Shrub Microsite Influences Post-fire Perennial Grass Establishment

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SUMMARY

Woody plants can cause localized increases in resources (i.e., resource islands) that can persist after fire. We tested the hypothesis that burned sagebrush subcanopies would have increased seedling establishment and performance of post-fire seeded perennial bunchgrasses compared to burned interspaces. We utilized five study sites in southeastern Oregon. The area was burned in a wildfire (2007) and re-seeded in the same year with a seed mix that included non-native and native perennial bunchgrasses. Seedling density, height, and reproductive status were measured in October of 2008 in burned subcanopy and interspace microsites. Seeded non-native perennial grasses had greater densities than seeded native species and were six times more abundant in burned subcanopies compared to burned interspaces. Density of natives in burned subcanopies was 24 times higher than burned interspaces. Seedlings were taller in burned subcanopies compared to burned interspaces and subcanopy microsites had more reproductive seedlings than interspace microsites. Our results suggest pre-burn shrub cover may be important to post-fire restoration of perennial grasses. Others have found that subcanopies have increased soil organic matter, nitrogen, and carbon (i.e., resource islands) and elevated post-fire soil temperature. Determining the mechanisms responsible for increased seeding success in subcanopy microsites may suggest tactics that could be used to improve existing restoration technologies.

INTRODUCTION

Wyoming big sagebrush (Artemisia tridentata ssp. wyomingensis) plant communities periodically burn and are at risk of conversion to exotic annual grasses after fire. Post-fire establishment of perennial grasses is critical to preventing exotic annual grass invasion of these plant communities. Revegetating Wyoming big sagebrush communities is a high priority because large areas have already been converted to exotic annual grass communities.

Establishment of desired vegetation is often needed after wildfires to restore ecosystem function and prevent invasion by exotic species. However, efforts to establish desirable vegetation are often unsuccessful in Wyoming big sagebrush plant communities (Eiswerth et al. 2009). Wyoming big sagebrush plants can create resource islands (i.e., areas of higher nutrient concentration) under their canopies (Doescher et al. 1984, Davies et al. 2007) and burning does not completely eliminate the resource island effect (Davies et al. 2009). Davies et al. (2009) speculated that, after fire, the burned subcanopies would be a more conducive environment for seedling establishment than burned interspaces. However, they did not test this theory, and the influence of resource islands on post-fire establishment of vegetation remains largely unexplored.
OBJECTIVES

The objective of this study was to determine if the success of post-fire seeded perennial grasses differed between interspace and subcanopy microsites. We hypothesized that at 1-year post-fire 1) seedling density would be greater in subcanopy microsites and 2) subcanopy sites would contain taller seedlings and a higher percentage of seedlings in a reproductive state (i.e., with developed seed heads).

METHODS

This study was conducted in the Wyoming big sagebrush alliance near Drewsey, Oregon, on land administered by the Bureau of Land Management. Elevation at study sites was approximately 3,600 ft and slopes were 2 – 5 percent. Soils were a complex series and surface textures ranged from clayey, to silty or gravelly loam underlain by clay pan or bedrock at depths from 5 to 20 inches. Annual precipitation is highly variable but averages approximately 13 inches with the majority falling as rain or snow during October to March; precipitation impacting germination, emergence, growth and survival of seedlings in this study (1 October, 2007 to 30 June, 2008) was 90 percent of the long-term average.

A 32,000-acre area, which included our study sites, was burned by wildfire in July of 2007. Prior to burning, this area was sagebrush/bunchgrass vegetation characterized by Wyoming big sagebrush, bluebunch wheatgrass (Pseudoroegneria spicata), Great Basin wildrye (Leymus cinereus), Sandberg bluegrass (Poa secunda), and medusahead (Taeniatherum caput-medusae). Our study sites were within a 9,800-acre area of the burn that was seeded with a rangeland drill in October of 2007. The seed mix included 4 lbs/acre (pure live seed) of crested wheatgrass (Agropyron cristatum), 2 lbs/acre of Siberian wheatgrass (Agropyron sibiricum), 2 lbs/acre of bluebunch wheatgrass, 1 lbs/acre of Secar Snake River wheatgrass (Elymus wawawaiensis), 0.5 lbs/acre of Great Basin wildrye and 0.5 lbs/acre of Sandberg bluegrass. Prior to burning, the study area was grazed by cattle during the growing season, but grazing was curtailed following fire in 2007 with continued non-use in 2008.

