

**FIRST YEAR RESULTS: VEGETATIVE RECOVERY FOLLOWING
1996 DOME WILDFIRE**

Progress Report

by

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EXECUTIVE SUMMARY

The Dome Fire of April and May of 1996 burned almost 17,000 acres of mostly ponderosa pine forest at Bandelier National Monument (BNM) and Santa Fe National Forest (SFNF), north-central New Mexico. The U. S. Forest Service lands of high and moderate burn intensity areas were reseeded with ryegrass (Lolium multiflorum) to quickly restore vegetation cover before the onset on summer rains, and hence prevent erosion and loss of soil cover. The Dome Fire prompted discussion about the effectiveness, as well as long-term impacts of reseeding on succession of native vegetation. This dialogue about reseeding is prevalent across the western U. S., yet reseeding success and impact are not routinely monitored and studied. Below is a preliminary report of vegetation monitoring and analysis after the Dome Fire.

Forty-nine permanent vegetation transects were established in 1997 to evaluate the post-fire and post-reseeding recovery of vegetation. Preliminary results indicate that native forbs provided more overstory in unseeded areas than in seeded areas, and increased ryegrass overstory was associated with decreased overstory of native forbs, and decreased native forb species richness. Conifer seedling density also decreased as overstory of ryegrass increased, and conifer seedling survival from 1997 to 1998 was very low in seeded, high burn intensity areas. Additionally, exotic plant overstory and understory, and exotic plant species richness were higher in seeded than unseeded areas; most of the exotic species found on transects in seeded areas, including ryegrass, were present in the seed mix. These results are probably not independent of the unusually wet late spring of 1997. The transects were re-evaluated in the summer 1998, but most of the data are yet to be analyzed. A final report will be produced that compares and contrasts 1997 and 1998 data, taking into account the unusually wet conditions in late spring 1997.

INTRODUCTION

In the spring of 1996, the Dome Fire burned nearly 17,000 acres of Bandelier National Monument and Santa Fe National Forest in the Jemez Mountains, north-central New Mexico. Pre-fire vegetation was predominantly ponderosa pine with mixed conifer at the higher elevations and

pinyon-juniper at the lower elevations. The U. S. Forest Service reseeded high and moderate burn intensity areas in SFNF with almost 430 kg of a predominantly annual grass seed mix consisting of 23-30% ryegrass. BNM chose not to reseed their land post-fire. The National Park Service initiated a study in the spring of 1997 to evaluate the post-fire recovery of vegetation. This report describes work conducted in the 1997 and 1998 field seasons, although the results presented are primarily from 1997.

BACKGROUND

Presettlement average natural fire intervals ranged from 5-15 years across the southwestern United States (Swetnam and Betancourt 1990, Swetnam and Baisan 1996), including the Jemez Mountains (Touchan et al. 1996). Since the late 1800's, widespread surface fires ceased in the Jemez Mountains due to intense grazing and fire suppression (Allen 1989, Touchan et al. 1996). This gradual change in land management policies has altered the landscape in the southwest from park-like stands to dense, dog-hair thickets of ponderosa pine. This slow conversion set the stage for high-intensity, catastrophic, crown fires (Swetnam and Baisan 1996, Touchan et al. 1996).

Vegetation loss after a catastrophic fire has the potential to cause erosion and sediment movement, while affecting other biologic, geomorphic, and hydrologic processes. Costly post-fire rehabilitation practices, such as reseeding, have been applied by land managers for over a century, yet remain controversial (Everett et al 1990). Reseeding is applied to burned areas because regrowth of native species may be too slow or density of surviving plants too sparse to provide soil stability and restore nutrient cycles (Tiedemann and Klock 1976, Taskey et al. 1989). Grasses are used most often in reseeding because they establish easily and occupy disturbed sites rapidly (Everett et al. 1990). Published experiments give conflicting results including: 1) reseeding reduces erosion (Roby 1989); 2) reseeding has no effect (Roby 1989), and; 3) reseeding success depends on aspect and elevation (Wakimoto 1979, Miles et al. 1989). Also, an increase in long-term erosion could occur in the lull between the decline of seeded grasses and recovery of native

vegetation (Nadkarni and Odion 1986), particularly if nitrogen depletion by the former inhibits the latter.

Little is known about the consequences of seeding exotics, such as ryegrass, on the natural succession of an ecosystem after fire, and documented results have been mixed. Some studies reveal a significant reduction in biomass of natives, native species richness, and total density of natives (Nadkarni and Odion 1986, Conard et al. 1991). Some contend that ryegrass also kills native annuals and shrub seedlings through competition for nitrogen (Dodge 1979, Wakimoto 1979). Opponents of ryegrass seeding argue that it is a strong competitor for water, nutrients, light, and growing space and may have allelopathic properties that could harm competing native species. Opponents further believe that although it is only transient in the ecosystem, its effects may be long-term (Corbett and Rice 1966, Hanes 1971, Biswell 1974, Arndt 1979, Wakimoto 1979, Keeley 1981, Gautier 1982, Griffin 1982, Zedler et al. 1983, Nadkarni and Odion 1986, Conard et al. 1991). Proponents of ryegrass seeding agree that ryegrass may interfere with native species, but because it dies out within 3 to 4 years, ryegrass does not threaten the long-term integrity of the ecosystem (Schultz et al. 1955, Krammes and Hill 1963, Corbett and Green 1965, Conrad 1979, Dodge 1979, Kay et al. 1981, Gautier 1982).

Short- and long-term effects of reseeding on soil erosion, nutrient cycling, and natural succession in native plants (in particular the effects of ryegrass on succession in ponderosa pine ecosystems) remain uncertain. Where ryegrass was used to reseed the Marble-Cone Fire, in the Santa Lucia Range in central California, naturally regenerated ponderosa pine seedlings had lower survivorship than in unseeded plots (Griffin 1982). Similarly, following wildfires in Stanislaus National Forest, on the west slope of the Sierra Nevadas, increased ryegrass cover was associated with decreased ponderosa pine seedling density. Percent cover of native herbaceous vegetation and shrub seedling density also decreased as cover of ryegrass increased (Conard et al. 1991). Finally, both the success of reseeding and long-term recovery of native vegetation depend in large part on climatic conditions, which vary in space and time.

OBJECTIVES

The general objective of this study is to examine the recovery of vegetation following the Dome Fire. Specific research questions, that define specific research objectives, include:

- 1) Did vegetation recovery (by life form) differ among regions, burn intensities, and seeding treatments?
- 2) Did seeding affect the cover, composition, and diversity of native forbs?
- 3) Was the cover of exotic plants different between seeding treatments, and did composition and diversity of exotics differ among regions, burn intensities, and seeding treatments?
- 4) Did the presence of ryegrass affect native forb cover and species richness, or conifer regeneration?
- 5) How was conifer regeneration affected by region, burn intensity, seeding treatment, and percent litter?
- 6) Did grazing intensity of ungulates differ by strata?

METHODS

Forty-nine random points were selected within three strata, and 49 permanent transects were established in the summer of 1997 (Map 1). The study areas were restricted to those dominated by ponderosa pine prior to the fire. All transects were located on slopes of 0-16 degrees. Strata were based on combinations of burn intensity, seeding treatment, and elevation/precipitation region. Burn intensity included high (all needles consumed), moderate (most needles scorched), and low to unburned (majority of needles remained green). Seeding treatments consisted of seeded or unseeded. BNM (region 3) and one area on the SFNF (region 2) were left unseeded. The three elevation/precipitation regions are defined by elevation, and location relative to average summer storm tracks over the Jemez Mountains. Geographically, region 1 is furthest to the north, region 2 is most central, and region 3 is southernmost and includes BNM.

Table 1 is a layout of the sampling design and number of samples in each strata. The 0 m and 50 m ends of each transect were permanently marked with 61 cm aluminum stakes imprinted

with transect name and end. The stakes were marked with abbreviated transect names based on the aforementioned strata (e.g., 1HAS1 0 is in region 1, in a high burn intensity area, on "A" slope (0 - 8 degrees), in a seeded area, and is the first of two or three transects with the same attributes, and marks the 0 m end, respectively). In 1998, location of living trees near the transect and other distinguishing physical characteristics of each plot were mapped.

Understory and overstory of the herbaceous vegetation were evaluated using the line intercept method (50 m transects) (Mueller-Dombois and Ellenberg 1974). Understory and overstory of all live and dead vegetation were measured (to the nearest cm) as it intercepted the vertical plane above the transect. Canopy of all live trees was recorded; canopy of dead trees was only included if it was within 2 meters above the transect.

Ocular estimates of overstory were also made for herbaceous vegetation within eyesight of each transect. This was done so that vegetation not included on the transect was not ignored. Each species was given a cover code of S (0-10%), L (11-25%), M (25-75%), or H (76-100%). These plant lists and estimated coverages are not included in this report but will be in the final report.

Conifer regeneration was evaluated in 20 m x 50 m plots centered on each transect. All seedlings (< 1 m) were counted and identified to species when possible. Each seedling was also aged as a seedling (< 1 yr. old) or a yearling ($\geq$ 1 yr. old). Corners of the plots were permanently marked with blank 61 cm aluminum stakes.

