ENGLEMANN SPRUCE GERMINATION IN GROUP SELECTION

FIRST-YEAR RESULTS FROM COLUMBINE PATCH CUT STUDY- March 2016

Background

Our goal was to investigate edge effects and coarse woody debris management on regeneration success in group selection openings. We implemented an Engelmann spruce germination study on the Uncompahgre Plateau in group selection openings. Permanent plots were installed in spring of 2015. Group selection is an uneven-aged system used in the West to regenerate high elevation spruce-fir forests with small (<1 ac) openings. Engelmann spruce (*Picea engelmannii* Parry ex Engelm.) is a notoriously difficult species to regenerate, and there has been a history of regeneration failures following group selection cuts on the Uncompahgre Plateau.

Our Study

To better understand and promote Engelmann spruce regeneration on the Uncompahgre Plateau, we implemented a study during the 2015 growing season. In group selection openings that were part of the 2013 Columbine patch cut, 25 manipulative plots were installed in early summer, 2015. Pairwise seeded and planted seedling plots were implemented. In this study we isolated and manipulated coarse woody debris (CWD) and distance from edge. These variables tell us how much CWD to retain and how big an opening should be. Previous research has shown that Engelmann spruce germinates experience mortality due to heat girdling at temperatures above 25°C. We installed temperature sensors to examine this threshold in respect to our treatments.

Research Questions:

1) Is there a difference in Engelmann spruce germination with increased distance from edge?
2) Is there a difference in Engelmann spruce germination with increased coarse woody debris retention?
3) Is there a difference in maximum soil temperatures between treatment types?

Treatment Effects

The treatments we studied were: scarified with 36 tons ha $^{-1}$ (16 tons ac^{-1}) of CWD, scarified with 27 tons ha^{-1} (12 tons ac^{-1}) of CWD, scarified with 0 metric tons ha^{-1} of CWD, and an un-scarified control that was the residual fuel loading from the creation of the openings (USFS). Seeding in this experiment was to simulate natural regeneration in a controlled manner. Non-seeded plots were to account for natural regeneration not arising from our seeds.

Average germination over the course of the growing season was significantly increased with the CWD treatments at all distances from the edge of the opening (Fig. 1). Also, there was no interaction between treatment and distance from edge. This tells us that treatment effects are beneficial at all distances, whether adjacent to the edge or in the middle of an opening.

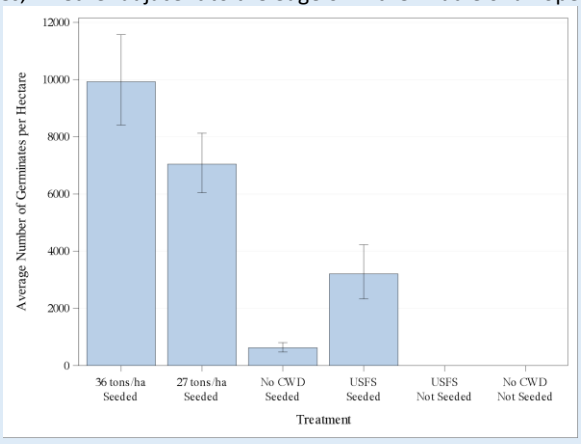

Figure 1: Average germination levels per hectare across the growing season. Both the unseeded USFS treatment and the unseeded No CWD treatments had zero germination. 36tons ha^{-1}, 27 tons ha^{-1}, No CWD, and the seeded USFS treatment are all significantly different from each other (alpha=0.05) and from zero. Error bars represent standard error.

Summary

- Residual coarse woody debris increases Engelmann spruce germination throughout openings, even against the edge
- The southern edge provides a benefit to spruce germination up to 1.5 tree lengths away
- The shade from coarse woody debris keeps maximum temperatures below known heat girdling levels
- Increases in coarse woody debris increase germination success through 36 metric tons ha^{-1} (16 tons ac^{-1})

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Distance from Edge Effects

On the south side of the openings the distance from the drip line was a significant predictor for germination (Figure 2). On the north side it had no influence. This tells us that up to 1.5 tree lengths there is a positive effect from the shade the southern edge provides on germination. In this study we used 27 metric tons ha^{-1} (12 tons ac^{-1}) for a low fuel loading and 36 metric tons ha-1 (16 tons ac^{-1}) for a high fuel loading. Higher amounts of coarse woody debris led to a higher germination rate.