In October of 2008, we identified five burned sites that had supported sagebrush at the time of burning. Sagebrush subcanopy microsites were associated with persistent dead woody material and were characterized by a blackened soil surface ranging from 20 to 40 inches in diameter (Fig. 1). At each study site we randomly selected 20 subcanopy and 20 interspace microsites. For purposes of data collection and analysis we grouped seeded species and labeled Agropyron as “non-native” and the remaining genera as “native”. At each microsite, we counted the number of perennial grass seedlings, by species group (native or non-native), within a 16 by 20-inch quadrat and measured the average seedling height by species group during October of 2008. Only those seedlings occurring within a drill row were counted. Presence or absence of reproductive seedlings (visible seed head) was noted by species group for each quadrat. Data were statistically analyzed to compare differences in seedling density, height, and reproductive status between subcanopy and interspace microsites.
RESULTS AND DISCUSSION

Non-natives dominated the perennial grass seedling population based on density with 8.0 seedlings/yd² (± 2.0) compared to 1.0 seedlings/yd² (± 0.6) for natives. Native seedlings were absent at one site in subcanopy microsites and three sites in interspace microsites; non-natives were present in all site/microsite combinations. Microsite effect on density varied by species group. Density of non-native seedlings in subcanopy microsites was about six times higher than in interspace microsites (Fig. 2). For native seedlings, density at subcanopy microsites was 24 times higher than interspace microsites (Fig. 2). In contrast to density, native and non-native seedlings had similar performance with respect to height, but seedling height varied by microsite. Seedling height for subcanopy microsites (across species) averaged 10.0 inches (± 0.8) compared to 4.5 inches (± 0.4) for interspace microsites (Fig. 2). Microsite effects on presence of reproductive seedlings varied by species group. In subcanopy microsites, a higher percentage of plots contained non-native reproductive seedlings (28 percent ± 4.9) compared to natives (3.0 percent ± 2.0, Fig. 2). The percentage of subcanopy microsite plots containing native reproductive seedlings did not differ from the percentage of interspace microsite plots containing native or non-native reproductive seedlings (Fig. 2). No reproductive seedlings were found within interspace microsites.

Overall, our results suggest that subcanopies were more conducive microsites for establishment¹ and performance of perennial grasses seeded after wildfire. The 6 - and 24-fold difference in density of introduced and native perennial bunchgrasses, respectively, between burned subcanopies and burned interspaces, along with increases in height and reproductive effort of subcanopy seedlings, indicates that shrubs had a significant positive influence on the success of revegetation efforts. Recent research suggests that shrub-associated alterations in soil properties may have at least short-term persistence after burning of the shrub (Davies et al. 2009). There is also a large increase in soil inorganic nitrogen the first year post-fire for subcanopy microsites (Stubbs and Pyke 2005, Davies et al. 2009). Eckert et al. (1986) reported reduced soil physical crusts in subcanopy microsites; soil physical crusts can reduce the establishment success of vegetation (Maestre et al. 2003). Another factor that could impact seedling success in subcanopy microsites is the darkening of the soil surface with fire (Fig. 1). Soil temperatures have been reported to increase on blackened soil surfaces following burning, leading to earlier growth initiation in spring and effectively lengthening the growing season (Wroblewski and Kauffman 2003, Davies et al. 2009). An earlier, extended growing season may be especially critical in regions where most of the precipitation occurs during winter.

MANAGEMENT IMPLICATIONS

Shrub microsites exert a post-fire influence on revegetation success as demonstrated by greater establishment and performance of post-fire seeded perennial grasses in subcanopy microsites. Seeded non-native perennial grasses were more successful (based on density and reproduction) than seeded native perennial grasses. Additional research to determine the mechanism(s) facilitating greater establishment in burned subcanopy microsites may provide

¹ Seedlings alive in October 2008 were considered to be “established” (1 year post-seeding).
information that could be incorporated into existing restoration technologies to improve efforts to revegetate Wyoming big sagebrush communities after fire.

REFERENCES


Figure 1. Following fire, areas within the sagebrush subcanopy appeared as blackened (left arrow) compared to interspace areas (right arrow). Contiguous black areas were used to define subcanopy microsites and contiguous non-blackened areas were defined as interspace. Residual stump of original sagebrush is within dotted circle at left.
Figure 2. Seedling density, height and percentage of plots with reproductive seedlings in burned Wyoming big sagebrush plant communities. Means are presented with their associated standard errors. Data were collected in October 2008, approximately 1 year post-seeding, and 15 months after the wildfire. Within a graph, bars without a common letter are different ($\alpha = 0.05$).