Trees and ungulate fecal pellet groups were inventoried in a 2 m belt centered along each 50 m transect. Every ungulate pellet group within the belt transect was identified as to source species, location along the transect was recorded, and then were removed from the belt transect. Identification, location, foliar damage, and whether it was live or dead was recorded for all standing trees in the belt transect.

Four photographs were taken at every transect for both years. One was taken at the 0 m end looking toward the 50 m end, and another at the 50 m end looking toward the 0 m end. The other 2 photographs were at the 25 m mark, one facing uphill and the other downhill.

The greatest weaknesses of this study are that no pre-fire data exists, and no research was conducted during the summer immediately following the fire and reseeding. The lack of the pre-fire data limits interpolations of post-fire vegetation recovery because no pre-fire reference data exist. Immediate post-fire data would have provided vegetation recovery information for a year that was unusually dry which could have been compared to 1997, an unusually wet year, and 1998, which had an average amount of precipitation. Given more man-power, additional transects could have been established and evaluated providing a more representative sample across the landscape. Finally, the vegetation sampling methodology may have been inappropriate because it was very difficult to weave a 50 m tape through the tall, robust seeded grasses, and place it on the ground to estimate vegetative ground cover.

One strength of this study is that the samples were stratified across the landscape to encompass the most representative sample possible given the limitations of man-power. Additionally, the use of ANOVA for a statistical methodology allows for comparisons among strata while accounting for differences in strata. Finally, annual climatic variation (e.g., precipitation) will be considered in the analysis of the comprehensive data from this study. Specific precipitation data to consider are: 1996 was unusually dry from February through May, but wet in June; 1997 saw more precipitation in April and May than normal, and; 1998 was abnormally wet in February, March, and July, but dry from April to June.

STATISTICAL METHODS

A multi-way Analysis of Variance (ANOVA) was used to analyze overstory and understory of vegetation by growth form, influence of seeding on native forb cover and species richness, cover and species richness of exotic plants, regeneration of conifer seedlings, percent litter, and number of ungulate pellet groups according to region, burn intensity, and seeding treatment. Regions 2 and 3, moderate and high burn intensities, and seeded and unseeded areas were used in the aforementioned analyses to fulfill the criteria of a full-factorial design (3 x 2). Region 1 was excluded because it did not contain unseeded areas, and low burn intensity to unburned areas were

excluded because they did not contain seeded areas. Due to the high density of tall ryegrass plants and other seeded grasses on some of the seeded transects in the SFNF in 1997, it was very difficult to obtain accurate measurements of understory; therefore, some measurements may not be reliable. The effects of ryegrass on native forb cover, native forb species richness, and conifer regeneration, and the effects of litter on conifer seedling density were analyzed using linear regression for all 3 regions, moderate and high burn intensities, and seeded and unseeded areas.

RESULTS AND DISCUSSION

Objective 1: Vegetation Recovery According to Strata

Overstory

Mean overstory cover of each life form (and standard error) for all 3 regions according to region, burn intensity, and seeding treatment can be found in table 2. Burn intensity, seeding treatment, and region had no affect on overstory of trees or sub-shrubs (Table 3). Overstory of shrubs was greater in region 2, and overstory of grasses/sedges was higher in seeded areas. More grass cover in seeded areas may be attributed to the fact that grasses were predominant in the seed mix. Unseeded areas, region 3, and their interaction, were related to more forb overstory than in region 2 and in seeded areas. Overstory of mushrooms/fungus was larger where unseeded areas and region 3 interacted. Seeded grasses appear to have out-competed the forbs and mushrooms/fungus in region 2. It is possible that forbs and mushrooms/fungus naturally provide more cover in region 3, or the unusually wet spring provided better growing conditions for forbs and mushrooms/fungus in these areas.

Understory

Mean understory cover of each life form (and standard error) for all 3 regions according to region, burn intensity, and seeding treatment are located in table 4. Understory of trees, sub-shrubs, grasses/sedges, forbs, and mushrooms/fungus did not differ among burn intensities, seeding treatments, and regions (Table 5). High burn intensity areas in region 2 were related to more understory of shrubs than in moderate burn intensities and in region 3. The reason for this

interaction is unclear. Moss cover was higher in moderate burn intensity areas regardless of region and seeding treatment. The difference in moss cover may be due to the fire in high burn intensities which may have severely burned the soils and created an environment that was less hospitable to moss than the moderate intensity burns.

Objective 2: Effect of Seeding on Native Forbs

Native Forb Overstory

In moderate and high burn intensities (all regions), native forb cover was greater in unseeded ($x = 19.78\%$, $SE = 3.62$, $n = 16$) than seeded ($x = 8.25\%$, $SE = 2.84$, $n = 26$) areas ($\Delta = 11.65\%$, $F_{1,41} = 6.40$, $p = 0.016$, $95\% \text{ C.I.} = 2.34 \text{ to } 20.96$; where Δ is the mean difference between seeded and unseeded percent overstory native forbs) (Table 6). Overstory of native forbs was larger in region 3, in unseeded areas, and interactions of the two (BNM) (Table 9). Seeded species appear to have out-competed the native forbs, and native forbs may naturally provide more cover in region 3 than region 2.

Native Forb Understory

In moderate and high burn intensities (all regions), understory of native forb cover in seeded ($x = 0.063\%$, $SE = 0.029$, $n = 26$) areas was the same as in unseeded ($x = 0.065\%$, $SE = 0.038$, $n = 16$) areas ($\Delta = 0.0020\%$, $F_{1,41} = 0.0016$, $p = 0.97$, $95\% \text{ C.I.} = -0.098 \text{ to } 0.094$; where Δ is the mean difference between seeded and unseeded percent understory native forbs) (Table 7). Understory of native forbs was influenced by interactions of burn intensities and seeding treatments: native forb cover was higher in high burn intensities in seeded areas but higher in moderate burn intensities in unseeded areas (Table 9). It is unclear why this interaction occurred.

One possible explanation for the discrepancy between the results of native forb overstory (greater in unseeded than seeded areas) and understory (no difference between unseeded and seeded areas) is that the tall, dense grasses in the seeded areas may have made it more difficult to

get accurate measurements of native forb understory. Additionally, through competition for resources, the seeded grasses may have stunted the growth of native forbs resulting in smaller plants with less overstory in the seeded areas, without affecting the native forb understory component (Corbett and Rice 1966, Hanes 1971, Biswell 1974, Arndt 1979, Wakimoto 1979, Keeley 1981, Gautier 1982, Griffin 1982, Zedler et al. 1983, Nadkarni and Odion 1986, Conard et al. 1991).

Native Forb Composition and Diversity

Mean native forb species richness (and standard error) for all 3 regions according to region and seeding treatment are located in table 8. In moderate and high burn intensities (all regions), native forb species richness did not differ between seeded ($x = 11.27$, $SE = 0.81$, $n = 26$) and unseeded ($x = 10.75$, $SE = 1.04$, $n = 16$) areas ($\Delta = 0.52$, $F_{1,41} = 0.16$, $p = 0.70$, 95% C.I. = -2.14 to 3.18; where Δ is the mean difference between seeded and unseeded native forb species richness). There were more native forb species per transect in region 3 than region 2, but there was no relationship among number of native forbs, burn intensity, and seeding treatment (Table 9).

The most frequent native forbs and the percent of transects on which they occurred in region 1 (seeded) were C. fremontii (50.0%) and Allium cernuum (37.5%). Ten native forb species occurred on 25.0% and 11 on 12.5% of the remaining transects (Table 10). A. cernuum (55.6%) and Chenopodium fremontii (33.3%) occurred on the most transects in seeded areas in region 2. Eight of the remaining native forbs occurred on 22.2%, and 12 on 11.1% of the transects. In contrast, on the unseeded transects in SFNF (region 2), Erigeron sp. occurred on 62.5% and Taraxacum officinale on 50.0% of the transects. Of the remaining species, 6 occurred on 25.0%, and 5 on 12.5% of the transects. The most frequent native forb on seeded transects in region 3 was C. fremontii on 55.6% transects. C. graveolens appeared on 44.4%, and A. cernuum, Bahia dissecta, Cirsium sp., Erigeron sp., Linum neomexicanum, and Lithospermum multiflorum occurred on 33.3% of the transects. Of the remaining native forbs, 11 appeared on

22.2%, and 11 on 11.1% of the transects. The most frequent native forbs encountered on BNM (unseeded, region 3) were: C. fremontii (100.0%), Lotus wrightii (87.5%), Bahia dissecta and Polygonum sawatchense (75.0%), C. graveolens (62.5%), C. dessicatum and Nama dichotomum (50.0%), and Erigeron sp. (37.5%). Three of the remaining native forbs were found on 25.0%, and 15 on 12.5% of the transects. Diversity in native forb composition between strata may be attributed to differences in aspect, topography, elevation, substrate, seed bank composition, and competition from seeded species.

