Plant Recovery in Burn Scars Following Tree Removal from a Cascade Range Meadow

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ABSTRACT

Tree removal is necessary to restore meadows that have been invaded by conifers. However, woody residues that result from tree removal present an inherit fire risk. Our team wished to determine whether woody debris could be piled and burned without irreparable, long-term damage to the vegetation. We compared recovery of plant diversity and cover in 30 burn scars (~1 m radius) relative to adjacent unburned areas in three experimental tree-removal plots. We found that within 7 yr, the vegetation largely recovered in the burned locations, suggesting that burn piles are an environmentally feasible way to dispose of woody debris during meadow restoration.

INTRODUCTION

Restoration of conifer-invaded meadows requires tree removal and subsequent treatment of residual woody fuels to lower the risk of fire. Two common alternatives for fuel reduction include broadcast burning—which requires specific weather conditions and low fuel moisture—or pile burning—which is labor intensive, but safer to implement. However, pile burning can result in intense, localized heating of the soil and the resulting burn scars may be slow to recover. As part of a large-scale meadow restoration experiment in the Oregon Cascades, we assessed changes in exposed mineral soil and in the cover and richness of plant species 7 yr after pile burning.

METHODS

We conducted our research at Bunchgrass Ridge (44^0 N, 122^0 W) in the Willamette National Forest in the Oregon Cascades (**Fig. 1**, left panel). The site supports dry montane meadows and coniferous forests resulting from nearly 200 yr of encroachment. As part of a large-scale meadow restoration experiment, trees were removed from portions of the study area and residual slash was burned in piles ~2 m wide and ~2 m tall (**Fig. 5**). In 2013, 7 yr after burning, we sampled vegetation in and adjacent to 30 burn scars (10 in each of three experimental plots); similar data had been collected 1 and 3 yr after burning. Each scar was sampled with four, 0.1 m^2 quadrats to characterize areas of higher-intensity burn at the center (C), lower-intensity burn at the edge (E), and adjacent unburned areas (U1 and U2) (**Fig. 1**, right panel). In each quadrat we recorded the cover of each species and bare ground (mineral soil).

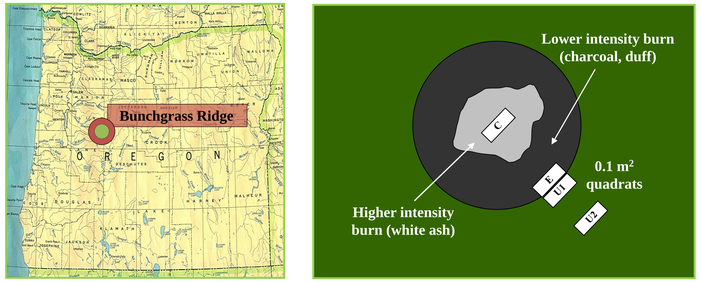
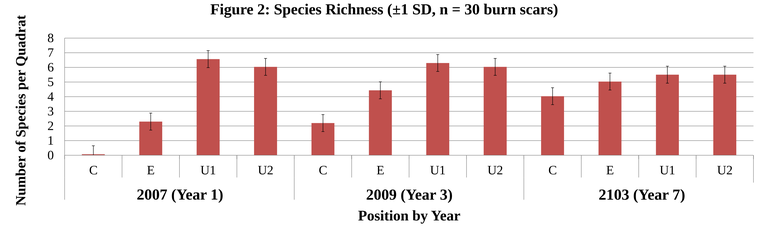


Figure 1: Location of Bunchgrass Ridge (left) and burn-scar sampling approach (right).

