Assessment of Winter Harvesting Influence on Soil Properties and Aspen Regeneration in Duck Mountain Provincial Park, SK

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Introduction

In Saskatchewan, many aspen (*Populus tremuloides*) forests are over mature and dying. These forest rely on disturbance such as fire to maintain the health and productivity of the forest ecosystem; however, fire events have been reduced due to fire suppression. Aspen has become an economically viable forest product and mechanical harvesting is being used as an alternative method to stimulate the rejuvenation of the forest. However, unsustainable harvesting practices could negatively effect aspen suckering and future regeneration success.

There are several factors that influence the level of soil disturbance: number of machine passes, soil texture, and season of harvest are of major importance. Studies have illustrated that with increasing number of machine passes, the soil strength and soil bulk density generally increase in a logarithmic fashion (McNabb et al., 2001; Zenner et al., 2007). To reduce the susceptibility of these soils, harvesting during the winter months is common practice in northern regions. During the winter months, soils are generally frozen and covered by a protective layer of snow, which increases the soils resistance to compaction; however, soil compaction can still occur. A study by Kolka et al. (2012), found that areas harvested during the winter did not experience as high a degree of compaction as summer harvested sites, yet compaction was still significantly higher than the undisturbed areas.

Skidders (Figure 1) often represent the majority of the site traffic within the block during harvesting. These tire driven machines make multiple passes throughout harvested areas to collect and centralize logs so they can be moved off site; potentially causing damage with each successive pass.

Figure 1: Skidder used to collect logs after cutting

The overall goal of this project is to assess whether the current harvesting methodology for old growth aspen forests in provincial parks is an environmentally sustainable management practice to stimulate aspen regeneration. This goal will be achieved by examining the relationship between the number of machine passes, intensity of soil compaction and its effects on the stocking density, root collar diameter, and height of regenerating aspen

Material & Method

Avenza PDFMaps and iPads were used to record machine traffic during the 2015-16 winter harvest.

ArcGIS 10.3 (ESRI, Redlands CA) was used to analyze machine traffic data and develop a machine traffic disturbance map. Disturbance map was classified into 6 disturbance classes based on the number of machine passes over the area.

Figure 2: Vertical bulk density core sampler

Soil compaction was measured with bulk density sampler (Figure 2). A total of 10 samples were taken for each disturbance class in each of the study blocks.

Regeneration levels recorded using a 1 x 1 m quadrat and # of suckers, height, and root collar diameter were recorded for all aspen suckers in August

Results

Table 1 : Mean bulk density for each disturbance class. Numbers in brackets represent standard deviation

Traffic Disturbance Class (# of Passes)	Block 1	Block 2	Block 4	Overall Average
	Bulk Density (g/cm^3)			
0	1.36 (0.13)	1.57 (0.13)	1.55 (0.08)	1.49 (0.15)
1-5	1.47 (0.10)	1.49 (0.25)	1.66 (0.14)	1.54 (0.19)
6-10	1.47 (0.16)	1.49 (0.12)	1.61 (0.11)	1.52 (0.14)
11-25	1.41 (0.09)	1.48 (0.17)	1.60 (0.11)	1.50 (0.15)
26-50	1.54 (0.14)	1.54 (0.23)	1.60 (0.11)	1.56 (0.17)
51-100	1.51 (0.17)	1.53 (0.16)	1.69 (0.16)	1.58 (0.17)