Objective 3: Exotic Plant Cover and Composition

Exotic Plant Overstory

The most prevalent exotic species and their mean overstory cover according to region and seeding treatment are identified in table 11. In moderate and high burn intensities (all regions), exotic plant overstory cover was higher in seeded ($x = 17.63\%$, $SE = 2.41$, $n = 26$) than unseeded ($x = 2.54\%$, $SE = 3.07$, $n = 16$) areas ($\Delta = 15.09\%$, $F_{1,41} = 14.94$, $p = 0.0004$, 95% C.I. = 7.20 to 22.99%; where Δ is the mean difference between seeded and unseeded percent overstory exotic plants). Exotic plant overstory cover was not affected by region or burn intensity (Table 14). Exotic plant overstory was higher in seeded than unseeded areas because there were exotics in the seed mix (i.e., most of the exotic species present were in the seed mix).

Exotic Plant Understory

The most prevalent exotic species and their mean understory cover according to region and seeding treatment are identified in table 12. In moderate and high burn intensities (all regions), exotic plant understory cover was higher in seeded ($x = 0.32\%$, $SE = 0.054$, $n = 26$) than unseeded ($x = 0.044\%$, $SE = 0.068$, $n = 16$) areas ($\Delta = 0.27\%$, $F_{1,41} = 9.76$, $p = 0.0033$, 95% C.I. = 0.096 to 0.45%; where Δ is the mean difference between seeded and unseeded percent understory exotic plants). Exotic plant understory cover was not affected by region or burn

intensity (Table 14). As with overstory, exotic plant understory was higher in seeded than unseeded areas because exotics were present in the seed mix.

Composition and Diversity of Exotic Plants

The occurrence of exotics was greater in moderate burn intensity and seeded areas but was not influenced by region (Table 14). Nine exotic plant species were encountered on transects. Six were grasses, and three were forbs. Exotics present in region 1 (seeded) and the number of transects on which they appeared were (Table 13): ryegrass (87.5%), Bromus inermis (75.0%), B. tectorum and Verbascum thapsus (37.5%), Conyza canadensis and L. perenne (25.0%), and B. japonicus (12.5%). Frequency of exotics in region 2 (seeded) were: ryegrass (100.0%), L. perenne and B. inermis (77.8%), B. tectorum (55.6%), V. thapsus (33.3%), B. japonicus (22.2%), and Triticum aestivum (11.1%). In contrast, the exotics in the unseeded areas in region 2 consisted of only the following four species: C. canadensis, ryegrass, and V. thapsus (50.0%), and B. inermis (37.5%). Besides ryegrass (100.0%), other exotics found on transects in seeded areas in region 3 were L. perenne (77.8%), B. inermis (55.6%), V. thapsus (50.0%), B. japonicus and C. canadensis (22.2%), and B. tectorum (11.1%). Only two exotic species were found on transects in the unseeded areas in region 3: C. canadensis (87.5%) and Lactuca serriola (12.5%). Interesting points to note are that ryegrass occurred on all transects in the seeded areas in regions 2 and 3, and B. japonicus, B. tectorum, L. perenne, and T. aestivum were only found on seeded transects. Consideration must given to the abnormally high amounts of precipitation in April and May of this year as it may have contributed to the success of exotics introduced into this system.

As previously mentioned, a survey of plants in the immediate vicinity of the transect were identified and given a cover class, but these are not included in this report. Hence, additional exotic species may have been observed on site.

Objective 4: Effect of Ryegrass on Native Forbs and Conifer Regeneration

Increased ryegrass cover was associated with decreased overstory of native forbs (Fig. 1), decreased native forb species richness (Fig. 2), and decreased conifer seedling density (Fig. 3). It appears that ryegrass has out-competed native forbs and conifer seedlings by reducing available light, nutrients, or water (Corbett and Rice 1966, Hanes 1971, Biswell 1974, Arndt 1979, Wakimoto 1979, Keeley 1981, Gautier 1982, Griffin 1982, Zedler et al. 1983, Nadkarni and Odion 1986, Conard et al. 1991).

Objective 5: Effects of Strata and Litter on Conifer Regeneration

Strata

Mean number (and SE) of conifer seedlings per plot for all 3 regions according to strata are in table 15. There was no difference in the number of conifer seedlings between seeding treatments and regions, but there were more conifer seedlings in areas of moderate burn intensity (Table 16). According to these results and the maps made in 1998, conifer regeneration was indicative of the burn intensity (moderate) because more live trees survived to provide a seed source for natural regeneration. Since the lightly burned to unburned areas were not included in the ANOVA, it is worth noting that the highest conifer regeneration occurred in these areas where most of the trees survived (Table 15).

Litter

Mean percent litter (and SE) per transect for all 3 regions according to strata are in table 17. There was no difference in percent litter between seeding treatments and regions, but there was more litter in areas of moderate burn intensities (Table 18). Increased percent litter was associated with an increase in conifer seedling density (moderate and high burn intensities, both seeding treatments, and all regions) (Fig. 4). Transects in moderate burn intensities not only had more pine needle litter on the ground, but according to mapping done in 1998, there were higher incidences of live trees within 50 m of the plot. Again, as with conifer regeneration and burn intensity, the needle litter could be more indicative of the burn intensity in which needles were scorched but not

consumed, allowing more trees to survive, providing a seed source for natural regeneration. Percent litter and conifer regeneration may not have a causal relationship, but rather percent litter may only be a function of burn intensity.

Objective 6: Ungulate Grazing

Mean number (and standard error) of ungulate pellet groups for all 3 regions according to strata are located in table 19. More ungulate pellet groups were present on transects in seeded than unseeded areas (Table 20). Region and burn intensity had no effect on the number of pellet groups. More grass overstory in seeded regions may have provided more forage and cover for ungulates resulting in more use, and thus more pellet groups in these areas.

UPDATE

During the summer of 1998, these 49 transects and plots were re-read and evaluated. Empirical evidence shows the following trends: ryegrass has diminished to litter in most areas; survival of last year's conifer seedlings is approximately 2% (seeded) vs. 25% (unseeded) in high burn intensity areas, and 33% (seeded) vs. 32% (unseeded) in moderate burn intensity areas; there is new conifer seedling establishment this year; C. canadensis may be the dominant exotic this year (especially in the unseeded areas); and, some of last year's common native forbs (e.g., Bahia dissecta, Chenopodium graveolens, Conyza schiendeanana, Linum neomexicanum, and Nama dichotomum) are almost non-existent this year.

A GIS map (Map 1) and UTM coordinates of all transects (Appendix A) are included in this report. Data sheets with standing trees, pellet groups, and conifer seedling information, and plot maps are available upon request.

Following the completion of this report, the analysis of the data collected in 1998, and the remaining 1997 data, will begin. Anticipated date of completion for detailed final report is summer 1999.

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Table 1. Sampling design and layout of transects and plots.

Region	Burn Intensity	Seeding Treatment	N
1 Elevation: 2373 - 2593 m	High	Seeded	4
		Unseeded	0
	Moderate	Seeded	4
		Unseeded	0
	Unburned	Seeded	0
		Unseeded	2
2 Elevation: 2342 - 2410 m	High	Seeded	4
		Unseeded	4
	Moderate	Seeded	5
		Unseeded	4
	Unburned	Seeded	0
		Unseeded	2
3 Elevation: 2068 - 2410 m	High	Seeded	4
		Unseeded	4
	Moderate	Seeded	5
		Unseeded	4
	Unburned	Seeded	0
		Unseeded	3
Total			49

Table 2. Mean percent overstory (and SE) cover by life form according to region, seeding treatment, and burn intensity (BI).

		Region 1				Region 2				Region 3			
		Seeded		Unseeded		Seeded		Unseeded		Seeded		Unseeded	
		High BI		Moderate BI		Unburned		High BI		Moderate BI		Unburned	
Life Form		n = 8	n = 8	n = 2	n = 8	n = 8	n = 9	n = 8	n = 8	n = 2	n = 8	n = 9	n = 8
Tree	mean	0.28	1.60	52.35	0.025	1.04	1.04	0	0.20	54.95	0	0.44	0.18
	SE	0.28	1.60	15.25	0.025	1.04	1.04	0	0.17	10.35	0	0.44	0.10
Shrub	mean	9.00	1.25	6.20	9.45	3.60	3.60	12.70	11.28	6.15	1.05	4.34	0.28
	SE	4.86	0.66	0.80	4.21	1.89	1.89	6.38	9.85	6.15	1.02	1.19	0.19
Sub-shrub	mean	0.10	0	0.050	1.78	0.20	0.20	1.00	2.33	0	1.08	0.80	0.025
	SE	0.10	0	0.050	1.03	0.20	0.20	0.97	0.99	0	0.64	0.43	0.025
Grass/sedge	mean	57.43	54.55	7.25	45.73	41.26	41.26	11.00	6.65	18.85	37.65	42.76	1.25
	SE	7.43	17.44	3.05	5.43	10.02	10.02	4.04	2.15	11.75	14.73	13.88	0.44
Forb	mean	8.55	13.88	10.30	5.08	2.86	2.86	4.43	4.05	6.80	17.70	12.52	38.08
	SE	3.03	6.73	0.20	3.62	0.61	0.61	3.51	0.97	3.60	9.22	5.38	8.50
Mushroom	mean	0.025	0	0	0	0	0	0.025	0.050	0.050	0	0.060	0
	SE	0.025	0	0	0	0	0	0.025	0.029	0.050	0	0.040	0

Table 3. Overstory differences according to life form and strata (significant p-values in bold).