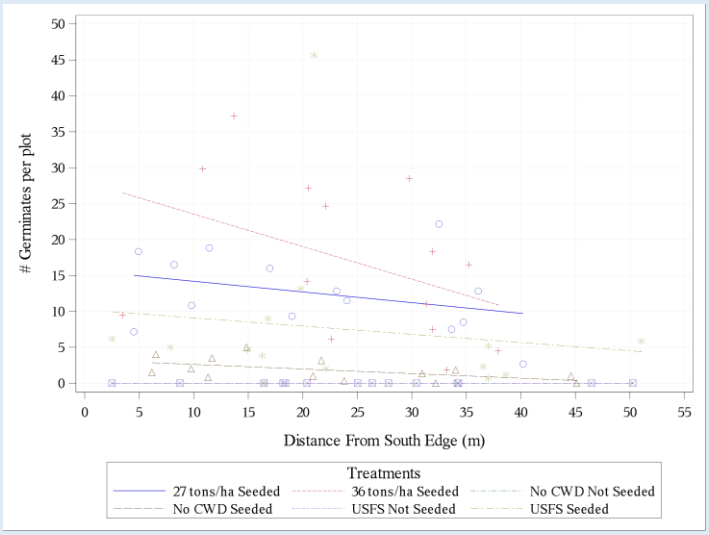

Figure 2: Number of germinates plotted over distance from edge. The south side showed a significant decrease in germination as distance increased (p = 0.0134). The north side showed no correlation between germination and distance (p = 0.6828). Trend lines are shown for each treatment. Individual points represent the six germination counts for a plot averaged over the course of one growing season.

Environmental Factors

The shaded temperature sensors had a significantly lower maximum temperature than the other 3 scenarios (Figure 3). Previous studies have shown that Engelmann spruce germination is at a high risk of heat girdling above 25°C. All three non-shaded maximum temperatures were above this threshold.

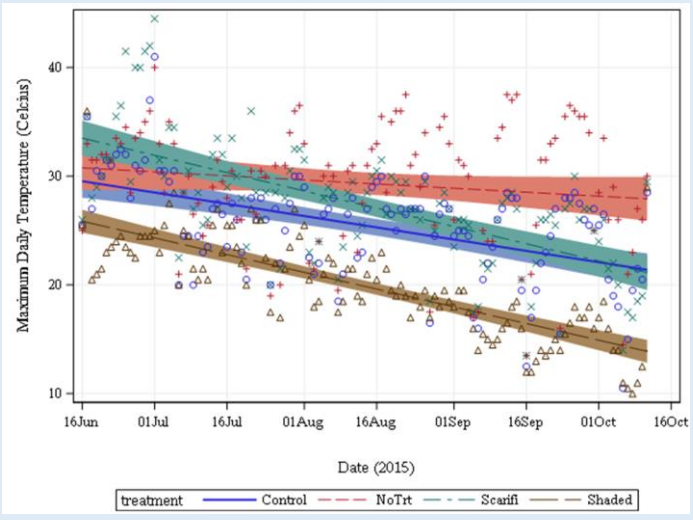

Figure 3: Scatter plot of maximum daily temperature values throughout the growing season. Trend lines are shown for each treatment with a 95% confidence interval. The shaded placement was significantly cooler than the other sensors (p <0.0001).

Potential Next Steps

- Continue to monitor plots to better understand natural regeneration over time
- Monitor planted seedlings to increase understanding of artificial regenerating spruce in group selection
- Find the effect that finer coarse woody debris has on germination
- Expand study to include other species

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