plant species in the plots. On average, the burned plots in the pairs contained 4.27 more species / plot than did the unburned plots, and the t-value was statistically significant ($p = 0.033$). This strong result from the t-test is interesting because the difference between the burned plot and the unburned plot was not consistent: in three of the 15 plot pairs, the burned plots had fewer plant species, and in 12 of the pairs, it had more species. The large mean difference, and the relatively low variation in differences, came about because the very large positive differences in 6 of the pairs from 3 of the fires overwhelmed the smaller negative differences.

The final paired-sample t-test on numbers of plant species suggested that, when all fires are analyzed together, fire may have had (at best) a weak effect. For the 27 plot pairs, the burned plots had a slightly greater average number of species (1.81), and the probability for the t-value was rather high ($p = 0.162$).

In summary, the effect of fire on number of plant species seems to be mixed. In the Line Creek Fire, it apparently consistently reduced the number plant species present. In the Fairfield Hill Fire, there is some indication that it increased the number of plant species. Similarly, in all of the Popo Agie-area fires taken together, fire increased the number of plant species. And there is some indication that it has increased the number of species generally, when all of the fires are examined together. The differences from the individual plot pairs show that fire has had a mixed effect, even within the limited geographical areas of individual fires.

Number of Exotic Plant Species

Paired-sample t-tests suggested that fire has had no influence on the number of exotic plant species in any of the north-area fires individually, or in those fires as a group (Table 21). (The North Fork Fire, with only one plot pair, was not analyzed individually but was included in the analysis of the fires as a group.) Hence the reduction in the number of all plant species seen in the Line Creek Fire (see above) must have resulted from a reduction exclusively in the number of native plant species.

Among the four Popo Agie-area fires (the Homestead Fire was excluded), fire appears to have increased the number of exotic plant species in the Fairfield Hill Fire. The mean difference between burned plots and unburned plots was 1.333 species / plot, and the probability value was quite low ($p = 0.057$). The higher number of exotic species in the burned plot was consistent among all three of the plot pairs. Fire may have increased the number of exotics in the Pass Creek Fire as well: three of the five plot pairs had more exotics in the burned plot (there was no difference in the other two pairs), resulting in a mean difference of 1.4 more exotics in the burned plots. The probability of this result, though, was fairly high ($p = 0.135$). In all four Popo Agie-area fires together, fire appears to have increased the number of exotic species slightly, by 0.667 species / plot. The probability of this result ($p = 0.096$) is suggestive, but inconclusive.

Similarly, when the plot pairs from all 8 fires were analyzed together, fire appears to have slightly increased the number of exotic species. The mean difference for this group was only 0.556 species / plot, and the probability value ($p = 0.041$) was quite low.

In summary, the results suggest that fire has increased the number of exotic plant species in some individual fires, and in the fires generally. But the increase is slight, and apparently is not present everywhere.

Numbers of Annual and Biennial Species

We examined the numbers of annual and biennial plant species present to see if fire benefitted these short-lived species by removing competition from established perennial plants or by reducing the amount of litter cover and thereby providing more sites for seed germination. Paired-sample t-tests were used on the variable, [number of annual and biennial plant species in the burned plot] – [number of annual and biennial plant species in the unburned plot]. The tests showed no statistically-significant differences between the mean number of annuals in burned plots and the mean number in unburned plots (Table 22). Within individual fires, the mean difference in number of annual and biennial species ranged from -0.25 species per plot (burned plots had fewer species) to 1.33 species per plot; in the single plot pair in the North Fork Fire, the burned plot had 5 species more than the unburned plot. Differences were highly variable within most of the fires, and in none of the fires did the burned plots consistently have either more or fewer annual and biennial species than the unburned plots. Increasing the sample sizes in the tests by grouping fires together also produced very small mean differences, none of which were statistically significant.

Overall Species Composition of the Vegetation

The last vegetation feature we investigated was differences among the plots in relative amounts of the herbaceous plant species present. We knew (from the paired-sample t-tests on shrub canopy cover) that fire had a marked effect in reducing the abundance of shrubs, and wanted to see if fire also affected the abundance of the herbaceous undergrowth species. With most statistical tests, differences in abundance can be practically examined for only a few species at a time. Multivariate ordination, though, allows for examination of similarity among many species and plots simultaneously. Ordination works by, first, calculating the degree of similarity (or of its opposite, difference) among every pair of plots, using one of a number of quantitative measures. Second, the quantitative measures of similarity are used to calculate the location of every plot on graphical axes. Different kinds of ordination use different methods for converting the similarity values into the coordinates on the axes, but the point of every method is to display the relationships among plots so that they can be easily assessed.

Calculating the coordinates on the axes always results in loss of some of the information about plot-to-plot similarity contained in the original set of similarity values, and one goal of ordination is to preserve in the ordination axes as much of the original information as possible. McCune and Grace (2002) describe ordination and other multivariate analysis techniques specifically for investigators interested in vegetation studies.

We used the full data set of 59 plots and 198 herbaceous plant species in the ordination analysis. Each data point was transformed before analysis from the absolute estimate of canopy cover for a species in a plot to the proportion of the cover in the plot that that species contributed (relativization by plot total). We made this conversion because we already knew (from the paired-sample t-tests) that burned plots differed from unburned plots in amounts of herbaceous cover, and we wanted to focus this analysis on changes in the abundances of individual species. We chose non-metric multidimensional scaling as the ordination technique because it often reveals useful patterns among samples (McCune and Grace 2002). To calculate similarity, we used the relative Sorenson method. Appendix III shows the details of the ordination analysis.

Figure 24 shows the patterns of similarity in composition of the herbaceous undergrowth among the 59 plots. Each square symbol in the figure represents an unburned plot, and each circle represents a burned plot. The closer together are two symbols in Figure 24, the more similar in species composition are the plots that they represent. The three axes displayed in Figure 24 represent 79% of the information about plot-to-plot similarity contained in the similarity measures.

The intermixing of symbols for burned plots with those for unburned plots in Figure 24 indicates that the ordination found no obvious difference in relative amounts of herbaceous plants between burned and unburned plots. Had the two groups of plots differed in species composition, then the squares would have been concentrated in different parts of the ordination diagram from the circles.

<u>Ground Cover</u>

We tested for the effects of fire on the three ground-cover types that we think were most likely affected by fire and that have the most effects on establishment of plants and on soil erosion: bare soil, plant litter, and lichens and mosses (Table 3). For the analyses, we combined the three lichens types (non-foliose, foliose, and vagrant) and moss together into a single biological crust variable.

In all of the fires except the Littlerock-Bennett Fire, the mean percentage cover of bare soil was greater on the burned plots than the unburned plots (Table 23). On only three fires (Legg Creek, Line Creek, and Freak Mountain) was the difference statistically significant. In all of the plot pairs on those three fires, the burned plot had more bare soil than the unburned plot, and the mean difference was as little as 26% of the unburned-plot mean (on the Legg Creek Fire) and as great as 693% (on the Line Creek Fire). On the Fairfield Hill, Homestead, Middle Fork 2002, and Pass Creek Fires, mean burned-plot bare soil was greater than mean-unburned plot bare soil, but none of those differences was statistically significant; and within each of those fires, the burned plot had more bare soil than the unburned in some pairs and less in others. On the Littlerock-Bennett Fire, the burned plot had less bare soil than the unburned plot in every pair, but the mean burned-plot to unburned-plot difference was not statistically significant.

When plot pairs were analyzed in groups, mean amount of bare soil was significantly greater on burned plots than unburned plots for the four northern fires together, for the five Popo Agie-area fires together, and for all of the fires together. The mean burned-to-unburned plot difference was greatest on the northern fires (>65% of the unburned plot average), intermediate on all fires together (almost 50% of the unburned plot average), and least on the Popo Agie-area fires (approximately 39% of the unburned plot average).

Burned-plot to unburned-plot differences in percent cover of plant litter were opposite those of bare soil: mean litter cover was less on the burned plots than the unburned plots on all fires except the Littlerock Bennett Fire (which also stood apart from other fires for bare soil) (Table 23). The difference was statistically significant only for the Legg Creek, Freak Mountain, and Pass Creek Fires, in which all of the plot pairs had less litter on the burned plots than the unburned plots. Those mean differences were approximately 25% of the unburned-plot mean on the Freak Mountain and Pass Creek Fires, and over 50% on Legg Creek. In the other fires where mean litter cover was less on the burned plots (Line Creek, Fairfield Hill, and Middle Fork 2002), the mean difference was not statistically significant even though nearly all of the plot pairs showed less litter on the burned plot. In the Littlerock-Bennett Fire, the difference among plots were inconsistent, although 3 of 4 pairs had more litter on the burned plot than the unburned plot.

As with the analysis of bare soil, pooling the plot pairs revealed significant differences: mean litter cover was significantly less on burned plots than unburned plots for the four northern fires together (> 29% less relative to the unburned plots), the five Popo Agie-area fires together (approximately 22% less), and all of the fires together (>24% less).

Differences in cover of biological crust organisms (lichens and moss) between burned plots and unburned plots were analyzed with Wilcoxon's signed-rank tests because the data violated the assumption of normal differences on which the paired-sample t-test is based. Cover of biological crust was very sparse on nearly all of the plots, and differences were small (Table 23). Mean cover was less on the burned plots than unburned plots in all of the fires, but no statistical significant differences were found for the individual fires. Pooled data, though, showed that mean biological crust cover was less on burned plots than unburned plots on the four northern fires together, the five Popo Agie-area fires together, and on all fires together.

In summary, fire increased the amount of bare soil and decreased the cover of plant litter and biological soil crust organisms. The increase in bare soil and decrease in litter were variable on the majority of fires. The decrease in biological crust appeared to be consistent among fires but very small. All three of these variables showed the importance of sample size, with the effects being clearest when the fires were examined together.

Summary: Effects of Fire

The marked effect of fire on this sagebrush-dominated vegetation is obvious from even cursory observation. The reduction in canopy cover of all shrubs and of evergreen shrubs (i.e., sagebrush) was substantial on all of fires that we studied and has persisted for 10 years. Fire also has reduced the canopy cover of deciduous shrubs but the effect of fire on them seems to be weaker than on sagebrush: we found significant reductions in deciduous shrub cover on only two individual fires and for the Popo Agie-area fires as a group, but not for the northern-area fires as a group. The reduction in deciduous shrub cover may appear weaker because deciduous shrubs are much less common in the vegetation in general: antelope bitterbrush is by far the most common species, and it contributed substantial cover only in some of the Popo Agie-area fires.

Density of shrubs also is greatly reduced by fire. Only in the Legg Creek area did fire either not significantly reduce density of shrubs in the burned vegetation or has shrub density nearly recovered to unburned levels.

The effects of fire on the herbaceous undergrowth in sagebrush vegetation are weaker. Canopy cover of all herbaceous species appears to have increased after being burned (in contrast to the sharp decrease in shrub cover), but the variability among plot-pairs in individual fires was great enough that we found a significant effect in only two individual fires. The effect was clear, though, when the plots from individual fires were pooled for analysis. In looking at canopy cover of only the exotic plant species (all of which are herbs), we found evidence from the microplot data that fire has caused an increase so slight (and so inconsistent among fires) that it can be seen only when large groups of plots are examined together. Surprisingly, the data from the cheatgrass transects do not suggest an increase in cover of exotics.

The number of plant species in the vegetation (most of which, by far, are herbaceous) appears to be little affected by fire. Fire may have reduced the number of species in the Line Creek Fire (which burned only a year before we sampled), but may have increased the number of plant species in the Fairfield Hill Fire (which burned 12 years before our study). Analysis of all the plot pairs from the Popo Agie-area fires suggests that fire slightly increased the number of plant species present in the vegetation, but this is not true for the northern-area fires as a group. For just the exotic plants, fire seems to have slightly increased the number of species in the vegetation, as it did the canopy cover of those species; both responses to fire by exotics are so small that they appear only when data from a number of fires are analyzed together.

While fire increases the abundance (i.e., canopy cover) of all herbaceous species, it seems to have no effect on the relative abundances of individual species, as indicated by the ordination analysis. If the proportion of the canopy cover contributed by each of these species is used as a measure, then fire appears to leave the herbaceous component of the vegetation unchanged.

Fire seems to have slightly increased the amount of bare soil and slightly decreased the amount of plant litter on the soil surface, but these effects seem to be quite variable within individual fires. In contrast, cover of lichens and mosses seems to have declined consistently due to fire. The organisms are rare in the areas we studied, and their decrease with fire is very small.

COMPARISONS AMONG FIRES

In addition to comparing paired plots with each other to elucidate the effects of fire, we also compared the fires with one another to get a better idea of how the effects of fire might have varied from one place to another. We used Kruskal-Wallis tests for these comparisons, and in all of those tests, we excluded the the plots from the Lower North Fork and Homestead Fires because we had only one plot or two plots from each of those fires for the tests. We had at least three plots from each of the other fires for each test, which allowed the Minitab software to calculate the medians that are used in the tests. When a Kruskal-Wallis test indicated a statistically significant difference among medians, we did not use additional statistical tests to compare pairs of medians to determine which differed significantly from each other. Instead, we simply compared the the ranges in plots from each group visually (Figures 25 through 28).

Of the eight Kruskal-Wallis tests that we performed, seven returned statistically significant results, indicating differences among fires. Canopy cover of herbaceous plants in the burned plots differed significantly among fires, but canopy cover of herbaceous plants in the unburned plots did not (Figure 25). This result suggests that fire produced differences within vegetation that had been fairly homogeneous before being burned. Burned plots in the Pass Creek, Freak Mountains, and Legg Creek Fires generally had the most herbaceous cover, and plots in the Line Creek and Homestead Fires had relatively little.

Although the amount of total herbaceous cover appeared to differ very little among the fires, we did find statistically significant differences among the fires in the proportion of that cover contributed by exotic plant species (Figure 26). In the Legg Creek, Lower North Fork, Fairfield Hill, and Freak Mountain Fires, very little of the herbaceous cover in the burned plots was contributed by exotics (< 0.1, or 10%). In contrast, burned plots in the Line Creek, Homestead, and Middle Fork 2002 Fires had higher relative amounts of exotic plant cover ($\geq$ 0.2, or 20%). The pattern was similar in the unburned plots, with the Line Creek, Lower North Fork, Fairfield Hill, and Freak Mountain Fires containing very little canopy cover from exotic species (< 0.05, or 5%). Unburned plots in the Middle Fork 2002 Fire showed a wide range in the proportion of exotic herbaceous canopy, from approximately 0.05 (5%) up to 0.3 (30%)

The number of plant species per plot (an indication of species richness in the vegetation) varied significantly among the fires, in both the burned plots and the unburned plots (Figure 27). The pattern among fires was similar in the burned plots and the unburned plots, with Legg Creek having few species (< 30), Fairfield Hill and Pass Creek containing relatively many species (30 or more), and the other fires ranging between those high and low numbers. Burned and unburned plots in the Middle Fork 2002 Fire, and burned plots in the Pass Creek Fire, showed wide ranges in numbers of plant species present.

Finally, we found statistically significant differences among the fires in the proportions of the plant species that were exotics, both in the burned plots and the unburned plots (Figure 28). Plots from the Fairfield Hill, Freak Mountains, and Pass Creek Fires, both burned and unburned, had the lowest proportions of exotics(< 0.1, or < 10% of the species). In contrast, both burned and unburned plots in the Middle Fork 2002 Fire had proportions a relatively large number of exotics (> 0.1, or > 10% exotics). Proportions of exotics were relatively high in plots from the Legg Creek and Littlerock-Bennett Fires as well.

DISCUSSION

The effect of fire that appeared most clearly from our analyses is the one apparent in even cursory examination of the burned areas: fire all but removes the shrub stratum from this sagebrush-dominated vegetation. The effects we found on the herbaceous undergrowth and the ground cover were more subtle and less consistent: the amount of herbaceous canopy cover generally increases, and exotic plant species contribute slightly more of that herbaceous cover; the number of plant species in the vegetation increases slightly after fire, and exotic species become slightly more common; despite the slight increases in cover and number of exotic species, though, the overall species composition of the herbaceous stratum appears to remain virtually unchanged (because the exotic species are minor parts of the vegetation in many plots); and the amount of plant litter and biological soil crust organisms (the latter rare in this vegetation to begin with) decrease, while the amount of bare ground increases.

Our data come from a limited span of time since fire (Table 5), and so we were able to conclude little about how long the effects of fire linger in this sagebrush vegetation. The vegetation in the Fairfield Hill Fire and Legg Creek Fire had had 12 seasons and 11 seasons, respectively, of growth between the fire and our sampling. Shrub density showed the least burned-plot-to-unburned-plot difference in the Legg Creek Fire, perhaps because shrubs had begun to grow back more in that fire than in others. (The relatively small reduction in shrub density there may also have been a consequence of the patchy manner of burning; Legg Creek appeared to have been the most patchy of the fires.) In the remaining seven fires, the shrub stratum had had less than a decade to recover, and in two of the fires (Line Creek and Freak Mountains), we sampled in the first growing season after the fire. Establishment of sagebrush seedlings is episodic, occurring only in relatively wet, cool springs (Perryman *et al.* 2001). Hence the re-establishment of the shrub stratum will depend not only on how much time passes after the fire, but also on the nature of the weather during that time.

Our data also came predominantly from prescribed fires that burned between late September and early April, during the dormant period for virtually all of the herbaceous plants. Only two of the fires in which we sampled, Littlerock-Bennett and Pass Creek, were wildfires that burned in summer when the herbaceous plants may have been growing. We noticed nothing in our data to suggest that fire had a different effect on the herbaceous species in the two areas burned by the wildfires than it did in the areas burned by the prescribed fires (Figures 25 - 28, Tables 21 and 22).

In this project, we tried to balance the benefit of collecting a substantial amount of information from each fire with the benefit of sampling in as many fires as possible. We suspect that the failure of many of the paired-sample tests to show statistical significance for some fire effects in individual burned areas is a result of the small numbers of plot pairs from individual burned areas; those effects of fire on the vegetation likely are real, but subtle enough that our samples sizes were too small to show them. If this were not the case, then we would not have found statistically significant effects when we performed the same tests on larger data sets made by combining data from individual fires.

Despite the limitations in our data set, we think that the set of sampling points, the sampling design, and the sampling methods that we used provide a good basis for monitoring many vegetation changes in individual burned areas as well as changes in burned areas on the Shoshone National Forest in general. Obviously, to monitor the vegetation in a specific burned area, managers must collect more samples from that area than we did. The additional sampling points that they need can be added onto the set of points that we have already permanently established. Moreover, the data that we have collected will allow managers to calculate how many additional samples they will need to estimate a given vegetation parameter to any desired degree of accuracy and precision. Calculating the necessary number of samples requires an estimate of the variability in the parameter within the area, and managers can use our data to estimate that variability.

The macroplot with nested subsamples that we used seems to be an efficient way to collect information about the vegetation parameters that we studied. Two experienced field workers needed around 90 minutes to collect information at a sampling point, from the time they arrived at the point until they finished loading their gear to leave. (Travelling to and from points, of course, took additional time, as did selecting the sampling points during a day or two of reconnaissance per area.) The macroplot and subsamples that we used can be adapted to study different vegetation parameters that especially interest Forest Service fire managers and biologists. For example, fire managers might forego collecting canopy-cover data for individual plant species, and concentrate instead on estimating biomass or fine-fuel load. Cover or frequency estimates might be made for plant species of special interest to managers, such as cheatgrass.

Our macroplot may be too small for some applications, and certainly many of the burned areas can accommodate larger sample plots. We found, though, that the 10 m x 25 m macroplot allowed us to sample in patchy burned areas. For example, with this relatively small macroplot, we were able to locate sampling points throughout the Legg Creek Fire and in the eastern end of the Fairfield Hill Fire, both of which are composed of a fairly fine-grained mosaic of burned and unburned patches. The rather small macroplot also was advantageous in several other fires where the unburned sagebrush vegetation around the fire margin grows in small patches, even though the burned area is large and continuous.

One important sampling problem for which our macroplot-and-subsample approach is unsuited is documenting the distribution and abundance of cheatgrass and other invasive weeds. We discovered in the Middle Fork 2002 Fire that, even with the addition of cheatgrass transects, our approach of only sampling intensively at few points failed to give us a good picture of cheatgrass distribution and abundance there. A combination of a few intensive samples (similar to ours) to adequately document abundance of cheatgrass, combined with numerous quicker samples (perhaps simply showing just presence or absence, or yielding a semi-quantitative estimate of abundance) well distributed throughout the area, should give managers the information that they need to assess cheatgrass in areas where they plan to burn, and to show whether the weed is spreading in areas where they have already burned.

Knowing where cheatgrass (and other weeds such as Dalmatian toadflax) are growing, and how common they are, will be crucial to preventing their drastic increase due to fire. The importance of having reliable information about weeds for planning fire programs is illustrated by the abundance of cheatgrass in parts of Sinks Canyon and its relative rarity in other parts. Cheatgrass is widespread and (in many places) dense in the Middle Fork 2002 prescribed burn area (Figure 21, and many photographs in Appendix III), and may be even more dense in the adjacent the Middle Fork 1999 prescribed burn area

(Figure 30). In contrast, cheatgrass is much less common in the nearby Fairfield Hill Fire (Figure 30), where it generally grows in small amounts (Table 10) but also (we observed) forms denser patches in rocky sites high on the slope. Had reliable data on distribution and abundance of cheatgrass in Sinks Canyon been available to fire managers in the late 1990s, might they have decided not to burn the south-facing slopes and thereby possibly have prevented cheatgrass from becoming so common? Were the patches of cheatgrass that now grow on rocky sites at Fairfield Hill present before the prescribed fire there, or have they appeared since then? Cheatgrass seems to have suddenly become abundant in the Popo Agie River drainage in past decade (Tom Ryder, Wyoming Game and Fish Department, personal communication), and fire managers may have to adjust their prescribed-fire programs to account for a new ecological role of the weed in the area. The role of fire in promoting the spread of cheatgrass in sagebrush vegetation elsewhere, and the resulting increase in fire frequency and degradation of the sagebrush-dominated ecosystem, is well known (Knight 1994, pp. 103-105).

However the macroplot-and-subsample method that we used is modified, and whatever vegetation parameters are measured, there are three components that we urge be included in any sampling program. These components will strengthen the collection and interpretation of any sort of information, from detailed data on plant species composition (such as we collected) to photographs used in photo-monitoring.

First, using a paired-sample design is critical to understanding the extent to which changes in the vegetation after fire are due to fire as compared to weather, or climate, or other factors that influence the vegetation. A paired-sample design requires that some time and money be dedicated to sampling in areas that were not treated or are not slated for treatment, and therefore reduces the number of samples that can be taken in the treated vegetation. This can be a drawback in studies that monitor vegetation change after a fire in a single burned area, or that compare the effects of different fire treatments. In those studies, a greater number of samples from the burned vegetation would allow more precise estimates and stronger statistical tests for differences among burned areas, or among treatments. But without measurements at sampling points in the untreated vegetation, managers simply cannot be sure how much of the change in the treated area after the fire is due to the treatment and how much is due to other factors.

Second, fire crews should leave areas of untreated vegetation suitable for use as control areas. The paired-sample design that we stress requires this. We found two cases where the lack of suitable untreated areas prevented us from collecting information. In the Lower North Fork Fire area, we were able to locate only one pair of plots because we could not find enough unburned sagebrush vegetation with slope and aspect similar to the burned vegetation in which to place a second unburned point. In the Middle Fork 1999 Fire area in Sinks Canyon, we were unable to collect any data because the small amount of unburned sagebrush vegetation around the margin of the fire grew on much gentler slopes (with different exposure to sun) than the extensive burned area. Controlling a prescribed fire can be difficult, we know, but if fire managers can designate places within a burned area that are to remain unburned, and direct fire away from those areas, they will leave the necessary control vegetation. Those unburned areas should be chosen to represent the different combinations of vegetation structure and composition, slope, aspect, and substrate present in the burned area. Each unburned area should be large enough to accommodate the sampling unit that the managers plan to use to collect information, plus an undisturbed buffer around the sample.

Finally, we urge that prescribed fire programs include the collection of data before the burn, both from the treated areas and the untreated control areas. Collecting data from control areas before the burn may be a risky investment of time and money because the fire may (despite the best efforts of the fire crew) burn through the intended control areas, but it seems likely that fires can be controlled well enough in most cases to make the investment worthwhile. Combining pre-burn sampling with paired samples produces an especially strong study design that statisticians refer to as a before-after, control-intervention (BACI) sampling design.

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FIGURES

Figure 1. General locations within the Shoshone National Forest of burned areas studied in 2008 and 2009.

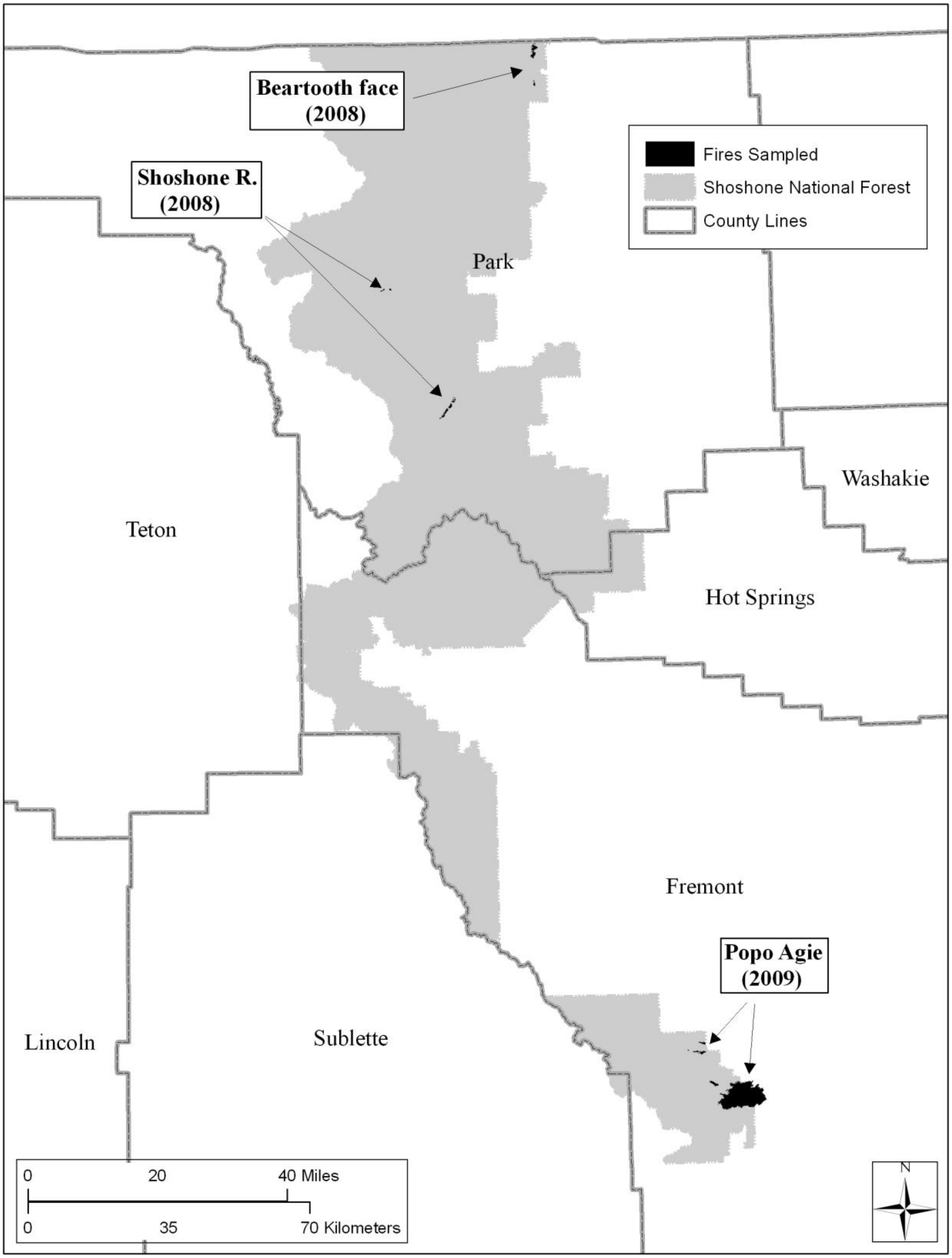


Figure 2. Arrangement of sampling units at each sampling point.
The cheatgrass transect was used only in 2009.

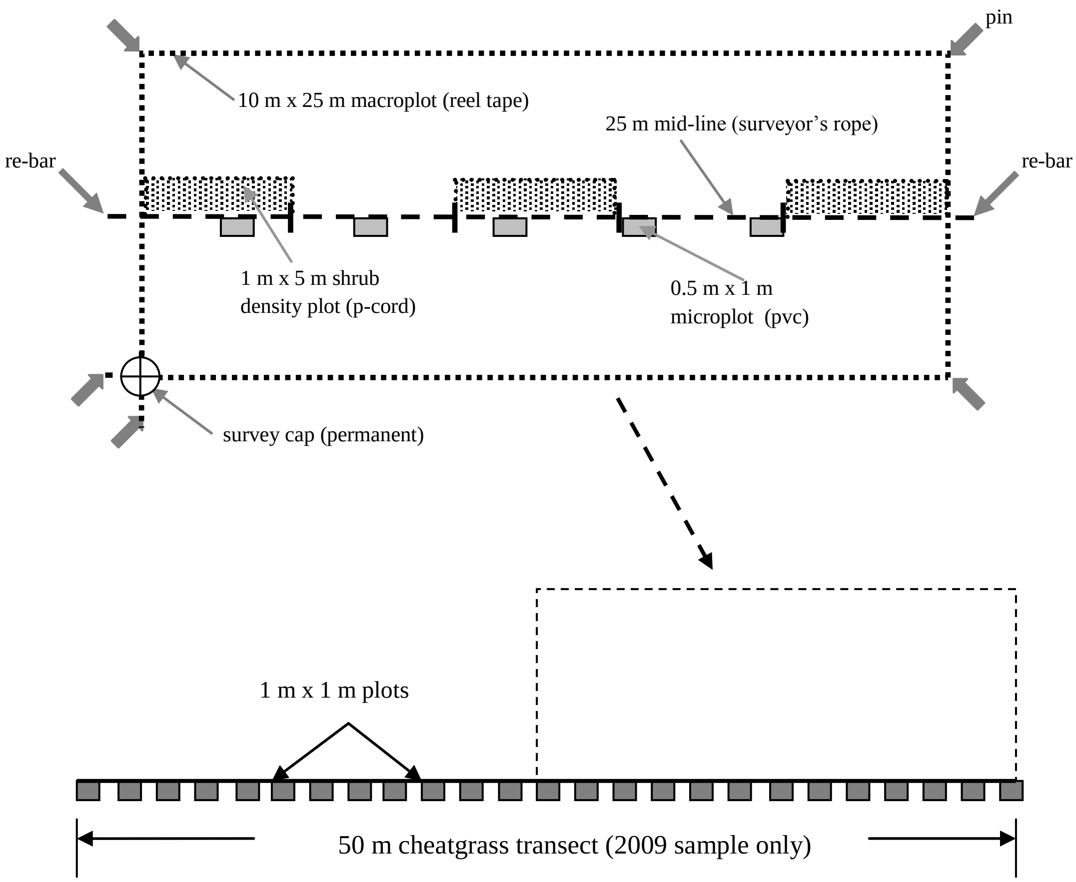
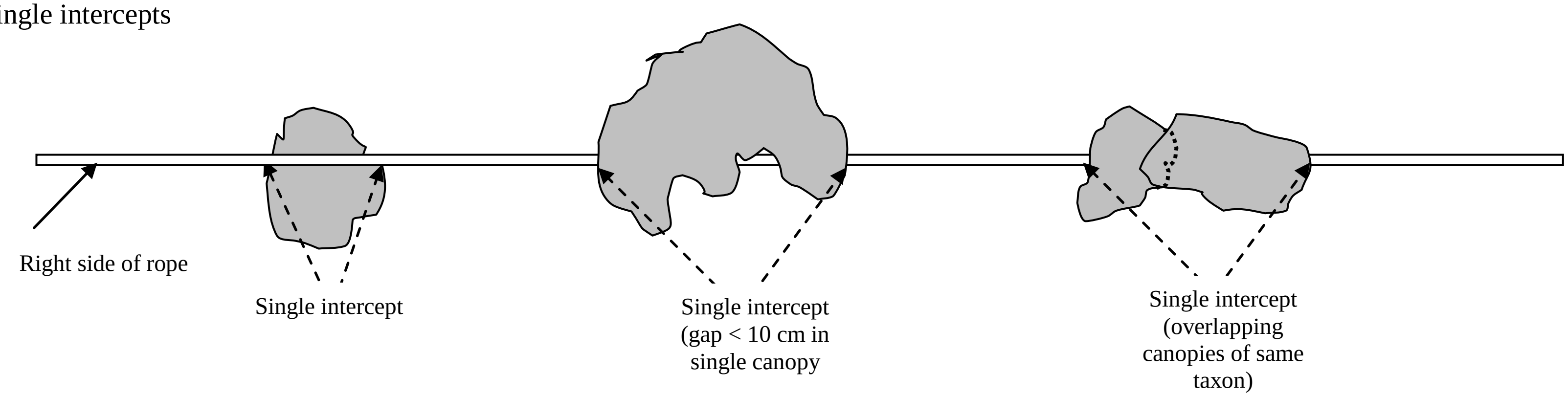


Figure 3. Examples of how gaps and overlapping canopies were treated in measurements of shrub canopy intercepts.

a. Single intercepts



b. Two intercepts

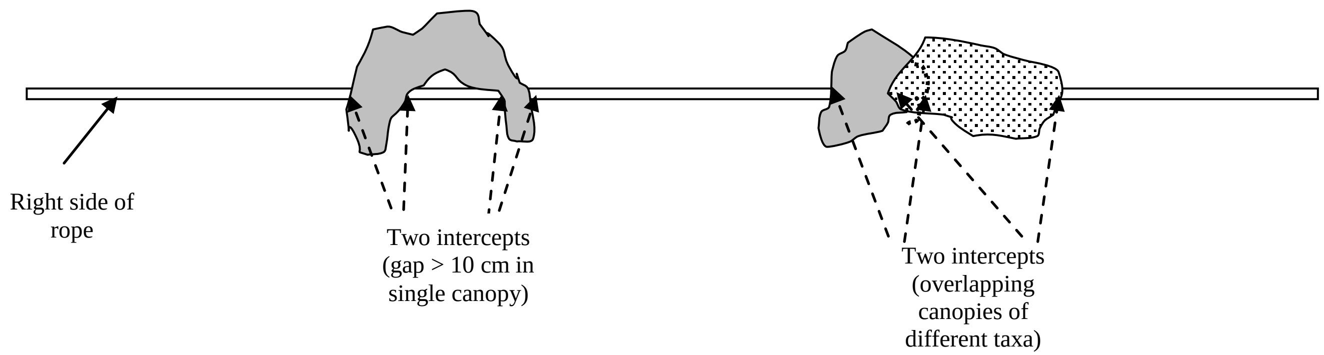


Figure 4. Locations of sampling points in the Lower North Fork Fire.
The plots at these points were sampled in 2008.

a. General location of the areas burned in the fire.

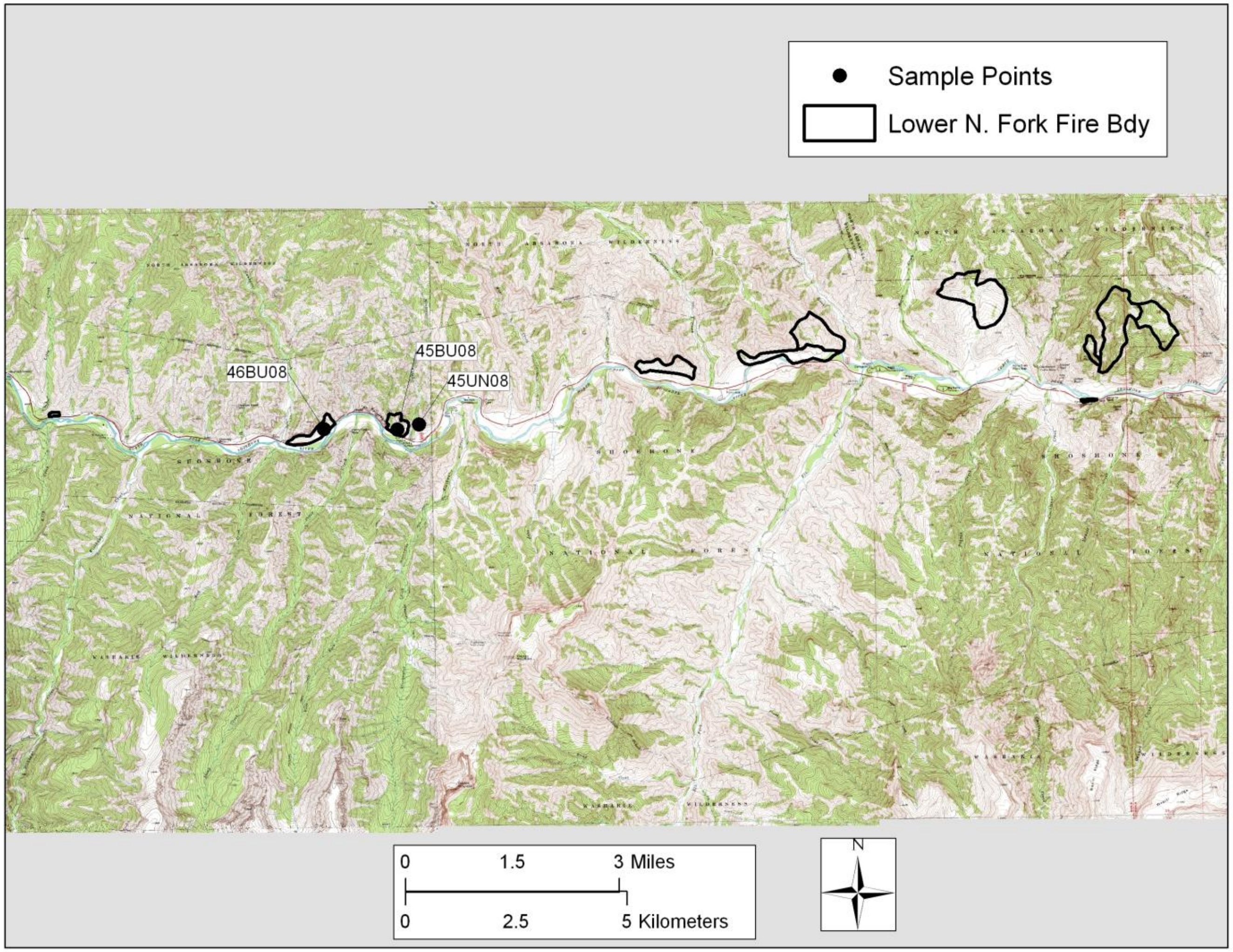


Figure 4 (continued).

b. Detailed map of the locations of the sampling points.