Life form	Strata	Mean difference	SE	F*	P	95% C.I. (lower & upper)	
Tree	Burn intensity	-0.43	0.25	2.83	0.10	-0.094	0.090
	Seeding treatment	-0.11	0.25	0.18	0.67	-0.063	0.41
	Region	-0.14	0.25	0.30	0.59	-0.066	0.38
Shrub	Burn intensity	0.29	1.48	0.04	0.84	-2.73	3.32
	Seeding treatment	-1.00	1.48	0.46	0.50	-4.03	2.02
	Region	3.42	1.45	5.38	0.030	0.41	6.44
Sub-shrub	Burn intensity	0.18	0.25	0.51	0.48	-0.33	0.69
	Seeding treatment	-0.05	0.25	0.05	0.83	-0.56	0.46
	Region	-0.29	0.25	1.34	0.26	-0.22	0.80
Grass/sedge	Burn intensity	-0.65	3.08	0.05	0.83	-6.95	5.64
	Seeding treatment	17.23	3.08	31.24	<0.0001	10.93	23.52
	Region	1.43	3.07	0.22	0.65	-4.85	7.70
Forb	Burn intensity	0.90	1.73	0.27	0.60	-2.63	4.44
	Seeding treatment	-5.97	1.73	11.96	0.0017	-9.52	-2.44
	Region	-11.32	1.73	43.00	<0.0001	-14.85	-7.79
	Seed trt x region	5.83	1.73	11.41	0.0021	2.30	9.37
Mushroom/fungus	Burn intensity	-0.01	0.0075	2.11	0.16	-0.026	0.0044
	Seeding treatment	-0.0016	0.0075	0.048	0.83	-0.017	0.014
	Region	0.001	0.0075	0.02	0.89	-0.014	0.016
	Seed trt x region	-0.018	0.0075	5.63	0.025	-0.033	-0.0024

*df = 3,33

Table 4. Mean percent understory cover (and SE) by life form according to region, seeding treatment, and burn intensity (BI).

Life Form	Region 1						Region 2						Region 3					
	Seeded			Unseeded			Seeded			Unseeded			Seeded			Unseeded		
	n = 8	n = 8	n = 8	n = 2	n = 8	n = 8	n = 8	n = 9	n = 8	n = 8	n = 8	n = 8	n = 8	n = 9	n = 8	n = 8	n = 8	n = 3
	High BI	Moderate BI	Unburned	High BI	Moderate BI	Unburned	High BI	Moderate BI	Unburned	High BI	Moderate BI	Unburned	High BI	Moderate BI	Unburned	High BI	Moderate BI	Unburned
Tree	mean	0.75	0.38	1.30	1.08	0.86	0.90	0.70	0.10	0.78	0.96	0.40	0.43	0.40	0.43	0.40	0.40	0.40
	SE	0.41	0.24	0.50	0.70	0.37	0.53	0.35	0.10	0.78	0.47	0.15	0.43	0.31	0.43	0.31	0.31	0.31
Shrub	mean	0.10	0	0.050	0.050	0	0.10	0	0.050	0	0.060	0	0	0	0	0	0	0
	SE	0.071	0	0.050	0.050	0	0.041	0	0.050	0	0.027	0	0	0	0	0	0	0
Sub-shrub	mean	0	0	0	0.025	0	0	0.025	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0.025	0	0	0.025	0	0	0	0	0	0	0	0	0	0
Grass/sedge	mean	2.48	1.75	0.45	0.93	1.82	1.28	0.15	0.50	2.45	1.24	0.025	0.53	0.93	0.53	0.93	0.93	0.93
	SE	0.80	0.42	0.050	0.32	0.92	0.95	0.17	0.20	1.64	0.77	0.025	0.26	0.88	0.26	0.88	0.88	0.88
Forb	mean	0.025	0	0.050	0.23	0.26	0	0	1.20	0.20	0.12	0.025	0.75	0.033	0.75	0.033	0.033	0.033
	SE	0.025	0	0.050	0.14	0.21	0	0	1.20	0.12	0.12	0.025	0.27	0.033	0.27	0.033	0.033	0.033
Mushroom	mean	0	0	0	0	0	0	0.025	0	0	0	0	0.050	0	0.050	0	0	0
	SE	0	0	0	0	0	0	0.025	0	0	0	0	0.050	0	0.050	0	0	0
Moss	mean	3.55	16.88	2.50	0.98	1.56	0	11.23	1.00	0.050	4.54	0.40	2.05	0.033	2.05	0.033	0.033	0.033
	SE	1.24	7.34	2.50	0.98	0.69	0	5.99	0.80	0.050	3.13	0.57	1.16	0.033	1.16	0.033	0.033	0.033

Table 5. Understory differences according to life form and strata (significant p-values in bold).

Life form	Strata	Mean difference	SE	F*	P	95% C.I. (lower & upper)	
Tree	Burn intensity	0.025	0.17	0.022	0.88	-0.31	0.36
	Seeding treatment	0.16	0.17	0.89	0.35	-0.18	0.50
	Region	0.11	0.17	0.46	0.50	-0.23	0.45
Shrub	Burn intensity	0.011	0.0098	1.14	0.29	-0.0096	0.031
	Seeding treatment	0.002	0.0098	0.040	0.84	-0.018	0.022
	Region	0.0088	0.0098	1.12	0.30	-0.0097	0.031
	BI x region	0.027	0.0098	7.60	0.010	0.0070	0.047
Sub-shrub	Burn intensity	0.00033	0.0042	0.0062	0.94	-0.0082	0.0088
	Seeding treatment	-0.00033	0.0042	0.0062	0.94	-0.0089	0.0082
	Region	0.0059	0.0042	2.00	0.17	-0.0026	0.014
Grass/sedge	Burn intensity	0.16	0.29	0.16	0.69	-0.47	0.70
	Seeding treatment	0.56	0.29	3.83	0.060	-0.025	1.14
	Region	0.0088	0.29	0.0010	0.98	-0.57	0.59
Forb	Burn intensity	-0.080	0.059	1.86	0.18	-0.20	0.040
	Seeding treatment	-0.013	0.059	0.0005	0.98	-0.12	0.12
	Region	-0.075	0.059	1.63	0.21	-0.19	0.045
	Seed trt x region	0.12	0.059	4.15	0.051	-0.00045	0.24
Mushroom/fungus	Burn intensity	-0.0089	0.0064	1.93	0.18	-0.022	0.0042
	Seeding treatment	-0.0099	0.0064	2.38	0.13	-0.023	0.0032
	Region	-0.0030	0.0064	0.21	0.65	-0.016	0.010
Moss	Burn intensity	-2.54	1.18	4.62	0.040	-4.96	-0.13
	Seeding treatment	-0.032	1.18	0.0007	0.98	-2.45	2.39
	Region	1.52	1.18	1.66	0.21	-0.89	3.93

*df = 3,33

Table 6. Mean native forb overstory according to region, seeding treatment, and burn intensity.

	Region 1			Region 2					Region 3				
	Seeded		Unseeded	Seeded		Unseeded			Seeded		Unseeded		
	High BI	Moderate BI	Unburned	High BI	Moderate BI	High BI	Moderate BI	Unburned	High BI	Moderate BI	High BI	Moderate BI	Unburned
	n = 4	n = 4	n = 2	n = 4	n = 5	n = 4	n = 4	n = 2	n = 4	n = 5	n = 4	n = 4	n = 3
mean	8.65	13.14	10.66	2.23	2.20	3.82	3.02	5.04	17.71	4.55	41.89	38.78	18.51
SE	2.99	6.44	0.340	1.00	0.56	3.30	1.17	1.86	9.19	2.69	12.18	4.06	6.25

Table 7. Mean native forb understory according to region, seeding treatment, and burn intensity.

Region 1				Region 2				Region 3					
Seeded		Unseeded		Seeded		Unseeded		Seeded		Unseeded			
High BI	Moderate BI	Unburned	High BI	Moderate BI	High BI	Moderate BI	Unburned	High BI	Moderate BI	High BI	Moderate BI	Unburned	
n = 4	n = 4	n = 2	n = 4	n = 5	n = 4	n = 4	n = 2	n = 4	n = 5	n = 4	n = 4	n = 3	
mean	0.015	0.020	0.050	0.17	0.012	0	0.010	0.030	0.20	0	0	0.25	0.027
SE	0.015	0.0082	0.050	0.13	0.012	0	0.010	0.030	0.12	0	0	0.12	0.018

Table 8. Mean native forb species richness according to region, seeding treatment, and burn intensity.

Region 1				Region 2				Region 3					
Seeded		Unseeded		Seeded		Unseeded		Seeded		Unseeded			
High BI	Moderate BI	Unburned	High BI	Moderate BI	High BI	Moderate BI	Unburned	High BI	Moderate BI	High BI	Moderate BI	Unburned	
n = 4	n = 4	n = 2	n = 4	n = 5	n = 4	n = 4	n = 2	n = 4	n = 5	n = 4	n = 4	n = 3	
mean	11.0	11.8	18.5	9.8	9.8	7.8	9.8	14.0	12.8	12.6	12.3	13.3	15.7
SE	1.7	1.9	6.5	1.4	1.0	1.2	1.4	0	4.1	2.9	1.1	1.7	3.8

Table 9. Differences of percent cover and native forb species richness according to strata (significant p-values in bold).