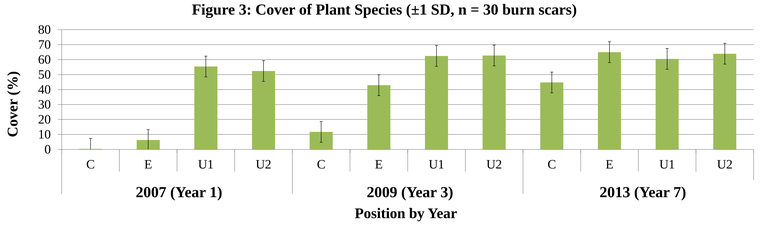
RESULTS

Figure 2: Species Richness (±1 SD, n = 30 burn scars)



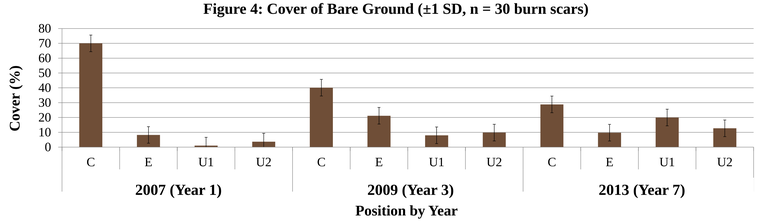
Ratio of C to Average of U1 and U2 (2007, 2009, 2013) = 0.01, 0.36, 0.73
Ratio of E to Average of U1 and U2 (2007, 2009, 2013) = 0.37, 0.72, 0.92

Figure 3: Cover of Plant Species (±1 SD, n = 30 burn scars)



Ratio of C to Average of U1 and U2 (2007, 2009, 2013) = 0.06, 0.19, 0.72
Ratio of E to Average of U1 and U2 (2007, 2009, 2013) = 0.12, 0.69, 1.04

Figure 4: Cover of Bare Ground (±1 SD, n = 30 burn scars)



Ratio of C to Average of U1 and U2 (2007, 2009, 2013) = 29.6, 4.50, 1.76
Ratio of E to Average of U1 and U2 (2007, 2009, 2013) = 3.48, 2.37, 0.60

Species Richness. From 2007 to 2013, the number of species in the unburned quadrats (U1 and U2) remained relatively constant (**Fig. 2**). In contrast, the centers and edges of the burn scars (C and E) showed continuous increases in diversity, with rates somewhat steeper at the edges where burning was less intense. Based on trends to date, diversity at the center may be comparable to unburned areas at the next measurement (compare ratios of C to averages of U1 and U2).

Cover of Plant Species. Changes in total plant cover (**Fig. 3**) were similar to those of richness. Cover in unburned quadrats remained relatively constant while cover in the centers and edges of the burn scars increased significantly. As with richness, rates of increase in cover were greater at the edges than at the centers (compare ratios of C and E to averages of U1 and U2).

Cover of Bare Ground. In the centers of the scars, where intense burning removed most of the litter layer, cover of bare ground declined (**Fig. 4**) as plant cover increased. By comparison, bare ground at the edges and in the unburned vegetation was much lower but variable over time—possibly due to soil mounding by gophers.

CONCLUSIONS

- Intensity of burning appears to influence the rate of vegetation recovery within burn scars, with the centers lagging behind the edges. However, recovery at the edges may also benefit by greater vegetative spread from adjacent unburned areas.
- Despite these differences, our results indicate that within 7 yr after pile burning, total plant cover and richness within burn scars approach levels observed in adjacent unburned vegetation.
- Given this rate of recovery it appears that not even high-intensity burning has a permanent effect on the local vegetation.

Figure 5: Burning of slash piles in 2006 (left) and post-burn measurements in 2013 (right).

FUTURE RESEARCH

We suggest that future analyses and new research address the following important questions:

1. Do current trends persist in the future? Given several more years, do the abundance and richness of species within the burn scars remain similar to those of the adjacent vegetation?
2. Although pile burning does not have a permanent effect on plant cover or richness, does it alter the local composition of species? Do certain species respond differently to burning than others?
3. Do our results apply to other meadow systems? Do different soils or vegetation types influence the pattern or pace of plant recovery following pile burning?

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