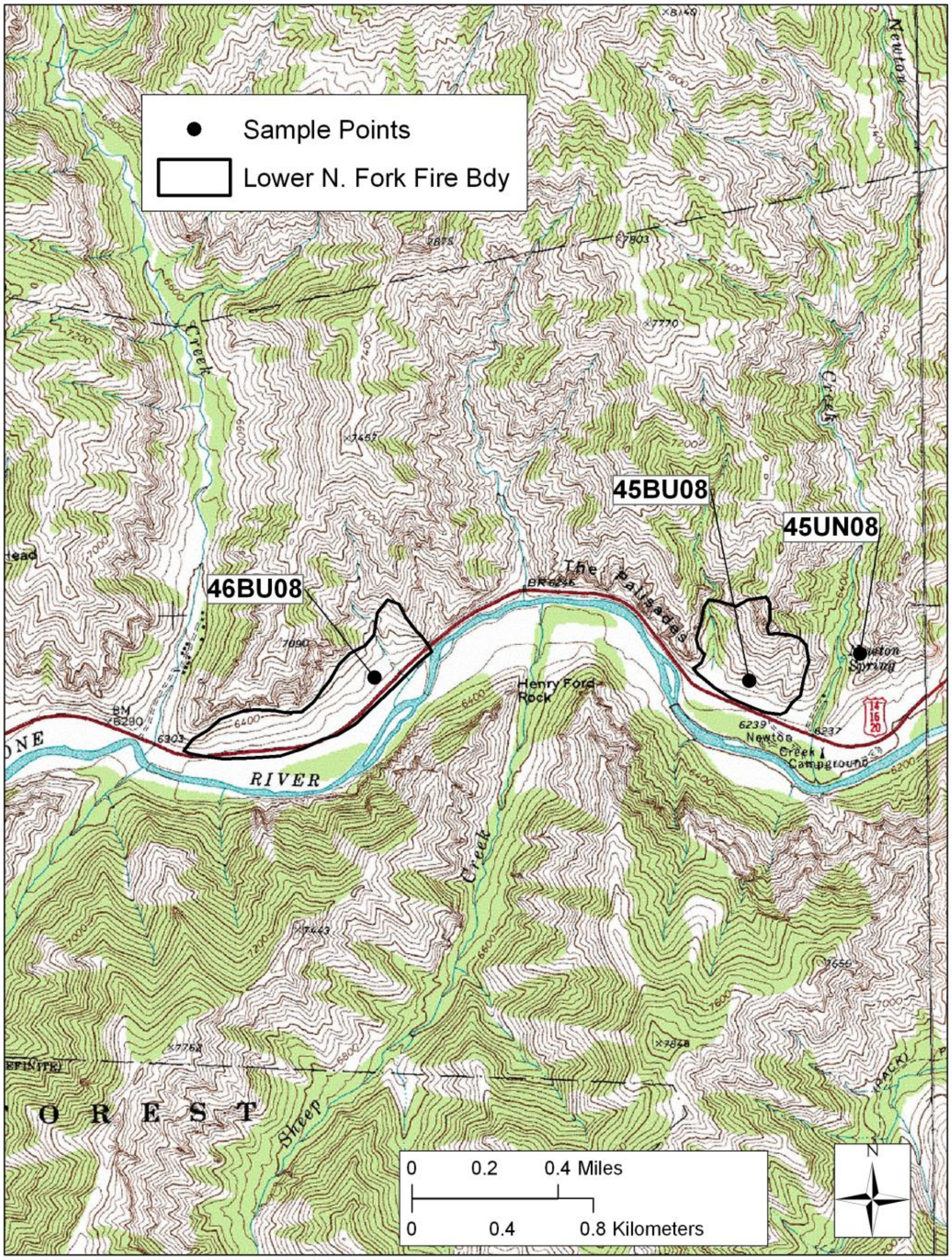


Figure 5. Photograph of unburned vegetation in the Lower North Fork Fire.
This is plot number 45UN08.

Figure 6. Locations of sampling points in the Legg Creek burned area.

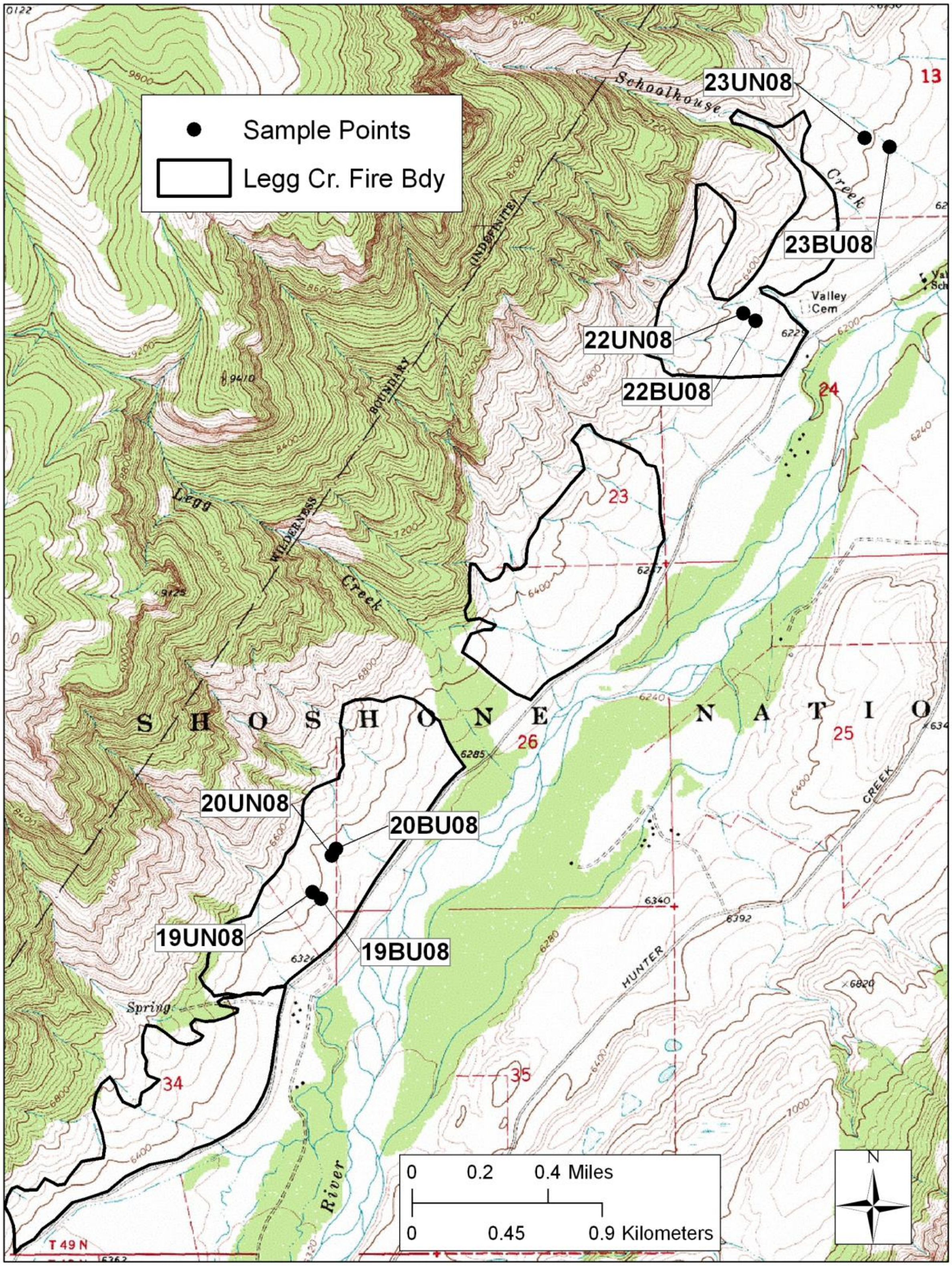


Figure 7. Sagebrush vegetation in the Legg Creek Fire area.
Vegetation in the foreground is unburned (plot 22UN08); background has been burned.

Figure 8. Locations of sampling points in the Line Creek burned area.

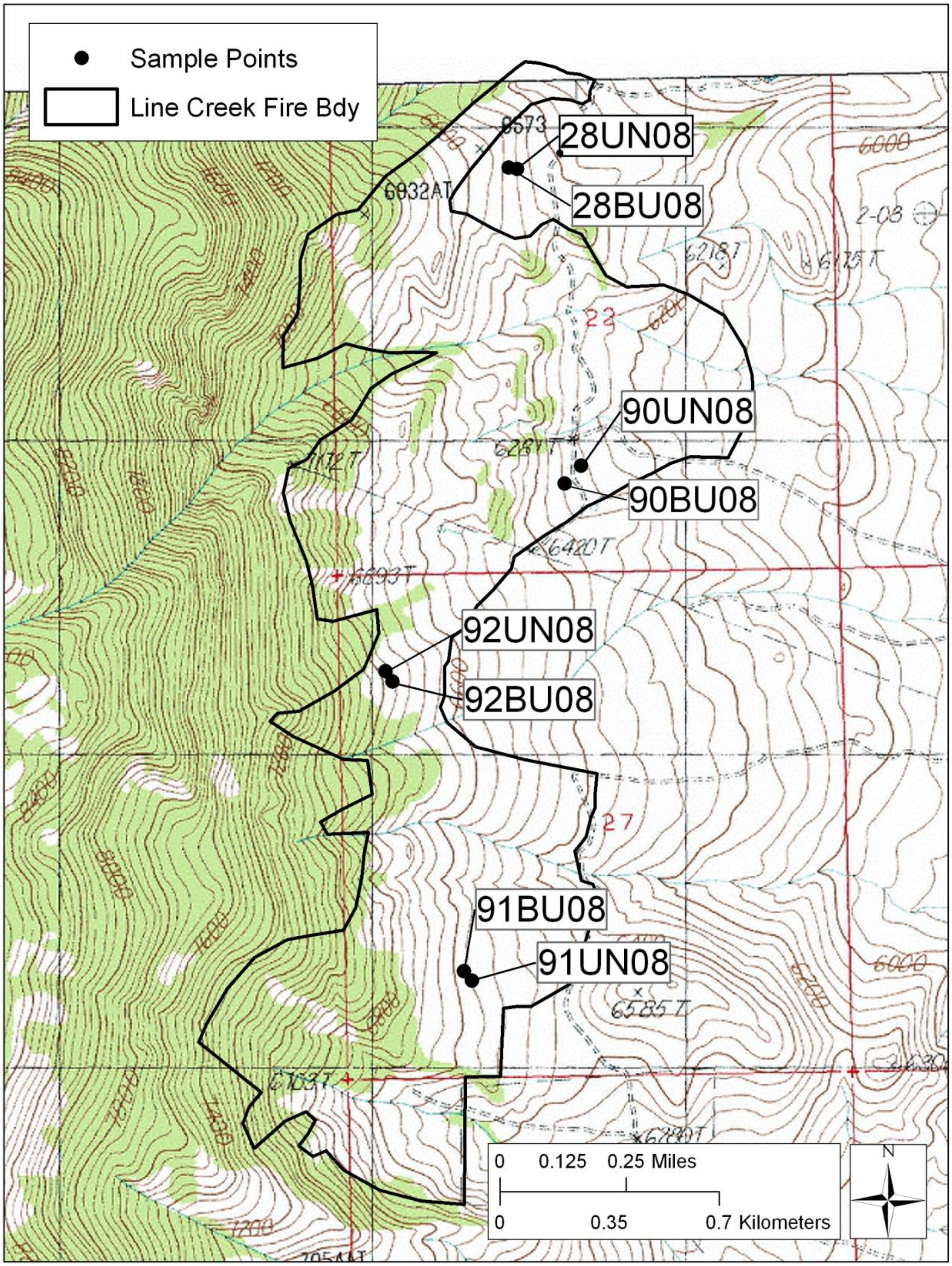


Figure 9. Black sagebrush steppe on broad upper footslopes in the Line Creek Fire area.
Most of the vegetation is unburned. The brown patch at the top of the near slope, where the dead trees stand, has been burned.

Figure 10. Unburned Wyoming big sagebrush shrub vegetation growing low on a north-facing slope in the Line Creek Fire area.

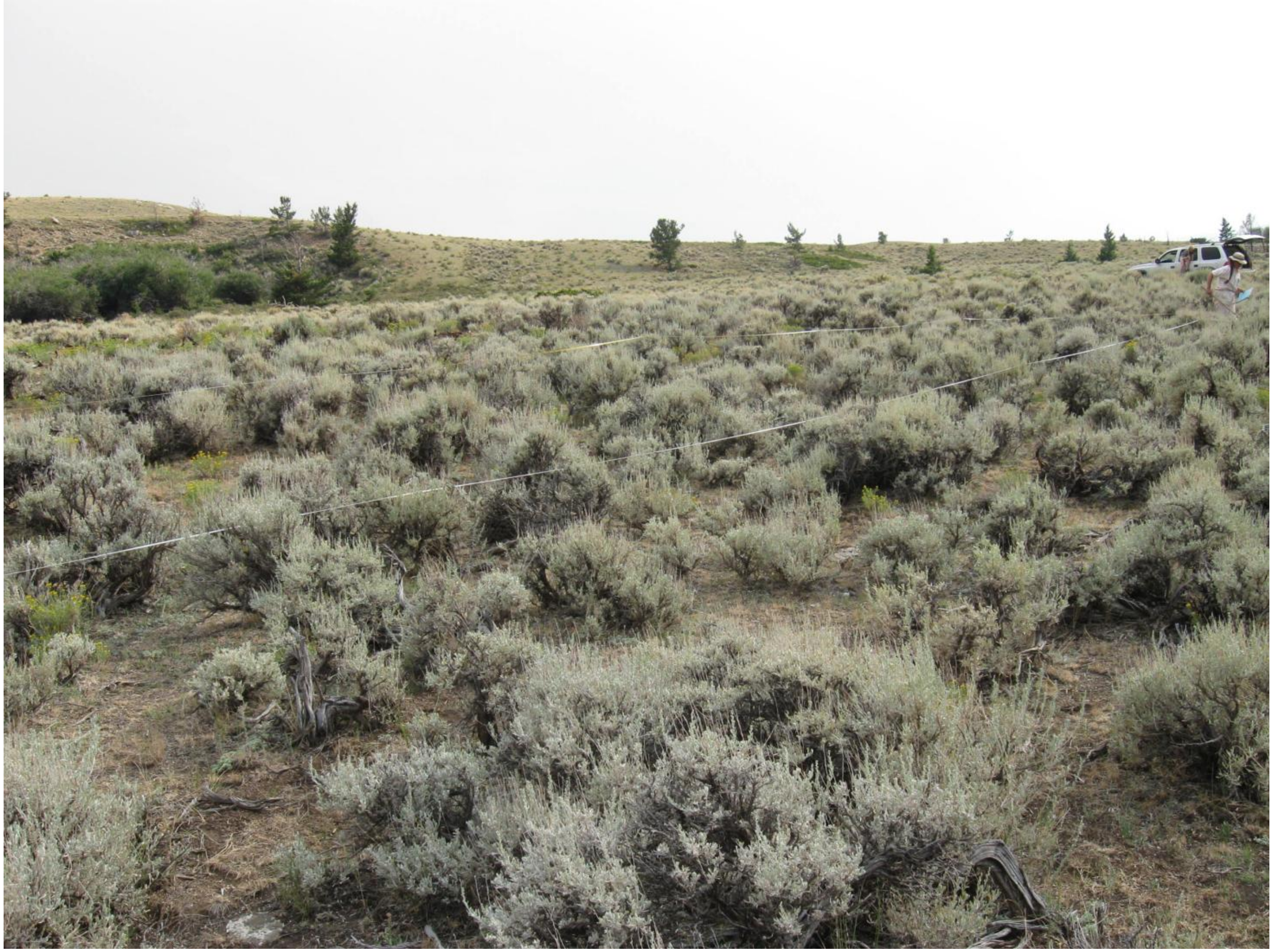


Figure 11. Unburned mountain big sagebrush shrub vegetation growing high on an east-facing slope next to conifer woodland in the Line Creek Fire area.

Figure 12. Locations of sampling points in the Littlerock-Bennett Fire area.

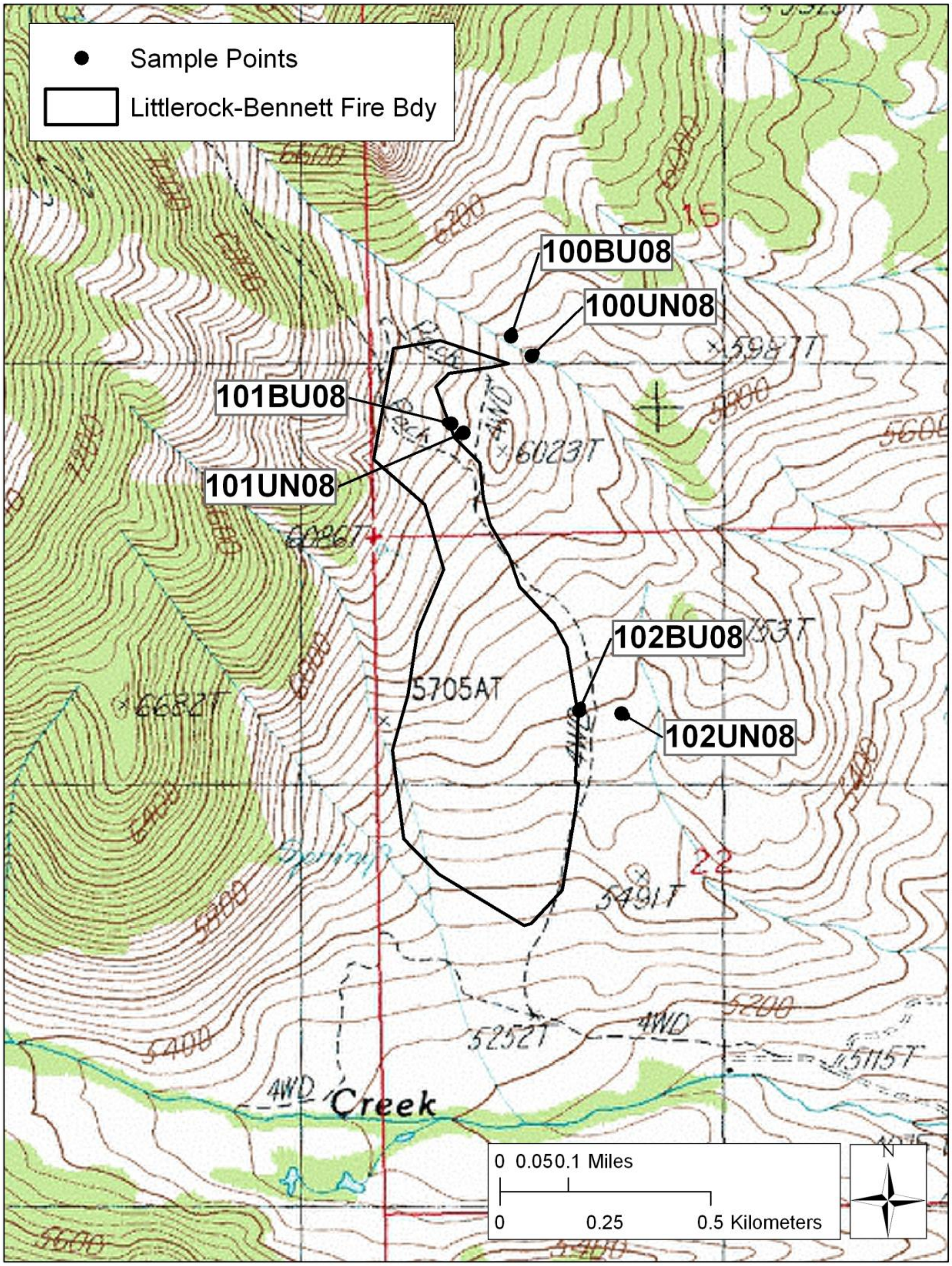


Figure 13. Vegetation in the Littlerock-Bennett Fire area.
Mountain big sagebrush shrub stands grow in the foreground (light-gray color), black sagebrush steppe grows on the even slope in the mid-ground (greenish color), to the left of the 2-track road in mid-photo. View is south toward Littlerock Creek.

Figure 14. Locations of sampling points in the Fairfield Hill Fire area.

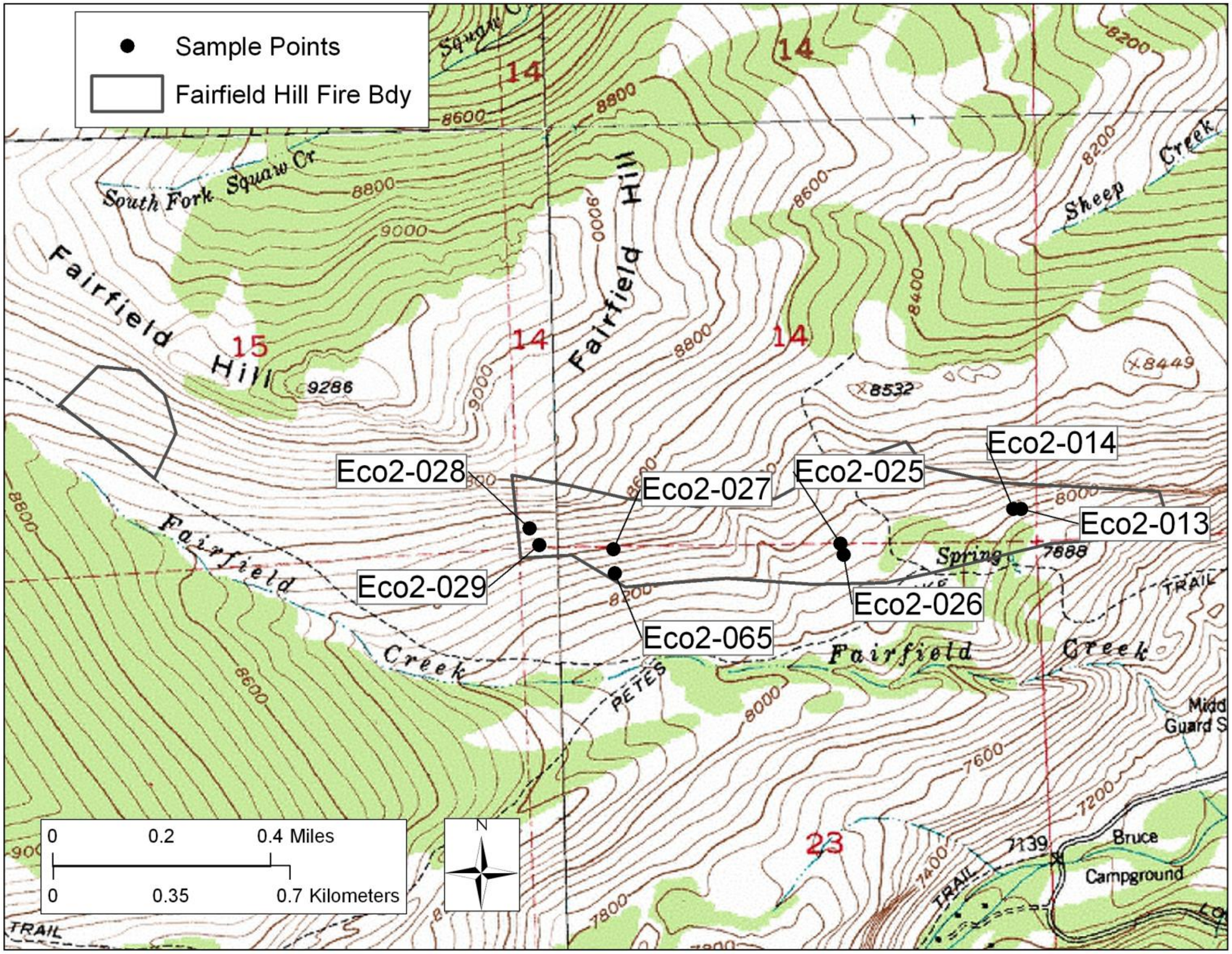


Figure 15. Vegetation in the Fairfield Hill Fire area.
The dense shrub vegetation up to mid-slope is unburned, and the sparse vegetation above mid-slope has been burned.

Figure 16. Locations of sampling points in the Freak Mountains Fire area.

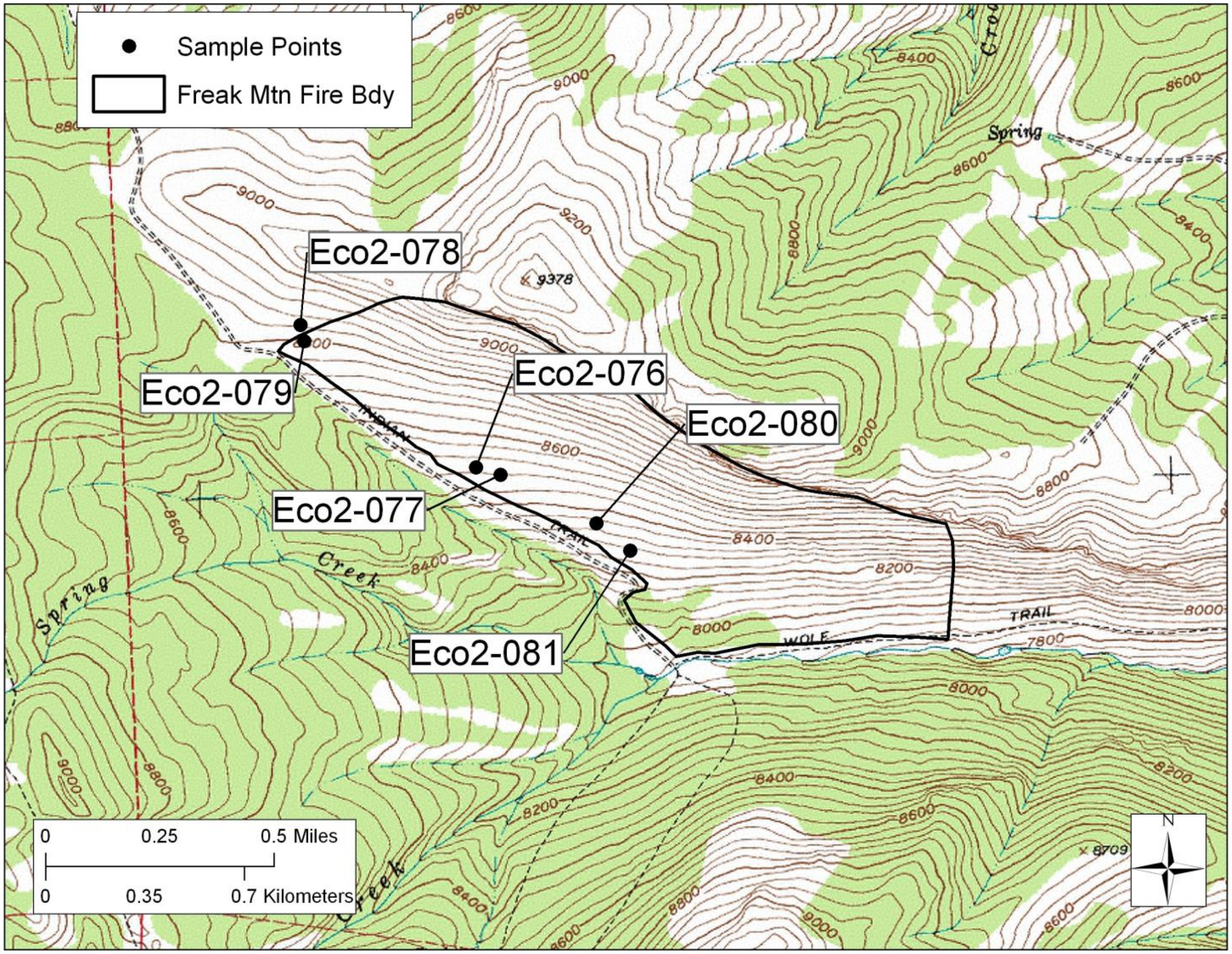


Figure 17. Unburned vegetation in the Freak Mountain Fire area.

Figure 18. Locations of sampling points in the Pass Creek Fire area.

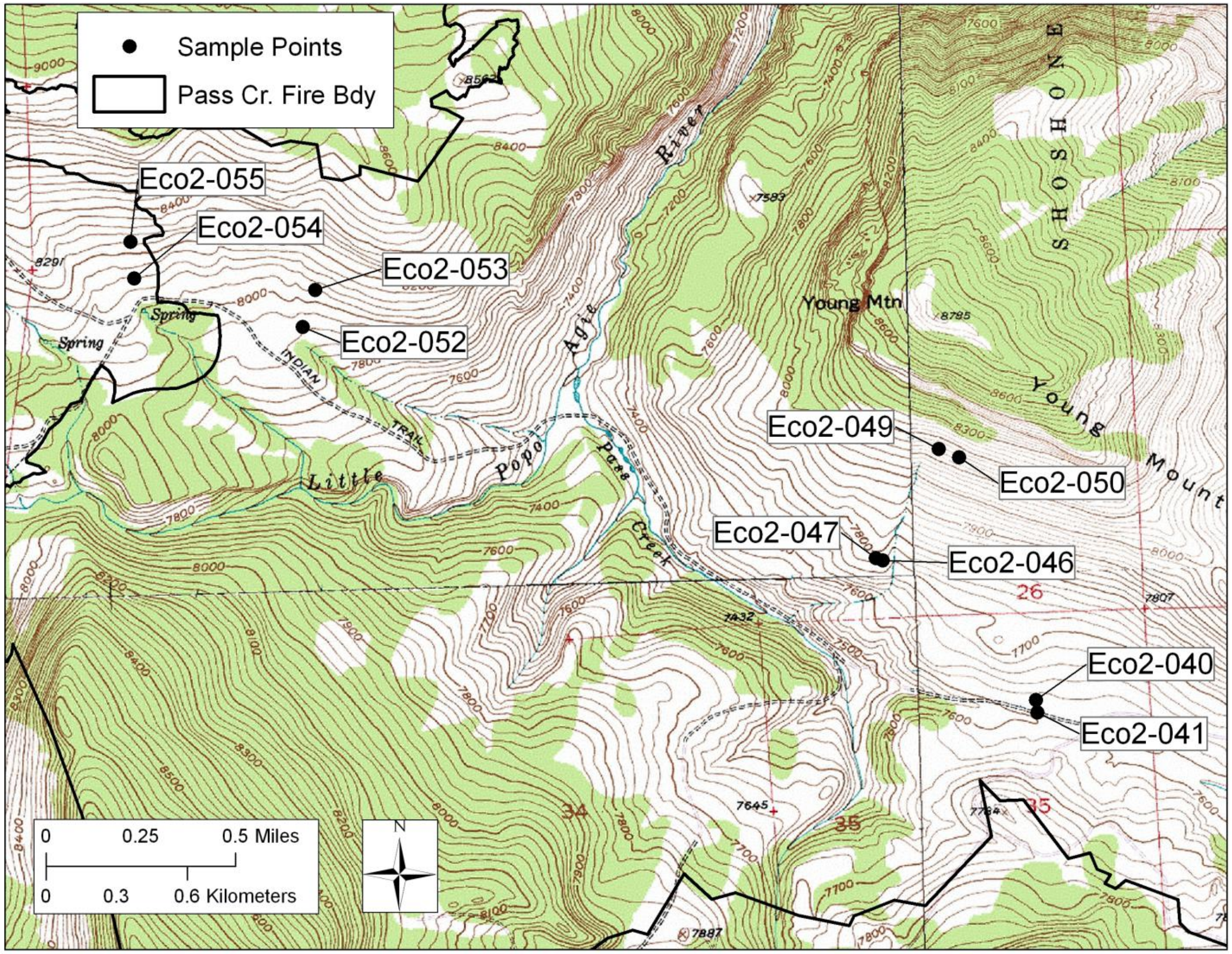


Figure 19. Large south-facing slope of Ed Young Mountain entirely burned in the Pass Creek Fire.
Data from unburned patches suggest that much of this slope was vegetated before the fire with mountain big sagebrush shrubland. The light-purple-colored patch of vegetation at the top of the slope below the cliffs is cheatgrass.

Figure 20. Locations of sampling points in the Middle Fork 2002 Fire area.

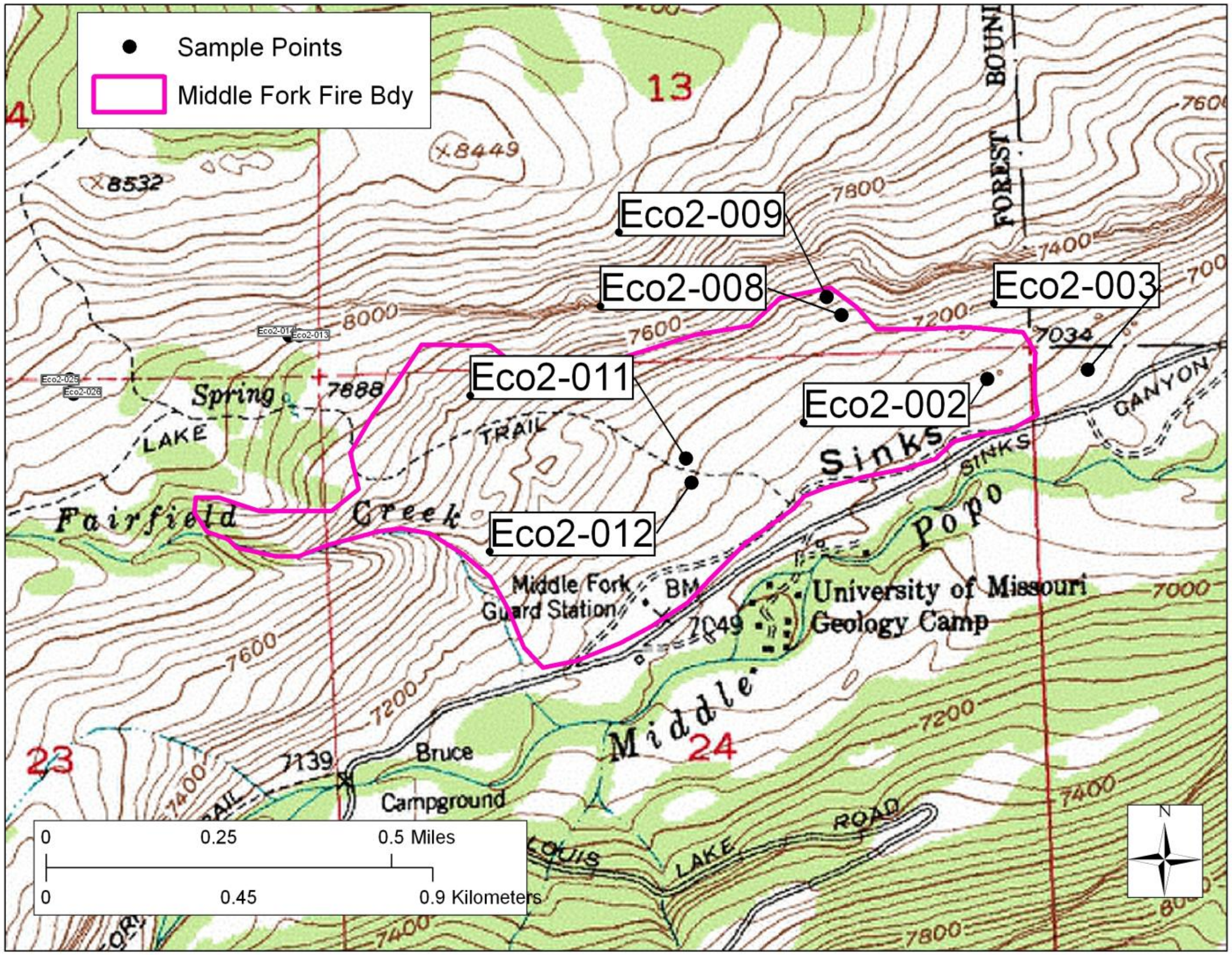


Figure 21. View across Sinks Canyon of the Middle Fork 2002 Fire area.
The view is northeast from the Louis Lake Road on the south side of the canyon. The fire burned the lower half of the far canyon wall, from the road in the canyon bottom up to the scattered unburned trees below the cliffs. The eastern (right) edge of the fire is marked by the edge of the unburned juniper woodland. The 2002 fire extended up the canyon (left) to the large draw immediately behind the limber pine in the foreground. The burned area to the left of that draw was burned in 1999. The purple tinge on the far canyon wall is caused by dense stands of cheatgrass.

Figure 22. Locations of sampling points in the Homestead Fire area.

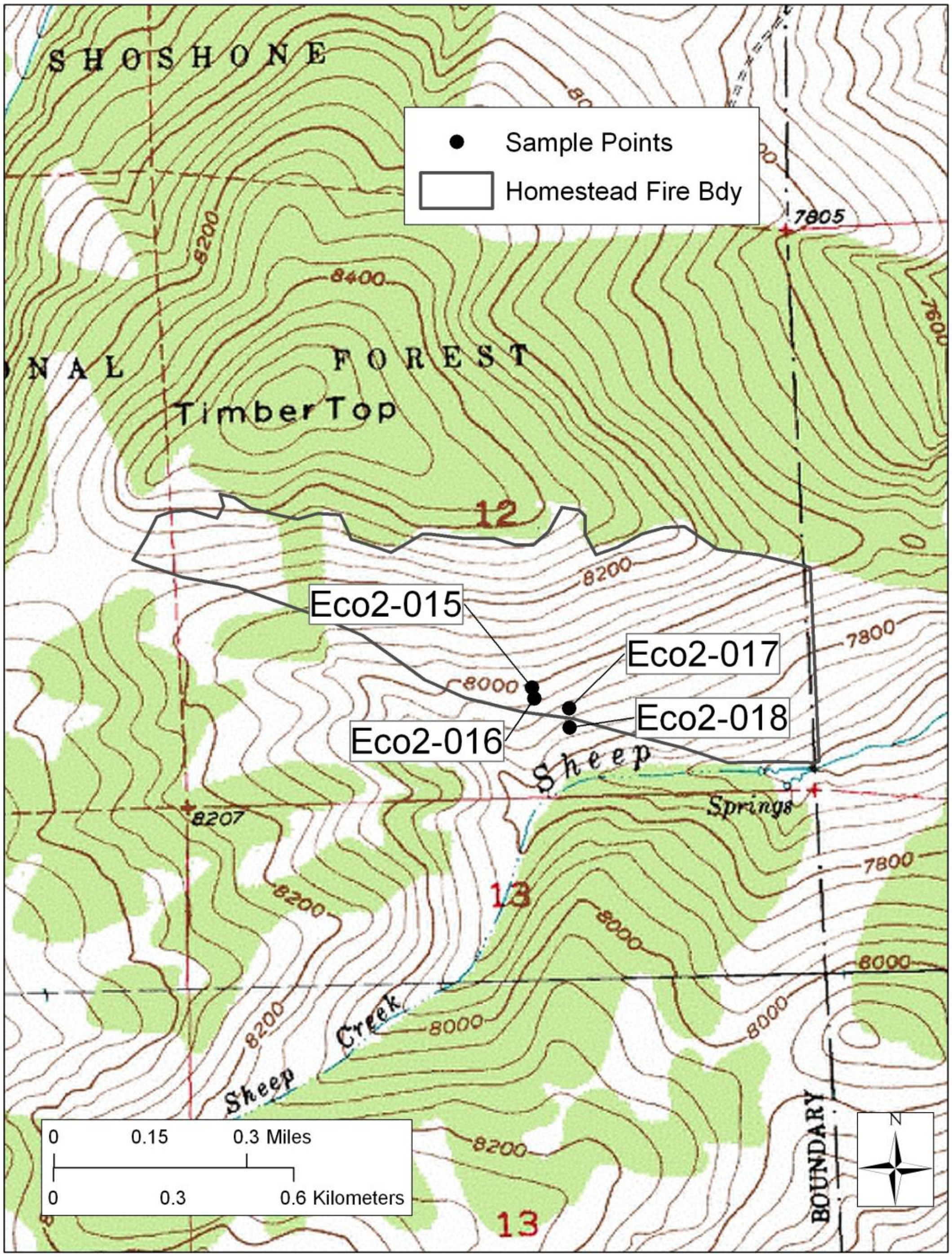


Figure 23. Vegetation in the Homestead Fire area.
The unburned shrub stand in the foreground is dominated by mountain big sagebrush.. The upper part of the slope, upward from the lower edge of the green patch of lupine, was burned.

