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# Impact of slash removal, drag scarification, and mounding on lodgepole pine cone distribution and seedling regeneration after cut-to-length harvesting on high elevation sites

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ABSTRACT

Excessive slash loading could pose a problem for the regeneration of the serotinous lodgpole pine especially in forests at higher elevation where soil temperature is limiting. In the past, these forests have commonly been harvested using full-tree harvesting where trees are processed at roadside; however, recently cut-to-length harvesting has become a more frequent harvesting method. In cut-to-length harvesting the harvested trees are processed in the block, as a result slash accumulation is much higher on these cutblocks. In an experimental field trial, the cone distribution, natural lodgepole pine regeneration, and the growth and establishment of planted lodgepole pine were evaluated in response to slash load, drag scarification, and mounding after cut-to-length harvesting of high elevation lodgepole pine stands in the Rocky Mountains. Twelve sites were established, each contained six plots which were randomly assigned to six treatment combinations of two slash removal (slash and slash removed) and three mechanical soil preparation treatments (no soil preparation, drag scarifying, and mounding). The slash removal reduced slash volume by more than 50% but also reduced the number of lodgepole pine cones available for regeneration by over 33%. However, soil mechanical treatments offset this effect as fewer cones were necessary to achieve high natural pine regeneration densities. Drag scarification of plots resulted in 12 times the number of pine seedlings compared to the non-prepared plots. Although slash removal did not have an effect on the number of naturally regenerated lodgepole pine seedlings, it had a positive effect on their growth performance. Conversely, planted pine seedlings had lower mortality and better growth in soils that had been mechanically prepared and had the slash removed; however, the growth effects became only apparent 4 years after planting. While slash removal and mechanical soil preparation did increase soil temperatures; the slash removal treatment had a more transient effect on soil temperatures than soil preparation. Differences in soil temperature decreased over time which appeared to be mostly driven by a warming of the soils in the plots with no soil preparation, likely a result of the decomposition of the finer slash and feathermosses. Overall, it appears that surface disturbance on these high elevation sites had a far greater effect on lodgepole pine regeneration and growth than the increased accumulation of slash as a result of cut-to-length harvesting.


## 1. Introduction

Lodgepole pine (*Pinus contorta* var. *latifolia* Loudon) is a widely distributed conifer species in western North America and is a dominant component of the forests in the foothills of the Rocky Mountains and at higher elevations of the boreal forest region. In large parts of its range, lodgepole pine is the most abundant commercial tree species and very important for the lumber and pulp industry. Two very distinct harvesting methods are currently used as clearcut silvicultural systems in these boreal pine stands. The most common harvesting method for lodgepole pine is full-tree harvesting, which uses feller-bunchers to cut trees and skidders to move cut bunches of intact trees to landings or roadside where they are delimbed and processed with conventional processors such as a delimber. The other system is cut-to-length harvesting which utilizes harvesters to cut and process trees within the cutblock and forwarders to move the processed logs to the roadside (McInnis and Roberts, 1995). Cut-to-length harvesting is thought to be the more economical option for harvesting high elevation sites with smaller diameter wood, as the felling,

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