Life form	Strata	Mean difference	SE	F*	P	95% C.I. (lower & upper)
% overstory native forbs	Burn intensity	2.20	1.90	1.34	0.26	-1.69 6.09
	Seeding treatment	-7.66	1.90	16.24	0.0004	-11.55 -3.77
	Region	-11.27	1.90	35.24	<0.0001	-15.16 -7.39
	Seed trt x Region	7.18	1.90	14.31	0.0007	3.30 11.07
% understory native forbs	Burn intensity	0.011	0.025	0.19	0.67	-0.041 0.063
	Seeding treatment	0.014	0.025	0.30	0.59	-0.038 0.066
	Region	-0.03	0.025	1.40	0.25	-0.082 0.022
	Seed trt x burn int	0.076	0.025	8.93	0.0057	0.024 0.13
native forb species richness	Burn intensity	0.017	0.55	0.001	0.98	-1.10 1.13
	Seeding treatment	-0.15	0.55	0.072	0.79	-1.26 0.97
	Region	-2.03	0.55	13.90	0.0008	-3.16 -0.92
	Seed trt x burn int	0.076	0.025	8.93	0.0057	0.024 0.13

*df = 3,33

Table 10. Number and percent of transects on which each native forb was found.

[illegible]

<i>Ipomopsis aggregata</i>	1	12.5	1	50.0	2	22.2	0	0	0	0	2	22.2	1	12.5	3	100.0
<i>Kuhnia chlorepis</i>	0	0	0	0	0	0	0	0	0	0	2	22.2	1	12.5	0	0
<i>Lappula redowski</i>	0	0	0	0	1	11.1	0	0	0	0	0	0	0	0	0	0
<i>Liatris punctata</i>	0	0	0	0	0	0	0	0	0	0	0	0	2	25.0	0	0
<i>Linum neomexicanum</i>	2	25.0	1	50.0	2	22.2	0	0	1	50.0	3	33.3	0	0	2	66.7
<i>Lithospermum multiflorum</i>	2	25.0	2	100.0	2	22.2	0	0	0	0	3	33.3	0	0	1	33.3
<i>Lotus wrightii</i>	0	0	0	0	0	0	0	0	1	50.0	2	22.2	7	87.5	1	33.3
<i>Lupinus kingii</i>	0	0	0	0	0	0	0	0	0	0	1	11.1	0	0	0	0
<i>Mentzelia albicaulis</i>	0	0	0	0	0	0	0	0	0	0	1	11.1	2	25.0	1	33.3
<i>M. pumila</i>	0	0	0	0	0	0	0	0	0	0	1	11.1	0	0	0	0
<i>Mertensia lanceolata</i>	1	12.5	0	0	0	0	2	25.0	0	0	1	11.1	0	0	0	0
<i>Nama dichotomum</i>	0	0	0	0	0	0	1	12.5	0	0	2	22.2	4	50.0	1	33.3
<i>Oenothera hookeri</i>	2	25.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Oxybaphus linearis</i>	0	0	0	0	1	11.1	1	12.5	0	0	2	22.2	0.1	12.5	0	0
<i>Penstemon barbatus</i>	2	25.0	0	0	1	11.1	0	0	0	0	2	22.2	2	25.0	0	0
<i>Phacelia heterophylla</i>	0	0	0	0	1	11.1	0	0	0	0	0	0	0	0	0	0
<i>Physalis foetens</i>	0	0	0	0	0	0	0	0	0	0	1	11.1	0	0	0	0
<i>Polygonum sawatchense</i>	0	0	0	0	0	0	0	0	0	0	0	0	6	75.0	0	0
<i>Pseudocympterus montanus</i>	0	0	0	0	2	22.2	0	0	0	0	2	22.2	0	0	0	0
<i>Senecio eremophilis</i>	1	12.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>S. fendleri</i>	1	12.5	1	50.0	0	0	0	0	0	0	0	0	0	0	0	0
<i>S. wootonii</i>	2	25.0	1	50.0	1	11.1	0	0	0	0	0	0	0	0	0	0
<i>Sisymbrium linearifolium</i>	0	0	0	0	0	0	0	0	0	0	1	11.1	1	12.5	0	0
<i>Solidago sp.</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	12.5	0	0
<i>S. spathulata</i>	0	0	0	0	0	0	0	0	0	0	1	11.1	0	0	0	0
<i>Sphaeralcea fendleri</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	12.5	0	0
<i>Taraxacum officinale</i>	1	12.5	1	50.0	1	11.1	4	50.0	0	0	0	0	0	0	0	0
<i>Thelypodium wrightii</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	12.5	0	0
<i>Thermopsis pinetorum</i>	0	0	1	50.0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Townsendia incana</i>	0	0	0	0	2	22.2	0	0	0	0	0	0	1	12.5	0	0
<i>Vicia americana</i>	0	0	1	50.0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Viguieria multiflora</i>	0	0	0	0	0	0	0	0	0	0	1	11.1	0	0	1	33.3

Table 11. Mean overstory cover exotic plant species by region and seeding treatment.

Exotic species	Region 1				Region 2				Region 3			
	Seeded		Unburned/ Unseeded		Seeded		Unseeded		Seeded		Unseeded	
	n = 8		n = 2		n = 9		n = 8		n = 9		n = 8	
	mean	SE	mean	SE	mean	SE	mean	SE	mean	SE	mean	SE
<i>Bromus inermis</i>	0.78	0.30	0	0	0.59	0.24	0.30	0.20	0.62	0.41	0	0
<i>B. tectorum</i>	0.075	0.062	0	0	0.089	0.051	0	0	0	0	0	0
<i>Conyza canadensis</i>	0.36	0.35	0	0	0	0	0.49	0.34	0.46	0.36	2.88	2.09
<i>Lolium multiflorum</i>	11.56	3.87	0	0	15.38	2.47	0.75	0.45	17.33	8.18	0	0
<i>L. perenne</i>	0.13	0.11	0	0	1.07	0.37	0	0	0.58	0.26	0	0
<i>Verbascum thapsus</i>	0.64	0.54	0	0	1.47	1.18	0.50	0.28	2.57	1.36	0	0

Table 12. Mean understory cover exotic plant species by region and seeding treatment.

Exotic species	Region 1						Region 2						Region 3					
	Seeded		Unburned/ Unseeded		Seeded		Unseeded		Unburned/ Unseeded		Seeded		Unseeded		Unburned/ Unseeded		Unburned/ Unseeded	
	mean	SE	mean	SE	mean	SE	mean	SE	mean	SE	mean	SE	mean	SE	mean	SE	mean	SE
	n = 8		n = 2		n = 9		n = 8		n = 2		n = 9		n = 8		n = 3			
<i>Bromus inermis</i>	0.028	0.028	0	0	0.069	0.036	0.053	0.034	0.090	0.090	0.029	0.029	0	0	0	0	0	0
<i>B. tectorum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Conyza canadensis</i>	0	0	0	0	0	0	0	0	0.46	0.46	0.0044	0.0044	0.025	0.017	0	0	0	0
<i>Lolium multiflorum</i>	0.21	0.16	0	0	0.25	0.11	0.64	0.62	0	0	0.26	0.075	0	0	0	0	0	0
<i>L. perenne</i>	0.0050	0.0050	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Verbascum thapsus</i>	0	0	0	0	0.024	0.018	0.0050	0.0050	0	0	0.040	0.040	0	0	0	0	0	0

Table 13. Number and percent of transects on which each exotic was found.

Region 1				Region 2				Region 3							
Seeded	Unburned/ Unseeded	Seeded	Unburned/ Unseeded	Seeded	Unburned/ Unseeded	Seeded	Unburned/ Unseeded	Seeded	Unburned/ Unseeded	Seeded	Unburned/ Unseeded				
n = 8		n = 2		n = 9		n = 8		n = 2		n = 9		n = 8		n = 3	
Exotic species	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#
Bromus inermis	6	75.0	0	0	7	77.8	3	37.5	1	50.0	5	55.6	0	0	0
B. japonicus	1	12.5	0	0	2	22.2	0	0	0	0	2	22.3	0	0	0
B. tectorum	3	37.5	0	0	5	55.6	0	0	0	0	1	11.1	0	0	0
Conyza canadensis	2	25.0	1	50.0	0	0	4	50.0	1	50.0	2	22.2	7	87.5	1
Lactuca serriola	0	0	0	0	0	0	0	0	0	0	0	0	1	12.5	0
Lolium multiflorum	7	87.5	1	50.0	9	100.0	4	50.0	2	100.0	9	100.0	0	0	1
L. perenne	2	25.0	0	0	7	77.8	0	0	0	0	7	77.8	0	0	0
Triticum aestivum	0	0	0	0	1	11.1	0	0	0	0	0	0	0	0	0
Verbascum thapsus	3	37.5	1	50.0	3	33.3	4	50.0	1	50.0	4	50.0	0	0	1

Table 14. Differences in number of extotic plants per transect according to strata (significant p-values in bold).