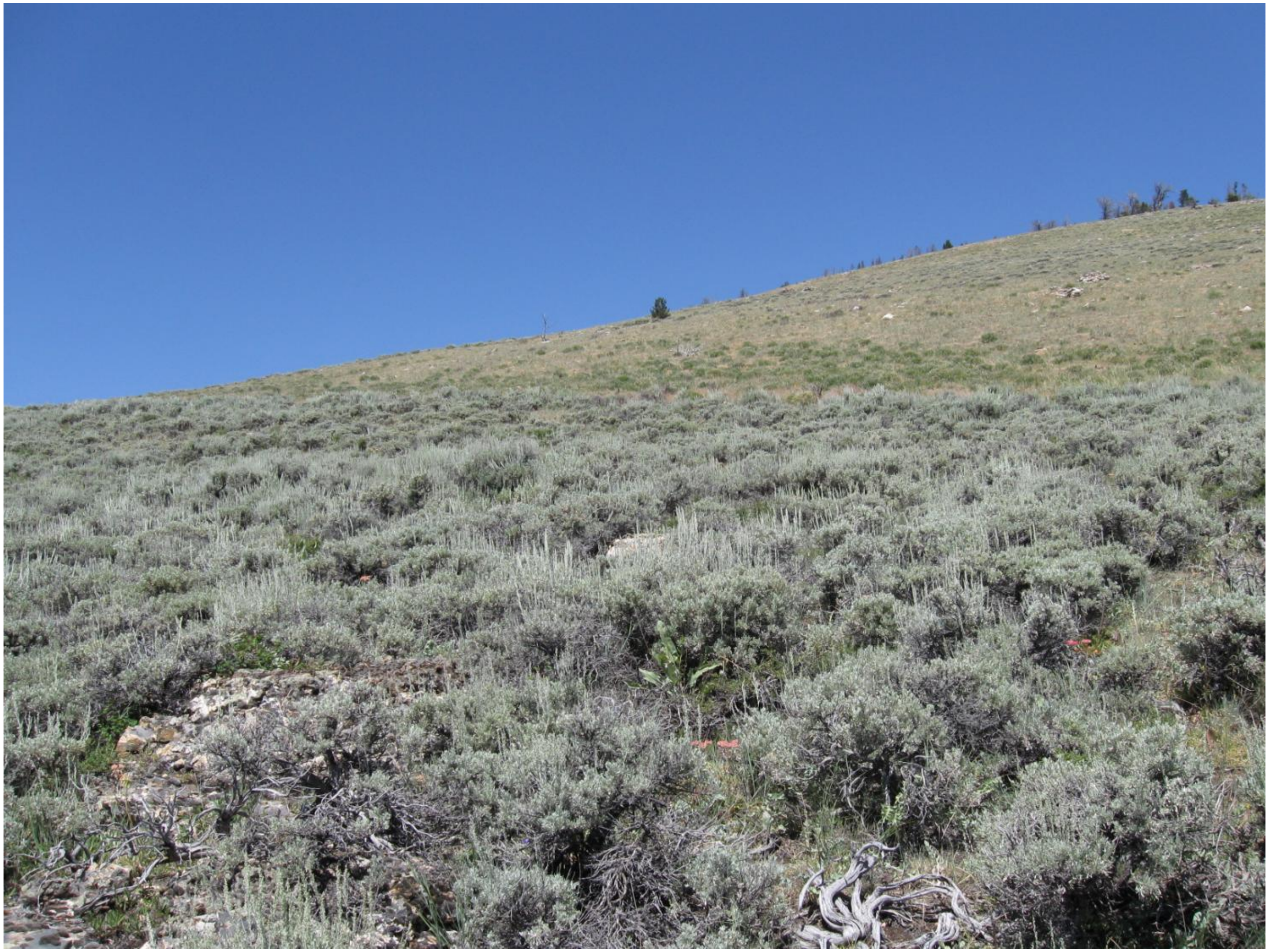


Figure 24. Diagram showing similarity in herbaceous plant species composition among unburned plots and burned plots.
See text for explanation.

a. Ordination axes 1 and 2

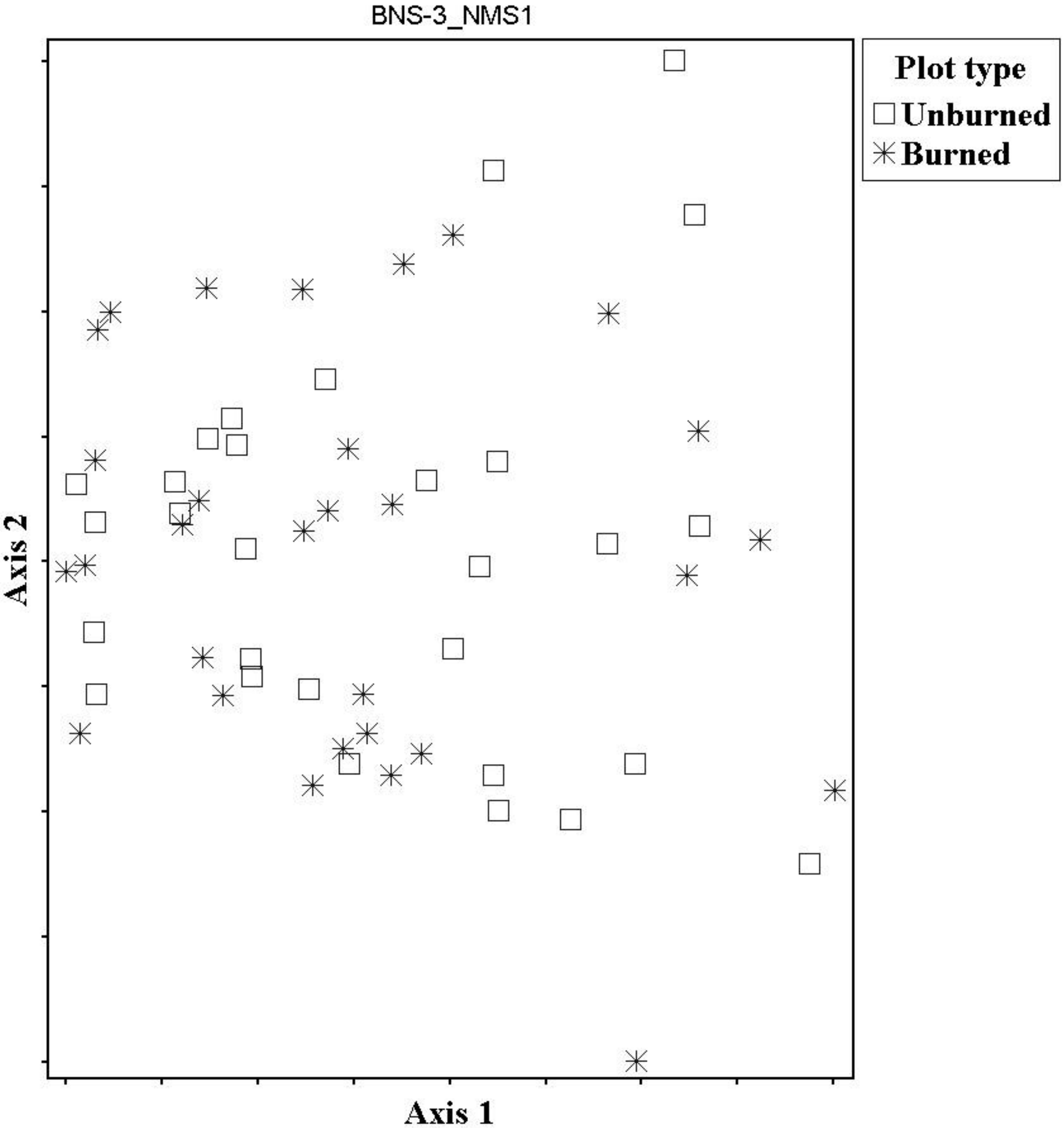


Figure 24 (continued).

b. Ordination axes 1 and 3

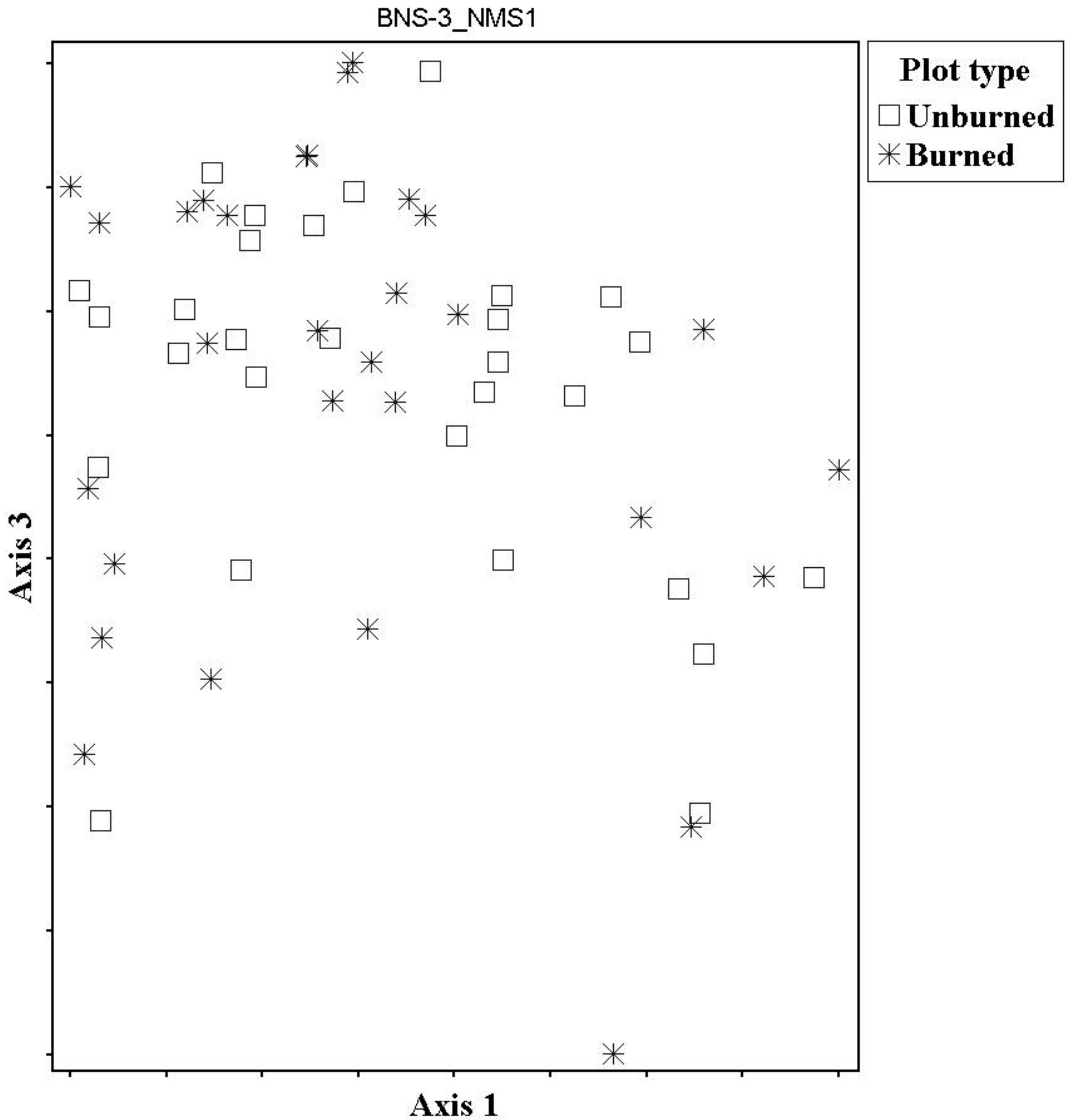


Figure 24 (continued).

c. Ordination axes 2 and 3

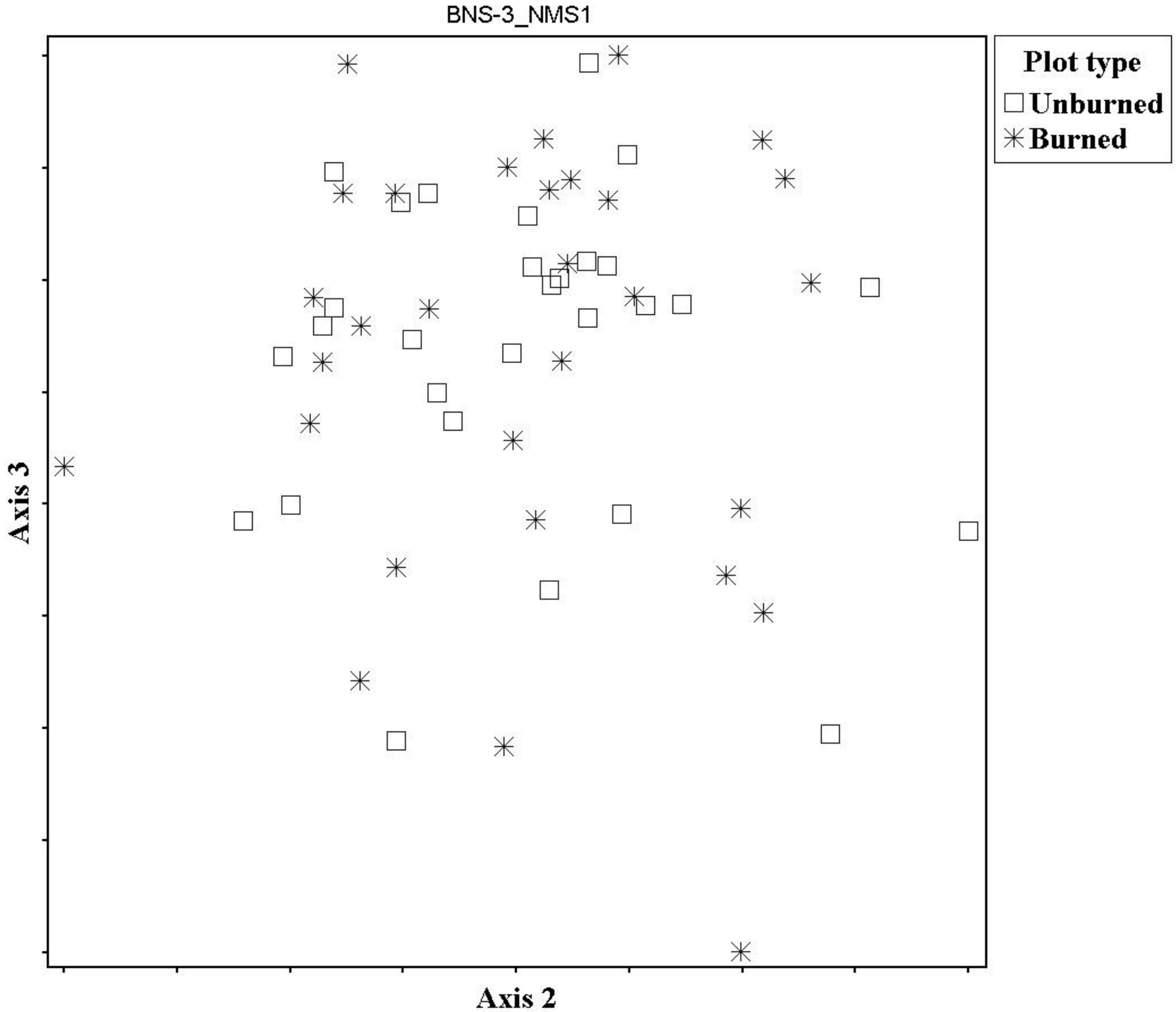
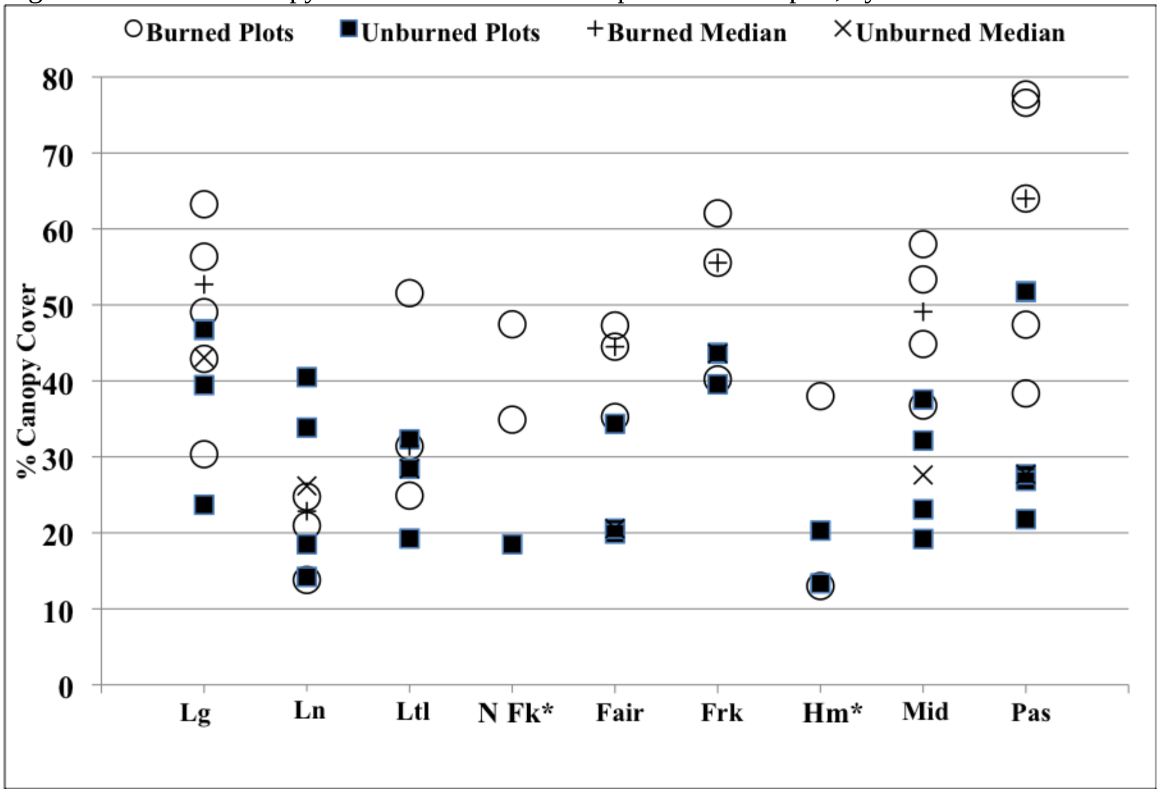


Figure 25. Percent canopy cover of all herbaceous species in each plot, by fire.



Abbreviations for Fires:

Lg = Legg Cr,
Ln = Line Cr,
Ltl = Little-rock-Bennett,
N Fk = North Fork,
Fair = Fairfield Hill,
Frk = Freak Mtn,
Hm = Homestead,
Mid = Middle Fk 2002,
Pas = Pass Cr

* The North Fork and Homestead Fires were not included in the statistical analyses.

Results of Kruskal-Wallis tests:

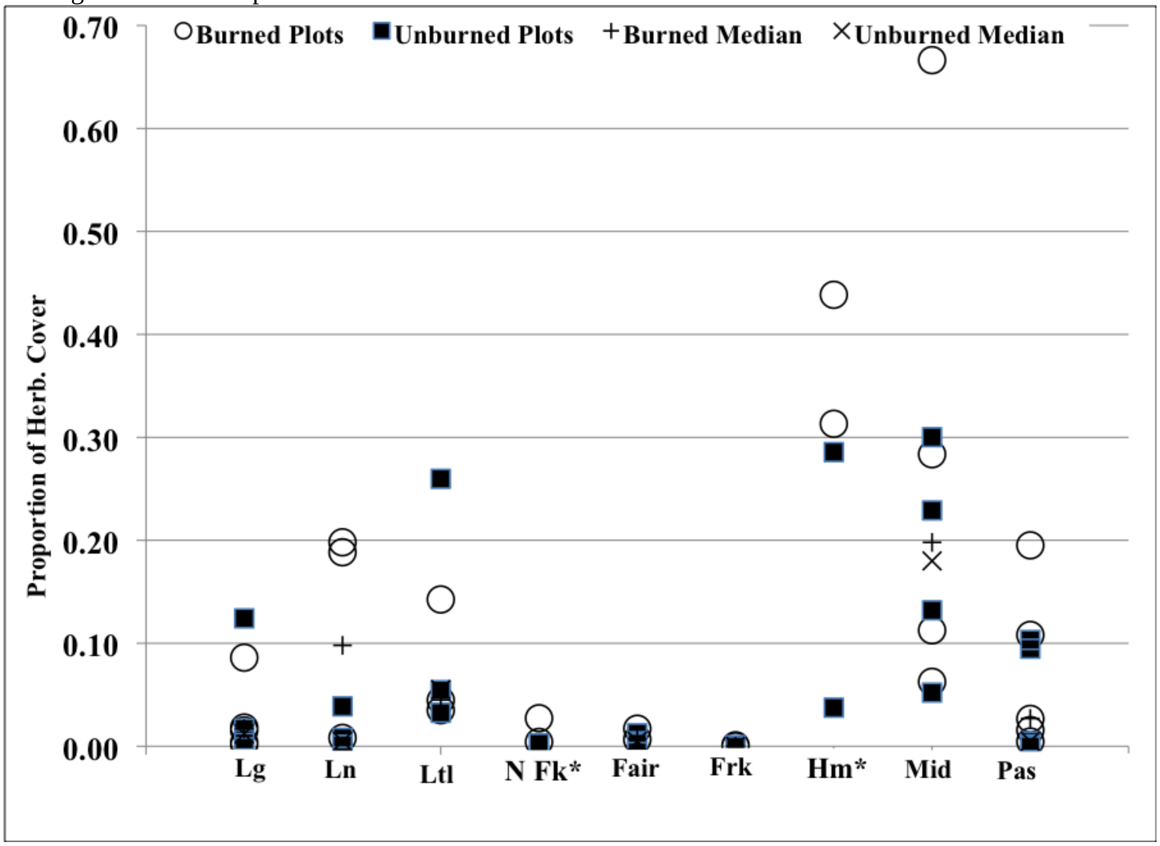
BURNED PLOTS: H=14.53, Deg Freedom = 6, p = 0.024

Fire	# of plots	Median Cover	Ave. Rank	Z
Legg Cr.	4	52.70	17.5	1.14
Line Cr.	4	22.85	2.7	-3.06
Littlerock-Bennett	3	31.40	9.0	-1.08
Fairfield Hill	3	44.5	11.0	-0.60
Freak Mtn.	3	55.55	17.0	0.84
Middle Fk 2002	4	49.10	15.0	0.43
Pass Cr.	5	64.00	19.8	2.05
Overall	26		13.5	

UNBURNED PLOTS: H=8.28, Deg Freedom = 6, p = 0.218

Fire	# of plots	Median Cover	Ave. Rank	Z
Legg Cr.	4	43.07	18.5	1.42
Line Cr.	4	26.18	9.5	-1.14
Littlerock-Bennett	3	28.45	10.0	-0.84
Fairfield Hill	3	20.55	9.0	-1.08
Freak Mtn.	3	43.60	20.7	1.73
Middle Fk 2002	4	27.62	10.3	-0.92
Pass Cr.	5	27.70	15.8	0.75
Overall	26		13.5	

Figure 26. Proportion of the herbaceous canopy cover contributed by exotic plants in each plot, by fire. See Figure 25 for an explanation of the abbreviations for fire names.



* The North Fork and Homestead Fires were not included in the statistical analyses.

Results of Kruskal-Wallis tests:

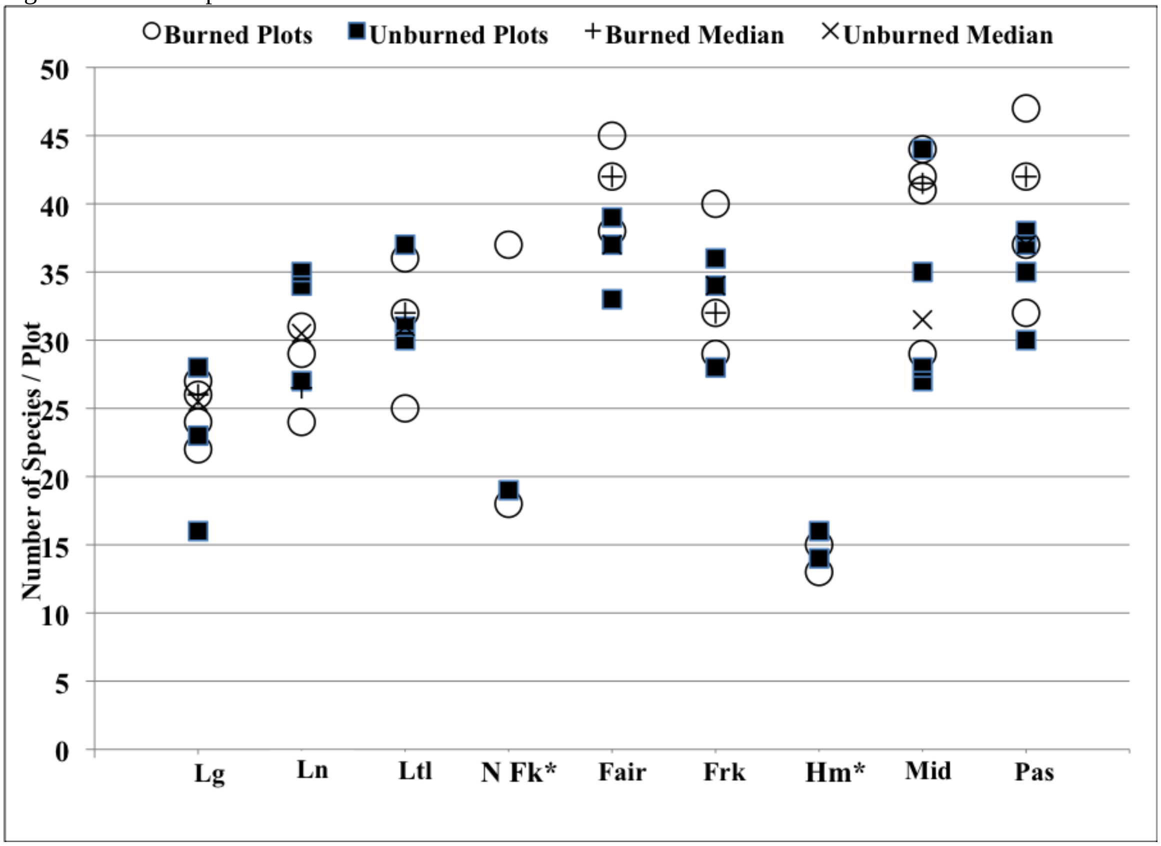
BURNED PLOTS: H=14.00, Deg Freedom = 6, p = 0.030 (adjusted for ties)

Fire	# of plots	Median Prop.	Ave. Rank	Z
Legg Cr.	4	0.0167	11.5	-0.57
Line Cr.	4	0.0982	14.8	0.36
Littlerock-Bennett	3	0.0446	17.3	0.92
Fairfield Hill	3	0.00674	9.0	-1.08
Freak Mtn.	3	0.0	2.0	-2.77
Middle Fk 2002	4	0.198	22.0	2.42
Pass Cr.	5	0.0266	14.6	0.36
Overall	26		13.5	

UNBURNED PLOTS: H=15.36, Deg Freedom = 6, p = 0.018 (adjusted for ties)

Fire	# of plots	Median Cover	Ave. Rank	Z
Legg Cr.	4	0.0117	14.5	0.28
Line Cr.	4	0.00479	10.3	-0.92
Littlerock-Bennett	3	0.0545	20.0	1.57
Fairfield Hill	3	0.00487	11.0	-0.60
Freak Mtn.	3	0.0	2.7	-2.61
Middle Fk 2002	4	0.181	22.8	2.63
Pass Cr.	5	0.00483	12.0	-0.49
Overall	26		13.5	

Figure 27. Number of plant species per plot, by fire.
See Figure 25 for an explanation of the abbreviations for fire names.



* The North Fork and Homestead Fires were not included in the statistical analyses. Note that plant identifications in the Homestead Fire plots are somewhat problematic.

Results of Kruskal-Wallis tests:

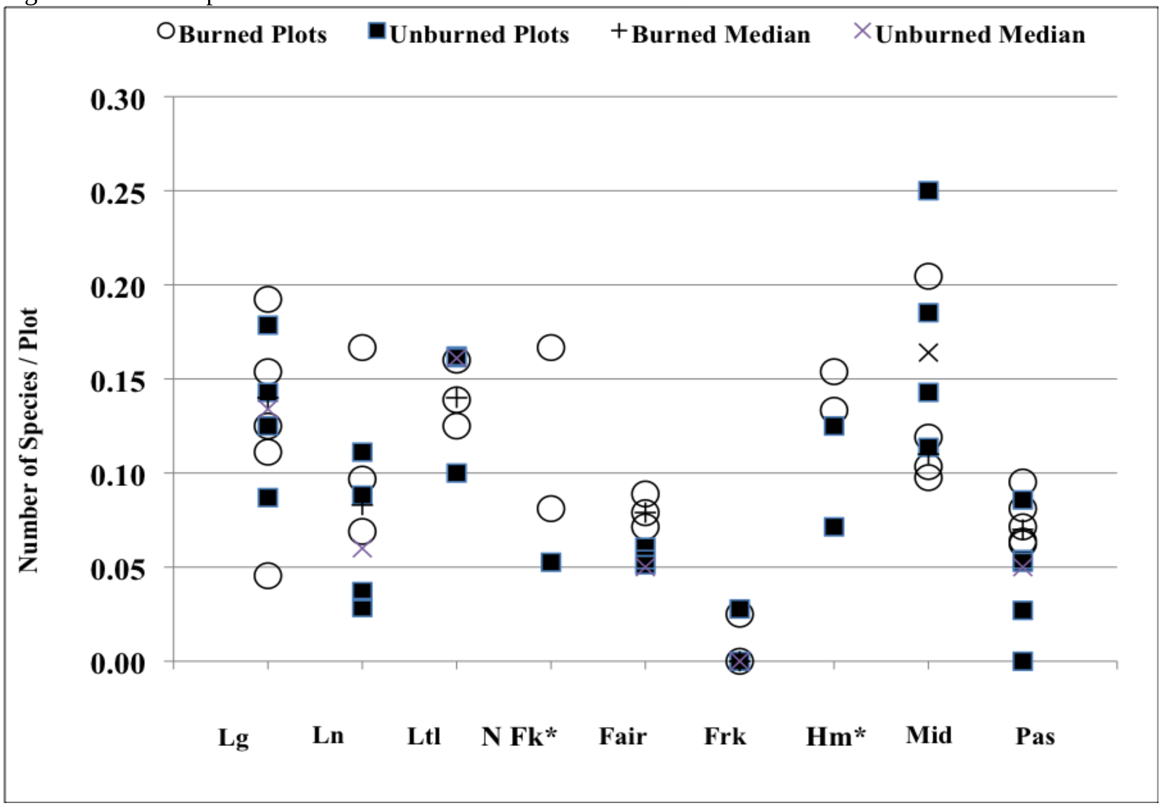
BURNED PLOTS: H=17.00, Deg Freedom = 6, p = 0.009 (adjusted for ties)

Fire	# of plots	Median Prop.	Ave. Rank	Z
Legg Cr.	4	26.0	5.1	-2.38
Line Cr.	4	26.5	5.9	-2.17
Littlerock-Bennett	3	32.0	10.7	-0.68
Fairfield Hill	3	42.0	21.2	1.85
Freak Mtn.	3	32.0	13.3	-0.04
Middle Fk 2002	4	41.5	18.4	1.39
Pass Cr.	5	42.0	19.6	1.98
Overall	26		13.5	

UNBURNED PLOTS: H=11.17, Deg Freedom = 6, p = 0.083 (adjusted for ties)

Fire	# of plots	Median Cover	Ave. Rank	Z
Legg Cr.	4	25.5	4.5	-2.56
Line Cr.	4	30.5	9.9	-1.03
Littlerock-Bennett	3	31.0	14.7	0.28
Fairfield Hill	3	37.0	19.8	1.52
Freak Mtn.	3	34.0	13.7	0.04
Middle Fk 2002	4	31.5	13.6	0.04
Pass Cr.	5	37.0	18.9	1.76
Overall	26		13.5	

Figure 28. The proportion of plant species in each plot that are exotic, by fire.
See Figure 25 for an explanation of the abbreviations for fire names.



* The North Fork and Homestead Fires were not included in the statistical analyses. Note that species identifications in the Homestead Fire plots are somewhat problematic.

Results of Kruskal-Wallis tests:

BURNED PLOTS: H=18.05, Deg Freedom = 6, p = 0.006 (adjusted for ties)

Fire	# of plots	Median Prop.	Ave. Rank	Z
Legg Cr.	4	0.139	20.9	2.10
Line Cr.	4	0.083	12.3	-0.36
Littlerock-Bennett	3	0.139	21.2	1.85
Fairfield Hill	3	0.079	10.2	-0.80
Freak Mtn.	3	0.0	2.0	-2.77
Middle Fk 2002	4	0.111	18.7	1.49
Pass Cr.	5	0.071	8.7	-1.56
Overall	26		13.5	

UNBURNED PLOTS: H=19.59, Deg Freedom = 6, p = 0.003 (adjusted for ties)

Fire	# of plots	Median Cover	Ave. Rank	Z
Legg Cr.	4	0.134	19.4	1.67
Line Cr.	4	0.063	11.3	-0.64
Littlerock-Bennett	3	0.161	20.3	1.65
Fairfield Hill	3	0.054	10.2	-0.80
Freak Mtn.	3	0.0	3.0	-2.53
Middle Fk 2002	4	0.164	22.4	2.52
Pass Cr.	5	0.053	7.7	-1.89
Overall	26		13.5	

Figure 29. View north up the extensively burned, south-facing slope of Ed Young Mountain. The purple-tinged patch below the cliff band at the top of the slope is cheatgrass.

Figure 30. View from the Louis Lake Road northwest across Sinks Canyon.
Fairfield Hill is the high point on the far horizon. Much of the unforested slope below the far horizon burned in the Fairfield Hill Fire. The Middle Fork 1999 Fire burned the moraine in the middle of the scene, immediately above the trees in the foreground and below the fringe of trees crossing the middle of the scene. The purple color in the Middle Fork 1999 Fire area is cheatgrass.

TABLES

Table 1. Criteria for a point to be chosen for a BURNED sampling point.
1. Point lay in vegetation burned in the most recent fire.
2. The site around the point was large enough to hold the 10 m x 25 m macroplot and a burned border ≥ 3 m wide on a slope of uniform substrate, slope steepness, and slope aspect.
3. The site contained no roads, constructed trails, excavations, or other similar surface disturbances
4. The site appeared to contain NO plants that were seeded or otherwise intentionally planted there -- such as the area in Sinks Canyon near the old ranger station that was a horse pasture and seems to have been seeded to smooth brome

Table 2. Criteria for a point to be chosen for an UNBURNED sampling point.
1. Point lay OUTSIDE an area burned in the most recent fire.
2. The site around the point was large enough to hold the 10 m x 25 m macroplot and an unburned border ≥ 3 m wide.
3. The site was similar to its intended matched burned point in geologic substrate, slope steepness, and slope aspect.
4. This unburned site and its intended matched burned point seemed to have supported similar vegetation before the fire.
5. The site contained no roads, constructed trails, excavations, or other similar surface disturbances
6. The site appeared to contain NO plants that were seeded or otherwise intentionally planted there -- such as the area in Sinks Canyon near the old ranger station that was a horse pasture and seems to have been seeded to smooth brome

Table 3. Categories of ground cover.

Category	**Description**
Bare soil	Particles < 2 mm
Gravel	Rock fragments 2 - 75 mm
Rock	Rock fragments > 75 mm
Bedrock	--
Litter	Herbaceous plant material, not anchored
Wood	Woody plant material, not anchored
Plant base	Herbaceous or woody plant material, anchored in soil
Non-crustose lichen	Lichens attached to soil but not forming thin crust, i.e., squamulose, gelatinous, & foliose
Crustose lichen	Lichens forming thin crust on soil surface
Vagrant lichen	Lichens not attached to soil
True moss	--
Clubmoss	Plants in genus *Selaginella*

Table 4. Cover-classes for estimating cover of plants and ground-cover in the microplots.

Range (percent of microplot covered)	**Value recorded**	**Mid-point**
< 1%	1	0.5%
1% - 5%	2	3.5%
5.1% - 15%	3	10%
15.1% - 25%	4	20%
25.1% - 50%	5	37.5%
50.1% - 75%	6	62.5%
75.1% - 100%	7	87.5%

Table 5. Sampling points in each burned area.
The type of fire (prescribed vs. wild), the date of the fire, and the number of seasons of plant growth since fire, are shown for each of the fires.

Burned Plot in Pair	**Sampling Date**	**Unburned Plot in Pair**	**Sampling Date**
2008 Field Season			
Legg Creek (prescribed, 3/20/1997, 11 seasons)			
19BU08	6/19/2008	19UN08	6/19/2008
20BU08	6/19/2008	20UN08	6/19/2008
22BU08	6/18/2008	22UN08	6/18/2008
23BU08	6/18/2008	23UN08	6/18/2008
Line Creek (prescribed, 9/27/2007, 0 seasons)			
28BU08	8/17/2008	28UN08	8/19/2008
90BU08	8/20/2008	90UN08	8/17/2008
91BU08	8/20/2008	91UN08	8/20/2008
92BU08	8/21/2008	92UN08	8/20/2008
Littlerock-Bennett (wild, 7/20/2003, 4 seasons)			
100BU08	8/21/2008	100UN08	8/21/2008
101BU08	8/22/2008	101UN08	8/22/2008
102BU08	8/22/2008	102UN08	8/22/2008
Lower North Fork (prescribed, 10/14/2005, 2 seasons)			
45BU08	6/15/2008	45UN08	6/16/2008
46BU08	6/15/2008	None	--
2009 Field Season			
Fairfield Hill (prescribed, 4/9/1996, 12 seasons)			
Eco2-025	8/1/2009	Eco2-026	8/1/2009
Eco2-027	7/31/2009	Eco2-065	7/31/2009
Eco2-028	7/31/2009	Eco2-029	7/31/2009
Freak Mountain (prescribed, 11/7/2008, 0 seasons)			
Eco2-077	8/7/2009	Eco2-076	8/7/2009
Eco2-079	8/7/2009	Eco2-078	8/7/2009
Eco2-081	8/8/2009	Eco2-080	8/7/2009
Homestead (prescribed, 4/9/2006, 3 seasons)			
Eco2-016	8/12/2009	Eco2-015	8/12/2009
Eco2-017	8/11/2009	Eco2-018	8/11/2009
Middle Fork 2002 (prescribed, 1/14/2002, 7 seasons)			
Eco2-002	7/12/2009	Eco2-003	7/12/2009
Eco2-008	7/28/2009	Eco2-009	7/28/2009
Eco2-012	7/30/2009	Eco2-011	7/30/2009
Eco2-013	7/30/2009	Eco2-014	7/30/2009
Pass Creek (wild, 8/25/2002, 6 seasons)			
Eco2-040	7/14/2009	Eco2-041	8/4/2009
Eco2-046	8/5/2009	Eco2-047	8/5/2009
Eco2-049	8/5/2009	Eco2-050	8/5/2009
Eco2-052	8/6/2009	Eco2-054	8/6/2009
Eco2-053	8/8/2009	Eco2-055	8/6/2009

Table 6. Percent canopy cover of plants and percent cover of ground-cover types in plots of the Lower North Fork Fire.
Use the PLANTS code to find the species' scientific name in Table 15. Exotic species are noted by an asterisk*. Average cover for a species is calculated only for the plots in which the species occurred.

	Plot Number	45BU08	45UN08	46BU08		
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Freq. (n=3**	**Ave. Cover**
	Evergreen Tree					
PIFL2	limber pine	0.04			1	0.0
	EvergreenTree Total	*0.04*			*1*	*0.0*
	Deciduous Shrub					
ARFR4	prairie sagewort			0.05	1	0.1
CHVIL4	yellow rabbitbrush			0.08	1	0.1
ERNA10	rubber rabbitbrush	0.04		0.6	2	0.3
RICEP	whisky currant		0.05	0.08	2	0.1
	Deciduous Shrub Total	*0.04*	*0.05*	*0.81*	*3*	*0.3*
	Evergreen Shrub					
ARTRV	mountain big sagebrush	0.05	25.6		2	12.8
OPPO	plains pricklypear	0.05		0.05	2	0.1
	Evergreen Shrub Total	*0.1*	*25.6*	*0.05*	*3*	*8.6*
	Forb					
AGGLL	false agoseris	0.05	0.05	0.3	3	0.1
ALDE*	desert madwort			0.05	1	0.1
ALTE	textile onion		0.1		1	0.1
ANMI3	littleleaf pussytoes			0.1	1	0.1
ANPA4	small-leaf pussytoes			0.1	1	0.1
ANRO2	rosy pussytoes		0.1		1	0.1
ARHOR	second rockcress		0.2		1	0.2
ASPU9	woollypod milkvetch		0.6	0.05	2	0.3
BASA3	arrowleaf balsamroot			0.05	1	0.1
CALI4	Wyoming Indian paintbrush			0.1	1	0.1
CHSA2	Rocky Mountain goosefoot	0.1		0.05	2	0.1
COPA3	maiden blue eyed Mary	0.3	0.1		2	0.2
COUMP	pale bastard toadflax			0.1	1	0.1
CRIN4	limestone hawksbeard	0.1	3.2	2.9	3	2.1
CYAC	plains springparsley	0.05	0.05		2	0.1
DEBI	little larkspur			0.1	1	0.1
DEINI	mountain tansymustard	6.8		14.1	2	10.5
DEINP	mountain tansymustard			1	1	1.0
ERIN7	shy wallflower			0.1	1	0.1
LACTU	lettuce	0.1		0.7	2	0.4
LIRU4	western stoneseed			0.1	1	0.1
LUAR3	silvery lupine			0.05	1	0.1
MEDI	bushy blazingstar	0.05			1	0.1
MEOF	yellow sweetclover	0.05			1	0.1
MIFL2	manyflowered monkeyflower		0.05		1	0.1

Table 6 (continued).