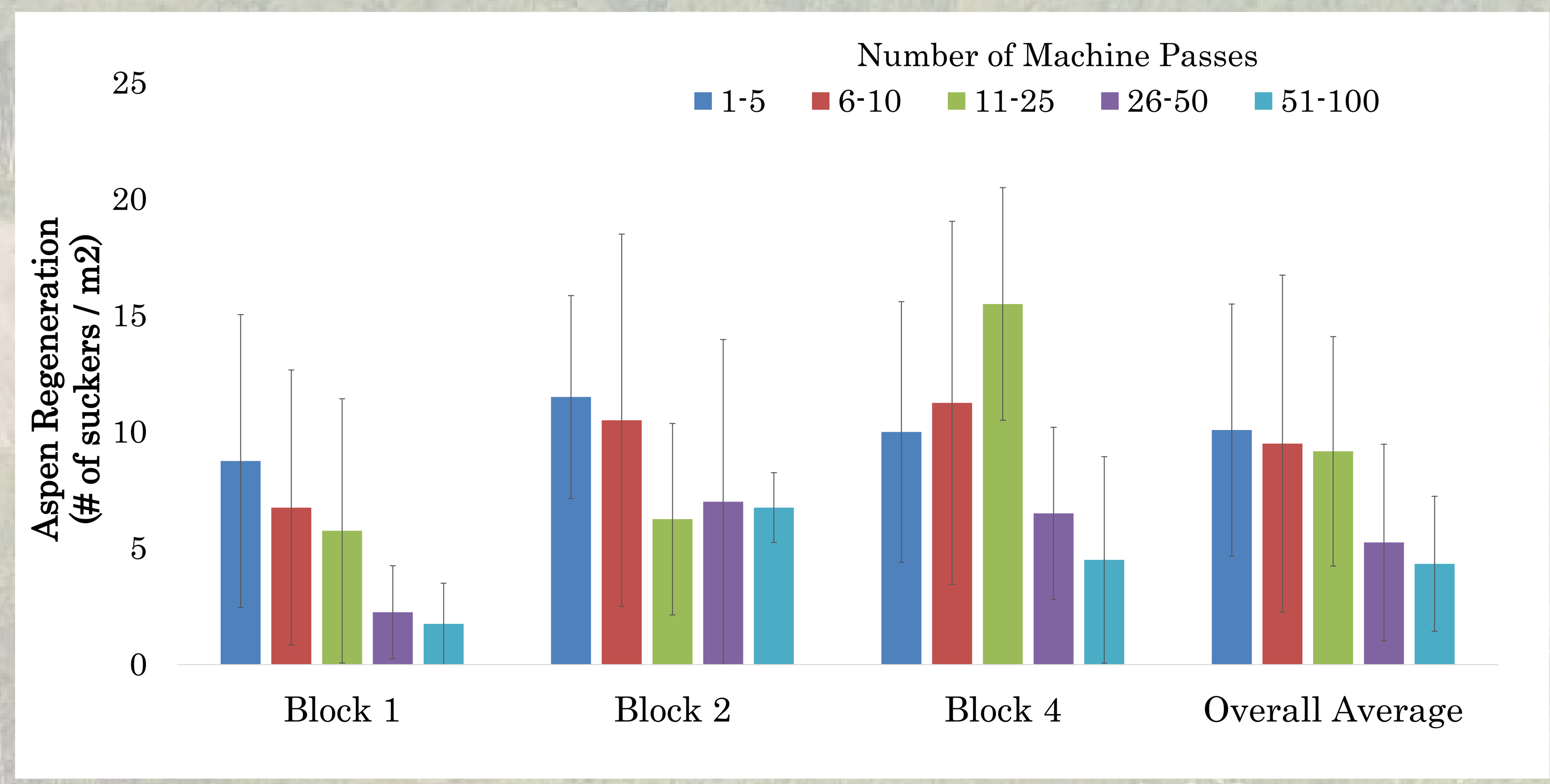

Figure 3 : Mean aspen sucker density for each disturbance classes within each block. Error bars represent standard deviation.