Life form	Strata	Mean difference	SE	F*	P	95% C.I. (lower & upper)	
% overstory exotics	Burn intensity	-2.44	2.22	1.21	0.28	-6.96	2.09
	Seeding treatment	8.34	2.22	14.16	0.0007	3.81	12.87
	Region	-0.96	2.21	0.19	0.67	-5.47	3.55
% understory exotics	Burn intensity	-0.0063	0.039	0.025	0.87	-0.086	0.074
	Seeding treatment	0.15	0.039	14.62	0.0006	0.070	0.23
	Region	0.0088	0.039	0.051	0.82	-0.071	0.089
Exotic species richness	Burn intensity	-0.59	0.18	10.61	0.0028	-0.96	-0.22
	Seeding treatment	1.03	0.18	32.23	<0.0001	0.66	1.40
	Region	0.32	0.18	3.22	0.083	-0.044	0.69

*df = 3,33

Table 16. Differences in number of conifer seedlings per plot according to strata (significant p-values in bold).

Life form	Strata	Mean difference	SE	F*	P	95% C. I. (lower and upper)	
# conifer seedlings	Burn intensity	-0.46	0.066	48.32	<0.0001	-0.60	-0.33
	Seeding treatment	-0.020	0.066	0.092	0.76	-0.12	0.16
	Region	0.075	0.066	1.28	0.27	0.27	0.21

*df = 3,33

Table 17. Mean percent cover litter per transect according to strata.

		Region 1				Region 2				Region 3			
		Seeded		Unseeded		Seeded		Unseeded		Seeded		Unseeded	
		High BI		Moderate BI		Unburned		High BI		Moderate BI		Unburned	
		n = 4	n = 4	n = 2	n = 4	n = 5	n = 4	n = 4	n = 2	n = 4	n = 5	n = 4	n = 3
mean	24.15	58.05	63.45	10.85	52.48	3.43	63.95	82.00	4.03	71.76	8.65	54.90	78.37
SE	9.79	6.45	4.55	6.46	11.21	1.36	6.15	8.60	1.34	7.88	6.83	14.48	9.12

Table 18. Differences in percent litter per transect according to strata (significant p-values in bold).

Life form	Strata	Mean difference	SE	F*	P	95% C. I. (lower and upper)
% litter	Burn intensity	-27.03	2.94	84.73	<0.0001	-33.03 -21.04
	Seeding treatment	1.04	2.94	0.13	0.73	-4.96 7.04
	Region	-1.58	2.93	0.29	0.59	-7.56 4.40

*df = 3,33

Table 19. Mean number (and SE) of ungulate pellet groups per transect (1997) according to region, seeding treatment, and burn intensity.

		Region 1				Region 2				Region 3				
		Seeded		Unseeded		Seeded		Unseeded		Seeded		Unseeded		
		High BI	Moderate BI	Unburned	High BI	Moderate BI	High BI	Moderate BI	Unburned	High BI	Moderate BI	High BI	Moderate BI	Unburned
		n = 4	n = 4	n = 2	n = 4	n = 5	n = 4	n = 4	n = 4	n = 2	n = 4	n = 5	n = 4	n = 3
mean		12.00	16.25	6.00	10.50	19.00	0.75	3.00	16.00	4.75	9.60	0	0.75	5.33
SE		5.82	5.81	6.00	3.62	8.48	0.75	1.78	3.00	4.11	2.79	0	0.48	3.38

Table 20. Differences in number of ungulate pellet groups per transect (1997) according to strata (significant p-values in bold).

Life form	Strata	Mean difference	SE	F*	P	95% C. I. (lower and upper)	
# pellet groups	Burn intensity	-2.11	1.46	2.09	0.16	-5.09	0.87
	Seeding treatment	4.99	1.46	11.68	0.0018	2.01	7.97
	Region	2.41	1.45	2.75	0.11	-0.56	5.38

*df = 3,33

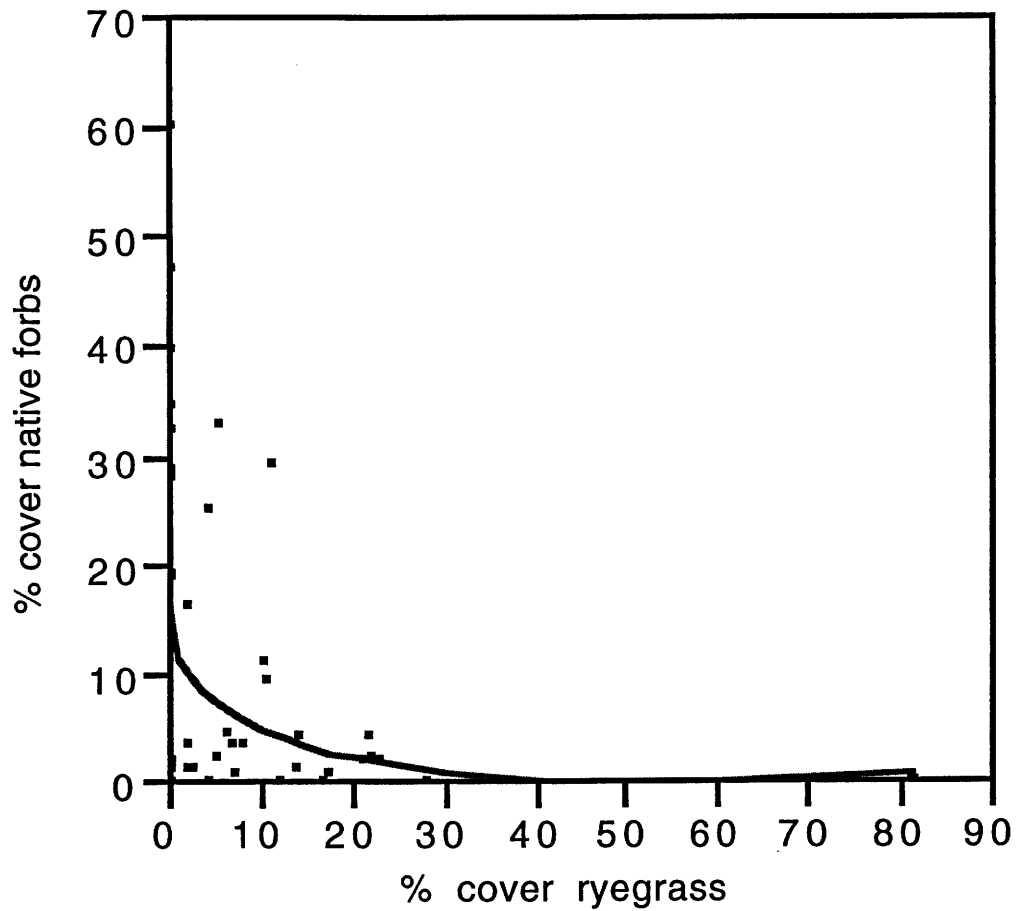


Fig. 1. Percent overstory ryegrass (*Lolium* spp.) (live and dead) vs. percent overstory native forbs. R^2 adjusted = 0.30, $F_{1,40} = 16.59$, $p = 0.0002$; $(\% \text{ cover overstory native forbs})^{0.5} = 4.04$ (SE = 0.41) - 0.56 (SE = 0.14) $(\% \text{ cover overstory ryegrass})^{0.5}$.