	Plot Number	45BU08	45UN08	46BU08		
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Freq. (n=3)**	**Ave. Cover**
PACA15	woolly groundsel		0.05	0.05	2	0.1
PEER	fuzzytongue penstemon			0.05	1	0.1
PELAL7	larchleaf beardtongue	0.05			1	0.1
PHHO	spiny phlox			0.05	1	0.1
PTTEA	turpentine wavewing	0.05			1	0.1
TALA2*	rock dandelion			0.2	1	0.2
TRDU*	yellow salsify	0.05			1	0.1
UnkBor1	White borage			0.05	1	0.1
VIAMM3	mat vetch	0.6	0.2		2	0.4
VIOLA	violet			0.2	1	0.2
WOORO	Oregon cliff fern		0.6		1	0.6
	Forb Total	*8.35*	*5.3*	*20.55*	*3*	*11.4*
Graminoid						
ACNED	Dore's needlegrass			0.6	1	0.6
BRTE*	cheatgrass	0.1	0.05	0.7	3	0.3
CADU6	needleleaf sedge			0.05	1	0.1
FEID	Idaho fescue			5.8	1	5.8
HECO26	needle and thread			0.1	1	0.1
KOMA	prairie Junegrass		1.8	0.3	2	1.1
LEKI2	spike fescue		0.05	0.1	2	0.1
POSE	Sandberg bluegrass		1.3	1.9	2	1.6
PSSPS	bluebunch wheatgrass	39	10	4.8	3	17.9
	Graminoid Total	*39.1*	*13.2*	*14.35*	*3*	*22.2*
All Species Total		*47.63*	*44.15*	*35.76*	*3*	*42.5*
Ground Cover						
	Bare Soil	42.5	9.3	14	3	21.9
	Gravel	57.5	31.5	18.7	3	35.9
	Rock	4.4	38.5	2.1	3	15.0
	Animal Droppings	0.2		1.5	2	0.9
	Plant Litter	1	4.3	24.6	3	10.0
	Wood	2.8	2.9	3.4	3	3.0
	Live Plant Base	0.7		1.5	2	1.1
	Clubmoss				0	
	Non-foliose Lichen		0.1		1	0.1
	Foliose Lichen				0	
	Vagrant Lichen				0	
	Moss		0.3		1	0.3
Sagebrush Seedlings						
	Sage Sdlgs / Sq M	0	0	0		
Miscellaneous Plot Features						
	Plot_Date	6/15/2008	6/16/2008	6/15/2008		
	Number_of_Pair	45UN08	45BU08	none		
	Magnetic declination	14	14	14		

Table 6 (continued).

PLANTS Code	Plot Number Common Name	45BU08 Burned	45UN08 Unburned	46BU08 Burned	Freq. (n=3)	Ave. Cover
	Aspect	210	221	88		
	Slope in degrees	30	36	11		
	Slope shape	Straight	Unknown	Straight		
	Aspect	210	221	88		
	Azimuth	44	49	268		
	Bearing of Plot Ends	280	139	178		
	Bedrock	Dark crystalline	Unknown	Unknown		
	Coord_System	UTM	UTM	UTM		
	Datum	NAD83	NAD83	NAD83		
	UTM_Zone	12N	12N	12N		
	Northing	4923196	4923315	4923211		
	Easting	598609	599097	596956		
	Township	T52N	T52N	T52N		
	Range	R107W	R107W	R107W		
	Section	20	21	19		
	Elevation, feet	6399	6458	6299		
	Elevation, meters	1950	1968	1919		

Table 7. Percent canopy cover of plants and percent cover of ground-cover types in plots of the Legg Creek Fire.
Use the PLANTS code to find the species' scientific name in Table 15. Exotic species are noted by an asterisk* . Average cover for a species is calculated only for the plots in which the species occurred.

	Plot	19BU08	19UN08	20BU08	20UN08	22BU08	22UN08	23BU08	23UN08	All Plots	
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Freq. (n=8)**	**Ave. Cover**
					Deciduous Shrubs						
ARFR4	prairie sagewort	1.3	1.2	2.6	0.05	0.6	0.05	0.05	0.05	8	0.7
CHVIL4	yellow rabbitbrush	5.52	0.05	0.4	0.2	3	0.05	0.48		7	1.4
ERNA10	rubber rabbitbrush	0.05		0.05	2			0.05		4	0.5
RICEP	whisky currant	0.05	0.05	2		0.05				4	0.5
RIOXO	Canadian gooseberry	0.05								1	0.1
ROWO	Woods' rose				0.05					1	0.1
SYORU	Utah snowberry				0.1					1	0.1
	Deciduous Shrub Total	*6.97*	*1.3*	*5.05*	*2.4*	*3.65*	*0.1*	*0.58*	*0.05*	*8*	*2.5*
					Evergreen Shrubs						
ARTRT	basin big sagebrush	0.05			36.44	0.05	0.05	3.64	23.88	6	10.7
ARTRW8	Wyoming big sagebrush	0.05		0.05			9.04			3	3.0
JUSC2	Rocky Mountain juniper		0.05				4.2			2	2.1
OPPO	plains pricklypear	2	1.2	1.2		0.05	0.05	13.5	2	7	2.9
	Evergreen Shrub Total	*2.1*	*1.25*	*1.25*	*36.44*	*0.1*	*13.34*	*17.14*	*25.88*	*8*	*12.2*
					Forbs						
ACMIO	western yarrow				0.05					1	0.1
AGGL	pale agoseris	0.05	0.05	0.05	0.8					4	0.2
ALDE*	desert madwort			0.1	0.05	0.05		0.05		4	0.1
ALLIU	onion		0.05		0.1			0.1		3	0.1
ANMI3	littleleaf pussytoes		0.05	0.05		0.6				3	0.2
ANRO2	rosy pussytoes						0.1			1	0.1
ASPU9	woollypod milkvetch					0.05		0.05		2	0.1
CHLE4/ CHPR5	narrowleaf goosefoot/desert goosefoot	0.1	0.05	0.05				0.1	0.3	5	0.1
COPA3	maiden blue eyed Mary		0.05							1	0.1
COUMP	pale bastard toadflax				0.1					1	0.1
CRIN4	limestone hawksbeard	0.7	3.4	0.05		0.6	0.1	0.05		6	0.8
CYAC	plains springparsley							0.05		1	0.1
DEINV	mountain tansymustard	2.4	3.2	0.1	0.1	12.6	0.8	0.05	1	8	2.5
DRNE	woodland draba				0.2					1	0.2

Table 7 (continued).

	Plot	19BU08	19UN08	20BU08	20UN08	22BU08	22UN08	23BU08	23UN08	All Plots	
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Freq. (n=8)**	**Ave. Cover**
ERIGE2	fleabane					0.05				1	0.1
ERIN7	shy wallflower						0.05	0.05		2	0.1
HEDYS	sweetvetch	0.05	0.05							2	0.1
LAOCO*	flatspine stickseed	16.1	0.3	0.8	0.3	4.2	1.3	2.7	6	8	4.0
LIDA*	Dalmatian toadflax	0.05	0.05							2	0.1
LIRU4	western stoneseed					0.05	0.05			2	0.1
LUARL5	silvery lupine				0.05					1	0.1
ORFA	clustered broomrape							0.05		1	0.1
OXSES	white locoweed	0.05	0.6			0.05				3	0.2
PACA15	woolly groundsel		0.05			0.05	0.05			3	0.1
PELAL7	larchleaf beardtongue							0.6		1	0.6
PHHO	spiny phlox					0.2	0.9	0.2	0.05	4	0.3
PSLA3	lemon scurfpea	2.6	1.2	0.05			0.6	0.05		5	0.9
SALSO*	Russian thistle			0.1				0.05	0.1	3	0.1
SIAL2*	tall tumblemustard					0.05	0.1			2	0.1
SISYM*	hedgemustard					0.6			0.05	2	0.3
SPCO	scarlet globemallow					0.05	0.05	0.05	0.05	4	0.1
TALA2*	rock dandelion		0.05	0.05	0.05					3	0.1
TRDU*	yellow salsify	0.1	0.1	0.2	0.6		0.05	0.05		6	0.2
UnkFrb08-2	Decumbent forb				1.2					1	1.2
UnkFrb08-3	Forb, opposite leaves						0.05			1	0.1
UnkFrb08-4	Unknown								0.05	1	0.1
VIOLA	violet	0.05	0.05	0.1	0.2					4	0.1
WOSC	Rocky Mountain woodsia		0.05							1	0.1
	Forb Total	*22.25*	*9.35*	*1.7*	*3.8*	*19.2*	*4.2*	*4.25*	*7.6*	*8*	*9.0*
Graminoids											
ACHY	Indian ricegrass				0.05	0.05			0.05	3	0.1
BRTE*	cheatgrass	4.7	4.7	0.7	0.05	0.05				5	2.0
CADU6	needleleaf sedge			4	21.1	0.05				3	8.4
ELELE	squirreltail							0.05		1	0.1
HECO26	needle and thread	0.6	2	43.5	4.6	19.1	2.7	28.5	1.2	8	12.8

Tables 7 (continued).

	Plot	19BU08	19UN08	20BU08	20UN08	22BU08	22UN08	23BU08	23UN08	All Plots	
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Freq. (n=8)**	**Ave. Cover**
JUARL	mountain rush				0.05					1	0.1
KOMA	prairie Junegrass	0.1	2.7	0.7	2.5	3.2	1.9	0.6	0.05	8	1.5
LECI4	basin wildrye			0.05						1	0.1
PASM	western wheatgrass			2.8	1.8			0.7		3	1.8
POPR*	Kentucky bluegrass				0.05					1	0.1
POSE	Sandberg bluegrass	0.2	3.2	1.2	0.8	0.8	0.9	0.8	0.7	8	1.1
PSSPS	bluebunch wheatgrass	28.5	17.5	8.6	12	6.6	37	8	14.1	8	16.5
	Graminoid Total	*34.1*	*30.1*	*61.55*	*43*	*29.85*	*42.5*	*38.65*	*16.1*	*8*	*37.0*
All Species Total		*65.42*	*42*	*69.55*	*85.64*	*52.8*	*60.14*	*60.62*	*49.63*		*60.7*
	Ground Cover										
	Bare Soil	14.1	11.7	62.5	52.5	29	26	52.5	35.6	8	35.5
	Gravel	7.2	3.4	6.8	2.9	2.5	9.2	3	1.5	8	4.6
	Rock	22.5	28	0.7	3.3	21.1	37	0.7	0.7	8	14.3
	Animal Droppings	0.4	1.3	0.9	0.5	2.4	0.9	3.9	4.4	8	1.8
	Plant Litter	15.5	33.5	17.5	36.5	9.2	12.7	14	33.5	8	21.6
	Wood	2	4.4	3.4	2.9	1.4	1	3.9	7.3	8	3.3
	Live Plant Base	0.4	0.6	0.8	0.2	0.3	0.3	1.3	0.9	8	0.6
	Clubmoss	0	0	0	0	0	0	0	0	0	
	Non-foliose Lichen	0	0	0	0	0.1	0	0	0	1	0.1
	Foliose Lichen	0.3	2.3	0.3	2	0.8	0.5	1	1	8	1.0
	Vagrant Lichen	0	0	0	0	0	0	0	0	0	
	Moss	0	4.8	0	0	0.6	0.6	0.1	0.2	5	1.3
	Sagebrush Seedlings										
	Sage Sdlgs / Sq M	0	0	0	0	0	0	0	0.8	1	
	Miscellaneous Plot Features										
	Plot Date	6/19/2008	6/19/2008	6/19/2008	6/19/2008	6/18/2008	6/18/2008	6/18/2008	6/18/2008		
	Paired Plot	19UN08	19BU08	20UN08	20BU08	22UN08	22BU08	23UN08	23BU08		
	Slope, deg.	32	32	26	28	22	22	28	26		
	Slope shape	Concave	Convex	Straight	Straight	Convex	Convex	Straight	Straight		

Tables 7 (continued).

	Plot	19BU08	19UN08	20BU08	20UN08	22BU08	22UN08	23BU08	23UN08		
		Burned	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**		
	Mag. declination	14	14	14	14	14	14	14	14		
	Aspect, deg.	100	92	142	108	114	116	100	72		
	Azimuth long edge	288	290	348	309	206	316	276	324		
	Bearing of plot end	198	200	258	219	116	226	186	234		
	Bedrock	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown		
	Coord. system	UTM	UTM	UTM	UTM	UTM	UTM	UTM	UTM		
	Datum	NAD83	NAD83	NAD83	NAD83	NAD83	NAD83	NAD83	NAD83		
	UTM_Zone	12N	12N	12N	12N	12N	12N	12N	12N		
	Northing	4892798	4892828	4893032	4893002	4895531	4895566	4896354	4896395		
	Easting	612357	612318	612428	612408	614412	614353	615045	614928		
	Township	T49N	T49N	T49N	T49N	T49N	T49N	T49N	T49N		
	Range	R106W	R106W	R106W	R106W	R106W	R106W	R106W	R106W		
	Section	27	27	27	27	24	24	13	13		
	Elevation, feet	6397	6421	6376	6368	6327	6363	6367	6414		
	Elevation, meters	1949	1957	1943	1941	1928	1939	1940	1955		

Table 8. Percent canopy cover of plants and percent cover of ground-cover types in plots of the Line Creek Fire.
Use the PLANTS code to find the species' scientific name in Table 15. Exotic species are noted by an asterisk* . Average cover for a species is calculated only for the plots in which the species occurred.

	Plot Number	**28BU08**	**28UN08**	**90BU08**	**90UN08**	**91BU08**	**91UN08**	**92BU08**	**92UN08**	**All Plots**	
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Freq. (n=8)**	**Ave. Cover**
	Deciduous Shrubs										
ARFR4	prairie sagewort	0.05	0.2	0.05	0.2	0.1	0.1	0.05	0.1	8	0.1
CHVIL4	yellow rabbitbrush			1.12	4.52		0.05			3	1.9
ERNA10	rubber rabbitbrush			2	0.05		0.05		0.05	4	0.5
GUSA2	broom snakeweed		0.05				0.05			2	0.1
TECA2	spineless horsebrush					0.05				1	0.1
	Deciduous Shrub Total	*0.05*	*0.25*	*3.17*	*4.77*	*0.15*	*0.25*	*0.05*	*0.15*	*8*	*1.1*
	Evergreen Shrubs										
ARNO4	black sagebrush		25.72				0.05			2	12.9
ARTRV	mountain big sagebrush								27.24	1	27.2
ARTRW8	Wyoming big sagebrush				34.48	0.1	27.56			3	20.7
JUSC2	Rocky Mountain juniper						0.05			1	0.1
OPPO	plains pricklypear			0.05	0.05			0.05		3	0.1
	Evergreen Shrub Total		*25.72*	*0.05*	*34.53*	*0.1*	*27.66*	*0.05*	*27.24*	*7*	*16.5*
	Forbs										
ACMIO	western yarrow			0.05	1.2	0.7	0.05			4	0.5
AGGL	pale agoseris	0.8	0.1			0.7	0.1	0.1	0.1	6	0.3
ALBR2	shortstyle onion	0.05	0.05							2	0.1
ALDE*	desert madwort						0.05			1	0.1
ALLIU	onion				0.1		0.1	0.1	0.1	4	0.1
ANMI3	littleleaf pussytoes	0.05	0.2	0.05		0.2	3.2	4.6	2.7	7	1.6
ARCOC4	ballhead sandwort					0.2	0.5	1.3	0.9	4	0.7
ARHOP	Hooker's sandwort	0.05	0.6							2	0.3
ARHOR	second rockcress		0.1				0.05			2	0.1
ASMI9	timber milkvetch	0.3	0.05					5.3	8.6	4	3.6
ASMID	prostrate milkvetch			0.05	0.2	0.7	2			4	0.7
BEWY	Wyoming besseya						0.1			1	0.1
CALI4	Wyoming Indian paintbrush								0.05	1	0.1
CAMI2	littlepod false flax		0.05		0.05		0.05			3	0.1

Table 8 (continued).

	Plot Number	28BU08	28UN08	90BU08	90UN08	91BU08	91UN08	92BU08	92UN08	All Plots	
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Freq. (n=8)**	**Ave. Cover**
CANU3	sego lily	0.05	0.05		0.05					3	0.1
CEAR4	field chickweed			0.3	1.3	1.2	0.2	0.9	2.5	6	1.1
CHDOD	Douglas' dustymaiden	0.05								1	0.1
CHLE4/ CHPR5	narrowleaf goosefoot/desert goosefoot			0.05						1	0.1
COPA3	maiden blue eyed Mary					0.05	0.05			2	0.1
COUMP	pale bastard toadflax		0.05							1	0.1
CRMO4	Modoc hawksbeard						0.05		0.1	2	0.1
DEBI	little larkspur							0.05		1	0.1
DOCO	Bonneville shootingstar							0.05	0.05	2	0.1
DRABA	Draba		0.05							1	0.1
DRNE	woodland draba		0.1	0.05	0.3		0.2		0.2	5	0.2
DRPR	tall draba					0.05				1	0.1
ERCA2	tufted fleabane	0.05	1.3	3.2	0.6	0.05		0.05	0.2	7	0.8
GACO5	scarlet beeblossom		0.05							1	0.1
HEPA11	littleleaf alumroot	0.05	0.05						0.05	3	0.1
HEVIM3	hairy false goldenaster					0.05			0.05	2	0.1
LAOCO	flatspine stickseed			0.05						1	0.1
LERE7	bitter root						0.2	0.1	0.05	3	0.1
LIRU4	western stoneseed					0.05				1	0.1
LUARA5	silvery lupine							0.05		1	0.1
MELA3	prairie bluebells	0.1	0.1		0.05	0.1	0.05	0.1	0.05	7	0.1
MONU	Nuttall's povertyweed			0.1						1	0.1
OXCA4OXSE	field locoweed							2	0.05	2	1.0
OXSES	white locoweed			0.05	0.05					2	0.1
PACA15	woolly groundsel	0.1								1	0.1
PEER	fuzzytongue penstemon	0.1	0.1							2	0.1
PHHO	spiny phlox	2.9	0.9		0.05		1.4	0.2	0.2	6	0.9
PHLI	threadleaf phacelia							0.3	0.1	2	0.2
POAV	prostrate knotweed			0.1						1	0.1
POBI10	tansy cinquefoil			0.05	0.05	0.05	0.1	0.05	0.05	6	0.1
POTEN	cinquefoil				0.05					1	0.1
PTTEA	turpentine wavewing							0.05	0.6	2	0.3

Table 8 (continued).

	Plot Number	28BU08	28UN08	90BU08	90UN08	91BU08	91UN08	92BU08	92UN08	All Plots	
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Freq. (n=8)**	**Ave. Cover**
PYCAS	largeflower goldenweed		0.05							1	0.1
SELA	spearleaf stonecrop				0.05					1	0.1
SIDR	Drummond's campion								0.05	1	0.1
TALA2*	rock dandelion			3.9	0.4	0.7		0.05		4	1.3
TEACA2	stemless four-nerve daisy	0.6	0.05							2	0.3
TRDU*	yellow salsify	0.05		0.1				0.1	0.05	4	0.1
UnkBra	Mustard	0.1								1	0.1
UnkFab1	Legume, silver, ternate		0.05							1	0.1
VIAMM3	mat vetch			0.6	0.05					2	0.3
VIOLA	violet			0.1		0.1		0.05		3	0.1
WOORO	Oregon cliff fern								0.1	1	0.1
ZIVEG	grassy deathcamas					0.05	0.2	0.5	0.1	4	0.2
	Forb Total	*5.4*	*4.05*	*8.8*	*4.55*	*4.95*	*8.65*	*16*	*17*	*8*	*8.7*
					Graminoids						
ACNED	Dore's needlegrass					0.1			0.6	2	0.4
BRTE*	cheatgrass			0.05	0.1					2	0.1
CADU6	needleleaf sedge			5.3	0.3	0.7	0.5	1.9		5	1.7
CAFI	threadleaf sedge	20	25.1							2	22.6
CAXE	whitescale sedge					0.05				1	0.1
FEID	Idaho fescue					0.2	3	2.7	4.6	4	2.6
HECO26	needle and thread								0.05	1	0.1
KOMA	prairie Junegrass	2	1.5		0.1	1.8	0.4	0.8	0.1	7	1.0
LEKI2	spike fescue	0.05				2.1		0.05	0.05	4	0.6
PASM	western wheatgrass			6.7	5.8	1.3	2			4	4.0
POCUP3	Cusick's bluegrass					0.1	0.6	0.05	2.7	4	0.9
POPR*	Kentucky bluegrass					1.9	0.05	0.05		3	0.7
POSE	Sandberg bluegrass	0.1	0.7	0.1	3.3	0.6	2.5	1.8	3.2	8	1.5
PSSPS	bluebunch wheatgrass	2.8	2.5		0.05		0.8	1.4	12.2	6	3.3
	Graminoid Total	*24.95*	*29.8*	*12.15*	*9.65*	*8.85*	*9.85*	*8.75*	*23.5*	*8*	*15.9*
All Species Total		*30.4*	*59.82*	*24.17*	*53.5*	*14.05*	*46.41*	*24.85*	*67.89*		*40.1*
					Ground Cover						
	Bare Soil	42.5	9.9	16.1	2.9	47.5	0.8	4.8	1.4		

Table 8 (continued).

	Plot Number	28BU08	28UN08	90BU08	90UN08	91BU08	91UN08	92BU08	92UN08	All Plots	
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Freq. (n=8)**	**Ave. Cover**
	Gravel	37.5	3.9	30.1	0.3	2.4	0.4	7.3	0.3		
	Rock	3.9	3.8	1.3	0.6	5.3	5.3	5.2	5.8		
	Animal Droppings	4	0.4	0.4	0.5	2.3	1	0.1	0.5		
	Plant Litter	0.5	64	34.6	40.6	40.6	67.5	72.5	67.5		
	Wood	0.5	1	2	1	0.5	1	1	0.5		
	Live Plant Base	3	3	1	3	2.5	3	1.5	3		
	Clubmoss						1.2	0.6	0.3		
	Non-foliose Lichen		0.3				0.2		0.2		
	Foliose Lichen	0.1			0.1				0.2		
	Vagrant Lichen	0.1	1.5		0.1		0.1				
	Moss				21.1		5.3	1.2	12		
	Sagebrush Seedlings										
	Sage Sdlgs / Sq M	0	0	0	0	1.2	0	0	0	1	
	Miscellaneous Plot Features										
	Plot_Date	8/17/2008	8/19/2008	8/20/2008	8/17/2008	8/20/2008	8/20/2008	8/21/2008	8/20/2008		
	Number_of_Pair	28UN08	28BU08	90UN08	90BU08	91UN08	91BU08	92UN08	92BU08		
	Magnetic declination	0	12	12	12	12	12	12	12		
	Slope in degrees	14	15	8	8	16	14	14	14		
	Slope shape	Straight	Straight	Straight	Straight	Concave	Concave	Straight	Straight		
	Aspect	90	90	18	20	78	56	90	70		
	Azimuth	360	356	240	220	250	240	270	250		
	Bearing of Plot Ends	270	266	150	130	160	150	180	160		
	Bedrock	Unknown	Unknown	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Unknown		
	Coord_System	UTM	UTM	UTM	UTM	UTM	UTM	UTM	UTM		
	Datum	NAD83	NAD83	NAD83	NAD83	NAD83	NAD83	NAD83	NAD83		
	UTM_Zone	12N	12N	12N	12N	12N	12N	12N	12N		
	Northing	4984080	4984075	4983070	4983127	4981513	4981483	4982439	4982472		
	Easting	634375	634401	634553	634605	634231	634257	634004	633981		
	Township	T58N	T58N	T58N	T58N	T58N	T58N	T58N	T58N		
	Range	R103W	R103W	R103W	R103W	R103W	R103W	R103W	R103W		
	Section	22	22	22	22	27	27	27	27		
	Elevation, feet	6507	6467	6314	6293	6582	6569	6761	6765		
	Elevation, meters	1983	1971	1924	1918	2006	2002	2060	2062		

Table 9. Percent canopy cover of plants and percent cover of ground-cover types in plots of the Littlerock-Bennett Fire.
Use the PLANTS code to find the species' scientific name in Table 15. Exotic species are noted by an asterisk* . Average cover for a species is calculated only for the plots in which the species occurred.

	Plot Number	100BU08	100UN08	101BU08	101UN08	102BU08	102UN08		
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Freq. (n=6)**	**Ave. Cover**
	EvergreenTree								
PSMEG	Rocky Mountain Douglas-fir		0.05		0.6			2	0.3
	Evergreen Tree Total		*0.05*		*0.6*			*2*	*0.3*
	Deciduous Shrub								
ARFR4	prairie sagewort	3.3	3.4	0.05		5.3	1.5	5	2.7
CHVIL4	yellow rabbitbrush	0.8						1	0.8
ERNA10	rubber rabbitbrush	0.05	0.05					2	0.1
GUSA2	broom snakeweed	0.05	0.05			0.05	0.05	4	0.1
RHTRT	skunkbush sumac	0.05						1	0.1
RICEP	whisky currant	0.05						1	0.1
	Deciduous Shrub Total	*4.3*	*3.5*	*0.05*		*5.35*	*1.55*	*5*	*3.0*
	Evergreen Shrub								
ARNO4	black sagebrush		9.64				4.68	2	7.2
ARTRV	mountain big sagebrush	0.4	4.52	0.05	25.56		6.12	5	7.3
JUSC2	Rocky Mountain juniper		0.05					1	0.1
OPPO	plains pricklypear		0.05	0.6	0.05		0.05	4	0.2
	Evergreen Shrub Total	0.4	14.26	0.65	25.61		10.85	5	10.4
	Forb								
AGGL	pale agoseris	0.05	0.1	0.05			0.1	4	0.1
ALDE*	desert madwort	0.5	1	0.5	0.3			4	0.6
ALLIU	onion		0.2	0.05				2	0.1
ANMI3	littleleaf pussytoes	0.05		0.1	2.6			3	0.9
ARCOL	rock-loving sandwort			0.6	0.7			2	0.7
ARHOP	Hooker's sandwort	0.05				0.1		2	0.1
ARHOR	second rockcress	0.05			0.05			2	0.1
ASDR3	Drummond's milkvetch	0.6	0.05		0.05	0.05	0.1	5	0.2
ASMID	prostrate milkvetch		0.05					1	0.1
CAMI2	littlepod false flax		0.1					1	0.1
CANU3	sego lily	0.05	0.05					2	0.1

Table 9 (continued).

	Plot Number	100BU08	100UN08	101BU08	101UN08	102BU08	102UN08		
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Freq. (n=6)**	**Ave. Cover**
CEAR4	field chickweed	0.05			0.1			2	0.1
COPA3	maiden blue eyed Mary		0.5	0.2	0.1	0.2	0.1	5	0.2
CRCE	buttecandle					0.05		1	0.1
CRMO4	Modoc hawksbeard	0.1						1	0.1
DEBI	little larkspur				0.05			1	0.1
DRNE	woodland draba		0.1	0.5	0.4	0.1		4	0.3
ERCA2	tufted fleabane			0.05	0.05			2	0.1
EROVO4	cushion buckwheat						0.05	1	0.1
GACO5	scarlet beeblossom	0.1	0.05					2	0.1
HEVIM3	hairy false goldenaster	0.05	0.05	0.05		0.05	2.6	5	0.6
LAOCO	flatspine stickseed		0.1					1	0.1
LIPU	dotted blazing star					0.05	0.05	2	0.1
LOAM	Wyeth biscuitroot			0.05	0.05			2	0.1
LOAR5	field cottonrose				0.1	0.5	0.1	3	0.2
LUARA5	silvery lupine	2	0.05	13.5	0.05	0.05	0.05	6	2.6
MEDI	bushy blazingstar	0.05						1	0.1
MELA3/ MEHU2	prairie bluebells						0.1	1	0.1
OXCA4/ OXSE	field locoweed	0.05				0.6	0.05	3	0.2
OXSES	white locoweed			2	0.05	0.05	2	4	1.0
PHHA	silverleaf phacelia	0.05						1	0.1
PHHO	spiny phlox	0.05	3.9	0.1		1.4	0.9	5	1.3
PHLI	threadleaf phacelia		0.1	0.1	0.5			3	0.2
PLPA2	woolly plantain						0.05	1	0.1
PTTEA	turpentine wavewing	6.6	0.8					2	3.7
SIAL2*	tall tumblemustard	0.05	0.1	0.2	0.1	0.05		5	0.1
SIDR	Drummond's campion			0.05			0.05	2	0.1
TRDU*	yellow salsify	0.05	0.3	0.1	0.05	0.05	0.05	6	0.1
TRGY	hollyleaf clover	0.1						1	0.1
UnkFrb08-1	Unknown	0.05						1	0.1
VIAMM3	mat vetch	4.4	1					2	2.7

Table 9 (continued).

PLANTS Code	Plot Number Common Name	100BU08 Burned	100UN08 Unburned	101BU08 Burned	101UN08 Unburned	102BU08 Burned	102UN08 Unburned	Freq. (n=6)	Ave. Cover
ZIVEG	grassy deathcamas		0.05	0.1	0.2			3	0.1
	Forb Total	*15.1*	*8.65*	*18.3*	*5.5*	*3.3*	*6.35*	*6*	*9.5*
Graminoid									
ACHY	Indian ricegrass	0.05						1	0.1
ACNED	Dore's needlegrass	0.05	0.05	0.05	0.05			4	0.1
ARPUF	Fendler's threeawn						0.05	1	0.1
BOGR2	blue grama					0.2	0.2	2	0.2
BRRA2	bald brome	0.05	0.7					2	0.4
BRTE*	cheatgrass	2.9	2.8	1.5	1	0.5	0.9	6	1.6
CADU6	needleleaf sedge			0.3	1.3	0.1		3	0.6
CAFI	threadleaf sedge					12	12.7	2	12.4
CAXE	whitescale sedge			0.05	0.05			2	0.1
FEID	Idaho fescue		0.6	8.6	14.1		0.7	4	6.0
HECO26	needle and thread	0.05	0.8	0.05	0.1	4.7	0.7	6	1.1
KOMA	prairie Junegrass	0.1	0.2	0.6	0.05	0.8	0.9	6	0.4
LEKI2	spike fescue	1.3		0.05				2	0.7
PASM	western wheatgrass		0.05					1	0.1
POCUP3	Cusick's bluegrass			0.05				1	0.1
POSE	Sandberg bluegrass		0.7	2	0.1	0.1	0.1	5	0.6
PSSPS	bluebunch wheatgrass	5.3	4.7	20	6.2	9.2	9.2	6	9.1
VUOCO	sixweeks fescue					0.5	0.5	2	0.5
	Graminoid Total	*9.8*	*10.6*	*33.25*	*22.95*	*28.1*	*25.95*	*6*	*21.8*
All Species Total		*29.6*	*37.06*	*52.25*	*54.66*	*36.75*	*44.7*		*42.5*
Ground Cover									
	Bare Soil	22.6	25.2	1.5	13.8	3.9	16.3	6	13.9
	Gravel	30.1	11.7	0.5	0.4	14.6	32.1	6	14.9
	Rock	16	1.8	7.2	2.6	24.5	6.4	6	9.8
	Animal Droppings	1	1	1.5	0.4	1	0.9	6	1.0
	Plant Litter	23.1	41.5	87.5	72.5	28.5	13.2	6	44.4
	Wood	0.4	0.5	0.5	2.9	0.1	0.5	6	0.8
	Live Plant Base	0.5	1.5	3	3	2.5	1.5	6	2.0

Table 9 (continued).

	Plot Number	100BU08	100UN08	101BU08	101UN08	102BU08	102UN08		
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Freq. (n=6)**	**Ave. Cover**
	Clubmoss						2.7	1	2.7
	Non-foliose Lichen		0.3		0.1			2	0.2
	Foliose Lichen		0.2				0.5	2	0.4
	Vagrant Lichen							0	
	Moss		0.6		0.1			2	0.4
Sagebrush Seedlings									
	Sage Sdlgs / Sq M	0	0	0	0	0	0		
Miscellaneous Plot Features									
	Plot_Date								
	Number_of_Pair								
	Magnetic declination								
	Slope in degrees								
	Slope shape								
	Aspect								
	Azimuth								
	Bearing of Plot Ends								
	Bedrock								
	Coord_System								
	Datum								
	UTM_Zone								
	Northing								
	Easting								
	Township								
	Range								
	Section								
	Elevation, feet								
	Elevation, meters								

Table 10. Percent canopy cover of plants and percent cover of ground-cover types in plots of the Fairfield Hill Fire.
Use the PLANTS code to find the species' scientific name in Table 15. Exotic species are noted by an asterisk*. Average cover for a species is calculated only for the plots in which the species occurred.

	Plot Number	**Eco2-025**	**Eco2-026**	**Eco2-027**	**Eco2-065**	**Eco2-029**	**Eco2-028**		
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Freq. (n=6)**	**Ave. Cover**
	Deciduous Shrub								
AMAL2	Saskatoon serviceberry	0.05	0.05	2		0.05	0.05	5	0.4
ARFR4	prairie sagewort			4		0.6	0.05	3	1.6
CHVIL4	yellow rabbitbrush	0.05	0.05		0.92	0.05	0.05	5	0.2
LIPU11	granite prickly phlox			0.05		0.05		2	0.1
PRVIM	black chokecherry					0.05		1	0.1
PUTR2	antelope bitterbrush	4.96	20.76		29.32	3.56	33.56	5	18.4
RICEP	whisky currant					0.05		1	0.1
ROWO	Woods' rose	0.6				0.6	0.7	3	0.6
SYORU	Utah snowberry	1.04	2.84	1.24	1.08	1.64	2	6	1.6
TECA2	spineless horsebrush		0.05					1	0.1
	Deciduous Shrub Total	*6.7*	*23.75*	*7.29*	*31.32*	*6.65*	*36.41*	*6*	*18.7*
	Evergreen Shrub								
ARTRR2	Wyoming threetip sagebrush	0.05	0.56	0.05	0.72		4.92	5	1.3
ARTRV	mountain big sagebrush	2.08	28.84	8.88	36.32	5.56	13.32	6	15.8
	Evergreen Shrub Total	*2.13*	*29.4*	*8.93*	*37.04*	*5.56*	*18.24*	*6*	*16.9*
	Forb								
ACMIO	western yarrow	0.05	0.05					2	0.1
AGGL	pale agoseris	0.2	0.1	0.8	0.05	1.4	0.2	6	0.5
ALAL3*	pale madwort*		0.05	0.05	0.05		0.2	4	0.1
ALLIU	onion	0.05						1	0.1
ANMI3	littleleaf pussytoes	0.6	0.05		0.05			3	0.2
ARHOP	Hooker's sandwort	0.05	0.05	0.05		1.3	0.05	5	0.3
ARHOR	second rockcress		0.05	0.05	0.2	0.05	0.1	5	0.1
ASMI10	Missouri milkvetch		0.05				0.1	2	0.1
ASMI9	timber milkvetch	0.1						1	0.1
ASMIP2	Yellowstone milkvetch			0.05				1	0.1
BAIN	hoary balsamroot	2.6	1.8	0.05	0.6	0.05		5	1.0

Table 10 (continued).

	Plot Number	Eco2-025	Eco2-026	Eco2-027	Eco2-065	Eco2-029	Eco2-028		
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Freq. (n=6)**	**Ave. Cover**
BASA3	arrowleaf balsamroot		0.05		0.05	0.05	0.05	4	0.1
CAFL7	yellow Indian paintbrush	0.6	0.1	0.05	0.05	0.05	0.05	6	0.2
CAMI2*	littlepod false flax*	0.1		0.5	0.05	0.1	0.05	5	0.2
CANU3	sego lily	0.1		0.1	0.05	0.1	0.1	5	0.1
CHDOD	Douglas' dustymaiden	0.1		0.1		0.1		3	0.1
CIUN	wavyleaf thistle	0.05		0.05		0.05		3	0.1
COPA3	maiden blue eyed Mary	0.2	0.1		0.05	0.3	0.1	5	0.2
COUMP	pale bastard toadflax	0.1	0.6				0.2	3	0.3
CRAC2	tapertip hawksbeard	0.7	0.7	0.1	0.6	0.7	0.6	6	0.6
CYAC	plains springparsley					0.05		1	0.1
DEPII	western tansymustard			0.1				1	0.1
DOCO	Bonneville shootingstar	0.1			0.05			2	0.1
DRAL4	slender draba			0.1	0.05			2	0.1
ERAL13	Big Horn fleabane	0.05						1	0.1
ERAS2	western wallflower	0.05		0.05				2	0.1
EROVO4	cushion buckwheat					0.1	0.1	2	0.1
ERUMD3	sulphur-flower buckwheat	0.6	0.6	2	0.05	0.05	0.2	6	0.6
FRAT	spotted fritillary	0.05						1	0.1
GAAR	common gaillardia			0.05	0.05			2	0.1
IPAGA3	scarlet gilia			0.1		0.05		2	0.1
LILE3	Lewis flax	0.05	0.05	0.05	0.05	0.2	1.2	6	0.3
LIRU4	western stoneseed	0.05			0.05			2	0.1
LUAR3	silvery lupine	0.05		0.05	0.6	0.05	0.05	5	0.2
LUPIN	lupine		0.05					1	0.1
MACAC	hoary tansyaster			0.05		0.05	0.1	3	0.1
MELA3/ MEHU2	prairie bluebells	0.6	0.8		0.8		0.05	4	0.6
ORFA	clustered broomrape		0.05	0.1	0.05			3	0.1
OXSES	white locoweed			0.1	0.05		0.05	3	0.1
PACA15	woolly groundsel	0.6	0.05	0.05	0.05	0.05	0.05	6	0.1
PEATP5	small penstemon	1.3	0.7					2	1.0

Table 10 (continued).

PLANTS Code	Plot Number / Common Name	Eco2-025 Burned	Eco2-026 Unburned	Eco2-027 Burned	Eco2-065 Unburned	Eco2-029 Burned	Eco2-028 Unburned	Freq. (n=6)	Ave. Cover
PECY3	blue penstemon					0.05		1	0.1
PHHO	spiny phlox			0.05				1	0.1
PHMU3	flowery phlox	3.9	3.8	0.6	0.3		1.3	5	2.0
PHSA4	Fremont County twinpod			0.05		0.1		2	0.1
PTTEA	turpentine wavewing	5.2	1.8	0.05	4.4	6	0.1	6	2.9
STAC	stemless mock goldenweed	0.05	0.05					2	0.1
STRU3	desert wirelettuce			0.05		0.1	0.05	3	0.1
SYAS3	western aster	4.6		2	0.05		0.05	4	1.7
TALA2*	rock dandelion*					0.1		1	0.1
TRDU*	yellow salsify*	0.05		0.05		0.1		3	0.1
ZIVEG	grassy deathcamas	0.05	0.1					2	0.1
	Forb Total	*22.95*	*11.8*	*7.6*	*8.4*	*11.3*	*5.1*	*6*	*11.2*
Graminoid									
BRTE*	cheatgrass*	0.1	0.05					2	0.1
CARO5	Ross' sedge		0.05	0.05				2	0.1
ELELE	squirreltail		0.05					1	0.1
KOMA	prairie Junegrass	0.2	0.7		0.2		0.05	4	0.3
LEKI2	spike fescue	6	8.1	8.1		24	8.1	5	10.9
POCUP3	Cusick's bluegrass	8	1.3	0.7	3.3		1.3	5	2.9
POPR*	Kentucky bluegrass*	0.05						1	0.1
POSE	Sandberg bluegrass		0.1	0.2	0.05		0.05	4	0.1
PSSPS	bluebunch wheatgrass	10	12.2	18.6	8.6	9.2	5.3	6	10.7
	Graminoid Total	*24.35*	*22.55*	*27.65*	*12.15*	*33.2*	*14.8*	*6*	*22.5*
All Species Total		*56.13*	*87.5*	*51.47*	*88.91*	*56.71*	*74.55*	*6*	*69.2*
Ground Cover									
	Bare Soil	37	43.7	21.6	16.2	12.6	1.3	6	22.1
	Gravel	4.4	3.9	40.5	4.8	37	33.7	6	20.7
	Rock	5.2	0.6	0.1		5.2		4	2.8
	Animal Droppings	0.3	0.7	0.3	0.3	0.3	0.2	6	0.4
	Plant Litter	34	45.1	26.1	77.5	33.5	55.5	6	45.3
	Wood	1.5	1	1.5	0.9	5.9	0.4	6	1.9

Table 10 (continued).