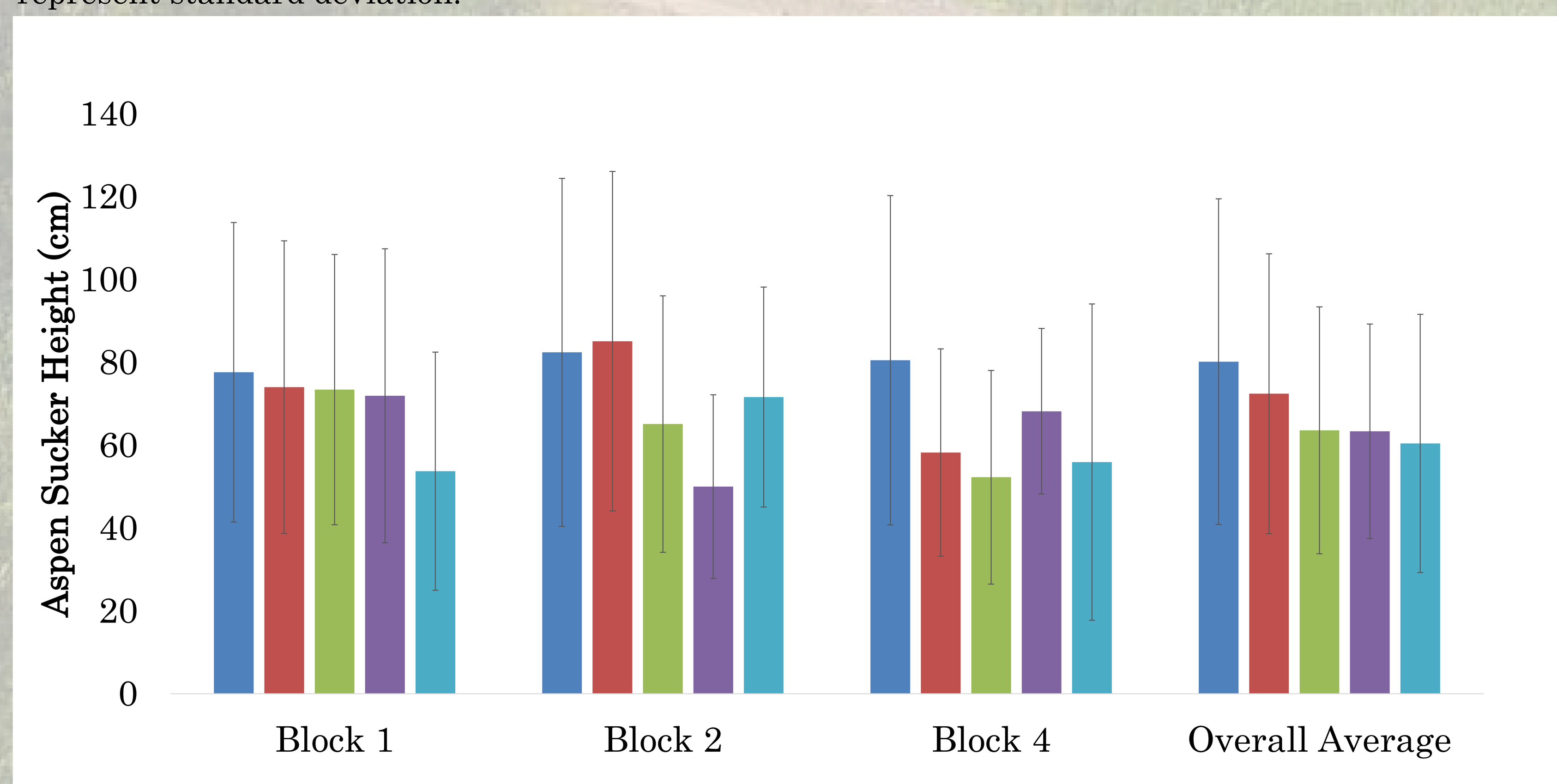

Figure 4: Mean aspen height for each disturbance class within each block. Error bars represent standard deviation.

