Management Implications of Using Tree Shelters for Restoration of High Elevation Spruce-Fir Forests in the Rocky Mountains

Douglass F Jacobs

Douglass F Jacobs is Professor with the Hardwood Tree Improvement and Regeneration Center, Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN 47907; Phone: (765) 494-3608; Email: djacobs@purdue.edu

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Abstract: This paper presents a summary of a research project designed to study the use of tree shelters as a means to provide initial shade for planted Engelmann spruce (*Picea englemannii* Parry ex Engelm.) seedlings on a reforestation site in southwestern Colorado where several past planting attempts had failed. Study results following 2, 6, and 11 growing seasons were formally published elsewhere. Four different shelter colors providing various shading levels and a control, consisting of shading using debris within the site, were included when the study was initiated in 1996. The darkest shelter color was excluded after two years due to high mortality. Half of the shelters were removed in 2000 to examine seedling response to tree shelter removal. In 2007, control seedlings had lower survival (35%) than any other treatment (ranging from 59 to 78%). Shelter removal in the lightest two shelter color treatments did not reduce survival, suggesting that seedlings can grow in full sun after four years of shading. The lightest shelter color with shelters removed produced the best overall seedling development. This paper elaborates on site- and landscape-level management implications surrounding results of this research.

Keywords: Colorado, environmental impact, forest restoration, gopher browse, Englemann spruce, *Picea engelmannii*, tube shelters

Introduction

This paper discusses site- and landscape-level management implications of a long-term study in the high elevation forests of southwestern Colorado (Figure 1) initiated to examine use of different colors of tree shelters (providing variable levels of shading) as a means to improve Engelmann spruce (*Picea englemannii* Parry ex Engelm.) reforestation success. A description of the project justification, study site (Figure 2), experimental methodology, and results following two growing seasons were presented in Jacobs and Steinbeck (2001). We found that use of lighter-colored tree shelters improved early growth and survival of planted seedlings as compared to the traditional method of relying upon natural shade within the site. This was attributed to decreased animal browse (i.e., gophers) of sheltered seedlings along with positive changes to seedling development associated with shelter microclimatic conditions (Oliet and Jacobs 2007). Seedling responses to subsequent tree shelter removal (vs. not) were then published after 6 (Jacobs 2004) and 11 (Jacobs 2001) growing seasons. Results indicated that control seedlings had lower survival (35%) than any other treatment (ranging from 59 to 78%). In the lightest 2 shelter color treatments, shelter removal did not reduce survival indicating that seedlings can grow in full sun after four years of shading. The best overall response (i.e., survival, absolute height, and root-collar diameter) occurred in the lightest shelter color with shelters removed.

Figure 1. High elevation Engelmann spruce-subalpine forest type in southwestern Colorado.

Figure 2. The Orphan Butte site located at an elevation of approximately 3273 m in the San Juan National Forest, Colorado. The entire 48-ha site was clearcut in 1971 and following failed natural regeneration, the site was planted in 1976, 1985, and 1996 in an effort to reach minimum stocking.

Management Implications

This long-term project has produced encouraging results toward successful restoration of these high-elevation spruce-fir sites where past planting efforts have proven difficult (Figures 3 and 4). Results also help emphasize the importance of long-term monitoring of plantation experiments on harsh restoration sites before issuing management recommendations as results tend to shift over time (Oliet and others 2005). The best general responses after 11 growing seasons occurred in the lightest shelter color (with or without shelter removal) and the second lightest shelter (with shelter removal). Thus, a lighter color shelter (i.e., 24% PAR) is recommended in operation especially if the shelters may not be subsequently removed. Although seedlings without shelter removal in the lightest shelter color had excellent performance, shelter removal resulted in seedlings with significantly larger root-collar diameter. Additionally, growth restrictions for sheltered seedlings could still be observed in the future. Therefore, it is recommended that funding for shelter removal after four years be allocated on these restoration projects. Development of tree shelter design has advanced since the initiation of this study and more rigid models are now available that may allow relatively simple installation, removal, and reliable re-use at another site. This would provide further benefit in minimizing environmental contamination associated with discarded tree shelters. Finally, ability to re-use a tree shelter at multiple sites may help to reduce the cost of incorporating tree shelters into these restoration projects.

Figure 3. Sheltered Englemann spruce following 11 growing seasons.

Figure 4. tudy seedling beginning to produce reproductive cones after 11 growing seasons.

In addition to these stand-level management implications, it is interesting to ponder several larger, landscape-level issues related to this research. Efforts to salvage trees infected by the spruce bark beetle (*Dendroctonus rufipennis* Kirby) resulted in dramatic increases in harvesting in the high-elevation Rocky Mountain forests around 1950. Many of these clearcut sites remain poorly or partially stocked due to subsequent failure of both natural regeneration and plantings (Ronco and Noble 1971; Alexander 1987). Although the US Forest Service has continued with restoration plantings on these sites, the intensity of the program has fluctuated over time and generally declined in recent years partly due to a decline in general funds, especially those generated from timber sales. This brings forth a question regarding the fate of these understocked sites through various time scales (i.e., 100, 1,000, or 10,000 years). In the absence of planting, these sites will likely be invaded by natural regeneration of trees from surrounding stands but the timeframe required will depend on current stocking levels, seed availability, and site conditions. Hundreds of years may be required before full stocking is attained on some sites. Clearly this negatively affects the commercial potential of these sites and, simultaneously, the ecosystem and its ability to provide wildlife habitat, watershed protection, and carbon sequestration is impacted by conversion of these mature forests to non-stocked forestlands. In some cases, the US Forest Service is considering modifying land use designations to re-classify some of these clearcut sites as meadows. Some may argue that conversion of some forest sites to meadow via clearcutting has negligible impacts on these ecosystems at the landscape scale. Nevertheless, the US Forest Service must decide if they have a moral obligation to the public to ensure that these harvested sites are reforested.

References

Alexander RR. 1987. Ecology, silviculture, and management of the Engelmann spruce-subalpine fir type in the central and southern Rocky Mountains. USDA Forest Service Agriculture Handbook No. 659. 144 p.

Jacobs DF. 2004. Restoration of a Rocky Mountain spruce-fir forest: Sixth-year Engelmann spruce seedling response with or without tree shelter removal. Western Forest and Conservation Nursery Association. In: Riley, L.E., Dumroese, R.K., and T.D. Landis, technical coordinators. National Proceedings: Forest and Conservation Nursery Associations-2003. USDA Forest Service Rocky Mountain Research Station Proceedings RMRS-P-33:57-63.

Jacobs DF. 2011. Reforestation of a salvage-logged high-elevation clearcut: Engelmann spruce seedling response to tree shelters after eleven growing seasons. Western Journal of Applied Forestry 26:53-56.

Jacobs DF, Steinbeck K. 2001. Tree shelters improve the survival and growth of planted Engelmann spruce seedlings in southwestern Colorado. Western Journal of Applied Forestry 16:114-120.

Oliet J, Jacobs DF. 2007. Microclimatic conditions and plant morph-physiological development within a tree shelter environment during establishment of *Quercus ilex* seedlings. Agricultural and Forest Meteorology 144:58-72.

Oliet J, Planelles R, Caballero FA, Jacobs DF. 2005. Nursery fertilization and tree shelters affect long-term field response of *Acacia salicina* L. seedlings planted in Mediterranean semiarid conditions. Forest Ecology and Management 215:339-351.

Ronco F, Noble DL. 1971. Engelmann spruce regeneration in clearcut openings not insured by record seed crop. Journal of Forestry 69:578-579.