PLANTS Code	Plot Number Common Name	Eco2-025 Burned	Eco2-026 Unburned	Eco2-027 Burned	Eco2-065 Unburned	Eco2-029 Burned	Eco2-028 Unburned	Freq. (n=6)	Ave. Cover
	Live Plant Base	4.4	2.5	3.9	3	2.5	1.5	6	3.0
	Clubmoss							0	
	Non-foliose Lichen							0	
	Foliose Lichen							0	
	Vagrant Lichen							0	
	Moss				0.1			1	0.1
Sagebrush Seedlings									
	Sage Sdlgs / Sq M	0	0	0	0	0	0	0	
Miscellaneous Plot Features									
	Plot_Date	8/1/2009	8/1/2009	7/31/2009	7/31/2009	7/31/2009	7/31/2009		
	Number_of_Pair	Eco2-026	Eco2-025	Eco2-065	Eco2-027	Eco2-028	Eco2-029		
	Magnetic declination	12	12	12	12	12	12		
	Slope in degrees	24	24	31	30	30	31		
	Slope shape	Straight	Straight	Straight	Straight	Straight	Straight		
	Aspect	140	140	180	180	180	180		
	Azimuth	320	320	360	360	360	360		
	Bearing of Plot Ends	230	230	270	270	90	270		
	Bedrock	Limestone	Limestone	Limestone	Limestone	Limestone	Limestone		
	Coord_System	UTM	UTM	UTM	UTM	UTM	UTM		
	Datum	NAD83	NAD83	NAD83	NAD83	NAD83	NAD83		
	UTM_Zone	12N	12N	12N	12N	12N	12N		
	Northing	4734007	4733974	4733991	4733919	4734003	4734052		
	Easting	674719	674728	674049	674053	673830	673800		
	Township	T32N	T32N	T32N	T32N	T32N	T32N		
	Range	R101W	R101W	R101W	R101W	R101W	R101W		
	Section	14	23	23	23	14	14		
	Elevation, feet	8148	8123	8405	8308	8495	8544		
	Elevation, meters	2483	2476	2561	2532	2589	2604		

Table 11 Percent canopy cover of plants and percent cover of ground-cover types in plots of the Freak Mountain Fire. Use the PLANTS code to find the species' scientific name in Table 15. Exotic species are noted by an asterisk*. Average cover for a species is calculated only for the plots in which the species occurred.

	Plot Number	Eco2-076	Eco2-077	Eco2-078	Eco2-079	Eco2-080	Eco2-081		
PLANTS Code	**Common Name**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Freq. (n=6)**	**Ave. Cover**
	Deciduous Shrub								
AMAL2	Saskatoon serviceberry	0.05					0.05	2	0.1
CHVIL4	yellow rabbitbrush			0.05				1	0.1
PUTR2	antelope bitterbrush	0.6	0.7			13.32	1.44	4	4.0
ROWO	Woods' rose	0.05						1	0.1
SYORU	Utah snowberry	2	0.05	0.7		0.05		4	0.7
TECA2	spineless horsebrush					0.05	0.05	2	0.1
	Deciduous Shrub Total	*2.7*	*0.75*	*0.75*		*13.42*	*1.54*	*5*	*3.8*
	Evergreen Shrub								
ARTRR2	Wyoming threetip sagebrush			0.05				1	0.1
ARTRV	mountain big sagebrush	26.12		54.6	3.16	17.12		4	25.3
	Evergreen Shrub Total	*26.12*		*54.65*	*3.16*	*17.12*		*4*	*25.3*
	Forb								
ACMIO	western yarrow		2.6	0.05		0.05	0.05	4	0.7
AGGL	pale agoseris	0.3	0.3	0.9	1.4	0.2	0.1	6	0.5
AGGLD	pale agoseris		0.1		0.1		0.3	3	0.2
ALLIU	onion		0.05			0.1	0.05	3	0.1
ANMI3	littleleaf pussytoes	0.05			0.05	0.05	0.7	4	0.2
ARCOC4	ballhead sandwort	0.6	0.05	0.05	1.5	0.1		5	0.5
ARHOR	second rockcress	0.1		0.2		0.2	0.1	4	0.2
ASMI10	Missouri milkvetch		0.1			0.05		2	0.1
ASMI9	timber milkvetch	1.9	4.1	5.8	5.8	1	0.2	6	3.1
BASA3	arrowleaf balsamroot	18.1	12.6	1.2	6	14.2	21.6	6	12.3
CAFL7	yellow Indian paintbrush	0.6	0.1	0.05	0.05	0.05	0.05	6	0.2
CAMI2*	littlepod false flax*					0.05		1	0.1
CANU3	sego lily	0.05	0.05	0.05	0.05	0.2	0.2	6	0.1
CARO2	bluebell bellflower		0.05				0.05	2	0.1
CEAR4	field chickweed	0.3		0.1		0.4		3	0.3
COPA3	maiden blue eyed Mary	0.2				0.5	0.2	3	0.3

Table 11 (continued).

	Plot Number	Eco2-076	Eco2-077	Eco2-078	Eco2-079	Eco2-080	Eco2-081		
PLANTS Code	**Common Name**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Freq. (n=6)**	**Ave. Cover**
COUMP	pale bastard toadflax	0.05	0.7			1.2	0.7	4	0.7
CRAC2	tapertip hawksbeard	0.1	0.2	0.05	0.05	0.7	0.7	6	0.3
DEBI	little larkspur		0.1			0.05	0.05	3	0.1
DOCO	Bonneville shootingstar	0.1		0.05	0.05	0.05	0.05	5	0.1
ERAL13	Big Horn fleabane						0.05	1	0.1
ERUMD3	sulphur-flower buckwheat	0.6	0.1	0.05	0.2	1.3	0.1	6	0.4
FRAT	spotted fritillary				0.05			1	0.1
IPAGA3	scarlet gilia					0.7	0.1	2	0.4
LILE3	Lewis flax	0.05	0.05				0.1	3	0.1
LUAR3	silvery lupine	0.1	2.7	0.2	0.6		0.05	5	0.7
MELA3	prairie bluebells	0.4	2	1.3	0.2	0.4	1.9	6	1.0
ORFA	clustered broomrape	0.1				0.05		2	0.1
PACA15	woolly groundsel		0.1			0.7	1	3	0.6
PEATP5	small penstemon		0.05					1	0.1
PHHO	spiny phlox	0.05	3.2			0.7	0.05	4	1.0
PHMU3	flowery phlox	0.2	0.4	2	2.4	2.1	3.8	6	1.8
PTTEA	turpentine wavewing	0.2	0.6		0.1	0.05	0.1	5	0.2
SIDR	Drummond's campion		0.1		0.1		0.05	3	0.1
SYAS3	western aster		0.05				0.05	2	0.1
TALA2*	rock dandelion*						0.05	1	0.1
ZIVEG	grassy deathcamas	0.1	0.05				0.05	3	0.1
	Forb Total	*24.25*	*30.5*	*12.05*	*18.7*	*25.15*	*32.55*	*6*	*23.9*
Graminoid									
ACLE9	Letterman's needlegrass				0.05			1	0.1
ACNED	Dore's needlegrass				0.05			1	0.1
CADU6	needleleaf sedge	1.2		0.2	2			3	1.1
CARO5	Ross' sedge				0.05	0.05	2.6	3	0.9
CAVA3	valley sedge	0.05		0.05	1.2			3	0.4
CAXE	whitescale sedge			0.05				1	0.1
ELELE	squirreltail				0.05			1	0.1
FEID	Idaho fescue	5.2	4.4	7.2	12	5.8	0.05	6	5.8
KOMA	prairie Junegrass	0.6		0.1	0.1		0.7	4	0.4

Table 11 (continued).

	Plot Number	**Eco2-076**	**Eco2-077**	**Eco2-078**	**Eco2-079**	**Eco2-080**	**Eco2-081**		
PLANTS Code	**Common Name**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Freq. (n=6)**	**Ave. Cover**
LEKI2	spike fescue	4.6	0.05	9.5	3.2	0.6	0.05	6	3.0
POCUP3	Cusick's bluegrass	1.9	4.6	5.2	0.9	3.2	1.9	6	3.0
POSE	Sandberg bluegrass			0.6	1.9	0.2	0.2	4	0.7
PSSPS	bluebunch wheatgrass	5.9	22.5	4.6		8.6	17.5	5	11.8
	Graminoid Total	*19.45*	*31.55*	*27.5*	*21.5*	*18.45*	*23*	*6*	*23.6*
Al Species Total		*72.52*	*62.8*	*94.95*	*43.36*	*74.14*	*57.09*	*6*	*67.5*
	Ground Cover								
	Bare Soil	19.1	28	7.2	18.1	45.5	67.5	6	30.9
	Gravel	1.4	2.5	0.9	0.5	12	5.8	6	3.9
	Rock						0.6	1	0.6
	Animal Droppings	0.7	1	2.3	1	0.5	0.4	6	1.0
	Plant Litter	72.5	57	77.5	67.5	28.5	8.2	6	51.9
	Wood	1.5	1	1.3	1.5	1.5	1	6	1.3
	Live Plant Base	5.8	3	3	4.4	3	3	6	3.7
	Clubmoss								
	Non-foliose Lichen								
	Foliose Lichen								
	Vagrant Lichen								
	Moss	0.1		0.2				2	0.2
Sagebrush Seedlings									
	Sage Sdlgs / Sq M	0	0	0	0	0	0		
Miscellaneous Plot Features									
	Plot_Date	8/7/2009	8/7/2009	8/7/2009	8/7/2009	8/7/2009	8/8/2009		
	Number_of_Pair	Eco2-077	Eco2-076	Eco2-079	Eco2-078	Eco2-081	Eco2-080		
	Magnetic declination	12	12	12	12	12	12		
	Slope in degrees	16	20	21	19	22	21		
	Slope shape	Straight	Straight	Straight	Straight	Straight	Straight		
	Aspect	200	200	180	180	180	200		
	Azimuth	20	20	360	360	360	20		
	Bearing of Plot Ends	290	290	270	270	270	290		
	Bedrock	Limestone	Limestone	Limestone	Limestone	Limestone	Limestone		

Table 11 (continued).

	Plot Number	Eco2-076	Eco2-077	Eco2-078	Eco2-079	Eco2-080	Eco2-081		
PLANTS Code	**Common Name**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Freq. (n=6)**	**Ave. Cover**
	Coord_System	UTM	UTM	UTM	UTM	UTM	UTM		
	Datum	NAD83	NAD83	NAD83	NAD83	NAD83	NAD83		
	UTM_Zone	12N	12N	12N	12N	12N	12N		
	Northing	4726186	4726159	4726688	4726631	4725988	4725893		
	Easting	678464	678551	677846	677860	678888	679007		
	Township	T31N	T31N	T31N	T31N	T31N	T31N		
	Range	R100W	R100W	R101W	R100W	R100W	R100W		
	Section	7	7	12	7	17	17		
	Elevation, feet	8491	8499	8917	8797	8364	8296		
	Elevation, meters	2588	2590	2718	2681	2549	2528		

Table 12. Percent canopy cover of plants and percent cover of ground-cover types in plots of the Pass Creek Fire.
Use the PLANTS code to find the species' scientific name in Table 15. Exotic species are noted by an asterisk*. Average cover for a species is calculated only for the plots in which the species occurred.

	Plot Number	Eco2-041	Eco2-040	Eco2-047	Eco2-046	Eco2-050	Eco2-049	Eco2-054	Eco2-052	Eco2-055	Eco2-053		
PLANTS Code	**Common Name**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Freq. (n=10)**	**Ave. Cover**
	Deciduous Shrub												
AMAL2	Saskatoon serviceberry			1.08	0.05	0.8	0.4				0.05	5	0.5
ARFR4	prairie sagewort			0.6								1	0.6
CEVE	snowbrush ceanothus								0.05		0.05	2	0.1
CHVIL4	yellow rabbitbrush		0.05	2.28	0.7	0.88	7.64			0.05	0.05	7	1.7
ERNA10	rubber rabbitbrush			0.05	0.05							2	0.1
PUTR2	antelope bitterbrush			3.52	0.05	26.44	0.05	0.05		0.05	1.44	7	4.5
RICEP	whisky currant			0.05			0.05					2	0.1
ROWO	Woods' rose					0.05	0.05					2	0.1
SYORU	Utah snowberry			0.05		9.16	0.05		0.05			4	2.3
TECA2	spineless horsebrush				0.05		0.05	0.05	0.05	0.4	1.76	6	0.4
	Deciduous Shrub Total		*0.05*	*7.63*	*0.9*	*37.33*	*8.29*	*0.1*	*0.15*	*0.5*	*3.35*	*9*	*6.5*
	Evergreen Shrub												
ARNO4	black sagebrush			14.68	0.05							2	7.4
ARTRR2	Wyoming threetip sagebrush	1.28	0.6	0.05	0.1	2.68	12.28	0.05		1.44	0.05	9	2.1
ARTRV	mountain big sagebrush	28	0.05	0.05		18.56	1.6	42.28	13	27.48	1.36	9	14.7
	Evergreen Shrub Total	*29.28*	*0.65*	*14.78*	*0.15*	*21.24*	*13.88*	*42.33*	*13*	*28.92*	*1.41*	*10*	*16.6*
	Forb												
ACMIO	western yarrow	1.5	0.7						0.8		1.3	4	1.1
AGGL	pale agoseris			0.7	0.7	0.05	0.7	0.1	0.5	0.1	0.05	8	0.4
AGGLD	pale agoseris							0.1		0.1		2	0.1
AGGLL	false agoseris		0.05									1	0.1
ALAL3*	pale madwort*				0.3							1	0.3
ALLIU	onion				0.05		0.05	0.05				3	0.1
ANMI3	littleleaf pussytoes	2.8	0.8	0.6				1.2		4.6	0.6	6	1.8
ARCOC4	ballhead sandwort							0.1	0.1	0.1	0.2	4	0.1
ARHOP	Hooker's sandwort		10.1	3.3	7.2	0.05						4	5.2
ARHOR	second rockcress							0.1		0.2	0.1	3	0.1
ARNIC	arnica		0.05									1	0.1
ASAL7	alpine milkvetch								0.7			1	0.7
ASMI10	Missouri milkvetch						0.6			0.05	0.1	3	0.3

Table 12 (continued).

	Plot Number	Eco2-041	Eco2-040	Eco2-047	Eco2-046	Eco2-050	Eco2-049	Eco2-054	Eco2-052	Eco2-055	Eco2-053		
PLANTS Code	**Common Name**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Freq. (n=10)**	**Ave. Cover**
ASMI9	timber milkvetch	0.8		1.3			0.05	2.5	0.05	1.2	0.7	7	0.9
ASMID	prostrate milkvetch		4.1									1	4.1
BAIN	hoary balsamroot		0.7	6.6	4.4	0.05	0.1					5	2.4
BASA3	arrowleaf balsamroot			0.05	0.05	0.05	0.05	6.8	17.6	0.7	10.6	8	4.5
CAAND	northwestern Indian paintbrush							0.1				1	0.1
CAFL7	yellow Indian paintbrush			0.1	0.05	0.05	0.05	0.05		0.05	0.05	7	0.1
CAMI2*	littlepod false flax*			0.2		0.2	0.3		0.2	0.05	0.4	6	0.2
CANU3	sego lily			0.2	0.1			0.1		0.05		4	0.1
CARO2	bluebell bellflower			0.05					0.05			2	0.1
CEAR4	field chickweed	0.1						0.1		0.05	0.3	4	0.1
CHDOD	Douglas' dustymaiden			0.1	0.05	0.05	0.05				0.05	5	0.1
CIUN	wavyleaf thistle				0.05						0.05	2	0.1
COLI2	tiny trumpet	0.05							0.4			2	0.2
COPA3	maiden blue eyed Mary					0.2		0.3	0.4		0.2	4	0.3
COUMP	pale bastard toadflax			2.4	2.5						0.1	3	1.7
CRAC2	tapertip hawksbeard					0.6	0.6	0.05	0.1	0.7	0.05	6	0.4
DEPII	western tansymustard					0.05					0.05	2	0.1
DOCO	Bonneville shootingstar							0.05		0.1	0.05	3	0.1
DRAL4	slender draba			0.1			0.3				0.1	3	0.2
DROL	fewseed draba			0.05								1	0.1
ERAS2	western wallflower		0.05							0.05		2	0.1
ERCAC	sanddune wallflower			0.05	0.05	0.05	0.05	0.05				5	0.1
ERIOG	buckwheat		0.05									1	0.1
EROVO4	cushion buckwheat				0.1	0.05	0.05					3	0.1
ERUMD3	sulphur-flower buckwheat	1.3				0.1	0.1	0.6	10.2	0.6	0.7	7	1.9
EUBR	horned spurge				0.05							1	0.1
FRAT	spotted fritillary								0.05			1	0.1
GEAF	pleated gentian	2.6										1	2.6
GEVI2	sticky purple geranium								0.05			1	0.1
IPAGA3	scarlet gilia		0.05		0.05					0.05	0.05	4	0.1
LILE3	Lewis flax			0.7	0.7	0.05				0.05	0.1	5	0.3
LUAR3	silvery lupine	0.6	16					0.6	0.6	0.1		5	3.6
MACAC	hoary tansyaster				0.05					0.05		2	0.1

Table 12 (continued).

	Plot Number	Eco2-041	Eco2-040	Eco2-047	Eco2-046	Eco2-050	Eco2-049	Eco2-054	Eco2-052	Eco2-055	Eco2-053		
PLANTS Code	**Common Name**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Freq. (n=10)**	**Ave. Cover**
MAGR2	rayless tansyaster				0.05							1	0.1
MEOB	oblongleaf bluebells	0.05	0.7		0.1	0.05	0.1		0.3	0.1	0.1	8	0.2
MIGRH	slender phlox								0.1			1	0.1
ORFA	clustered broomrape					0.05						1	0.1
ORLU2	yellow owl's-clover	0.05										1	0.1
PACA15	woolly groundsel				0.7	0.05	0.05				0.05	4	0.2
PEATP5	small penstemon	0.1	0.05		0.6	0.1	0.3	1.8	0.05	0.8	0.7	9	0.5
PHHO	spiny phlox	0.05		2.5	4.4	0.1	0.05	1.3		0.9	1.3	8	1.3
PHMU3	flowery phlox	4.1	2	0.6					0.7	1.3	2.6	6	1.9
PODOD4	Douglas' knotweed								0.5			1	0.5
PODOJ2	Johnston's knotweed	0.7										1	0.7
POOVO	sheep cinquefoil		0.8		0.6							2	0.7
POPU9	beautiful cinquefoil	2.7										1	2.7
PTTEA	turpentine wavewing		0.1	1.4	5.2	3.2	0.7		0.05		0.1	7	1.5
SIAL2*	tall tumblemustard*								0.05			1	0.1
SIDR	Drummond's campion	0.1	0.1		0.1							3	0.1
STAC	stemless mock goldenweed			2.1	2	0.05	0.6	0.05		0.05	0.6	7	0.8
SYAS3	western aster	2.7	1.3	1.2	0.2		0.05	0.1	2.2	0.2	3.2	9	1.2
SYCA3	western meadow aster	0.7										1	0.7
TALA2*	rock dandelion*	0.8	0.3						0.05			3	0.4
TEACA2	stemless four-nerve daisy									0.05		1	0.1
TOIN	hoary Townsend daisy					0.05						1	0.1
TRDU*	yellow salsify*			0.05	1.3	0.05	0.05				0.1	5	0.3
VIOLA	violet	0.2	0.05						0.2			3	0.2
ZIVEG	grassy deathcamas	0.05			0.1		0.05				0.05	4	0.1
	Forb Total	*22.05*	*38.05*	*24.35*	*31.8*	*5.3*	*5*	*16.2*	*36*	*12.35*	*24.7*	*10*	*21.6*
						Graminoid							
ACLE9	Letterman's needlegrass								2.5			1	2.5
ACNED	Dore's needlegrass	2							4			2	3.0
BRPO2	Porter brome	0.1										1	0.1
BRTE*	cheatgrass*				0.1	2	8.9				0.1	4	2.8
CADU6	needleleaf sedge	0.7	1.3									2	1.0
CARO5	Ross' sedge			1.2	1.2		0.05				0.6	4	0.8
CAVA3	valley sedge		0.05						0.05			2	0.1

Table 12 (continued).

	Plot Number	Eco2-041	Eco2-040	Eco2-047	Eco2-046	Eco2-050	Eco2-049	Eco2-054	Eco2-052	Eco2-055	Eco2-053		
PLANTS Code	**Common Name**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Freq. (n=10)**	**Ave. Cover**
CAXE	whitescale sedge	0.1	0.05						16.6			3	5.6
DAUN	onespike danthonia	0.6										1	0.6
ELELE	squirreltail	0.6	0.6				0.05		0.05			4	0.3
ELTRT	slender wheatgrass	0.6							0.6			2	0.6
FEID	Idaho fescue	14.1							3.8	1.4	0.6	4	5.0
KOMA	prairie Junegrass	0.8	5.2	2.8	3.9	0.7	0.6	2.8	0.1	1.4	0.9	10	1.9
LEKI2	spike fescue			0.6					1.9		0.05	3	0.9
MEBU	oniongrass								0.6			1	0.6
MURI	mat muhly	0.05										1	0.1
PASM	western wheatgrass	0.6	7.2									2	3.9
POCUP3	Cusick's bluegrass	5.2	10.6	5.3	3.9	1.2	1.2	4.4		3.9	2.4	9	4.2
POPR*	Kentucky bluegrass*	4.1	0.05						8.1			3	4.1
POSE	Sandberg bluegrass	0.1		0.05	0.1	0.6		1.8	0.8	2	0.4	8	0.7
PSSPS	bluebunch wheatgrass		13.5	17.5	23	12	31.6	2.5	2.6	5.8	8.6	9	13.0
	Graminoid Total	29.65	38.55	27.45	32.2	16.5	42.4	11.5	41.7	14.5	13.65	10	26.8
	All Species Total	80.98	77.3	74.21	65.05	80.37	69.57	70.13	90.85	56.27	43.11	10	70.8
	Ground Cover												
	Bare Soil	2.8	31.6	30.5	26.5	22.5	16.1	26.6	28.7	35.5	62.5	10	28.3
	Gravel	0.3	1	4.4	9.2	2.4	4.8	2	0.4	4.4	5.8	10	3.5
	Rock			1.2	2.4	11.3	20.7		0.1	8.6	4.1	7	6.9
	Animal Droppings	1.9	0.3	0.2	0.3		0.4	0.9	0.1	0.1	0.3	9	0.5
	Plant Litter	82.5	62.5	47	33.5	59	38.7	57.5	54	19.6	10.6	10	46.5
	Wood	1.9	0.7	1.5	0.9	0.5	2	1	0.5	2.2	0.4	10	1.2
	Live Plant Base	5.8	2.5	7.8	9.2	2.5	1.5	3	11.3	3	2.5	10	4.9
	Clubmoss											0	
	Non-foliose Lichen			0.1						0.1	0.1	3	0.1
	Foliose Lichen											0	
	Vagrant Lichen			0.1				0.1				2	0.1
	Moss							0.5		0.1		2	0.3

Table 12 (continued).

PLANTS Code	Plot Number / Common Name	Eco2-041 Unburned	Eco2-040 Burned	Eco2-047 Unburned	Eco2-046 Burned	Eco2-050 Unburned	Eco2-049 Burned	Eco2-054 Unburned	Eco2-052 Burned	Eco2-055 Unburned	Eco2-053 Burned	Freq. (n=10)	Ave. Cover
Sagebrush Seedlings													
	Sage Sdlgs / Sq M	0.4	0	0	0	0	0.4	0.4	0	0	0	3	
Miscellaneous Plot Features													
	Plot_Date	8/4/2009	7/14/2009	8/5/109	8/5/2009	8/5/109	8/5/109	8/6/2009	8/6/2009	8/6/2009	8/8/2009		
	Number_of_Pair	Eco2-040	Eco2-041	Eco2-046	Eco2-047	Eco2-049	Eco2-050	Eco2-052	Eco2-054	Eco2-053	Eco2-055		
	Magnetic declination	12	14	12	12	12	12	12	12	12	12		
	Slope in degrees	10	15	20	23	22	20	21	16	26	21		
	Slope shape	Concave	Straight	Convex	Convex	Straight	Straight	Straight		Straight	Straight		
	Aspect	196	181	170	130	200	210	180	180	180	200		
	Azimuth	106	1	260	244	20	20	360	360	360	20		
	Bearing of Plot Ends	16	91	170	154	290	290	270	270	270	290		
	Bedrock	Limestone	Shale	Limestone	Limestone	Limestone	Limestone	Unknown	Limestone	Limestone	Limestone		
	Coord_System	UTM	UTM	UTM	UTM	UTM	UTM	UTM	UTM	UTM	UTM		
	Datum	NAD83	NAD83	NAD83	NAD83	NAD83	NAD83	NAD83	NAD83	NAD83	NAD83		
	UTM_Zone	12N	12N	12N	12N	12N	12N	12N	12N	12N	12N		
	Northing	4721042	4721095	4721699	4721688	4722128	4722162	4722889	4722681	4723044	4722839		
	Easting	684971	684965	684284	684313	684637	684552	681133	681848	681116	681902		
	Township	T31N	T31N	T31N	T31N	T31N	T31N	T31N	T31N	T31N	T31N		
	Range	R100W	R100W	R100W	R100W	R100W	R100W	R100W	R100W	R100W	R100W		
	Section	35	35	26	26	26	26	28	28	21	28		
	Elevation, feet	7605	7631	7767	7766	8167	8148	8115	7937	8244	8051		
	Elevation, meters	2317	2325	2367	2367	2489	2483	2473	2419	2512	2453		

Table 13. Percent canopy cover of plants and percent cover of ground-cover types in plots of the Middle Fork 2002 Fire.
Use the PLANTS code to find the species' scientific name in Table 15. Exotic species are noted by an asterisk*. Average cover for a species is calculated only for the plots in which the species occurred.

	Plot Number	**Eco2-002**	**Eco2-003**	**Eco2-008**	**Eco2-009**	**Eco2-012**	**Eco2-011**	**Eco2-013**	**Eco2-014**		
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Freq. (n=8)**	**Ave. Cover**
					Deciduous Shrub						
AMAL2	Saskatoon serviceberry								0.6	1	0.6
ARFR4	prairie sagewort			0.6	4			0.05	0.05	4	1.2
ARLU	white sagebrush	2.7	0.6	0.6	0.05	0.05	0.05	0.05		7	0.6
CHVIL4	yellow rabbitbrush			1	0.8	2.64		0.05	1.44	5	1.2
ERNA10	rubber rabbitbrush	0.05		0.05						2	0.1
GUSA2	broom snakeweed	0.05		0.05	0.05					3	0.1
LIPU11	granite prickly phlox			0.05	0.2					2	0.1
PRVIM	black chokecherry								0.05	1	0.1
PUTR2	antelope bitterbrush		4.36	5.04	2.32	8.48	21.4	5.6	23.24	7	10.1
RICEP	whisky currant	0.05		0.05					0.05	3	0.1
ROWO	Woods' rose				0.05			0.1		2	0.1
SYORU	Utah snowberry					0.05		12.56	6.8	3	6.5
TECA2	spineless horsebrush				3.04					1	3.0
	Deciduous Shrub Total	*2.85*	*4.96*	*7.44*	*10.51*	*11.22*	*21.45*	*18.41*	*32.23*	*8*	*13.6*
					Evergreen Shrub						
ARTRR2	Wyoming threetip sagebrush	0.05						0.05	0.05	3	0.1
ARTRV	mountain big sagebrush	0.05	16.28	0.05	13.16	0.05	15.76	0.05	31.8	8	9.7
JUSC2	Rocky Mountain juniper		0.05		0.05			0.05		3	0.1
	Evergreen Shrub Total	*0.1*	*16.33*	*0.05*	*13.21*	*0.05*	*15.76*	*0.15*	*31.85*	*8*	*9.7*
					Forb						
AGGL	pale agoseris						0.05		0.2	2	0.1
AGGLD	pale agoseris					0.2			0.1	2	0.2
AGGLL	false agoseris		0.1							1	0.1
ALAL3*	pale madwort*	4.4	3.9	2	0.4	1	0.5	1.5	1.4	8	1.9
ALCE2	nodding onion					0.05		0.05		2	0.1
ALLIU	onion								0.05	1	0.1
ANMI3	littleleaf pussytoes	0.05	0.05			0.05	0.05	0.1	0.1	6	0.1
APCA	Indianhemp			0.05						1	0.1
ARDR4	tarragon					0.6				1	0.6
ARHOP	Hooker's sandwort	0.05			0.05			0.05	0.05	4	0.1
ARHOR	second rockcress		0.1			0.05	0.05	0.1	0.1	5	0.1
ASDR3	Drummond's milkvetch	0.7				0.05	2			3	0.9

Table 13 (continued).

	Plot Number	Eco2-002	Eco2-003	Eco2-008	Eco2-009	Eco2-012	Eco2-011	Eco2-013	Eco2-014		
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Freq. (n=8)**	**Ave. Cover**
ASMI10	Missouri milkvetch	0.05		0.1		0.05				3	0.1
BAIN	hoary balsamroot	0.05			0.05	0.6	0.05	0.05	0.05	6	0.1
BASA3	arrowleaf balsamroot	0.05			0.05		0.05			3	0.1
CAAND	northwestern Indian paintbrush				0.05					1	0.1
CAFL7	yellow Indian paintbrush					0.05		0.05	0.05	3	0.1
CAMI2*	littlepod false flax*	0.2	0.05		0.05	0.2		0.05	0.05	6	0.1
CANU3	sego lily	0.1	0.1		0.05	0.05	0.1	0.05	0.1	7	0.1
CANU4*	nodding plumeless thistle*	0.05	0.05							2	0.1
CARO2	bluebell bellflower								0.05	1	0.1
CHDOD	Douglas' dustymaiden	0.05			0.05					2	0.1
CIUN	wavyleaf thistle			0.7				0.05		2	0.4
COPA3	maiden blue eyed Mary		0.1					0.1	0.3	3	0.2
COUMP	pale bastard toadflax							0.05		1	0.1
CRAC2	tapertip hawksbeard		0.05		0.05	3.9	4.6		0.7	5	1.9
CRYPT	cryptantha			0.05	0.1					2	0.1
DRAL4	slender draba					0.1	0.4	0.05		3	0.2
DRRE2	Carolina draba				0.05					1	0.1
ERAS2	western wallflower	0.05						0.1	0.05	3	0.1
ERCAC	sanddune wallflower			0.05	0.05					2	0.1
EROVO4	cushion buckwheat							0.05		1	0.1
ERUMD3	sulphur-flower buckwheat					0.05		0.05	0.05	3	0.1
GACO5	scarlet beeblossom	0.1	0.05	0.05	0.2	0.6		0.6		6	0.3
GRSQ	curlycup gumweed	0.05				0.05				2	0.1
HEVIM3	hairy false goldenaster			0.05	0.6	0.05				3	0.2
LIIN2	narrowleaf stoneseed			0.05						1	0.1
LILE3	Lewis flax	0.1	0.05		0.1	0.05		0.05	0.05	6	0.1
LIRU4	western stoneseed	0.05	4	4	0.7	0.6	0.7		1.2	7	1.6
LYJU	rush skeletonplant				0.2					1	0.2
MACAC	hoary tansyaster			0.05	0.1	0.05				3	0.1
MAGR2	rayless tansyaster	0.05								1	0.1
MELA3MEHU2	prairie bluebells	0.6				0.1		0.3	0.1	4	0.3
MEOF*	yellow sweetclover*						0.05			1	0.1
OENU	Nuttall's evening primrose	0.2								1	0.2
ORFA	clustered broomrape								0.05	1	0.1
OXCA4OXSE	field locoweed		0.05							1	0.1

Table 13 (continued).

	Plot Number	Eco2-002	Eco2-003	Eco2-008	Eco2-009	Eco2-012	Eco2-011	Eco2-013	Eco2-014		
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Freq. (n=8)**	**Ave. Cover**
PACA15	woolly groundsel	0.05		0.05	0.7			0.05		4	0.2
PEATP5	small penstemon		0.05			0.05	0.05	0.6	0.05	5	0.2
PECA12	mat rockspirea								0.05	1	0.1
PELAL7	larchleaf beardtongue			0.05						1	0.1
PHHO	spiny phlox	0.7	0.05	0.05	0.7	0.05		0.05		6	0.3
PIUN3	slender-spire orchid		0.05							1	0.1
PTTEA	turpentine wavewing		0.1			0.1	0.05	1.2	1.2	5	0.5
SIAL2*	tall tumblemustard*	0.05								1	0.1
SPCO	scarlet globemallow	0.05								1	0.1
SYAS3	western aster					0.6			0.05	2	0.3
TALA2*	rock dandelion*	0.1	0.1							2	0.1
TRDU*	yellow salsify*	0.1	0.05	0.05	0.05	0.05	0.05	0.1	0.05	8	0.1
UnkFrb09-1	Unknown							0.05		1	0.1
UnkFrb09-2	Unknown								0.05	1	0.1
UnkFrb09-3	Perennial forb, broad ovate leaves					0.05				1	0.1
VIOLA	violet	0.05								1	0.1
ZIVEG	grassy deathcamas								0.05	1	0.1
	Forb Total	*8.05*	*9.05*	*7.35*	*4.35*	*9.4*	*8.75*	*5.45*	*6.3*	*8*	*7.3*
Graminoid											
AGCR*	crested wheatgrass*					0.05				1	0.1
BRRA2*	bald brome*	0.05			0.1				0.05	3	0.1
BRTE*	cheatgrass*	10.8	4.8	33.5	0.4	1	7.9	3.4	1.5	8	7.9
CADU6	needleleaf sedge	0.05				0.1	0.6			3	0.3
CARO5	Ross' sedge	0.05	0.05	0.05				5.2	10	5	3.1
FEID	Idaho fescue					1.8	6.7			2	4.3
HECO26	needle and thread	0.05				4	0.05			3	1.4
KOMA	prairie Junegrass	0.05		0.6	1.4	3.2	0.05	0.7	0.1	7	0.9
LEKI2	spike fescue	16.5		0.05				0.6	0.05	4	4.3
PASM	western wheatgrass	0.05								1	0.1
POCUP3	Cusick's bluegrass	0.6	0.05		0.05	2	2.1	0.6	0.6	7	0.9
POPR*	Kentucky bluegrass*	0.7	0.7				0.1			3	0.5
POSE	Sandberg bluegrass	0.05		0.6	0.9	3.2	3.3	0.4	0.1	7	1.2
PSSPS	bluebunch wheatgrass	21	17.5	11.2	12	12	8	28.5	4.4	8	14.3
	Graminoid Total	*49.95*	*23.1*	*46*	*14.85*	*27.35*	*28.8*	*39.4*	*16.8*	*8*	*30.8*
All Species Total		*60.95*	*53.44*	*60.84*	*42.92*	*48.02*	*74.76*	*63.41*	*87.18*	*8*	*61.4*

Table 13 (continued).

	Plot Number	Eco2-002	Eco2-003	Eco2-008	Eco2-009	Eco2-012	Eco2-011	Eco2-013	Eco2-014		
PLANTS Code	**Common Name**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Unburned**	**Freq. (n=8)**	**Ave. Cover**
Ground Cover											
	Bare Soil	17.7	4.4	3.4	14.7	25.2	3.3	9.3	19.1	8	12.1
	Gravel	2	0.4	2	3.4	3.9	0.3	2.5	2.5	8	2.1
	Rock	0.6	7.5	17.7	6.7	1.8	1.8	7.2	5.3	8	6.1
	Animal Droppings	0.2	0.3	0.3	0.7	0.1	0.4	0.3	0.8	8	0.4
	Plant Litter	57.5	72.5	77.5	49	62.5	87.5	77.5	67.5	8	68.9
	Wood	2.5	1	0.5	0.5	18.8	0.8	1	0.4	8	3.2
	Live Plant Base	5.8	1.5	2	1	2.5	2	2	3	8	2.5
	Clubmoss										
	Non-foliose Lichen				2.4		0.3			2	1.4
	Foliose Lichen				0.1					1	0.1
	Vagrant Lichen										
	Moss	0.1			0.2	0.4	0.3	0.3	0.1	6	0.2
Sagebrush Seedlings											
	Sage Sdlgs / Sq m	0	0	0	0.4	0	0	0	0	1	
Miscellaneous Plot Features											
	Plot_Date	7/12/2009	7/12/2009	7/28/2009	7/28/2009	7/30/2009	7/30/2009	7/30/2009	7/30/2009		
	Number_of_Pair	Eco2-003	Eco2-002	Eco2-009	Eco2-008	Eco2-011	Eco2-012	Eco2-014	Eco2-013		
	Magnetic declination		13	14	14	12	12	12	12		
	Slope in degrees	23	34	35	31	12	15	29	30		
	Slope shape	Straight	Straight	Straight	Straight	Convex	Convex	Straight	Straight		
	Aspect	170	127	162	158	118	120	160	154		
	Azimuth	350	314	342	338	298	300	340	334		
	Bearing of Plot Ends	260	224	252	248	208	210	250	244		
	Bedrock	Limestone	Limestone	Limestone	Limestone	Limestone	Limestone	Limestone	Limestone		
	Coord_System	UTM	UTM	UTM	UTM	UTM	UTM	UTM	UTM		
	Datum	NAD83	NAD83	NAD83	NAD83	NAD83	NAD83	NAD83	NAD83		
	UTM_Zone	12N	12N	12N	12N	12N	12N	12N	12N		
	Northing	4734008	4734030	4734157	4734199	4733767	4733823	4734110	4734110		
	Easting	676854	677087	676514	676480	676165	676152	675253	675230		
	Township	T32N	T32N	T32N	T32N	T32N	T32N	T32N	T32N		
	Range	R101W	R100W	R101W	R101W	R101W	R101W	R101W	R101W		
	Section	24	19	13	13	24	24	14	14		
	Elevation, feet	7031	6959	7277	7382	7169	7185	8021	8032		
	Elevation, meters	2142	2121	2218	2250	2185	2189	2444	2448		

Table 14. Percent canopy cover of plants and percent cover of ground-cover types in plots of the Homestead Fire.
Use the PLANTS code to find the species' scientific name in Table 15. Exotic species are noted by an asterisk*. Average cover for a species is calculated only for the plots in which the species occurred.

	Plot Number	Eco2-015	Eco2-016	Eco2-018	Eco2-017		
PLANTS Code	**Common Name**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Freq. (n=4)**	**Ave. Cover**
	Deciduous Shrub						
AMAL2	Saskatoon serviceberry		0.05	0.05		2	0.1
PUTR2	antelope bitterbrush	0.05	0.05	0.88	0.05	4	0.3
SYORU	Utah snowberry		0.05	0.05	0.9	3	0.3
	Deciduous Shrub Total	*0.05*	*0.15*	*0.98*	*0.95*	*4*	*0.5*
	Evergreen Shrub						
ARTRR2	Wyoming threetip sagebrush	0.05				1	0.1
ARTRV	mountain big sagebrush	21.48	1.9	46.76	0.05	4	17.5
	Evergreen Shrub Total	*21.53*	*1.9*	*46.76*	*0.05*	*4*	*17.6*
	Forb						
ACMIO	western yarrow	0.05	0.05			2	0.1
ALAL3*	pale madwort*	0.5	3	1	4.4	4	2.2
ANTEN	pussytoes	0.4		0.3	1.2	3	0.6
ARHOP	Hooker's sandwort	0.1				1	0.1
ASMI9	timber milkvetch			0.1	0.1	2	0.1
BAIN	hoary balsamroot	3	0.1	1.3	3.8	4	2.1
BASA3	arrowleaf balsamroot	0.05	0.05	0.05	0.05	4	0.1
CEAR4	field chickweed	0.8		0.7	3.3	3	1.6
LIRU4	western stoneseed			0.7	0.05	2	0.4
LUARA5	silvery lupine	0.1	1.8		0.2	3	0.7
LUPIN	lupine		1.8	0.3	0.1	3	0.7
	Forb Total	*5*	*6.8*	*4.45*	*13.2*	*4*	*7.4*
	Graminoid						
BRTE*	cheatgrass*		2.7	4.8	7.5	3	5.0
KOMA	prairie Junegrass	2.5		0.05		2	1.3
POSE	Sandberg bluegrass	5.8	1	8.6	10.6	4	6.5
PSSPS	bluebunch wheatgrass	0.05	2.5	2.4	6.7	4	2.9
	Graminoid Total	*8.35*	*6.2*	*15.85*	*24.8*	*4*	*13.8*
All Species Total		*34.93*	*15.05*	*68.04*	*39*	*4*	*39.3*

Table 14 (continued).