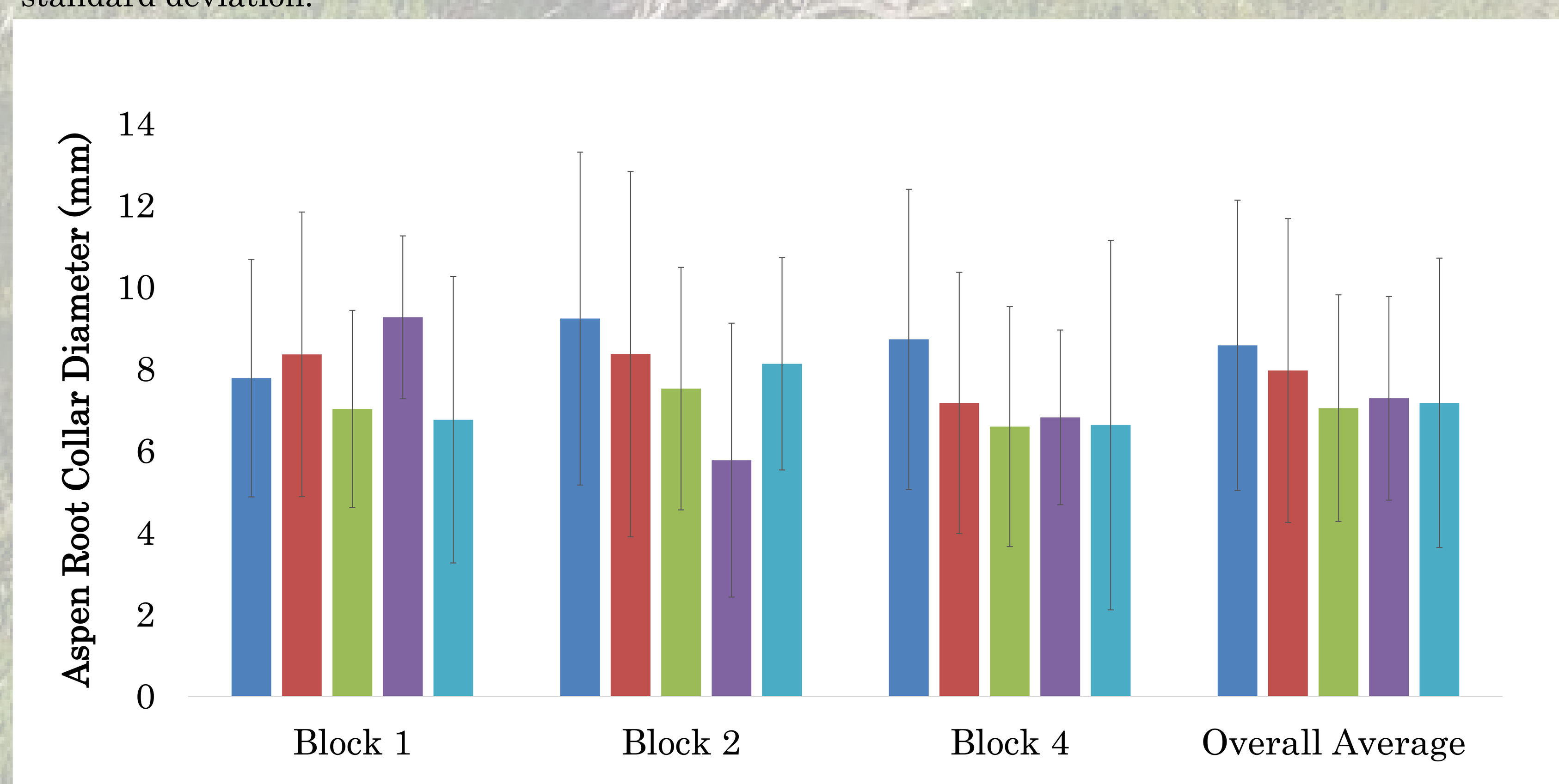

Figure 5: Mean aspen root collar diameter for each disturbance class within each block. Error bars represent standard deviation.

Results & Discussion

Average bulk density appears to increase with as little as 1 to 5 passes but continued to increase with as many as 51-100 passes. According to Daddow and Warrington (1983), root limiting bulk density for soils with a texture as those found in the Duck Mountains would be approximately 1.55 to 1.65 g cm^3 and therefore, could have an effect on the level of growth seen above ground.

This increased disturbance had effects on regeneration levels as well. With increasing number of passes, the number of suckers decreased. Our results suggest that heavily trafficked areas experience approximately half the regeneration than areas with only a few passes. Aspen sucker height and root collar diameter also decreased as the number of passes increased. A similar trend was observed by Zenner et al. (2007) with sucker density, height, and diameter all being negative effected by increasing levels of machine disturbance. However, increases in bulk density many not be the only factoring causing a decrease in regeneration. Heavy amounts of slash left behind on the forest floor (Figure 6) have also been shown to decrease sucker density and growth (Lieffers-Pitchard, 2004).

Figure 6: Slash loading potential effect on regeneration

Conclusion:

Winter harvested areas, that showed increasing traffic disturbance had increasing bulk density levels. This increase in traffic disturbance and bulk density also affected regeneration levels. Aspen sucker density, height, and root collar diameter all were lowest in regions with the highest level of disturbance.

The next phase of this project will be to assess the effects of slash loading on regeneration levels and develop a method to examine regeneration and slash distribution using Unoccupied Aerial Vehicles and multispectral sensors at a harvested block scale. This will be achieved with a DJI Phantom 4 and Parrot Sequoia Multispectral sensor (Figure 7) using GIS technology to develop vegetation indices in conjunction with the traffic maps.

Figure 7: DJI Phantom 4 with Sequoia multispectral addition

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