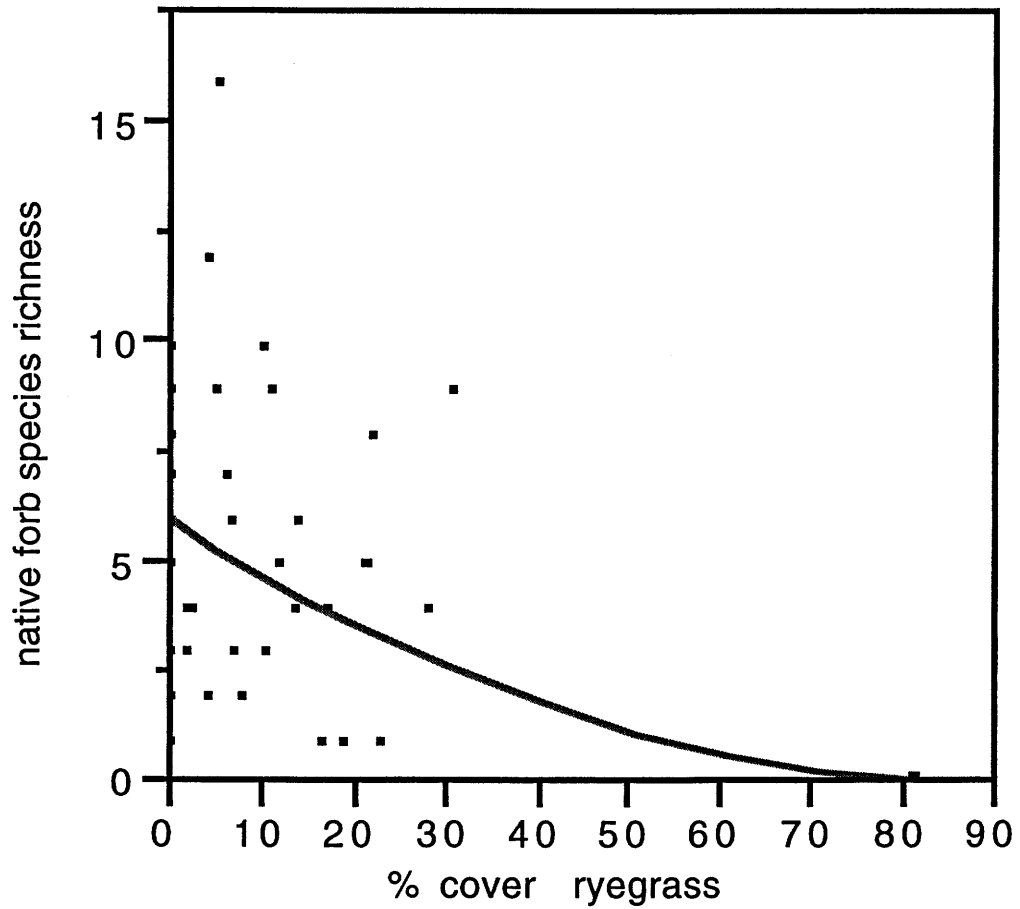


Fig. 2. Percent overstory ryegrass (*Lolium* spp.) (live and dead) vs. native forb species richness. R^2 adjusted = 0.22, $F_{1,40} = 12.53$, $p = 0.0011$; $(\text{native forb species richness})^{0.5} = 2.45$ (SE = 0.13) - 0.028 (SE = 0.0078) $(\% \text{ cover overstory ryegrass})^{0.5}$.

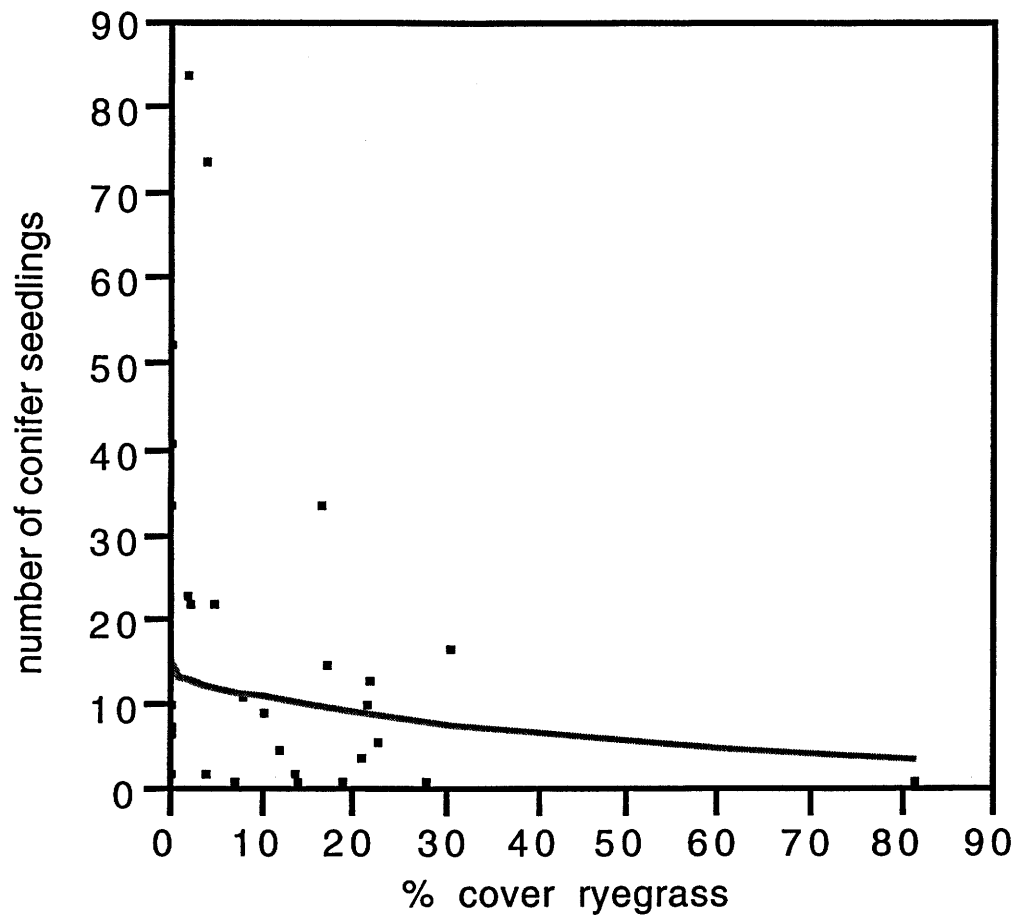


Fig. 3. Percent overstory ryegrass (live and dead) vs. number of conifer seedlings per plot. R^2 adjusted = 0.020, $F_{1,41} = 12.69$, $p = 0.38$; number of conifer seedlings = $15.19 \text{ (SE} = 4.51) - 1.31 \text{ (SE} = 1.46) (\% \text{ cover overstory ryegrass})^{0.5}$.

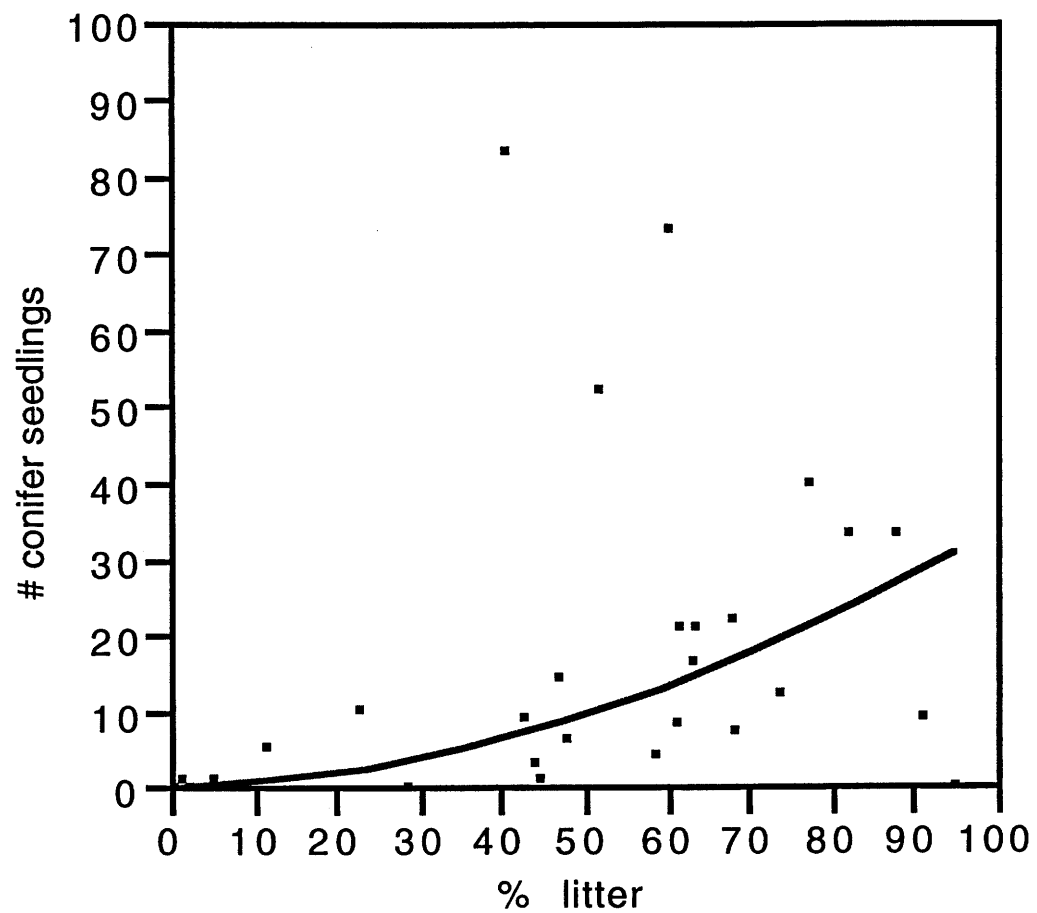
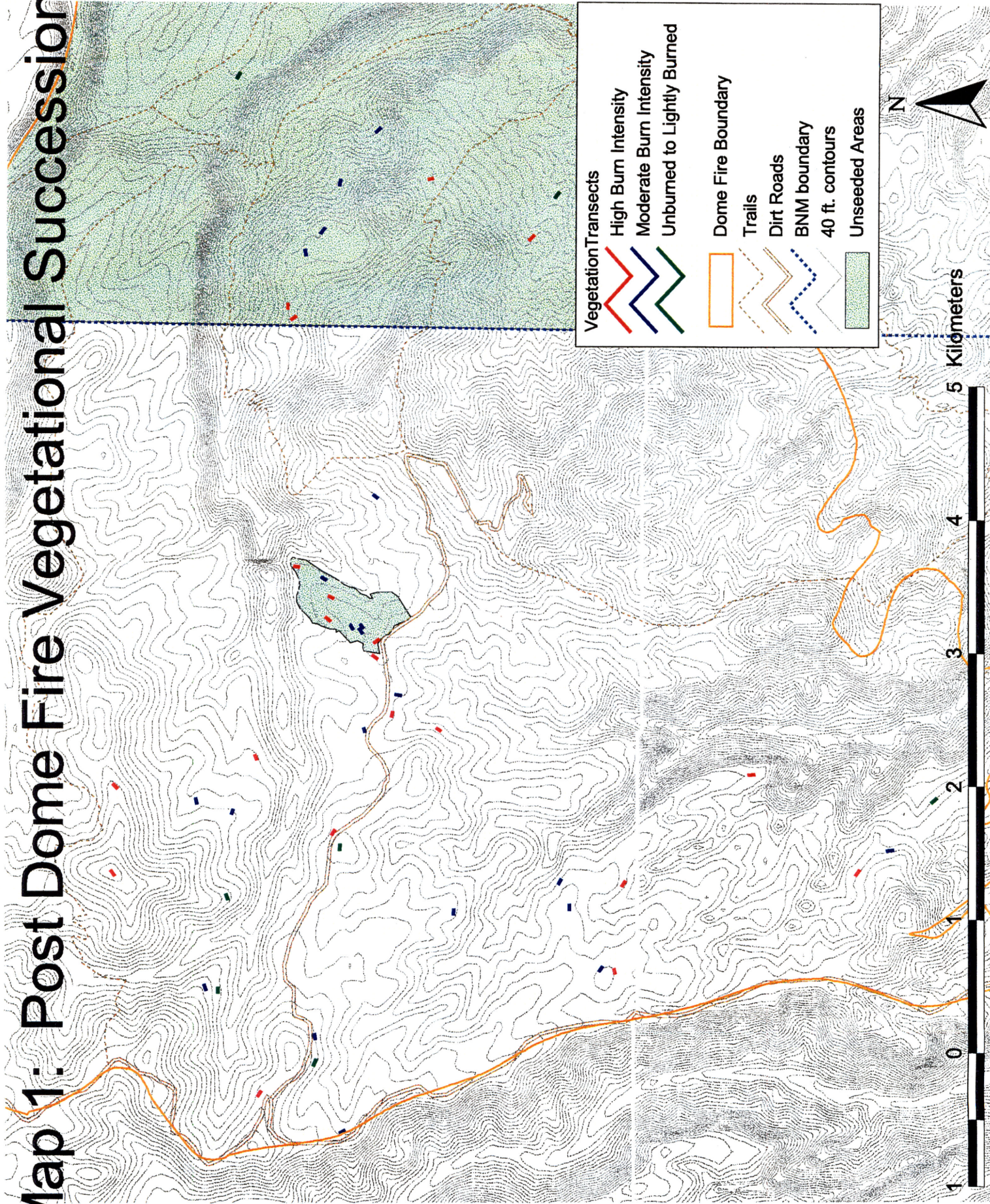