	Plot Number	Eco2-015	Eco2-016	Eco2-018	Eco2-017		
PLANTS Code	**Common Name**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Freq. (n=4)**	**Ave. Cover**
	Ground Cover						
	Bare Soil	3	2	2	5.3	4	3.1
	Gravel	0.5	0.5	0.5	1.5	4	0.8
	Rock		0.7			1	0.7
	Animal Droppings	0.1		0.2		2	0.2
	Plant Litter	0.5	3	7.2	5.9	4	4.2
	Wood	0.2	1	0.3	0.2	4	0.4
	Live Plant Base	2.5	4.4	10	7.2	4	6.0
	Clubmoss						
	Non-foliose Lichen						
	Foliose Lichen	0.2	0.1	0.1		3	0.1
	Vagrant Lichen						
	Moss						
	Sagebrush Seedlings						
	Sage Sdlgs / Sq M	0	0	0	0		
	Miscellaneous Plot Features						
	Plot_Date	8/12/2009	8/12/2009	8/11/2009	8/11/2009		
	Number_of_Pair	Eco2-016	Eco2-015	Eco2-017	Eco2-018		
	Magnetic declination	12	12	12	12		
	Slope in degrees	20	19	24	24		
	Slope shape	Straight	Concave	Straight	Concave		
	Aspect	160	160	170	170		
	Azimuth	340	340	350	350		
	Bearing of Plot Ends	250	250	260	260		

Table 14 (continued).

	Plot Number	Eco2-015	Eco2-016	Eco2-018	Eco2-017		
PLANTS Code	**Common Name**	**Unburned**	**Burned**	**Unburned**	**Burned**	**Freq. (n=4)**	**Ave. Cover**
	Bedrock	Limestone	Limestone	Limestone	Limestone		
	Coord_System	UTM	UTM	UTM	UTM		
	Datum	NAD83	NAD83	NAD83	NAD83		
	UTM_Zone	12N	12N	12N	12N		
	Northing	4736031	4736004	4735931	4735979		
	Easting	676151	676157	676245	676244		
	Township	T32N	T32N	T32N	T32N		
	Range	R101W	R101W	R101W	R101W		
	Section	12	12	12	12		
	Elevation, feet	7976	7942	7865	7921		
	Elevation, meters	2431	2420	2397	2414		

Table 15. Plants recorded in the sampling plots in 2008 and 2009.
All information except # plots (i.e., number of plots out of 59 in which species was recorded) and Growth-form are from the USDA-NRCS PLANTS database (USDA-NRCS 2009).

PLANTS Symbol	Accepted Scientific Name with Author	Common Name	Family	# plots	Origin	Growth-form	Life span
ACMIO	Achillea millefolium L. var. occidentalis DC.	western yarrow	Asteraceae	17	Native	Forb	Perennial
ACHY	Achnatherum hymenoides (Roem. & Schult.) Barkworth	Indian ricegrass	Poaceae	4	Native	Graminoid	Perennial
ACLE9	Achnatherum lettermanii (Vasey) Barkworth	Letterman's needlegrass	Poaceae	2	Native	Graminoid	Perennial
ACNED	Achnatherum nelsonii (Scribn.) Barkworth ssp. dorei (Barkworth & Maze) Barkworth	Dore's needlegrass	Poaceae	10	Native	Graminoid	Perennial
AGGL	Agoseris glauca (Pursh) Raf.	pale agoseris	Asteraceae	36	Native	Forb	Perennial
AGGLD	Agoseris glauca (Pursh) Raf. var. dasycephala (Torr. & A. Gray) Jeps.	pale agoseris	Asteraceae	7	Native	Forb	Perennial
AGGLL	Agoseris glauca (Pursh) Raf. var. laciniata (D.C. Eaton) Smiley	false agoseris	Asteraceae	5	Native	Forb	Perennial
AGCR	Agropyron cristatum (L.) Gaertn.	crested wheatgrass	Poaceae	1	Exotic	Graminoid	Perennial
ALLIU	Allium L.	onion	Liliaceae	17	Native	Forb	Perennial
ALBR2	Allium brevistylum S. Watson	shortstyle onion	Liliaceae	2	Native	Forb	Perennial
ALCE2	Allium cernuum Roth	nodding onion	Liliaceae	2	Native	Forb	Perennial
ALTE	Allium textile A. Nelson & J.F. Macbr.	textile onion	Liliaceae	1	Native	Forb	Perennial
ALAL3	Alyssum alyssoides (L.) L.	pale madwort	Brassicaceae	17	Exotic	Forb	Annual
ALDE	Alyssum desertorum Stapf	desert madwort	Brassicaceae	10	Exotic	Forb	Annual
AMAL2	Amelanchier alnifolia (Nutt.) Nutt. ex M. Roem.	Saskatoon serviceberry	Rosaceae	15	Native	DecidShrub	Perennial
ANTEN	Antennaria Gaertn.	pussytoes	Asteraceae	3	Native	Forb	Perennial
ANMI3	Antennaria microphylla Rydb.	littleleaf pussytoes	Asteraceae	33	Native	Forb	Perennial
ANPA4	Antennaria parvifolia Nutt.	small-leaf pussytoes	Asteraceae	1	Native	Forb	Perennial
ANRO2	Antennaria rosea Greene	rosy pussytoes	Asteraceae	2	Native	Forb	Perennial
APCA	Apocynum cannabinum L.	Indianhemp	Apocynaceae	1	Native	Forb	Perennial
ARHOR	Arabis holboellii Hornem. var. retrofracta (Graham) Rydb.	second rockcress	Brassicaceae	26	Native	Forb	Perennial
ARCOC4	Arenaria congesta Nutt. var. congesta	ballhead sandwort	Caryophyllaceae	13	Native	Forb	Perennial
ARCOL	Arenaria congesta Nutt. var. lithophila (Rydb.) Maguire	rock-loving sandwort	Caryophyllaceae	2	Native	Forb	Perennial
ARHOP	Arenaria hookeri Nutt. ssp. pinetorum (A. Nelson) W.A. Weber	Hooker's sandwort	Caryophyllaceae	19	Native	Forb	Perennial

Table 15 (continued).

PLANTS Symbol	Accepted Scientific Name with Author	Common Name	Family	# plots	Origin	Growth-form	Life span
ARPUF	Aristida purpurea Nutt. var. fendleriana (Steud.) Vasey	Fendler's threeawn	Poaceae	1	Native	Graminoid	Perennial
ARNIC	Arnica L.	arnica	Asteraceae	1	Native	Forb	Perennial
ARDR4	Artemisia dracunculus L.	tarragon	Asteraceae	1	Native	Forb	Perennial
ARFR4	Artemisia frigida Willd.	prairie sagewort	Asteraceae	30	Native	DecidShrub	Perennial
ARLU	Artemisia ludoviciana Nutt.	white sagebrush	Asteraceae	7	Native	DecidShrub	Perennial
ARNO4	Artemisia nova A. Nelson	black sagebrush	Asteraceae	8	Native	EvergrnShrub	Perennial
ARTRV	Artemisia tridentata Nutt. ssp. vaseyana (Rydb.) Beetle	mountain big sagebrush	Asteraceae	43	Native	EvergrnShrub	Perennial
ARTRT	Artemisia tridentata Nutt. ssp. tridentata	basin big sagebrush	Asteraceae	8	Native	EvergrnShrub	Perennial
ARTRW8	Artemisia tridentata Nutt. ssp. wyomingensis Beetle & Young	Wyoming big sagebrush	Asteraceae	7	Native	EvergrnShrub	Perennial
ARTRR2	Artemisia tripartita Rydb. ssp. rupicola Beetle	Wyoming threetip sagebrush	Asteraceae	20	Native	EvergrnShrub	Perennial
ASAL7	Astragalus alpinus L.	alpine milkvetch	Fabaceae	1	Native	Forb	Perennial
ASDR3	Astragalus drummondii Douglas ex Hook.	Drummond's milkvetch	Fabaceae	8	Native	Forb	Perennial
ASMI9	Astragalus miser Douglas ex Hook.	timber milkvetch	Fabaceae	20	Native	Forb	Perennial
ASMID	Astragalus miser Douglas ex Hook. var. decumbens (Nutt. ex Torr. & A. Gray) Cronquist	prostrate milkvetch	Fabaceae	6	Native	Forb	Perennial
ASMIP2	Astragalus miser Douglas ex Hook. var. praeteritus Barneby	Yellowstone milkvetch	Fabaceae	1	Native	Forb	Perennial
ASMI10	Astragalus missouriensis Nutt.	Missouri milkvetch	Fabaceae	10	Native	Forb	Perennial
ASPU9	Astragalus purshii Douglas ex Hook.	woollypod milkvetch	Fabaceae	4	Native	Forb	Perennial
BAIN	Balsamorhiza incana Nutt.	hoary balsamroot	Asteraceae	20	Native	Forb	Perennial
BASA3	Balsamorhiza sagittata (Pursh) Nutt.	arrowleaf balsamroot	Asteraceae	26	Native	Forb	Perennial
BEWY	Besseya wyomingensis (A. Nelson) Rydb.	Wyoming besseya	Scrophulariaceae	1	Native	Forb	Perennial
BOGR2	Bouteloua gracilis (Willd. ex Kunth) Lag. ex Griffiths	blue grama	Poaceae	3	Native	Graminoid	Perennial
BRPO2	Bromus porteri (J.M. Coult.) Nash	Porter brome	Poaceae	1	Native	Graminoid	Perennial
BRRA2	Bromus racemosus L.	bald brome	Poaceae	5	Exotic	Graminoid	Annual
BRTE	Bromus tectorum L.	cheatgrass	Poaceae	33	Exotic	Graminoid	Annual
CANU3	Calochortus nuttallii Torr. & A. Gray	sego lily	Liliaceae	27	Native	Forb	Perennial
CAMI2	Camelina microcarpa Andrz. ex DC.	littlepod false flax	Brassicaceae	22	Exotic	Forb	Annual
CARO2	Campanula rotundifolia L.	bluebell bellflower	Campanulaceae	5	Native	Forb	Perennial

Table 15 (continued).

PLANTS Symbol	Accepted Scientific Name with Author	Common Name	Family	# plots	Origin	Growth-form	Life span
CANU4	Carduus nutans L.	nodding plumeless thistle	Asteraceae	2	Exotic	Forb	Annual
CADU6	Carex duriuscula C.A. Mey.	needleleaf sedge	Cyperaceae	20	Native	Graminoid	Perennial
CAFI	Carex filifolia Nutt.	threadleaf sedge	Cyperaceae	4	Native	Graminoid	Perennial
CARO5	Carex rossii Boott	Ross' sedge	Cyperaceae	14	Native	Graminoid	Perennial
CAVA3	Carex vallicola Dewey	valley sedge	Cyperaceae	5	Native	Graminoid	Perennial
CAXE	Carex xerantica L.H. Bailey	whitescale sedge	Cyperaceae	7	Native	Graminoid	Perennial
CAAND	Castilleja angustifolia (Nutt.) G. Don var. dubia A. Nelson	northwestern Indian paintbrush	Scrophulariaceae	2	Native	Forb	Perennial
CAFL7	Castilleja flava S. Watson	yellow Indian paintbrush	Scrophulariaceae	22	Native	Forb	Perennial
CALI4	Castilleja linariifolia Benth.	Wyoming Indian paintbrush	Scrophulariaceae	2	Native	Forb	Perennial
CEVE	Ceanothus velutinus Douglas ex Hook.	snowbrush ceanothus	Rhamnaceae	2	Native	DecidShrub	Perennial
CEAR4	Cerastium arvense L.	field chickweed	Caryophyllaceae	19	Native	Forb	Perennial
CHDOD	Chaenactis douglasii (Hook.) Hook. & Arn. var. douglasii	Douglas' dustymaiden	Asteraceae	11	Native	Forb	Perennial
CHLE4CHPR5	Chenopodium leptophyllum (Moq.) Nutt. ex S. Watson/Chenopodium pratericola Rydb.	narrowleaf goosefoot/desert goosefoot	Chenopodiaceae	6	Native	Forb	Annual
CHSA2	Chenopodium salinum Standl.	Rocky Mountain goosefoot	Chenopodiaceae	2	Native	Forb	Annual
CHVIL4	Chrysothamnus viscidiflorus (Hook.) Nutt. ssp. lanceolatus (Nutt.) H.M. Hall & Clem.	yellow rabbitbrush	Asteraceae	30	Native	DecidShrub	Perennial
CIUN	Cirsium undulatum (Nutt.) Spreng.	wavyleaf thistle	Asteraceae	6	Native	Forb	Perennial
COPA3	Collinsia parviflora Lindl.	maiden blue eyed Mary	Scrophulariaceae	24	Native	Forb	Annual
COLI2	Collomia linearis Nutt.	tiny trumpet	Polemoniaceae	2	Native	Forb	Annual
COUMP	Comandra umbellata (L.) Nutt. ssp. pallida (A. DC.) Piehl	pale bastard toadflax	Santalaceae	14	Native	Forb	Perennial
CRAC2	Crepis acuminata Nutt.	tapertip hawksbeard	Asteraceae	23	Native	Forb	Perennial
CRIN4	Crepis intermedia A. Gray	limestone hawksbeard	Asteraceae	9	Native	Forb	Perennial
CRMO4	Crepis modocensis Greene	Modoc hawksbeard	Asteraceae	3	Native	Forb	Perennial
XLICHEN	Crustose lichen	Crustose Lichen		2	Native	Nonvascular	Perennial
XLICHEN	Non-crustose lichen	Lichen		4	Native	Nonvascular	Perennial
CRYPT	Cryptantha Lehm. ex G. Don	cryptantha	Boraginaceae	2	Native	Forb	Perennial

Table 15 (continued).

PLANTS Symbol	Accepted Scientific Name with Author	Common Name	Family	# plots	Origin	Growth-form	Life span
CRCE	Cryptantha celosioides (Eastw.) Payson	buttecandle	Boraginaceae	1	Native	Forb	Perennial
CYAC	Cymopterus acaulis (Pursh) Raf.	plains springparsley	Apiaceae	4	Native	Forb	Perennial
DAUN	Danthonia unispicata (Thurb.) Munro ex Macoun	onespike danthonia	Poaceae	1	Native	Graminoid	Perennial
DEBI	Delphinium bicolor Nutt.	little larkspur	Ranunculaceae	6	Native	Forb	Perennial
DEINI	Descurainia incana (Bernh. ex Fisch. & C.A. Mey.) Dorn ssp. incana	mountain tansymustard	Brassicaceae	2	Native	Forb	Annual
DEINP	Descurainia incana (Bernh. ex Fisch. & C.A. Mey.) Dorn ssp. procera (Greene) Kartesz & Gandhi	mountain tansymustard	Brassicaceae	1	Native	Forb	Annual
DEINV	Descurainia incana (Bernh. ex Fisch. & C.A. Mey.) Dorn ssp. viscosa (Rydb.) Kartesz & Gandhi	mountain tansymustard	Brassicaceae	8	Native	Forb	Annual
DEPII	Descurainia pinnata (Walter) Britton ssp. intermedia (Rydb.) Detling	western tansymustard	Brassicaceae	3	Native	Forb	Annual
DOCO	Dodecatheon conjugens Greene	Bonneville shootingstar	Primulaceae	12	Native	Forb	Perennial
DRABA	Draba L.	Draba	Brassicaceae	1	Native	Forb	Annual
DRAL4	Draba albertina Greene	slender draba	Brassicaceae	8	Native	Forb	Annual
DRNE	Draba nemorosa L.	woodland draba	Brassicaceae	10	Native	Forb	Annual
DROL	Draba oligosperma Hook.	fewseed draba	Brassicaceae	1	Native	Forb	Perennial
DRPR	Draba praealta Greene	tall draba	Brassicaceae	1	Native	Forb	Annual
DRRE2	Draba reptans (Lam.) Fernald	Carolina draba	Brassicaceae	1	Native	Forb	Annual
ELELE	Elymus elymoides (Raf.) Swezey ssp. elymoides	squirreltail	Poaceae	7	Native	Graminoid	Perennial
ELTRT	Elymus trachycaulus (Link) Gould ex Shinners ssp. trachycaulus	slender wheatgrass	Poaceae	2	Native	Graminoid	Perennial
ERNA10	Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & Baird	rubber rabbitbrush	Asteraceae	20	Native	DecidShrub	Perennial
ERIGE2	Erigeron L.	fleabane	Asteraceae	1	Native	Forb	Perennial
ERAL13	Erigeron allocotus S.F. Blake	Big Horn fleabane	Asteraceae	2	Native	Forb	Perennial
ERCA2	Erigeron caespitosus Nutt.	tufted fleabane	Asteraceae	9	Native	Forb	Perennial
ERIOG	Eriogonum Michx.	buckwheat	Polygonaceae	1	Native	Forb	Perennial
EROVO4	Eriogonum ovalifolium Nutt. var. ochroleucum (Small ex Rydb.) M. Peck	cushion buckwheat	Polygonaceae	7	Native	Forb	Perennial
ERUMD3	Eriogonum umbellatum Torr. var. dichrocephalum Gandog.	sulphur-flower buckwheat	Polygonaceae	22	Native	Forb	Perennial

Table 15 (continued).

PLANTS Symbol	Accepted Scientific Name with Author	Common Name	Family	# plots	Origin	Growth-form	Life span
ERAS2	Erysimum asperum (Nutt.) DC.	western wallflower	Brassicaceae	7	Native	Forb	Perennial
ERCAC	Erysimum capitatum (Douglas ex Hook.) Greene var. capitatum	sanddune wallflower	Brassicaceae	7	Native	Forb	Perennial
ERIN7	Erysimum inconspicuum (S. Watson) MacMill.	shy wallflower	Brassicaceae	3	Native	Forb	Perennial
EUBR	Euphorbia brachycera Engelm.	horned spurge	Euphorbiaceae	1	Native	Forb	Perennial
FEID	Festuca idahoensis Elmer	Idaho fescue	Poaceae	21	Native	Graminoid	Perennial
FRAT	Fritillaria atropurpurea Nutt.	spotted fritillary	Liliaceae	3	Native	Forb	Perennial
GAAR	Gaillardia aristata Pursh	common gaillardia	Asteraceae	2	Native	Forb	Perennial
GACO5	Gaura coccinea Nutt. ex Pursh	scarlet beeblossom	Onagraceae	9	Native	Forb	Perennial
GEAF	Gentiana affinis Griseb.	pleated gentian	Gentianaceae	1	Native	Forb	Perennial
GEVI2	Geranium viscosissimum Fisch. & C.A. Mey. ex C.A. Mey.	sticky purple geranium	Geraniaceae	1	Native	Forb	Perennial
GRSQ	Grindelia squarrosa (Pursh) Dunal	curlycup gumweed	Asteraceae	2	Native	Forb	Perennial
GUSA2	Gutierrezia sarothrae (Pursh) Britton & Rusby	broom snakeweed	Asteraceae	9	Native	DecidShrub	Perennial
HEDYS	Hedysarum L.	sweetvetch	Fabaceae	2	Native	Forb	Perennial
HECO26	Hesperostipa comata (Trin. & Rupr.) Barkworth	needle and thread	Poaceae	19	Native	Graminoid	Perennial
HEVIM3	Heterotheca villosa (Pursh) Shinners var. minor (Hook.) Semple	hairy false goldenaster	Asteraceae	10	Native	Forb	Perennial
HEPA11	Heuchera parvifolia Nutt. ex Torr. & A. Gray	littleleaf alumroot	Saxifragaceae	3	Native	Forb	Perennial
IPAGA3	Ipomopsis aggregata (Pursh) V.E. Grant ssp. aggregata	scarlet gilia	Polemoniaceae	8	Native	Forb	Perennial
JUARL	Juncus arcticus Willd. ssp. littoralis (Engelm.) Hultén	mountain rush	Juncaceae	1	Native	Graminoid	Perennial
JUSC2	Juniperus scopulorum Sarg.	Rocky Mountain juniper	Cupressaceae	9	Native	EvergrnShrub	Perennial
KOMA	Koeleria macrantha (Ledeb.) Schult.	prairie Junegrass	Poaceae	50	Native	Graminoid	Perennial
KRLA2	Krascheninnikovia lanata (Pursh) A. Meeuse & Smit	winterfat	Chenopodiaceae	1	Native	DecidShrub	Perennial
LACTU	Lactuca L.	lettuce	Asteraceae	2	Unknown	Forb	Annual
LAOCO	Lappula occidentalis (S. Watson) Greene var. occidentalis	flatspine stickseed	Boraginaceae	10	Native	Forb	Annual
LEKI2	Leucopoa kingii (S. Watson) W.A. Weber	spike fescue	Poaceae	26	Native	Graminoid	Perennial
LERE7	Lewisia rediviva Pursh	bitter root	Portulacaceae	3	Native	Forb	Perennial
LECI4	Leymus cinereus (Scribn. & Merr.) A. Löve	basin wildrye	Poaceae	1	Native	Graminoid	Perennial
LIPU	Liatris punctata Hook.	dotted blazing star	Asteraceae	3	Native	Forb	Perennial

Table 15 (continued).

PLANTS Symbol	Accepted Scientific Name with Author	Common Name	Family	# plots	Origin	Growth-form	Life span
LIPU11	Linanthus pungens (Torr.) J.M. Porter & L.A. Johnson	granite prickly phlox	Polemoniaceae	4	Native	DecidShrub	Perennial
LIDA	Linaria dalmatica (L.) Mill.	Dalmatian toadflax	Scrophulariaceae	2	Exotic	Forb	Perennial
LILE3	Linum lewisii Pursh	Lewis flax	Linaceae	20	Native	Forb	Perennial
LIIN2	Lithospermum incisum Lehm.	narrowleaf stoneseed	Boraginaceae	1	Native	Forb	Perennial
LIRU4	Lithospermum ruderale Douglas ex Lehm.	western stoneseed	Boraginaceae	15	Native	Forb	Perennial
LOAR5	Logfia arvensis (L.) Holub	field cottonrose	Asteraceae	3	Exotic	Forb	Annual
LOAM	Lomatium ambiguum (Nutt.) J.M. Coult. & Rose	Wyeth biscuitroot	Apiaceae	2	Native	Forb	Perennial
LUPIN	Lupinus L.	lupine	Fabaceae	4	Native	Forb	Perennial
LUAR3	Lupinus argenteus Pursh	silvery lupine	Fabaceae	16	Native	Forb	Perennial
LUARA5	Lupinus argenteus Pursh ssp. argenteus	silvery lupine	Fabaceae	10	Native	Forb	Perennial
LUARL5	Lupinus argenteus Pursh ssp. argenteus var. laxiflorus (Douglas ex Lindl.) Dorn	silvery lupine	Fabaceae	1	Native	Forb	Perennial
LYJU	Lygodesmia juncea (Pursh) D. Don ex Hook.	rush skeletonplant	Asteraceae	1	Native	Forb	Perennial
MACAC	Machaeranthera canescens (Pursh) A. Gray ssp. canescens	hoary tansyaster	Asteraceae	8	Native	Forb	Perennial
MAGR2	Machaeranthera grindelioides (Nutt.) Shinners	rayless tansyaster	Asteraceae	2	Native	Forb	Perennial
MEBU	Melica bulbosa Geyer ex Porter & J.M. Coult.	oniongrass	Poaceae	1	Native	Graminoid	Perennial
MEOF	Melilotus officinalis (L.) Lam.	yellow sweetclover	Fabaceae	2	Exotic	Forb	Annual
MEDI	Mentzelia dispersa S. Watson	bushy blazingstar	Loasaceae	2	Native	Forb	Annual
MELA3	Mertensia lanceolata (Pursh) DC.	prairie bluebells	Boraginaceae	13	Native	Forb	Perennial
MELA3MEHU2	Mertensia lanceolata (Pursh) DC. or Mertensia humilis Rydb.	prairie bluebells	Boraginaceae	9	Native	Forb	Perennial
MEOB	Mertensia oblongifolia (Nutt.) G. Don	oblongleaf bluebells	Boraginaceae	8	Native	Forb	Perennial
MIGRH	Microsteris gracilis (Hook.) Greene var. humilior (Hook.) Cronquist	slender phlox	Polemoniaceae	1	Native	Forb	Annual
MIFL2	Mimulus floribundus Lindl.	manyflowered monkeyflower	Scrophulariaceae	1	Native	Forb	Annual
MONU	Monolepis nuttalliana (Schult.) Greene	Nuttall's povertyweed	Chenopodiaceae	1	Native	Forb	Annual
Xmoss	Moss	Moss		1	Native	Nonvascular	Perennial
MURI	Muhlenbergia richardsonis (Trin.) Rydb.	mat muhly	Poaceae	1	Native	Graminoid	Perennial
OENU	Oenothera nuttallii Sweet	Nuttall's evening primrose	Onagraceae	1	Native	Forb	Perennial
OPPO	Opuntia polyacantha Haw.	plains pricklypear	Cactaceae	16	Native	EvergrnShrub	Perennial

Table 15 (continued).

PLANTS Symbol	Accepted Scientific Name with Author	Common Name	Family	# plots	Origin	Growth-form	Life span
ORFA	Orobanche fasciculata Nutt.	clustered broomrape	Orobanchaceae	8	Native	Forb	Annual
ORLU2	Orthocarpus luteus Nutt.	yellow owl's-clover	Scrophulariaceae	1	Native	Forb	Annual
OXCA4OXSE	Oxytropis campestris (L.) DC. or Oxytropis sericea Nutt.	field locoweed	Fabaceae	6	Native	Forb	Perennial
OXSES	Oxytropis sericea Nutt. var. sericea	white locoweed	Fabaceae	12	Native	Forb	Perennial
PACA15	Packera cana (Hook.) W.A. Weber & A. Löve	woolly groundsel	Asteraceae	23	Native	Forb	Perennial
PASM	Pascopyrum smithii (Rydb.) A. Löve	western wheatgrass	Poaceae	11	Native	Graminoid	Perennial
PEATP5	Penstemon attenuatus Douglas ex Lindl. var. pseudoprocerus (Rydb.) Cronquist	small penstemon	Scrophulariaceae	17	Native	Forb	Perennial
PECY3	Penstemon cyaneus Pennell	blue penstemon	Scrophulariaceae	1	Native	Forb	Perennial
PEER	Penstemon eriantherus Pursh	fuzzytongue penstemon	Scrophulariaceae	3	Native	Forb	Perennial
PELAL7	Penstemon laricifolius Hook. & Arn. ssp. laricifolius	larchleaf beardtongue	Scrophulariaceae	3	Native	Forb	Perennial
PECA12	Petrophytum caespitosum (Nutt.) Rydb.	mat rockspirea	Rosaceae	1	Native	Forb	Perennial
PHHA	Phacelia hastata Douglas ex Lehm.	silverleaf phacelia	Hydrophyllaceae	1	Native	Forb	Perennial
PHLI	Phacelia linearis (Pursh) Holz.	threadleaf phacelia	Hydrophyllaceae	5	Native	Forb	Annual
PHHO	Phlox hoodii Richardson	spiny phlox	Polemoniaceae	35	Native	Forb	Perennial
PHMU3	Phlox multiflora A. Nelson	flowery phlox	Polemoniaceae	17	Native	Forb	Perennial
PHSA4	Physaria saximontana Rollins	Fremont County twinpod	Brassicaceae	2	Native	Forb	Perennial
PIFL2	Pinus flexilis James	limber pine	Pinaceae	2	Native	EvergrnTree	Perennial
PIUN3	Piperia unalascensis (Spreng.) Rydb.	slender-spire orchid	Orchidaceae	1	Native	Forb	Perennial
PLPA2	Plantago patagonica Jacq.	woolly plantain	Plantaginaceae	1	Native	Forb	Annual
POCUP3	Poa cusickii Vasey ssp. pallida Soreng	Cusick's bluegrass	Poaceae	32	Native	Graminoid	Perennial
POPR	Poa pratensis L.	Kentucky bluegrass	Poaceae	11	Exotic	Graminoid	Perennial
POSE	Poa secunda J. Presl	Sandberg bluegrass	Poaceae	55	Native	Graminoid	Perennial
POAV	Polygonum aviculare L.	prostrate knotweed	Polygonaceae	1	Exotic	Forb	Annual
PODOD4	Polygonum douglasii Greene ssp. douglasii	Douglas' knotweed	Polygonaceae	1	Native	Forb	Annual
PODOJ2	Polygonum douglasii Greene ssp. johnstonii (Munz) J.C. Hickman	Johnston's knotweed	Polygonaceae	1	Native	Forb	Annual
POTEN	Potentilla L.	cinquefoil	Rosaceae	1	Native	Forb	Perennial
POBI10	Potentilla bipinnatifida Douglas ex Hook.	tansy cinquefoil	Rosaceae	6	Native	Forb	Perennial
POOVO	Potentilla ovina Macoun ex J.M. Macoun var. ovina	sheep cinquefoil	Rosaceae	2	Native	Forb	Perennial

Table 15 (continued).

PLANTS Symbol	Accepted Scientific Name with Author	Common Name	Family	# plots	Origin	Growth-form	Life span
POPU9	Potentilla pulcherrima Lehm.	beautiful cinquefoil	Rosaceae	1	Native	Forb	Perennial
PRVIM	Prunus virginiana L. var. melanocarpa (A. Nelson) Sarg.	black chokecherry	Rosaceae	2	Native	DecidShrub	Perennial
PSSPS	Pseudoroegneria spicata (Pursh) A. Löve ssp. spicata	bluebunch wheatgrass	Poaceae	56	Native	Graminoid	Perennial
PSME	Pseudotsuga menziesii (Mirb.) Franco	Douglas-fir	Pinaceae	1	Native	EvergrnTree	Perennial
PSMEG	Pseudotsuga menziesii (Mirb.) Franco var. glauca (Beissn.) Franco	Rocky Mountain Douglas-fir	Pinaceae	1	Native	EvergrnTree	Perennial
PSLA3	Psoralidium lanceolatum (Pursh) Rydb.	lemon scurfpea	Fabaceae	5	Native	Forb	Perennial
PTTEA	Pteryxia terebinthina (Hook.) J.M. Coult. & Rose var. albiflora (Torr. & A. Gray) Mathias	turpentine wavewing	Apiaceae	28	Native	Forb	Perennial
PUTR2	Purshia tridentata (Pursh) DC.	antelope bitterbrush	Rosaceae	27	Native	DecidShrub	Perennial
PYCAS	Pyrrocoma carthamoides Hook. var. subsquarrosa (Greene) G. Brown & Keil	largeflower goldenweed	Asteraceae	1	Native	Forb	Perennial
RHTRT	Rhus trilobata Nutt. var. trilobata	skunkbush sumac	Anacardiaceae	1	Native	DecidShrub	Perennial
RICEP	Ribes cereum Douglas var. pedicellare W.H. Brewer & S. Watson	whisky currant	Grossulariaceae	13	Native	DecidShrub	Perennial
RIOXO	Ribes oxyacanthoides L. ssp. oxyacanthoides	Canadian gooseberry	Grossulariaceae	1	Native	DecidShrub	Perennial
ROWO	Rosa woodsii Lindl.	Woods' rose	Rosaceae	9	Native	DecidShrub	Perennial
SALSO	Salsola L.	Russian thistle	Chenopodiaceae	3	Exotic	Forb	Annual
SELA	Sedum lanceolatum Torr.	spearleaf stonecrop	Crassulaceae	1	Native	Forb	Perennial
SIDR	Silene drummondii Hook.	Drummond's campion	Caryophyllaceae	9	Native	Forb	Perennial
SISYM	Sisymbrium L.	hedgemustard	Brassicaceae	2	Exotic	Forb	Annual
SIAL2	Sisymbrium altissimum L.	tall tumblemustard	Brassicaceae	8	Exotic	Forb	Annual
SPCO	Sphaeralcea coccinea (Nutt.) Rydb.	scarlet globemallow	Malvaceae	5	Native	Forb	Perennial
STAC	Stenotus acaulis (Nutt.) Nutt.	stemless mock goldenweed	Asteraceae	9	Native	Forb	Perennial
STRU3	Stephanomeria runcinata Nutt.	desert wirelettuce	Asteraceae	3	Native	Forb	Perennial
SYORU	Symphoricarpos oreophilus A. Gray var. utahensis (Rydb.) A. Nelson	Utah snowberry	Caprifoliaceae	22	Native	DecidShrub	Perennial
SYAS3	Symphyotrichum ascendens (Lindl.) G.L. Nesom	western aster	Asteraceae	17	Native	Forb	Perennial
SYCA3	Symphyotrichum campestre (Nutt.) G.L. Nesom	western meadow aster	Asteraceae	1	Native	Forb	Perennial
TALA2	Taraxacum laevigatum (Willd.) DC.	rock dandelion	Asteraceae	15	Exotic	Forb	Perennial
TECA2	Tetradymia canescens DC.	spineless horsebrush	Asteraceae	11	Unknown	DecidShrub	Perennial

Table 15 (continued).

PLANTS Symbol	Accepted Scientific Name with Author	Common Name	Family	# plots	Origin	Growth-form	Life span
TEACA2	Tetraneuris acaulis (Pursh) Greene var. acaulis	stemless four-nerve daisy	Asteraceae	3	Native	Forb	Perennial
TOIN	Townsendia incana Nutt.	hoary Townsend daisy	Asteraceae	1	Native	Forb	Perennial
TRDU	Tragopogon dubius Scop.	yellow salsify	Asteraceae	33	Exotic	Forb	Annual
TRGY	Trifolium gymnocarpon Nutt.	hollyleaf clover	Fabaceae	1	Native	Forb	Perennial
UnkBor1	Unknown borage 1	White borage	Boraginaceae	1	Native	Forb	Perennial
UnkFrb08-1	Unknown forb 08-1	Unknown	Unknown	1	Unknown	Forb	Unknown
UnkFrb08-2	Unknown forb 08-2	Decumbent forb	Unknown	1	Unknown	Forb	Unknown
UnkFrb08-3	Unknown forb 08-3	Forb, opposite leaves	Unknown	1	Unknown	Forb	Unknown
UnkFrb08-4	Unknown forb 08-4	Unknown	Unknown	1	Unknown	Forb	Unknown
UnkFrb09-1	Unknown forb 09-1	Unknown	Unknown	1	Unknown	Forb	Unknown
UnkFrb09-2	Unknown forb 09-2	Unknown	Unknown	1	Unknown	Forb	Unknown
UnkFrb09-3	Unknown forb 09-3	Perennial forb, broad ovate leaves	Unknown	1	Unknown	Forb	Unknown
UnkFab1	Unknown legume 1	Legume, silver, ternate	Fabaceae	1	Unknown	Forb	Unknown
UnkBra	Unknown mustard	Mustard	Brassicaceae	1	Unknown	Forb	Unknown
UnkShrb08-1	Unknown shrub 08-1		Unknown	1	Unknown	DecidShrub	Perennial
VIAMM3	Vicia americana Muhl. ex Willd. ssp. minor (Hook.) C.R. Gunn	mat vetch	Fabaceae	6	Native	Forb	Perennial
VIOLA	Viola L.	violet	Violaceae	12	Native	Forb	Perennial
VUOCO	Vulpia octoflora (Walter) Rydb. var. octoflora	sixweeks fescue	Poaceae	2	Native	Graminoid	Annual
WOORO	Woodsia oregana D.C. Eaton ssp. oregana	Oregon cliff fern	Dryopteridaceae	2	Native	Forb	Perennial
WOSC	Woodsia scopulina D.C. Eaton	Rocky Mountain woodsia	Dryopteridaceae	1	Native	Forb	Perennial
ZIVEG	Zigadenus venenosus S. Watson var. gramineus (Rydb.) Walsh ex M. Peck	grassy deathcamas	Liliaceae	17	Native	Forb	Perennial
ARCO5	Arenaria congesta Nutt.	ballhead sandwort	Caryophyllaceae		Native	Forb	Perennial
CHENO	Chenopodium L.	annual goosefoot	Chenopodiaceae		Native	Forb	Annual
DEIN5	Descurainia incana (Bernh. ex Fisch. & C.A. Mey.) Dorn	mountain tansymustard	Brassicaceae		Native	Forb	Annual
PODO4	Polygonum douglasii Greene	Douglas' knotweed	Polygonaceae		Native	Forb	Annual
UnkForb	Unknown Forb		Unknown		Unknown	Forb	Unknown

Table 16. Results from paired-sample t-tests on percent canopy cover of shrubs.
Values are percent canopy cover. Data are from the line-intercept transects. Bold typeface indicates statistically significant test results.

Plot pair (burned/ unburned)	**Burned Plot**				**Unburned Plot**				**Difference, Burned – Unburned (*D*)**			
	Evergreen Alive	**Decid. Alive**	**All Live**	**All Dead**	**Evergreen Alive**	**Decid. Alive**	**All Live**	**All Dead**	**Evergreen Alive**	**Decid. Alive**	**All Live**	**All Dead**
Legg Creek Prescribed (n=4 plot pairs)												
19BU / 19UN	0	5.52	5.52	0	26	0	26	12.2	-26	5.52	-20.48	-12.2
20BU / 20UN	0	0.4	0.4	5.2	36.44	0.2	36.64	0.2	-36.44	0.2	-36.24	5
22BU / 22UN	0	3	3	0.04	13.24	0	13.24	1.56	-13.24	3	-10.24	-1.52
23BU / 23UN	3.64	0.48	4.12	5.36	23.88	0	23.88	11.4	-20.24	0.48	-19.76	-6.04
Mean	*0.91*	*2.35*	*3.26*	*2.65*	*24.89*	*0.05*	*29.94*	*6.34*	***-23.98***	*2.3*	***-21.68***	*-3.69*
***D** as % of unburned*									***-96***	*460*	***-72***	*-58*
SEM									***4.9***	*1.24*	***5.39***	*3.63*
T value									***-4.89***	*1.85*	***-4.03***	*-1.02*
Probability									***0.016***	*0.162*	***0.028***	*0.384*
Line Creek Prescribed (n=4 plot pairs)												
28BU / 28UN	0	0	0	0.36	25.72	0	25.72	9.96	-25.72	0	-25.72	-9.6
90 BU / 90UN	0	1.12	1.12	2.48	34.48	4.52	39	8.24	-34.48	-3.4	-37.88	-5.76
91BU / 91UN	0	0	0	4.2	27.56	0	27.56	8	-27.56	0	-27.56	-3.8
92BU / 92UN	0	0	0	5.44	27.24	0	27.24	9.04	-27.24	0	-27.24	-3.6
Mean	*0*	*0.28*	*0.28*	*3.12*	*28.75*	*1.13*	*29.88*	*8.81*	***-28.75***	*-0.85*	***-29.6***	***-5.69***
***D** as % of unburned*									***-100***	*-30*	***-99***	***-65***
SEM									***1.95***	*0.85*	***2.79***	***1.39***
T value									***-14.73***	*-1*	***-10.61***	***-4.09***
Probability									***0.001***	*0.391*	***0.002***	***0.026***
Littlerock-Bennett Wild (n=3 plot pairs)												
100BU / 100UN	0.4	0.8	1.2	0	14.16	0	14.16	11.96	-13.76	0.8	-12.96	-11.96
101BU / 101UN	0	0	0	0.76	29.16	0	29.16	17.44	-29.16	0	-29.16	-16.68
102BU / 102UN	0	0	0	0.68	10.8	0	10.8	1	-10.8	0	-10.8	-0.32
Mean	*0.13*	*0.267*	*0.4*	*0.48*	*18.04*	*0*	*18.04*	*10.13*	***-17.91***	*0.267*	***-17.64***	*-9.65*
***D** as % of unburned*									***-99***	*267*	***-98***	*-95*
SEM									***5.69***	*0.267*	***5.79***	*4.86*
T value									***-3.15***	*1*	***-3.04***	*-1.99*
Probability									***0.088***	*0.423*	***0.093***	*0.185*
North Fork prescribed (n=1 plot pair)												
45BU / 45UN	0	0.04	0.04	0.04	25.6	0	25.6	0	-25.6	0.04	-25.56	0.04

Table 16 (continued).

Plot pair (burned/ unburned)	Burned Plot				Unburned Plot				Difference, Burned – Unburned (*D*)			
	Evergreen Alive	Decid. Alive	All Live	All Dead	Evergreen Alive	Decid. Alive	All Live	All Dead	Evergreen Alive	Decid. Alive	All Live	All Dead
Four Northern Fires (n=12 plot pairs)												
Mean	*0.34*	*0.947*	*1.28*	*2.05*	*24.52*	*0.393*	*24.92*	*7.58*	***-24.19***	*0.553*	***-23.63***	***-5.54***
D *as % of unburned*									***-99***	*141*	***-95***	***-73***
SEM									***2.36***	*0.605*	***2.63***	***1.78***
T value									***-10.27***	*0.92*	***-8.99***	***-3.11***
Probability									***0***	*0.38*	***0***	***0.01***
Fairfield Hill prescribed (n=3 plot pairs)												
Eco2-025 / Eco2-026	2.08	6	8.08	1.52	29.4	23.6	53	4.76	-27.32	-17.6	-44.92	-3.24
Eco2-027 / Eco2-065	8.88	1.24	10.12	5.24	37.04	31.32	68.36	1.36	-28.16	-30.08	-58.24	3.88
Eco2-028 / Eco2-029	5.56	5.2	10.76	1.52	18.24	33.56	51.8	0	-12.68	-28.36	-41.04	1.52
Mean	*5.51*	*4.15*	*9.65*	*2.76*	*28.23*	*29.49*	*57.72*	*2.04*	***-22.72***	***-25.35***	***-48.07***	*0.72*
D *as % of unburned*									***-80***	***-86***	***-83***	*35*
SEM									***5.03***	***3.91***	***5.21***	*2.09*
T value									***-4.52***	***-6.49***	***-9.23***	*0.34*
Probability									***0.046***	***0.023***	***0.012***	*0.764*
Freak Mountain prescribed (n=3 plot pairs)												
Eco2-077 / Eco2-076	0	0	0	4.4	26.12	0	26.12	3.64	-26.12	0	-26.12	0.76
Eco2-079 / Eco2-078	3.16	0	3.16	5.88	54.6	0	54.6	0	-51.44	0	-51.44	5.88
Eco2-081 / Eco2-080	0	1.44	1.44	2.68	17.12	13.32	30.44	1.84	-17.12	-11.88	-29	0.84
Mean	*1.1*	*0.48*	*1.53*	*4.32*	*32.6*	*4.44*	*37.05*	*1.83*	***-31.6***	*-3.96*	***-35.52***	*2.49*
D *as % of unburned*									***-97***	*-89*	***-96***	*136*
SEM									***10.3***	*3.96*	***8***	*1.69*
T value									***-3.07***	*-1*	***-4.44***	*1.47*
Probability									***0.092***	*0.423*	***0.047***	*0.279*
Homestead Wild (n=2 plot pairs)												
Eco2-016 / Eco2-015	0	0	0	2.36	21.48	0	21.48	0.12	-21.48	0	-21.48	2.24
Eco2-017 / Eco2-018	0	0	0	0.24	46.76	0.88	47.64	0	-46.76	-0.88	-47.64	0.24
Mean	*0*	*0*	*0*	*1.3*	*34.12*	*0.44*	*34.56*	*0.06*	*-34.12*	*-0.44*	*-34.56*	*1.24*
D *as % of unburned*									*-100*	*-100*	*-100*	*207*

Table 16 (continued).

Plot pair (burned/ unburned)	Burned Plot				Unburned Plot				Difference, Burned – Unburned (*D*)			
	Evergreen Alive	Decid. Alive	All Live	All Dead	Evergreen Alive	Decid. Alive	All Live	All Dead	Evergreen Alive	Decid. Alive	All Live	All Dead
Middle Fork 2002 prescribed (n=4 plot pairs)												
Eco2-002 / Eco2-003	0	0	0	0.72	16.28	4.36	20.64	5.08	-16.28	-4.36	-20.64	-4.36
Eco2-008 / Eco2-009	0	6.04	6.04	0	13.16	6.16	19.32	2.96	-13.16	-0.12	-13.28	-2.96
Eco2-012 / Eco2-011	0	11.12	11.12	0	15.76	21.4	37.16	0	-15.76	-10.28	-26.04	0
Eco2-013 / Eco2-014	0	18.16	18.16	1.4	31.8	31.48	63.28	3.92	-31.8	-13.32	-45.12	-2.52
Mean	*0*	*8.83*	*8.8*	*0.53*	*19.25*	*15.85*	*35.1*	*2.99*	***-19.25***	***-7.02***	***-26.3***	*-2.46*
***D** as % of unburned*									***-100***	***-44***	***-75***	***-82***
SEM									***4.24***	***2.96***	***6.81***	***0.909***
T value									***-4.54***	***-2.37***	***-3.86***	***-2.71***
Probability									***0.02***	***0.098***	***0.031***	***0.073***
Pass Creek wild (n=5 plots pairs)												
Eco2-040 / Eco2-041	0	0	0	1.56	29.28	0	29.28	0	-29.28	0	-29.28	1.56
Eco2-046 / Eco2-047	0	0	0	0	14.68	6.88	21.56	0.96	-14.68	-6.88	-21.56	-0.96
Eco2-049 / Eco2-050	13.88	8.04	21.92	2.72	21.24	37.28	58.52	1.96	-7.36	-29.24	-36.6	0.76
Eco2-052 / Eco2-054	13	0	13	0.28	42.28	0	42.28	0.68	-29.28	0	-29.28	-0.4
Eco2-053 / Eco2-055	1.36	3.2	4.56	0.84	28.92	0.4	29.32	1.28	-27.56	2.8	-24.76	-0.44
Mean	*5.65*	*2.25*	*7.9*	*1.08*	*27.28*	*8.91*	*36.19*	*0.976*	***-21.63***	*-6.66*	***-28.29***	*0.104*
***D** as % of unburned*									***-79***	*-75*	***-78***	*11*
SEM									***4.5***	*5.87*	***2.54***	*0.46*
T value									***-4.81***	*-1.14*	***-11.15***	*0.23*
Probability									***0.009***	*0.319*	***0***	*0.832*
Five Popo Agie Area Fires (n=17 plot pairs)												
Mean	*2.82*	*3.56*	*6.37*	*1.845*	*27.3*	*12.39*	*39.69*	*1.68*	***-24.48***	***-8.84***	***-33.32***	*0.165*
***D** as % of unburned*									***-90***	***-71***	***-84***	*10*
SEM									***2.86***	***2.74***	***3.07***	*0.626*
T value									***-8.57***	***-3.22***	***-10.84***	*0.26*
Probability									***0***	***0.005***	***0***	*0.796*
All Fire (n=29 plot pairs)												
Mean	*1.73*	*2.4*	*4.13*	*1.928*	*25.28*	*7.18*	*32.46*	*4.123*	***-23.55***	***-4.78***	***-28.33***	***-2.194***
***D** as % of unburned*									***-93***	***-67***	***-87***	***-53***
SEM									***2.01***	***1.77***	***2.39***	***0.964***
T value									***-11.7***	***-2.69***	***-11.34***	***-2.28***
Probability									***0***	***0.012***	***0***	***0.031***

Table 17. Results from paired-sample t-tests on percent canopy cover of herbaceous plant growth-forms in each plot.
Values are percent canopy cover. Data are from the microplots. Bold typeface indicates statistical significance.

	Burned Plot			**Unburned Plot**			**Difference, Burned – Unburned**		
Plot pair (burned/ unburned)	**Gramin-oids**	**Forbs**	**All Herbs**	**Gramin-oids**	**Forbs**	**All Herbs**	**Gramin-oids**	**Forbs**	**All Herbs**
Legg Creek Prescribed (n=4 plot pairs)									
19BU / 19UN	34.1	22.25	56.35	30.1	9.35	39.45	4	12.9	16.90
20BU / 20UN	61.55	1.7	63.25	43	3.8	46.80	18.55	-2.1	16.45
22BU / 22UN	29.85	19.2	49.05	42.5	4.2	46.70	-12.65	15	2.35
23BU / 23UN	38.65	4.25	42.90	16.1	7.6	23.70	22.55	-3.35	19.20
Mean	*41.04*	*11.85*	*52.89*	*32.93*	*6.24*	*39.16*	*8.11*	*5.61*	***13.73***
D *as % of unburned*							*24.6%*	*89.9%*	***35.1%***
SEM							*7.99*	*4.84*	***3.84***
T value							*1.02*	*1.16*	***3.57***
Probability							*0.385*	*0.330*	***0.037***
Line Creek Prescribed (n=4 plot pairs)									
28BU / 28UN	24.95	5.4	30.35	29.8	4.05	33.85	-4.85	1.35	-3.5
90BU / 90UN	12.15	8.8	20.95	9.65	4.55	14.20	2.5	4.25	6.75
91BU / 91UN	8.85	4.95	13.80	9.85	8.65	18.50	-1	-3.7	-4.70
92BU / 92UN	8.75	16	24.75	23.5	17	40.50	-14.75	-1	-15.75
Mean	*13.68*	*8.79*	*22.46*	*18.20*	*8.56*	*26.76*	*-4.53*	*0.22*	*-4.30*
D *as % of unburned*							*-24.9%*	*2.6%*	*-16.1%*
SEM							*3.72*	*1,69*	*4.60*
T value							*-1.22*	*0.13*	*-0.93*
Probability							*0.311*	*0.903*	*0.419*
Littlerock-Bennett wild (n=3 plot pairs)									
100BU / 100UN	9.8	15.1	24.90	10.6	8.65	19.25	-0.8	6.45	5.65
101BU / 101UN	33.25	18.3	51.55	22.95	5.5	28.45	10.3	12.8	23.1
102BU / 102UN	28.1	3.3	31.40	25.95	6.35	32.30	2.15	-3.05	-0.9
Mean	*23.72*	*12.23*	*35.95*	*19.83*	*6.83*	*26.67*	*3.88*	*5.40*	*9.28*
D *as % of unburned*							*19.6%*	*79.1%*	*34.8%*
SEM							*3.32*	*4.61*	*7.16*
T value							*1.17*	*1.17*	*1.30*
Probability							*0.363*	*0.362*	*0.324*
North Fork prescribed (n=1 plot pair)									
45BU/45UN	39.1	8.35	47.45	13.2	5.3	18.50	25.9	3.05	28.95
D *as % of unburned*							*196%*	*57.5%*	*156%*
Four Northern Fires (n=12 plot pairs)									
Mean	*27.42*	*10.63*	*38.06*	*23.10*	*7.08*	*30.18*	*4.33*	***3.55***	***7.87***
D *as % of unburned*							*18.7%*	*50.1%*	***26.1%***
SEM							*3.73*	***1.97***	***3.81***
T value							*1.16*	***1.80***	***2.07***
Probability							*0.271*	***0.100***	***0.063***
Fairfield Hill prescribed (n=3 plot pairs)									
Eco2-025 / Eco2-026	24.35	22.95	47.30	22.55	11.8	34.35	1.8	11.15	12.95
Eco2-027 / Eco2-065	27.65	7.6	35.25	12.15	8.4	20.55	15.5	-0.8	14.70
Eco2-028 / Eco2-029	33.2	11.3	44.50	14.8	5.1	19.90	18.4	6.2	24.60
Mean	*28.40*	*13.95*	*42.35*	*16.50*	*8.43*	*29.93*	*11.90*	*5.52*	***17.42***
D *as % of unburned*							*72.1%*	*65.5%*	***58.2%***
SEM							*5.12*	*3.47*	***3.63***
T value							*2.32*	*1.59*	***4.80***
Probability							*0.146*	*0.253*	***0.041***

Table 17 (continued).

	Burned Plot			**Unburned Plot**			**Difference, Burned – Unburned**		
Plot pair (burned/ unburned)	**Gramin-oids**	**Forbs**	**All Herbs**	**Gramin-oids**	**Forbs**	**All Herbs**	**Gramin-oids**	**Forbs**	**All Herbs**
Freak Mountain prescribed (n=3 plot pairs)									
Eco2-077 / Eco2-076	31.55	30.5	62.05	19.45	24.25	43.70	12.1	6.25	18.35
Eco2-079 / Eco2-078	21.5	18.7	40.20	27.5	12.05	39.55	-6	6.65	0.65
Eco2-081 / Eco2-080	23	32.55	55.55	18.45	25.15	43.60	4.55	7.4	11.95
Mean	*25.35*	*27.25*	*52.60*	*21.80*	*20.48*	*42.28*	*3.55*	***6.77***	*10.32*
D *as % of unburned*							*16.3%*	***33.1%***	*24.4%*
SEM							*5.25*	***0.337***	*5.17*
T value							*0.68*	***20.08***	*1.99*
Probability							*0.569*	***0.002***	*0.184*
Homestead prescribed (n=2 plot pairs)									
Eco2-016 / Eco2-015	6.2	6.8	13.00	8.35	5	13.35	-2.15	1.8	-0.35
Eco2-017 / Eco2-018	24.8	13.2	38.00	15.85	4.45	20.30	8.95	8.75	17.70
Mean	*15.50*	*10.00*	*25.50*	*12.10*	*4.73*	*16.83*	*3.40*	*5.28*	*8.68*
D *as % of unburned*							*28.1%*	*116%*	*51.6%*
Middle Fork 2002 prescribed (n=4 plot pairs)									
Eco2-002 / Eco2-003	49.95	8.05	58.00	23.1	9.05	32.15	26.85	-1	25.85
Eco2-008 / Eco2-009	46	7.35	53.35	14.85	4.35	19.20	31.15	3	34.15
Eco2-012 / Eco2-011	27.35	9.4	36.75	28.8	8.75	37.55	-1.45	0.65	-0.8
Eco2-013 / Eco2-014	39.4	5.45	44.85	16.8	6.3	23.10	22.6	-0.85	21.75
Mean	*40.68*	*7.56*	*48.24*	*20.89*	*7.11*	*28.00*	***19.79***	*0.45*	***20.24***
D *as % of unburned*							***94.7%***	*6.3%*	***72.3%***
SEM							***7.29***	*0.928*	***7.47***
T value							***2.71***	*0.48*	***2.71***
Probability							***0.073***	*0.661*	***0.073***
Pass Creek wild (n=5 plots pairs)									
Eco2-040 / Eco2-041	38.55	38.05	76.60	29.65	22.05	51.70	8.9	16	24.90
Eco2-046 / Eco2-047	32.2	31.8	64.00	27.45	24.35	51.80	4.75	7.45	12.20
Eco2-049 / Eco2-050	42.4	5	47.40	16.5	5.3	21.80	25.9	-0.3	25.60
Eco2-052 / Eco2-054	41.7	36	77.70	11.5	16.2	27.70	30.2	19.8	50.00
Eco2-053 / Eco2-055	13.65	24.7	38.35	14.5	12.35	26.85	-0.85	12.35	11.50
Mean	*33.70*	*27.11*	*60.81*	*19.92*	*16.05*	*35.97*	***13.78***	***11.06***	***24.84***
D *as % of unburned*							***69.2%***	***68.9%***	***69.1%***
SEM							***6.07***	***3.50***	***6.97***
T value							***2.27***	***3.16***	***3.56***
Probability							***0.086***	***0.034***	***0.023***
Five Popo Agie-area Fires (n=17 plot pairs)									
Mean	*30.79*	*18.20*	*48.99*	*18.96*	*12.05*	*31.01*	***11.84***	***6.15***	***17.98***
D *as % of unburned*							***62.4%***	***51%***	***58%***
SEM							***2.96***	***1.49***	***3.12***
T value							***4.00***	***4.12***	***5.76***
Probability							***0.001***	***0.001***	***0.000***
All Fires (n=29 plot pairs)									
Mean	*29.40*	*15.07*	*44.47*	*20.67*	*10.00*	*30.67*	***8.73***	***5.07***	***13.8***
D *as % of unburned*							***42.4%***	***50.7%***	***45%***
SEM							***2.38***	***1.20***	***2.55***
T value							***3.66***	***4.23***	***5.41***
Probability							***0.001***	***0.000***	***0.000***

Table 18. Results from Wilcoxon's signed-rank tests on canopy cover of native plant species and exotic species.
Values are percent canopy cover. Data are from the microplots.

	Burned Plot			**Unburned Plot**			**Differences, Burned - Unburned**
Plot pair (burned/ unburned)	**Natives**	**Exotics**	**Unknown**	**Natives**	**Exotics**	**Unknown**	**Exotics**
Legg Creek Prescribed (n=4 plot pairs)							
19BU / 19UN	55.1	4.85	0	66.6	4.9	0	-0.05
20BU / 20UN	68.05	1.15	0	74.5	0.8	1.2	0.35
22BU / 22UN	49.1	0.75	0	58.25	0.15	0.05	0.6
23BU / 23UN	57	0.15	0	43.65	0.15	0.05	0
Mean		*1.725*			*1.5*		*0.225*
Z value							*0.7428*
Probability							*0.4576*
Line Creek Prescribed (n=4 plot pairs)							
28BU / 28UN	30.25	0.05	0/1	59	0.05	0.05	0
90BU / 90UN	20.2	4.15	0	45.15	0.55	0	3.6
91BU / 91UN	11.4	2.6	0.05	58.8	0.15	0	2.45
92BU / 92UN	24.65	0.2	0	69.2	0.05	0	0.15
Mean		*1.75*			*0.2*		*1.55*
Z value							*1.4586*
Probabily							*0.1374*
Littlerock-Bennett wild (n=3 plot pairs)							
100BU / 100UN	24.85	3.55	0.05	42.1	5	0	-1.45
101BU / 101UN	49.95	2.3	0	66.3	1.55	0	0.75
102BU / 102UN	35.65	1.1	0	34.9	1.05	0	0.05
Mean		*2.317*			*2.53*		*-0.217*
V value							*3*
Probability							*1*
North Fork prescribed (n=1 plot pair)							
45BU/45UN	51.25	0.2	0.1	24.5	0.05	0	0.15
Four Northern Fires (n=12 plot pairs)							
Mean		*1.754*			*1.204*		*0.55*
Z value							***1.8907***
Probability							***0.0587***
Fairfield Hill prescribed (n=3 plot pairs)							
Eco2-025 / Eco2-026	54.35	0.3	0	77.4	0.1	0.05	0.2
Eco2-027 / Eco2-065	46.9	0.6	0	74.1	0.1	0	0.5
Eco2-028 / Eco2-029	59.35	0.3	0	84.5	0.25	0	0.05
Mean		*0.4*			*0.15*		*0.25*
V value							*6*
Probability							*0.25*
Freak Mountain prescribed (n=3 plot pairs)							
Eco2-077 / Eco2-076	62.8	0	0	86.5	0	0	0
Eco2-079 / Eco2-078	40.8	0	0	102.85	0	0	0
Eco2-081 / Eco2-080	55.6	0.05	0.05	55	0.05	0.05	0
Mean		*0.0167*			*0.0167*		*0*
Z value							*
Probability							*

Table 18 (continued).

	Burned Plot			**Unburned Plot**			**Differences, Burned – Unburned**
Plot pair (burned/ unburned)	**Natives**	**Exotics**	**Unknown**	**Natives**	**Exotics**	**Unknown**	**Exotics**
Middle Fork 2002 prescribed (n=4 plot pairs)							
Eco2-002 / Eco2-003	44.5	16.45	0	76.15	9.65	0	6.8
Eco2-008 / Eco2-009	26.75	35.55	0	44.6	1	0.7	34.55
Eco2-012 / Eco2-011	47.15	2.3	0.05	75.5	8.6	0	-6.3
Eco2-013 / Eco2-014	58.35	5.05	0.05	81.55	3.05	0.05	2
Mean		*14.838*			*5.575*		*9.263*
V avlue							*8*
Probability							*0.375*
Pass Creek wild (n=5 plots pairs)							
Eco2-040 / Eco2-041	76.95	0.35	0	76.6	4.9	0	-4.55
Eco2-046 / Eco2-047	63.3	1.7	0.05	76.75	0.25	0	1.45
Eco2-049 / Eco2-050	43	9.25	0.05	71.5	2.25	0	7
Eco2-052 / Eco2-054	74.6	8.4	0.05	73.4	0	0.05	8.4
Eco2-053 / Eco2-055	48.75	0.6	0.05	56	0.05	0.1	0.55
Mean		*4.06*			*1.49*		*2.57*
V value							*12*
Probability							*0.3125*
Four Popo Agie-area Fires (n=15 plot pairs)							
Mean		*5.39*			*2.02*		*3.38*
Z value							***2.0277***
Probability							***0.0426***
All Fires, excluding Homestead (n=27 plot pairs)							
Mean		*3.78*			*1.66*		***2.12***
Z Value							***2.7259***
Probability							***0.0064***

Table 19. Results of Wilcoxon's signed-rank tests on frequency and cover of cheatgrass on transects in burned and unburned areas of the Popo Agie-area fires.

	Burned Transects		**Unburned Transects**		**Difference, Burned - Unburned**	
Transect pair (burned/unburned)	**Frequency**	**Percent Cover**	**Frequency**	**Percent Cover**	**Frequency**	**Percent Cover**
Fairfield Hill prescribed (n=3 plot pairs)						
Eco2-025 / Eco2-026	0.04	0.02	0	0	0.04	0.02
Eco2-027 / Eco2-065	0	0	0	0	0	0
Eco2-028 / Eco2-029	0	0	0	0	0	0
Mean	*0.013*	*0.007*	*0.000*	*0.000*	*0.013*	*0.007*
***D** as % of unburned*					--	--
Z Value					*0.6667*	*0.6667*
Probability					*0.505*	*0.505*
Freak Mountain prescribed (n=3 plot pairs)						
Eco2-077 / Eco2-076	0	0	0	0	0	0
Eco2-079 / Eco2-078	0	0	0	0	0	0
Eco2-081 / Eco2-080	0	0	0	0	0	0
Mean	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
***D** as % of unburned*					--	--
Z Value					*NA*	*NA*
Probability					*NA*	*NA*
Homestead prescribed (n=2 plot pairs)						
Eco2-016 / Eco2-015	0.88	3.82	0	0	0.88	3.82
Eco2-017 / Eco2-018	0.44	1.18	0.6	1.64	-0.16	-0.46
Mean	*0.660*	*2.500*	*0.300*	*0.820*	*0.360*	*1.680*
***D** as % of unburned*					*120.00%*	*204.88%*
Middle Fork 2002 prescribed (n=4 plot pairs)						
Eco2-002 / Eco2-003	1	12.26	1	20.44	0	-8.18
Eco2-008 / Eco2-009	1	47.16	1	6.04	0	41.12
Eco2-012 / Eco2-011	1	9.5	1	13.42	0	-3.92
Eco2-013 / Eco2-014	0.88	24.34	1	2.62	-0.12	21.72
Mean	*0.970*	*23.315*	*1.000*	*10.630*	*-0.030*	*12.685*
***D** as % of unburned*					*-3.00%*	*119.33%*
Z or V Value					*Z = -0.75*	*V = 7*
Probability					*0.4533*	*0.625*
Pass Creek wild (n=5 plots pairs)						
Eco2-040 / Eco2-041	0	0	0	0	0	0
Eco2-046 / Eco2-047	0.12	0.06	0	0	0.12	0.06
Eco2-049 / Eco2-050	1	9.34	0.56	1.74	0.44	7.6
Eco2-052 / Eco2-054	0	0	0	0	0	0
Eco2-053 / Eco2-055	0.4	0.5	0	0	0.4	0.5
Mean	*0.304*	*1.980*	*0.112*	*0.348*	*0.192*	*1.632*
***D** as % of unburned*					*171.43%*	*468.97%*
Z Value					*1.5556*	*1.5556*
Probability					*0.1198*	*0.1198*
Five Popo Agie-area Fires (n=17 plot pairs)						
Mean	*0.35*	*4.93*	*0.24*	*2.55*	*0.10*	*2.39*
***D** as % of unburned*					*41.35%*	*93.72%*
Z Value					*1.2027*	*1.1835*
Probability					*0.229*	*0.237*

Table 20. Results from paired-sample t-tests on densities of live shrubs in burned and unburned plots. Data are from shrub density subplots. Values are shrubs / square meter.

Plot pair (burned/unburned)	**Burned Plot**	**Unburned Plot**	**Difference, Burned – Unburned**
Legg Creek Prescribed (n=4 plot pairs)			
19BU / 19UN	0.53	0.73	-0.20
20BU / 20UN	0.00	0.60	-0.60
22BU / 22UN	0.80	0.67	0.13
23BU / 23UN	0.27	0.87	-0.60
Mean	*0.40*	*0.72*	*-0.318*
***D** as % of unburned*			*-44.19%*
SEM			*0.176*
T value			*-1.80*
Probability			*0.170*
Line Creek Prescribed (n=4 plot pairs)			
28BU / 28UN	0.00	3.87	-3.87
90BU / 90UN	0.47	2.40	-1.93
91BU / 91UN	1.53	4.33	-2.80
92BU / 92UN	0.00	1.73	-1.73
Mean	*0.50*	*3.08*	***-2.58***
***D** as % of unburned*			***-83.78%***
SEM			***0.488***
T value			***-5.29***
Probability			***0.013***
Littlerock-Bennett wild (n=3 plot pairs)			
100BU / 100UN	0.13	1.33	-1.20
101BU / 101UN	0.00	1.60	-1.60
102BU / 102UN	0.00	1.13	-1.13
Mean	*0.04*	*1.36*	***-1.31***
***D** as % of unburned*			***-96.72%***
SEM			***0.146***
T value			***-8.95***
Probability			***0.012***
North Fork prescribed (n=1 plot pair)			
45BU/45UN	0.00	1.20	-1.20
***D** as % of unburned*			*-100.00%*
Four Northern Fires (n=12 plot pairs)			
Mean	*0.31*	*1.71*	***-1.39***
***D** as % of unburned*			***-81.76%***
SEM			***0.322***
T value			***-4.33***
Probability			***0.001***
Fairfield Hill prescribed (n=3 plot pairs)			
Eco2-025 / Eco2-026	0.93	3.13	-2.20
Eco2-027 / Eco2-065	0.93	2.27	-1.33
Eco2-028 / Eco2-029	0.80	3.13	-2.33
Mean	*0.89*	*2.84*	***-1.96***
***D** as % of unburned*			***-68.75%***
SEM			***0.311***
T value			***-6.30***
Probability			***0.024***

Table 20 (continued).

Plot pair (burned/unburned)	Burned Plot	Unburned Plot	Difference, Burned – Unburned
Freak Mountain prescribed (n=3 plot pairs)			
Eco2-077 / Eco2-076	0.00	1.33	-1.33
Eco2-079 / Eco2-078	0.00	2.13	-2.13
Eco2-081 / Eco2-080	0.00	2.00	-2.00
Mean	*0.00*	*1.82*	***-1.82***
***D** as % of unburned*			***-100.00%***
SEM			***0.248***
T value			***-7.34***
Probability			***0.018***
Homestead prescribed (n=2 plot pairs)			
Eco2-016 / Eco2-015	0.33	1.07	-0.73
Eco2-017 / Eco2-018	0.00	1.93	-1.93
Mean	*0.17*	*1.50*	*-1.33*
***D** as % of unburned*			*-88.89%*
Middle Fork 2002 prescribed (n=4 plot pairs)			
Eco2-002 / Eco2-003	0.00	1.00	-1.00
Eco2-008 / Eco2-009	0.60	1.13	-0.53
Eco2-012 / Eco2-011	0.33	1.13	-0.80
Eco2-013 / Eco2-014	2.33	2.73	-0.40
Mean	*0.82*	*1.50*	***-0.68***
***D** as % of unburned*			***-45.56%***
SEM			***0.135***
T value			***-5.07***
Probability			***0.015***
Pass Creek wild (n=5 plots pairs)			
Eco2-040 / Eco2-041	0.13	2.40	-2.27
Eco2-046 / Eco2-047	0.00	3.27	-3.27
Eco2-049 / Eco2-050	2.67	2.00	0.67
Eco2-052 / Eco2-054	0.80	2.20	-1.40
Eco2-053 / Eco2-055	0.80	1.53	-0.73
Mean	*0.88*	*2.28*	***-1.40***
***D** as % of unburned*			***-61.40%***
SEM			***0.670***
T value			***-2.09***
Probability			***0.105***
Five Popo Agie-area Fires (n=17 plot pairs)			
Mean	*0.63*	*2.02*	***-1.40***
***D** as % of unburned*			***-68.99%***
SEM			***0.230***
T value			***-6.07***
Probability			***0.000***
All Fires (n=29 plot pairs)			
Mean	*0.50*	*1.89*	***-1.39***
***D** as % of unburned*			***-73.75%***
SEM			***0.186***
T value			***-7.50***
Probability			***0.000***

Table 21. Results of paired-sample t-tests on numbers of plant species per plot. Data are from the microplots and the line-intercept transects.

Plot pair (burned/ unburned)	Burned Plot: All Spp	Burned Plot: Natives	Burned Plot: Exotics	Burned Plot: Unknown	Unburned Plot: All Spp	Unburned Plot: Natives	Unburned Plot: Exotics	Unburned Plot: Unknown	Difference, Burned - Unburned: All Spp	Difference, Burned - Unburned: Exotics
Legg Creek Prescribed (n=4 plot pairs)										
19BU / 19UN	24	21	3	0	28	24	4	0	-4	-1
20BU / 20UN	26	21	5	0	28	22	5	1	-2	0
22BU / 22UN	26	22	4	0	23	20	2	1	3	2
23BU / 23UN	27	24	3	0	16	13	2	1	11	1
Mean	*25.75*		*3.75*		*23.75*		*3.25*		*2*	*0.5*
SEM									*3.34*	*0.645*
T value									*0.6*	*0.77*
Probability									*0.592*	*0.495*
Line Creek Prescribed (n=4 plot pairs)										
28BU / 28UN	22	20	1	1	27	25	1	1	-5	0
90BU / 90UN	24	20	4	0	27	24	3	0	-3	1
91BU / 91UN	29	26	2	1	34	31	3	0	-5	-1
92BU / 92UN	31	28	3	0	35	34	1	0	-4	2
Mean	*26.5*		*2.5*		*30.75*		*2*		***-4.25***	*0.5*
SEM									***0.479***	*0.645*
T value									***-8.88***	*0.77*
Probability									***0.003***	*0.495*
Littlerock-Bennett wild (n=3 plot pairs)										
100BU / 100UN	36	30	5	1	37	31	6	0	-1	-1
101BU / 101UN	32	28	4	0	31	26	5	0	1	-1
102BU / 102UN	25	21	4	0	30	27	3	0	-5	1
Mean	*31*		*4.333*		*32.67*		*4.667*		*-1.67*	*-0.333*
SEM									*1.76*	*0.667*
T value									*-0.94*	*-0.5*
Probability									*0.444*	*0.667*
North Fork prescribed (n=1 plot pair)										
45BU/45UN	*18*	*14*	*3*	*1*	*19*	*18*	*1*	*0*	*-1*	*2*
Four Northern Fires (n=12 plot pairs)										
Mean	*26.67*		*3.417*		*27.92*		*3*		*-1.25*	*0.417*
SEM									*1.33*	*0.358*
T value									*-0.94*	*1.16*
Probability									*0.368*	*0.269*
Fairfield Hill prescribed (n=3 plot pairs)										
Eco2-025 / Eco2-026	45	41	4	0	39	36	2	1	6	2
Eco2-027 / Eco2-065	42	39	3	0	33	31	2	0	9	1
Eco2-028 / Eco2-029	38	35	3	0	37	35	2	0	1	1
Mean	*41.67*		*3.333*		*36.33*		*2*		*5.33*	***1.333***
SEM									*2.33*	***0.333***
T value									*2.29*	***4***
Probability									*0.15*	***0.057***

Table 21 (continued).

	Burned Plot				**Unburned Plot**				**Difference, Burned - Unburned**	
Plot pair (burned/ unburned)	**All Spp**	**Natives**	**Exotics**	**Unknown**	**All Spp**	**Natives**	**Exotics**	**Unknown**	**All Spp**	**Exotics**
Freak Mountain prescribed (n=3 plot pairs)										
Eco2-077 / Eco2-076	32	32	0	0	34	34	0	0	-2	0
Eco2-079 / Eco2-078	29	29	0	0	28	28	0	0	1	0
Eco2-081 / Eco2-080	40	38	1	1	36	34	1	1	4	0
Mean	*33.67*		*0.333*		*32.67*		*0.333*		*1*	*0*
SEM									*1.73*	*0*
T value									*0.58*	*
Probability									*0.622*	*
Middle Fork 2002 prescribed (n=4 plot pairs)										
Eco2-002 / Eco2-003	44	35	9	0	28	21	7	0	16	2
Eco2-008 / Eco2-009	29	26	3	0	35	29	5	1	-6	-2
Eco2-012 / Eco2-011	42	36	5	1	27	22	5	0	15	0
Eco2-013 / Eco2-014	41	36	4	1	44	38	5	1	-3	-1
Mean	*39*		*5.25*		*33.5*		*5.5*		*5.5*	*-0.25*
SEM									*5.81*	*0.854*
T value									*0.95*	*-0.29*
Probability									*0.414*	*0.789*
Pass Creek wild (n=5 plots pairs)										
Eco2-040 / Eco2-041	32	30	2	0	37	35	2	0	-5	0
Eco2-046 / Eco2-047	42	38	3	1	38	36	2	0	4	1
Eco2-049 / Eco2-050	37	33	3	1	35	32	3	0	2	0
Eco2-052 / Eco2-054	42	37	4	1	30	29	0	1	12	4
Eco2-053 / Eco2-055	47	43	3	1	37	35	1	1	10	2
Mean	*40*		*3*		*35.4*		*1.6*		*4.6*	*1.4*
SEM									*3.03*	*0.748*
T value									*1.52*	*1.87*
Probability									*0.203*	*0.135*
Four Popo Agie-area Fires (n=15 plot pairs)										
Mean	*38.8*		*3.133*		*34.53*		*2.467*		***4.27***	***0.667***
SEM									***1.8***	***0.374***
T value									***2.37***	***1.78***
Probability									***0.033***	***0.096***
All Fires, excluding Homestead (n=27 plot pairs)										
Mean	*33.41*		*3.259*		*31.59*		*2.704*		*1.81*	***0.556***
SEM									*1.26*	***0.258***
T value									*1.44*	***2.15***
Probability									*0.162*	***0.041***

Table 22. Results from paired-sample t-tests on numbers of plant species of different life spans in each plot.
Data are from the microplots and the line-intercept transects.

	Burned Plot			Unburned Plot			Difference, Burned - Unburned	
Plot pair (burned/ unburned)	**Annuals & Biennials**	**Perennials**	**Unknown Lifespan**	**Annuals & Biennials**	**Perennials**	**Unknown Lifespan**	**Annuals & Biennials**	**Perennials**
Legg Creek Prescribed (n=4 plot pairs)								
19BU/19UN	5	19	0	6	22	0	-1	
20BU/20UN	7	19	0	6	21	1	1	
22BU/22UN	6	20	0	4	18	1	2	
23BU/23UN	7	20	0	5	10	1	2	
Mean	*6.25*			*5.25*			*1*	
SEM							*0.707*	
T value							*1.41*	
Probability							*0.252*	
Line Creek Prescribed (n=4 plot pairs)								
28BU/28UN	1	20	1	3	23	1	-2	
90BU/90UN	7	17	0	3	24	0	4	
91BU/91UN	2	27	0	4	30	0	-2	
92BU/92UN	2	29	0	3	32	0	-1	
Mean	*3*			*3.25*			*-0.25*	
SEM							*1.44*	
T value							*-0.17*	
Probability							*0.873*	
Littlerock-Bennett wild (n=3 plot pairs)								
100BU/100UN	6	29	1	10	27	0	-4	
101BU/101UN	7	25	0	8	23	0	-1	
102BU/102UN	7	18	0	6	24	0	1	
Mean	*6.67*			*8*			*-1.33*	
SEM							*1.45*	
T value							*-0.92*	
Probability							*0.456*	
North Fork prescribed (n=1 plot pair)								
45BU/45UN	8	10	0	3	16	0	5	
Four Northern Fires (n=12 plot pairs)								
Mean	*5.417*			*5.083*			*0.333*	
SEM							*0.762*	
T value							*0.44*	
Probability							*0.67*	
Fairfield Hill prescribed (n=3 plot pairs)								
Eco2-025 / Eco2-026	4	41	0	4	35	0	0	
Eco2-027 / Eco2-065	6	36	0	5	28	0	1	
Eco2-028 / Eco2-029	3	35	0	3	34	0	0	
Mean	*4.333*			*4*			*0.333*	
SEM							*0.333*	
T value							*1*	
Probability							*0.423*	

Table 22 (continued).

	Burned Plot			Unburned Plot			Difference, Burned – Unburned	
Plot pair (burned/ unburned)	**Annuals & Biennials**	**Perennials**	**Unknown Lifespan**	**Annuals & Biennials**	**Perennials**	**Unknown Lifespan**	**Annuals & Biennials**	**Perennials**
Freak Mountain prescribed (n=3 plot pairs)								
Eco2-077 / Eco2-076	0	32	0	2	32	0	-2	
Eco2-079 / Eco2-078	0	29	0	0	28	0	0	
Eco2-081 / Eco2-080	1	39	0	3	33	0	-2	
Mean	*0.333*			*1.667*			*-1.333*	
SEM							*0.667*	
T value							*-2*	
Probability							*0.184*	
Middle Fork 2002 prescribed (n=4 plot pairs)								
Eco2-002 / Eco2-003	7	37	0	6	22	0	1	
Eco2-008 / Eco2-009	3	26	0	6	29	0	-3	
Eco2-012 / Eco2-011	5	36	1	5	22	0	0	
Eco2-013 / Eco2-014	6	34	1	7	36	1	-1	
Mean	*5.25*			*6*			*-0.75*	
SEM							*0.854*	
T value							*-0.88*	
Probability							*0.444*	
Pass Creek wild (n=5 plots pairs)								
Eco2-040 / Eco2-041	0	32	0	3	34	0	-3	
Eco2-046 / Eco2-047	3	39	0	3	35	0	0	
Eco2-049 / Eco2-050	4	33	0	6	29	0	-2	
Eco2-052 / Eco2-054	6	36	0	1	29	0	5	
Eco2-053 / Eco2-055	6	41	0	1	36	0	5	
Mean	*3,8*			*2.8*			*1*	
SEM							*1.7*	
T value							*0.59*	
Probability							*0.589*	
Four Popo Agied-area Fires (n=15 plot pairs)								
Mean	*3.6*			*3.667*			*-0.067*	
SEM							*0.628*	
T value							*-0.11*	
Probability							*0.917*	
All Fires, excluding Homestead (n=27 plot pairs)								
Mean	*4.407*			*4.296*			*0.111*	
SEM							*0.478*	
T value							*0.23*	
Probability							*0.818*	

Table 23. Results from paired-sample tests* on percent cover of selected ground-cover types in each plot. Data are from the microplots.