Fig. 4. Percent litter vs. number of conifer seedlings per plot. R^2 adjusted = 0.41, $F_{1,41} = 29.55$, $p < 0.0001$; $(\text{number of conifer seedlings})^{0.5} = 0.48 \text{ (SE = 0.47)} + 0.054 \text{ (SE = 0.0099) \% litter}$.

Map 1: Post Dome Fire Vegetational Succession



Appendix A: UTM coordinates for Dome Fire Vegetation Recovery Transects.

Transect	Easting	Northing	Burn Intensity	Seeding Treatment	Transect End
1has1	374279	3959644	high	seeded	0m
1has1	374322	3959661	high	seeded	50m
1has2	373491	3960692	high	seeded	0m
1has2	373447	3960660	high	seeded	50m
1hbs1	371904	3959610	high	seeded	0m
1hbs1	371862	3959640	high	seeded	50m
1hbs2	374071	3960642	high	seeded	0m
1hbs2	374111	3960679	high	seeded	50m
1mas1	373888	3959825	moderate	seeded	0m
1mas1	373929	3959812	moderate	seeded	50m
1mas2	374010	3960081	moderate	seeded	0m
1mas2	373962	3960070	moderate	seeded	50m
1mbs1	372624	3960004	moderate	seeded	0m
1mbs1	372672	3960021	moderate	seeded	50m
1mbs2	373673	3961045	moderate	seeded	0m
1mbs2	373623	3961072	moderate	seeded	50m
1u1	373275	3959849	unburned	unseeded	0m
1u1	373320	3959866	unburned	unseeded	50m
1u2	372601	3959919	unburned	unseeded	0m
1u2	372651	3959922	unburned	unseeded	50m
2has1	375033	3958825	high	seeded	0m
2has1	375002	3958781	high	seeded	50m
2has2	374582	3958685	high	seeded	0m
2has2	374629	3958673	high	seeded	50m
2hbs1	373782	3959087	high	seeded	0m
2hbs1	373736	3959112	high	seeded	50m
2hbs2	374483	3958328	high	seeded	0m
2hbs2	374511	3958366	high	seeded	50m
2mas1	373161	3958242	moderate	seeded	0m
2mas1	373209	3958234	moderate	seeded	50m
2mas2	374514	3958884	moderate	seeded	0m
2mas2	374477	3958872	moderate	seeded	50m
2mbs1	372267	3959225	moderate	seeded	0m
2mbs1	372316	3959232	moderate	seeded	50m
2mbs2	374748	3958662	moderate	seeded	0m
2mbs2	374740	3958611	moderate	seeded	50m
2mbs3	376186	3958821	moderate	seeded	0m
2mbs3	376159	3958780	moderate	seeded	50m
2hau1	375147	3958771	high	unseeded	0m
2hau1	375116	3958815	high	unseeded	50m
2hau2	375438	3959096	high	unseeded	0m
2hau2	375458	3959140	high	unseeded	50m
2hbu1	375667	3959340	high	unseeded	0m
2hbu1	375671	3959387	high	unseeded	50m
2hbu2	375308	3959159	high	unseeded	0m
2hbu2	375274	3959120	high	unseeded	50m
2mau1	375220	3958885	moderate	unseeded	0m
2mau1	375256	3958911	moderate	unseeded	50m
2mau2	375226	3958917	moderate	unseeded	0m
2mau2	375184	3958886	moderate	unseeded	50m

2mbu1	375250	3958981	moderate	unseeded	0m
2mbu1	375211	3958957	moderate	unseeded	50m
2mbu2	375571	3959149	moderate	unseeded	0m
2mbu2	375596	3959188	moderate	unseeded	50m
2u1	373677	3959048	unburned	unseeded	0m
2u1	373625	3959054	unburned	unseeded	50m
2u2	372080	3959240	unburned	unseeded	0m
2u2	372131	3959217	unburned	unseeded	50m
3has1	372740	3957082	high	seeded	0m
3has1	372784	3957094	high	seeded	50m
3has2	374172	3956083	high	seeded	0m
3has2	374171	3956138	high	seeded	50m
3hbs1	373368	3957040	high	seeded	0m
3hbs1	373410	3957011	high	seeded	50m
3hbs2	373489	3955341	high	seeded	0m
3hbs2	373444	3955372	high	seeded	50m
3mas1	372796	3957172	moderate	seeded	0m
3mas1	372757	3957202	moderate	seeded	50m
3mas2	373194	3957416	moderate	seeded	0m
3mas2	373246	3957413	moderate	seeded	50m
3mbs1	373426	3957469	moderate	seeded	0m
3mbs1	373381	3957493	moderate	seeded	50m
3mbs2	373631	3955097	moderate	seeded	0m
3mbs2	373623	3955153	moderate	seeded	50m
3mbs3	371620	3959013	moderate	seeded	0m
3mbs3	371595	3959055	moderate	seeded	50m
3hau1	377438	3959411	high	unseeded	0m
3hau1	377467	3959371	high	unseeded	50m
3hau2	378443	3958436	high	unseeded	0m
3hau2	378454	3958392	high	unseeded	50m
3hbu1	377512	3959430	high	unseeded	0m
3hbu1	377563	3959431	high	unseeded	50m
3hbu2	378050	3957671	high	unseeded	0m
3hbu2	378008	3957712	high	unseeded	50m
3mau1	377946	3959311	moderate	unseeded	0m
3mau1	377895	3959299	moderate	unseeded	50m
3mau2	378099	3959167	moderate	unseeded	0m
3mau2	378055	3959201	moderate	unseeded	50m
3mbu1	378816	3958771	moderate	unseeded	0m
3mbu1	378779	3958811	moderate	unseeded	50m
3mbu2	378446	3959054	moderate	unseeded	0m
3mbu2	378393	3959067	moderate	unseeded	50m
3lau1	379211	3959780	unburned	unseeded	0m
3lau1	379163	3959806	unburned	unseeded	50m
3u1	378360	3957493	unburned	unseeded	0m
3u1	378314	3957527	unburned	unseeded	50m
3u2	374004	3954789	unburned	unseeded	0m
3u2	373967	3954832	unburned	unseeded	50m