	Burned Plot			Unburned Plot			Difference, Burned – Unburned		
Plot pair (burned/ unburned)	Bare Soil	Plant Litter	Biological Crust	Bare Soil	Plant Litter	Biological Crust	Bare Soil	Plant Litter	Biological Crust*
Legg Creek Prescribed (n=4 plot pairs)									
19BU / 19UN	14.1	15.5	0.3	11.7	33.5	7.1	2.4	-18	-6.8
20BU / 20UN	62.5	17.5	0.3	52.5	36.5	2	10	-19	-1.7
22BU / 22UN	29	9.2	1.5	26	12.7	1.1	3	-3.5	0.4
23BU / 23UN	52.5	14	1.1	35.6	33.5	1.2	16.9	-19.5	-0.1
Mean	*39.53*	*14.05*	*0.80*	*31.45*	*29.05*	*2.85*	***8.08***	***-15.00***	*-2.05*
D as % of unburned							***25.7%***	***-51.6%***	*-71.9%*
SEM							***3.41***	***3.85***	*--*
*T/V/Z value**							***2.37***	***-3.90***	*V = 2*
Probability							***0.099***	***0.03***	*0.375*
Line Creek Prescribed (n=4 plot pairs)									
28BU / 28UN	42.5	0.5	0.2	9.9	64	1.8	32.6	-63.5	-1.6
90BU / 90UN	16.1	34.6	0	2.9	40.6	21.3	13.2	-6	-21.3
91BU / 91UN	47.5	40.6	0	0.8	67.5	5.6	46.7	-26.9	-5.6
92BU / 92UN	4.8	72.5	1.2	1.4	67.5	12.4	3.4	5	-11.2
Mean	*27.73*	*37.05*	*0.35*	*3.75*	*59.90*	*10.28*	***23.98***	*-22.85*	*-9.93*
D as % of unburned							***639.3%***	*-38.1%*	*-96.6%*
SEM							***9.71***	*15.1*	*--*
*T/V/Z value**							***2.47***	*-1.52*	*V = 0*
Probability							***0.090***	*0.227*	*0.125*
Littlerock-Bennett wild (n=3 plot pairs)									
100BU / 100UN	22.6	23.1	0	25.2	41.5	1.1	-2.6	-18.4	-1.1
101BU / 101UN	1.5	87.5	0	13.8	72.5	0.2	-12.3	15	-0.2
102BU / 102UN	3.9	28.5	0	16.3	13.2	0.5	-12.4	15.3	-0.5
Mean	*9.33*	*46.37*	*0.00*	*18.43*	*42.40*	*0.60*	*-9.10*	*3.97*	*-0.60*
D as % of unburned							*-49.4%*	*9.4%*	*-100.0%*
SEM							*3.25*	*11.2*	*--*
*T/V/Z value**							*-2.80*	*0.35*	*V = 0*
Probability							*0.107*	*0.757*	*0.25*
North Fork prescribed (n=1 plot pair)									
45BU/45UN	42.5	1	0	9.3	4.3	0.4	33.2	-3.3	-0.4
D as % of unburned							*357.0%*	*-76.7%*	*-100.0%*
Four Northern Fires (n=12 plot pairs)									
Mean	28.29	28.71	0.38	17.12	40.61	4.56	**11.18**	**-11.90**	**-4.18**
D as % of unburned							***65.3%***	***-29.3%***	***-91.6%***
SEM							***5.33***	***6.16***	***--***
*T/V/Z value**							***2.10***	***-1.93***	***V = 3***
Probability							***0.06***	***0.079***	***0.0024***
Fairfield Hill prescribed (n=3 plot pairs)									
Eco2-025 / Eco2-026	37	34	0	43.7	45.1	0	-6.7	-11.1	0
Eco2-027 / Eco2-065	21.6	26.1	0	16.2	77.5	0.1	5.4	-51.4	-0.1
Eco2-028 / Eco2-029	12.6	33.5	0	1.3	55.5	0	11.3	-22	0
Mean	*23.73*	*31.20*	*0.00*	*20.40*	*59.37*	*0.03*	*3.33*	*-28.17*	*-0.03*
D as % of unburned							*16.3%*	*-47.4%*	*-100.0%*
SEM							*5.30*	*12.0*	*--*
*T/V/Z value**							*0.63*	*-23.4*	*Z = -0.667*
Probability							*0.594*	*0.144*	*0.505*

Table 23 (continued).

Plot pair (burned/ unburned)	Burned Plot Bare Soil	Burned Plot Plant Litter	Burned Plot Biological Crust	Unburned Plot Bare Soil	Unburned Plot Plant Litter	Unburned Plot Biological Crust	Difference, Burned – Unburned Bare Soil	Difference, Burned – Unburned Plant Litter	Difference, Burned – Unburned Biological Crust*
Freak Mountain prescribed (n=3 plot pairs)									
Eco2-077 / Eco2-076	28	57	0	19.1	72.5	0.1	8.9	-15.5	-0.1
Eco2-079 / Eco2-078	18.1	67.5	0	7.2	77.5	0.2	10.9	-10	-0.2
Eco2-081 / Eco2-080	67.5	8.2	0	45.5	28.5	0	22	-20.3	0
Mean	*37.87*	*44.23*	*0.00*	*23.93*	*59.50*	*0.10*	***13.93***	***-15.27***	*-0.10*
D *as % of unburned*							***58.2%***	***-25.7%***	*-100.0%*
SEM							***4.07***	***2.98***	--
*T/V/Z value**							***3.42***	***-5.13***	*Z = -1.109*
Probability							***0.076***	***0.036***	*0.267*
Homestead prescribed (n=2 plot pairs)									
Eco2-016 / Eco2-015	2	3	0.1	3	0.5	0.2	-1	2.5	-0.1
Eco2-017 / Eco2-018	5.3	5.9	0	2	7.2	0.1	3.3	-1.3	-0.1
Mean	*3.65*	*4.45*	*0.05*	*2.5*	*3.85*	*0.15*	*1.15*	*0.6*	*-0.1*
D *as % of unburned*							*46.0%*	*15.6%*	*-66.7%*
Middle Fork 2002 prescribed (n=4 plot pairs)									
Eco2-002 / Eco2-003	17.7	57.5	0.1	4.4	72.5	0	13.3	-15	0.1
Eco2-008 / Eco2-009	3.4	77.5	0	14.7	49	2.7	-11.3	28.5	-2.7
Eco2-012 / Eco2-011	25.2	62.5	0.4	3.3	87.5	0.6	21.9	-25	-0.2
Eco2-013 / Eco2-014	9.3	77.5	0.3	19.1	67.5	0.1	-9.8	10	0.2
Mean	*13.90*	*68.75*	*0.20*	*10.38*	*69.13*	*0.85*	*3.53*	*-0.38*	*-0.65*
D *as % of unburned*							*34.0%*	*-0.5%*	*-76.5%*
SEM							*8.32*	*12.1*	--
*T/V/Z value**							*0.42*	*-0.03*	*V = 3*
Probability							*0.70*	*0.977*	*0.625*
Pass Creek wild (n=5 plots pairs)									
Eco2-040 / Eco2-041	31.6	62.5	0	2.8	82.5	0	28.8	-20	0
Eco2-046 / Eco2-047	26.5	33.5	0	30.5	47	0.2	-4	-13.5	-0.2
Eco2-049 / Eco2-050	16.1	38.7	0	22.5	59	0	-6.4	-20.3	0
Eco2-052 / Eco2-054	28.7	54	0	26.6	57.5	0.6	2.1	-3.5	-0.6
Eco2-053 / Eco2-055	62.5	10.6	0.1	35.5	19.6	0.2	27	-9	-0.1
Mean	*26.76*	*27.36*	*0.02*	*23.02*	*36.62*	*0.20*	*9.50*	***-13.26***	*-0.18*
D *as % of unburned*							*40.3%*	***-25.0%***	*-90.0%*
SEM							*7.64*	***3.23***	--
*T/V/Z value**							*1.24*	***-4.11***	*Z = -1.556*
Probability							*0.282*	***0.015***	*0.1198*
Five Popo Agie-area Fires (n=17 plot pairs)									
Mean	*24.30*	*41.74*	*0.06*	*17.49*	*53.32*	*0.30*	***6.81***	***-11.58***	***-0.24***
D *as % of unburned*							***38.9%***	***-21.7%***	***-80.4%***
SEM							***3.10***	***4.10***	**--**
*T/V/Z value**							***2.20***	***-2.82***	***Z = -2.224***
Probability							***0.043***	***0.012***	***0.0262***
All Fires (n=29 plot pairs)									
Mean	*25.95*	*36.34*	*0.19*	*17.34*	*48.06*	*2.06*	***8.61***	***-11.71***	***-1.87***
D *as % of unburned*							***49.7%***	***-24.4%***	***-90.6%***
SEM							***2.83***	***3.44***	**--**
*T/V/Z value**							***3.05***	***-3.41***	***Z = -3.605***
Probability							***0.005***	***0.002***	***0.0003***

* Cover of bare soil and litter were analyzed with paired-sample t-tests, which produce a T statistic. Cover of biotic crust was analyzed with Wilcoxon's signed-rank test, which produces either a V statistic or a Z statistic.

APPENDIX I. INSTRUCTIONS FOR FIELD SAMPLING IN THE 2009 SEASON.

The methods that we used in the 2008 season were essentially the same as those described here for 2009, except that we did not use the 50-m long cheatgrass transects in 2008.

INSTRUCTIONS FOR FIELD SAMPLING
2009 Shoshone National Forest Sagebrush Study

I. NAVIGATE TO SAMPLING POINT

A. BURNED POINTS

Start with the list of potential burned points. This list will have been made by WYNDD staff, using shape files of burned areas provided by USFS fire staff. The shape files contain polygons within which the vegetation burned, but each polygon also contains areas missed by the fire. Hence the polygons can guide us to general areas where we can find places to sample burned vegetation, but they cannot guide us to those places exactly.

Select a potential burned point and use the GPS receiver to navigate to it. Assess the site around the point to see if it meets our criteria (Table 1). If the site around the point meets the criteria, then designate the potential point as a burned sampling point. If the site fails to meet all of the criteria, move the point to the closest location that does meet the criteria. That place will become the burned sampling point. Record its coordinates with the GPS receiver; note whether or not you moved the original potential point and (if you moved it) the distance you moved it and the reason for moving it; and record the substrate, slope steepness, and slope aspect so that you can compare potential matched unburned points to it.

Table 1. Criteria that a site must meet to be chosen for a BURNED sampling point.
1. Point lies **inside** an area burned in the most recent fire.
2. The site around the point is large enough for us to locate the 10 m x 25 m macroplot and a burned border $\geq$ 3 m wide on a slope of uniform substrate, slope steepness, and slope aspect.
3. The site contains no roads, constructed trails, excavations, or other similar surface disturbances
4. The site appears to contain NO plants that were seeded or otherwise intentionally planted there -- such as the area in Sinks Canyon near the old ranger station that was a horse pasture and seems to have been seeded to smooth brome

B. UNBURNED POINTS

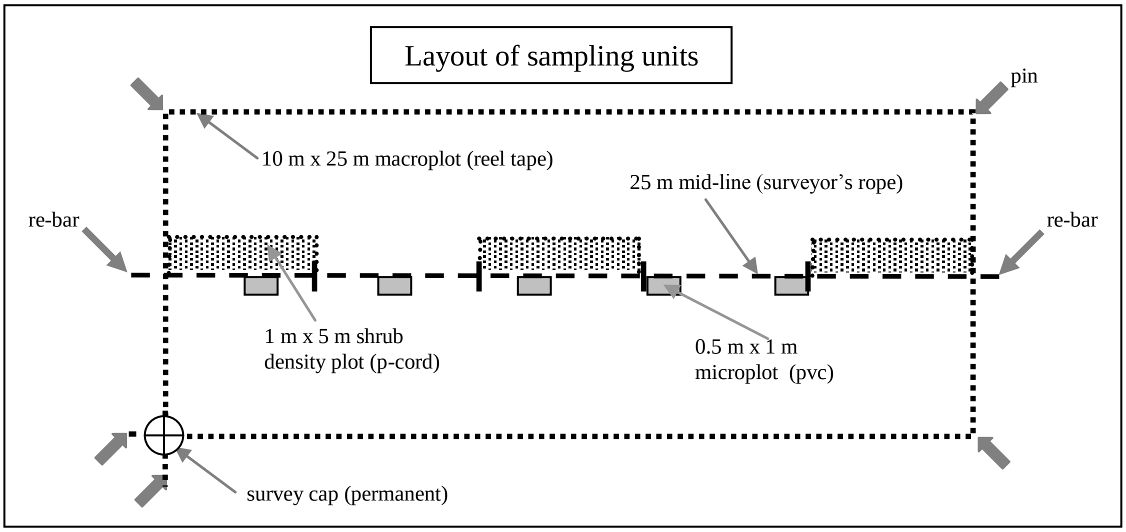
For each burned sampling point that you select in the field, select a point in nearby unburned vegetation that matches the burned point as closely as possible in substrate, slope steepness and aspect, and type of vegetation. Because each burn polygon will include areas of unburned vegetation, the unburned sampling point may lie inside the boundaries of the burn polygon.

Table 2 lists factors to consider in selecting an unburned sampling point.

Table 2. Criteria that a site must meet to be chosen for an UNBURNED sampling point.
1. Point lies OUTSIDE an area burned in the most recent fire.
2. The site around the point is large enough to hold the 10 m x 25 m macroplot and an unburned border $\geq$ 3 m wide.
3. The site is similar to its intended matched burned point in geologic substrate, slope steepness, and slope aspect.
4. This unburned site and its intended matched burned point seem to have supported similar vegetation before the fire.
5. The site contains no roads, constructed trails, excavations, or other similar surface disturbances
6. The site appears to contain NO plants that were seeded or otherwise intentionally planted there -- such as the area in Sinks Canyon near the old ranger station that was a horse pasture and seems to have been seeded to smooth brome

II. SET UP THE SAMPLING PLOT

Figure 1. Layout of sampling units at each point.



A. LAY OUT 10 M X 25 M MACROPLOT

-- Materials: 75-meter-long reel tape, sighting compass, 5 pins, 3 flags. (NOTE: We may use a 75-meter-long surveyor's rope instead of the reel tape.)
-- 2 people

1. Place the starting corner of the macroplot at the sampling point.
2. Decide how you want to orient the macroplot. When the macroplot lies on a slope, the long axis usually should run uphill. On flat ground, the long axis of the macroplot usually should run north-south. Use the sighting compass to ascertain the compass bearing in degrees of the long axis of the plot from the starting corner. This will be the azimuth from north. Record it. NOTE: be sure that the sighting compass is set to the proper magnetic declination, so that all bearings are taken from true north.
3. Use a pin to stake down the end of the tape. Place a flag at the 0 to mark the first corner
4. Lay out the near end of the macroplot, on a line 270^{o} from (i.e., at right angles to) the azimuth. With a 2-person crew, this is best accomplished by having person 1 stand back several feet from the starting point and sight over that point to a distant object that lies on the appropriate compass bearing. Person 2 pays out the tape as he or she walks toward the distant object, with person 1 keeping person 2 on the line formed by the first corner and the distant object. When person 2 reaches the second corner, 10 meters from the first, he or she anchors the 10-meter point on the tape with a pin.
5. Lay out the far side of the macroplot. Person 1 moves to the second corner and sights over that corner to a distant object lying on the plot azimuth. Under person 1's direction, person 2 pays out tape as he or she walks toward the third corner. At the third corner, person 2 anchors the 35-meter mark on the rope to a pin.
6. Lay out the far end of the macroplot. Person 1 moves to the third corner and guides person 2 as he or she walks toward the fourth corner. When person 2 reaches the 45-meter point on the tape, he or she stops and person 1 comes to that point. Person 1 holds the tape there as person 2 pays out tape and walks toward the flag at the first corner. At the first corner, person 2 uses a pin to anchor the end of the tape so that the 70-meter point lies over the 0 point. Back at the fourth corner, person 1 squares up the angle by tightening both legs of the tape and fastening the 45-meter point with a pin.

B. LAY OUT THE MID-LINE TRANSECT

-- Materials: 25+ m long surveyor's rope, two 18-inch pieces of rebar

-- 1 person

1. Use flags to mark the points where the mid-line crosses the ends of the macroplot, at the 5-meter and 40-meter points on the macroplot boundary rope.

2. Use a piece of re-bar to anchor the first end of the 25-meter surveyor's rope so that the 0 point on that rope lies over the 5-meter point on the end of the macroplot.

3. Walk toward the flag at the far end of the macroplot, paying out rope as you go. STAY TO THE LEFT OF THE MID-LINE AS YOU WALK, to avoid trampling the areas where you will soon take shrub canopy and herbaceous canopy measurements.

4. Upon reaching the far end of the macroplot, pull the 25-meter rope tight and fasten the end with the second piece of re-bar. The 25-meter point on the mid-line rope should lie near the 40-meter point on the macroplot boundary rope. It's important that the mid-line rope be taut and straight so that the shrub canopy intercept measurements are accurate.

C. MARK THE STARTING CORNER

-- Materials: aluminum survey cap, stamp set, wood block, ½" re-bar, hammer

-- One person

1. Use the hammer and stamp set to stamp the plot number into the survey cap.

2. Push the survey cap onto one end of the piece of re-bar.

3. Push the re-bar all the way into the ground. If you need to pound on the cap, use the wood block to protect it.

4. Use the GPS receiver to ascertain the coordinates (NAD 1983, UTM Zone 12N). Write them down on the data sheet and, if possible, store them as a waypoint and write the waypoint number on the data sheet.

III. COLLECT THE DATA

A. HERBACEOUS AND SUB-SHRUB CANOPY COVER, GROUND COVER, AND BIOLOGICAL SOIL CRUST

-- Materials: 0.5 m x 1 m PVC microplot frame, cardboard or plastic 50 sq cm and 250 sq cm templates

-- Measurements are made at 5 locations along the mid-line.

1. Place the PVC frame immediately along the right-hand side of the mid-line rope (looking up the rope from the 0 end), with the long axis parallel to the mid-line. The frame will be placed 5 times, with the ends at these marks on the mid-line rope: 3 - 4 m, 7- 8 m, 11 - 12 m, 15 - 16 m, and 19 - 20 m.

2. Estimate herbaceous and sub-shrub canopy cover.

a. Look down on the macroplot from above. Imagine a box extending upward from the macroplot frame, with the sides of the box vertical.

b. Record every plant species with any amount of canopy in the box. BE SURE TO LOOK FOR SMALL PLANTS BENEATH SHRUB CANOPIES. If you know the scientific name of a species, use it. If you don't, then use a unique descriptive name that will differentiate that species from all others, and that refers to some features of the plant. Examples: "Forb opposite round leaf", "Grass erect veined leaf". Use the same name from microplot to microplot. If you encounter a plant that you are sure you saw in an earlier macroplot and are sure that you can remember the name you used in that macroplot, use that name again and add either the number of the plot where you originally found it or a reference to the time when you originally found it. Examples: "Grass open head plot 01.01", "Forb erect yellow flower Thurs morning". Do not use the same name twice unless you are sure that you are seeing the same plant again. Assigning the same name to more than one species likely will confuse and frustrate the person who is trying to identify the unknown species.

c. Record a canopy-cover value (Table 3) for every species you find that expresses the percentage of the microplot's area beneath the canopies of all the individuals of that species.

Table 3. Canopy cover-class values used in estimating canopy cover of species in the herbaceous microplots.

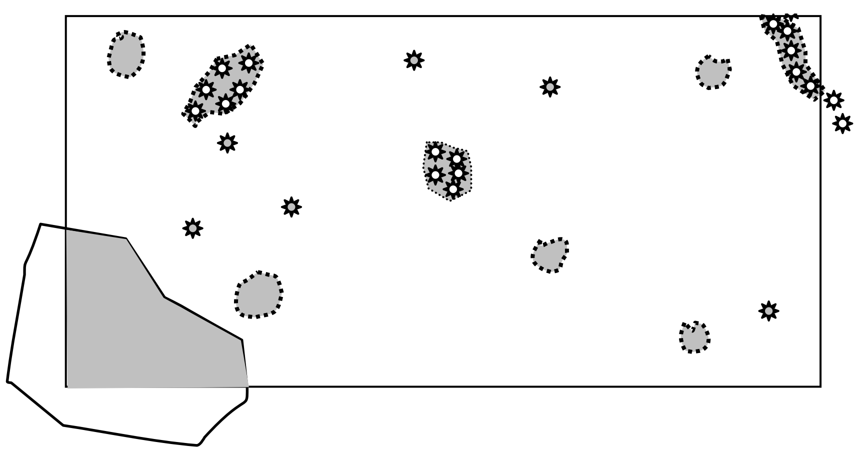
Cover interval (percent of microplot covered)	**Value recorded**
< 1%	1
1% - 5%	2
5.1% - 15%	3
15.1% - 25%	4
25.1% - 50%	5
50.1% - 75%	6
75.1% - 100%	7

The canopy of an individual plant is represented by the projection onto the ground of the polygon enclosed by a line drawn about the outermost leaves or live shoots. This polygon is relatively easy to imagine for plants that grow in clumps, such as shrubs, some grasses, and most forbs. For example, for bunchgrass species A, scan the microplot so that you see all of it from directly above and keep track of all of the individuals of A. Around each, imagine drawing a line that encloses the entire canopy lying above the microplot. Include openings up to 10 cm long. Add up (in your head) all of those canopy polygons and figure out what percentage interval they are in.

For rhizomatous grasses, that grow as separate stems arising individually from underground runners, imagining the cover polygons is harder. When the stems are scattered, each stem can have its own polygon. But when a number of stems grow close together in a bunch, you have to decide how widely to extend the polygon. Here's a rule of thumb: if the leaves of individual stems overlap, then those stems should be included inside a single polygon.

Use the templates that show various percentages of the microplot area, and the cover estimator charts, to help you estimate area

Figure 2. View of 50 cm x 100 cm herbaceous microplot, showing how polygons (shaded areas) are drawn around plant canopies.



3. Estimate ground cover.

a. Scan the microplot until you have seen the entire ground surface inside it from directly above.

b. Estimate (by cover-class interval, Table 3) the percentage of the ground surface covered by each of the 8 categories of ground cover (Table 4).

Table 4. Categories of ground cover	
Category	**Description**
Bare soil	Particles < 2 mm
Gravel	Rock fragments 2 - 75 mm
Rock	Rock fragments > 75 mm
Bedrock	--
Litter	Herbaceous plant material, not anchored
Wood	Woody plant material, not anchored
Plant base	Herbaceous or woody plant material, anchored in soil
Clubmoss	Plants in genus *Selaginella*

4. Record the presence of categories of biological soil crust (BSC)

Scan the microplot and record the presence of any of these 4 categories of BSC: non-foliose lichens (includes gelatinous and crustose lichens), foliose lichens, vagrant lichens, and mosses.

5. Move to the next location along the mid-line and repeat steps 1 through 4.

B. SHRUB CANOPY COVER

-- Materials: centimeter tape measure, two flags
-- Measurements are made on each of the five 5-meter long segments of the mid-line.

1. First 5-meter segment

a. Place a flag at the 0 mark on the surveyor's rope and a second flag at the 5-meter mark.

b. Look down on the right-hand side of surveyor's rope (viewed from the 0 end) from directly above.

c. Use the measuring tape to measure the length in centimeters of the edge of the rope above or below each shrub canopy (Figure 1).

(1) Include in the measurement those gaps < 10 cm long (i.e., lengths of the rope without canopy up to 10 cm long).

(2) Exclude gaps ≥ 10 cm long (i.e., a gap ≥ 10 cm long separates two canopy intercepts)

d. Record the species of the shrub (sub-species of sagebrush) and whether the portion of the canopy intercepted is alive or dead.

e. If the edge of the rope intersects two canopies, one above the other or the two mixed (Figure 1),

(1) If the canopies are from shrubs of the same taxon, then treat them as a single canopy and record just one intercept

(2) If the canopies are from shrubs of different taxa, then treat them as separate intercepts and record them separately.

2. Successive 5-meter segments.

a. Place one flag at the beginning of the segment and the second flag at the end of the segment

b. Repeat steps b through d above.

C. SHRUB DENSITY

-- Materials: p-cord for 1 m x 5 m plot, 4 pins.
-- Measurements are made at 3 locations along the mid-line.

1. Set up the 1 m x 5 m shrub plot at the first location along the mid-line (Figure 1).

a. Attach one end of the parachute cord to a pin at the 0 point on the mid-line rope and the other end to a pin at the 5 meter point

b. Attach one pin to each of the other two corner marks on the p-cord, stretch the cord out to make a rectangle, and set the pins.

2. For each shrub rooted inside the plot, record:
   a. the taxon,
   b. whether the shrub is alive or dead
   c. the height category: < 5 cm, 5 - 25 cm, 25 - 50 cm, > 50 cm

3. Repeat steps 1 and 2 for the plot at the 15 m and 20 m marks, and at the 20 m and 25 m marks.

D. SHRUB DIMENSIONS AND VIGOR

-- Materials: Tape measure
-- Measurements are made at 5 locations along the mid-line, at the 5 m, 10 m, 15 m, 20 m, and 25 m marks.

1. At the 5 m point, locate the 4 shrubs rooted nearest to the mark on the mid-line rope, 1 shrub in each of the 4 quadrants formed by the tape and a line perpendicular to it. Note that the nearest shrub may be a very small seedling.
2. On each shrub,
   a. Measure the height of the tallest part of the vegetative canopy (exclude flower heads), the length of the longest axis of the canopy, and the length of a second axis perpendicular to the first. Record all measurements in cm.
   b. Estimate the percentage of the canopy that is alive.
3. Move to successive sampling points and repeat steps 1 and 2. If one of the shrubs at a point also was the closest to the preceding point and you have already measured it, then take the measurements on the next-closest shrub.

E. CHEATGRASS COVER ALONG TRANSECT

-- Materials: 0.5 m x 1.0 m PVC microplot frame, 50-m long segment of reel tape
-- Estimates are made from 25 microplots arranged along the 50-m long transect. “Cheatgrass” includes all of the introduced, annual or winter-annual brome grasses.
1. The right side of the macroplot (looking up-slope from the starting corner) is marked by a 25-meter long segment of the reel tape, from the 45 meter point on the tape (at the 3rd corner) to the 70 meter point (at the starting corner). After anchoring the tape at the starting corner, run the tape out an additional 25 meters down-slope, to form a 50-meter long transect from the 3rd corner, through the starting corner, and down the slope.
2. Use the 0.5 m x 1.0 m microplot frame to estimate cheatgrass canopy cover in 25 plots along the right side transect, looking from the end.
   a. Lay the frame along the transect between the 94 meter and 95 meter points, and use the 7 canopy cover percent categories to record the amount of cheatgrass canopy cover.
   b. Repeat at alternate 1-meter segments of the transect, up to the final (25th) microplot at the 47 meter to 48 meter points.

IV. RECORD ALL SPECIES PRESENT IN THE MACROPLOT

Spend 10 minutes (use a watch) to time your search of the macroplot. Write down the name of every species you encounter that has not already been recorded from the herbaceous cover microplots or the shrub intersect transect. Use scientific names when possible, descriptive names when not (see A.2.b.above).

Collect a specimen of each taxon that cannot be identified with reasonable certainty.

V. Collect Ancillary Information

-- Materials: sighting compass, clinometer, camera

A. Aspect

Use the sighting compass to measure the direction of the slope on which the macroplot lies.

B. Slope

Use a clinometer to measure the steepness (in degrees) of the slope on which the macroplot lies.

C. Slope shape

Characterize the slope on which the macroplot lies as straight, concave, or convex.

D. Photograph

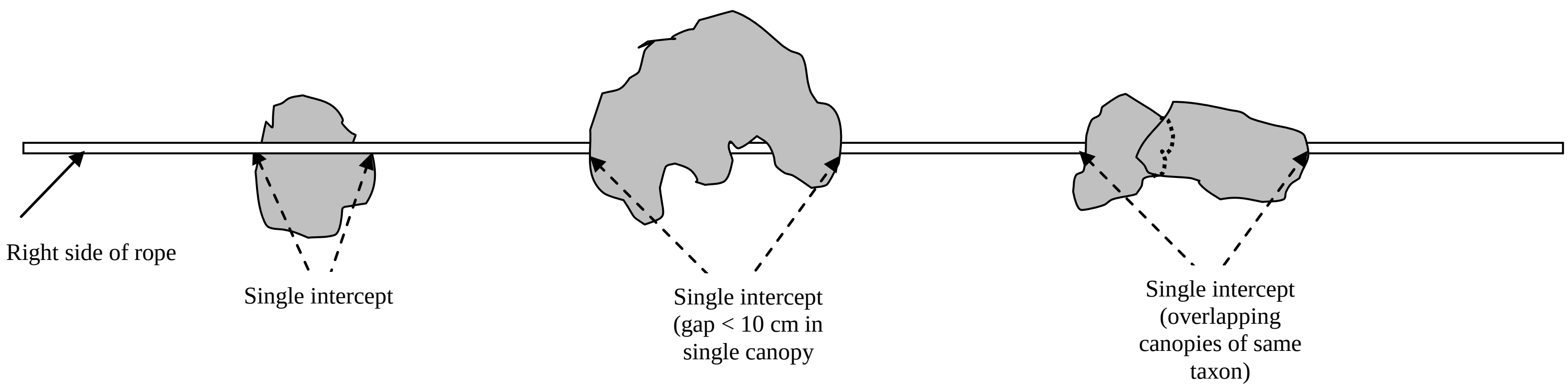
Take a photograph of the macroplot. When possible, stand at the starting point (the first corner) and look diagonally across the macroplot. When this aspect will not give a good view of the overall nature of the macroplot, stand at a different location, and describe it.

E. Notes

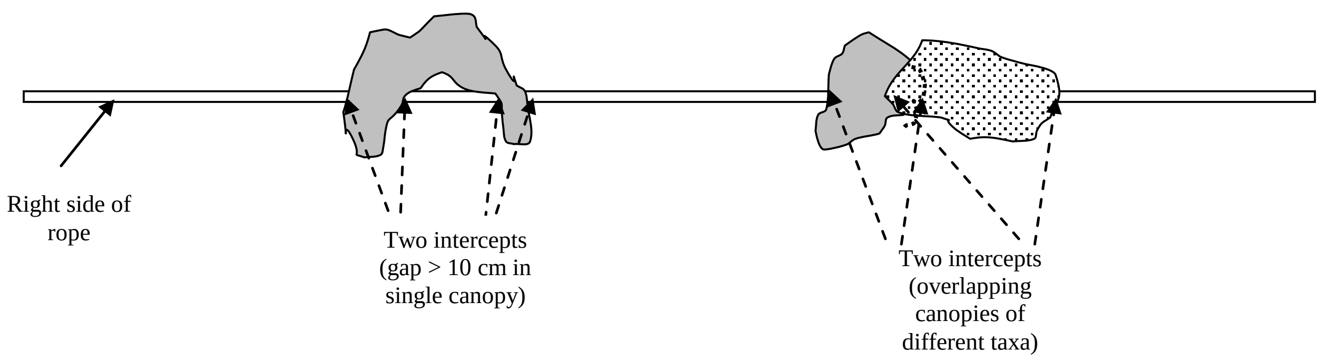
Record signs of disturbance, browsing, grazing, and other features in the macroplot. **COUNT THE NUMBER OF HARVESTER ANT MOUNDS AND THE NUMBER OF MAMMAL BURROWS IN THE MACROPLOTS**

Figure 1. Different cases of estimating shrub canopy intercepts

a. Single intercepts



b. Two intercepts



I. SAMPLING POINT INFORMATION

COORDINATES OF STARTING CORNER. USE UTM, NAD 1983. UTM Zone 12N.

________________________ m N (7 digits), _______________________ m E (6 digits). Waypoint #________, Accuracy ______

LEGAL DESCRIPTION AND MAP
T________N, R________W, Sec________, ________1/4. Elevation (use map) : _____________ft./m (circle one)

Map Name____ Scale_______________________ Code on Map______________

II. MACROPLOT INFORMATION

Azimuth (from true north) of long axis________ °. Bearing of end (90° from azimuth)________°. Magnetic decl.________°

ENVIRONMENT.

Aspect ________° **Slope** Angle ________° Shape (circle one): Straight Concave Convex

Bedrock (circle one): Shale Siltstone Sandstone Limestone/ Dolomite Light-colored Crystalline Dark Crystalline Quartzite Uncon Clay Uncon Silt Uncon Sand Unknown Glacial

Bedrock Notes____

Surface deposit (circle one): Residual Colluvial Aeolian Alluvial

Surface Notes____

Soil features (texture, rockiness, salt, tc.):____

____

PHOTOGRAPHS.

Number__________. Brief description____

____

Number__________. Brief description____

____

NOTES

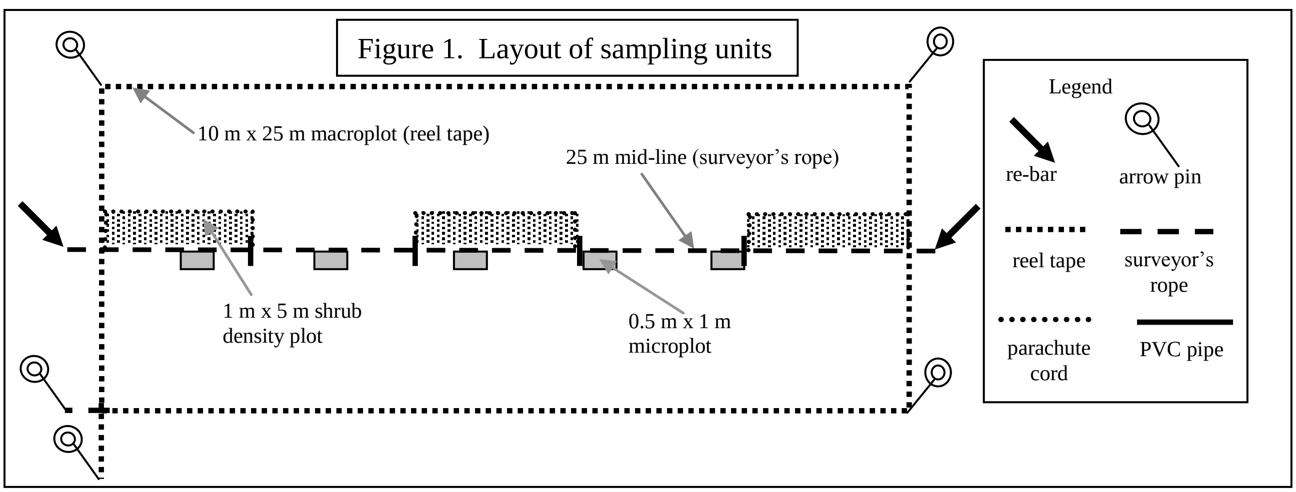
Disturbance evidence:____

____

Other.____

____

Figure 1. Layout of sampling units



DESCRIBE VEGETATION

1. One- or two-sentence summary of the appearance of the vegetation. Include distribution of major species (homogeneous or patchy), height of layers.

2. Does vegetation of plot seem similar to the vegetation on the surrounding landscape as a whole, or to vegetation on particular parts of the landscape?

3. Have plants been recently grazed or browsed? Are such plants common or rare in the plot?

4. What evidence (if any) did you notice of disturbance in the plot? Examples include burned or cut stumps, trails, tire tracks.

Uncertainty about measured or estimated values____
____

III. COVER IN MICROPLOTS

% Cover Range	<1	1 - 5	5.1 - 15	15.1 - 25	25.1 - 50	50.1 - 75	75.1 - 100
Value to Record	1	2	3	4	5	6	7

	Microplots							Microplots					
PLANT GROUPS	1 3m	2 7m	3 11 m	4 15 m	5 19 m	Ave	**PLANT SPECIES**	1 3m	2 7m	3 11 m	4 15 m	5 19 m	Coll
Total Canopy Cover													
Live Shrubs / Dead Shrubs													
Graminoids / Forbs													
GROUND COVER													
Soil (<2mm) / Gravel (2-75 mm)													
Rock (>75 mm) / Droppings													
Litter / Wood													
Plant base / Clubmoss													
BIOL. SOIL CRUST													
Non-foliose lich. / Foliose lich.													
Vagrant lichen / Moss													
CHECK DROPPINGS PRESENT													
Pellets													
Cattle													
Horse													
Sage-grouse													
# SAGE SEEDLINGS													
PLANT SPECIES	1 3m	2 7m	3 11 m	4 15 m	5 19 m								

IV. SHRUB CANOPY COVER

Record the length in centimeters of each intersection of a shrub canopy with the right-hand edge of the midline. Include gaps up to 10 cm long in the intersection. Exclude gaps > 10 cm long.

Transect Segment 1. 0 - 5 m

Species	Alive or Dead	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total Length

Transect Segment 2. 5 - 10 m

Species	Alive or Dead	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total Length

Transect Segment 3. 1 0 - 15 m

Species	Alive or Dead	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total Length

Continued on back

IV. SHRUB CANOPY COVER (CONTINUED)

Transect Segment 4. 15 - 20 m

Species	Alive or Dead	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total Length

Transect Segment 5. 20 - 25. m

Species	Alive or Dead	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total Length

V. SHRUB DIMENSIONS AND VIGOR

Pt 1. 5 m			Pt 2. 10 m			Pt 3. 15 m			Pt 4. 20 m			Pt 5. 25 m		
Species	Measurements		Species	Measurements		Species	Measurements		Species	Measurements		Species	Measurements	
Shrub	Height		Shrub	Height		Shrub 1	Height		Shrub 1	Height		Shrub 1	Height	
1	Length		1	Length			Length			Length			Length	
	Width			Width			Width			Width			Width	
	% alive			% alive			% alive			% alive			% alive	
Shrub	Height		Shrub	Height		Shrub 2	Height		Shrub 2	Height		Shrub 2	Height	
2	Length		2	Length			Length			Length			Length	
	Width			Width			Width			Width			Width	
	% alive			% alive			% alive			% alive			% alive	
Shrub	Height		Shrub	Height		Shrub 3	Height		Shrub 3	Height		Shrub 3	Height	
3	Length		3	Length			Length			Length			Length	
	Width			Width			Width			Width			Width	
	% alive			% alive			% alive			% alive			% alive	
Shrub	Height		Shrub	Height		Shrub 4	Height		Shrub 4	Height		Shrub 4	Height	
4	Length		4	Length			Length			Length			Length	
	Width			Width			Width			Width			Width	
	% alive			% alive			% alive			% alive			% alive	

VI. SHRUB DENSITY

Height Range	≤ 5 cm	5.1 - 25 cm	25.1 - 50 cm	> 50 cm
Height Class	1	2	3	4

Plot 1. 0 - 5 m				Plot 2. 10 - 15 m				Plot 3. 20 - 25 m			
#	Species	Alive/ Dead	Height Class	#	Species	Alive/ Dead	Height Class	#	Species	Alive/ Dead	Height Class

VII. CHEATGRASS TRANSECT

% Cover Range	<1	1 - 5	5.1 - 15	15.1 - 25	25.1 - 50	50.1 - 75	75.1 - 100
Value to Record	1	2	3	4	5	6	7

Make 50-m long transect by stretching tape that forms last side of macroplot an additional 25 m down-slope beyond starting corner. Transect thus is the 25-m long side of macroplot up-slope from starting corner plus 25-m long continuation of that line down-slope from starting corner. Transect extends from 45 m mark on tape (corner of macroplot) to 95 m mark on tape, and starting corner is at 70 m mark. Microplots measure 0.5 m x 1.0 m and lie on RIGHT side of transect looking up-slope. Start reading microplots at 95 m end of transect: place first microplot at 95 m – 94 m on tape and then at every other meter up to 47 m – 46 m.

Microplot Number	**Location Along Tape (meters)**	**Cheatgrass Cover Class**
1	95-94	
2	93-92	
3	91-90	
4	89-88	
5	87-86	
6	85-84	
7	83-82	
8	81-80	
9	79-78	
10	77-76	
11	75-74	
12	73-72	
13	71-70	
14	69-68	
15	67-66	
16	65-64	
17	63-62	
18	61-60	
19	59-58	
20	57-56	
21	55-54	
22	53-52	
23	51-50	
24	49-48	
25	47-46	

APPENDIX II. DETAILS OF THE NON-METRIC MULTIDIMENSIONAL SCALING ORDINATION

- Software: PC-ORD version 5.31
- Distance measure: relative Sorenson
- Starting configuration: random
- Number of runs with real data: 250
- Method of assessing the dimensionality of the data set: plot of stress in ordination result vs. number of dimensions (i.e., scree plot)
- Number of dimensions in final solution: 3
- Monte Carlo test result (number of runs on randomized data and probability that a similar final stress could have been obtained by chance): 250 runs on randomized data, $p = 0.004$.
- Number of iterations for final solution: 92
- Method of assessing stability of final solution: graph of stress vs. iteration number showed no change in stress after approximately 50 iterations (i.e., stress was constant for the final 42 iterations)
- Proportion of the variance represented by each axis (r^2 between dissimilarity in the original data matrix and distance in the ordination result):

Axis	Increment	Cumulative
1	.327	.327
2	.228	.555
3	.243	.798

- Basis for interpretation of result: 2-dimensional graphs of samples on ordination axes, showing intermixing of burned samples with unburned samples.

APPENDIX III. PHOTOGRAPHS OF SAMPLE PLOTS AND OTHER ASPECTS OF THE BURNED AREAS.

These photographs and ancillary information are in the accompanying file, "SNF_BurnedSage_AppendixIII.pdf".