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Northern Hardwoods Research Institute Inc.

Do season and method of harvest influence regeneration?

September 2018

Technical Note

Silviculture

INTRODUCTION

Several factors, such as light (Ricard et al., 2003), harvesting treatment (Gottesman and Keeton, 2017), season of harvest (Berger at al., 2004), overstory composition (Bose et al., 2016) and seedbed (Carpensen and Saprunoff, 2005) can impact the growth of regeneration.

In the northern hardwood forest, light is often recognized as the major factor limiting the growth of regeneration. However, the relative importance of light on regeneration growth is dependant on site conditions and species (Ricard et al., 2003). Even if we have a good knowledge of the factors limiting the growth of the regeneration following a harvesting treatment, not a lot is known about the interaction between those factors (Bose et al., 2014).

HIGHLIGHTS

- **Treatment intensity, season of harvest, harvesting method and their interaction term all had an influence on regeneration.**
- **A low treatment intensity and a treatment done in summer yielded higher proportion of commercial sapling.**
- **The highest density of commercial species was achieved with a manual full-tree harvesting method.**

METHODOLOGY

We used 68 plots all located in northern New Brunswick to see if treatment intensity (basal area cut), season and method of harvest and their interaction influenced sapling (tree with DBH ≥ 2 cm and < 10 cm) density and proportion of yellow birch, sugar maple and all commercial species (Table 1) following a silvicultural treatment. Different types of treatment were done in those plots, ranging from clear-cut to partial cut and the time since treatment was between 10 and 18 years. A wide range of overstory species composition before treatment was also encounter, from softwood to hardwood.

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METHODOLOGY

Table 1: List of commercial species

Balsam Fir	Eastern White Cedar	Sugar Maple	White Ash
Black Ash	American Beech	Red Spruce	White Birch
Black Spruce	Poplar	Tamarack	White Pine
Eastern Hemlock	Red Maple	Yellow Birch	White Spruce

We defined two seasons of harvest, summer (May to October) and winter (November to April) and three harvesting method were performed in our plots, manual full-tree (MAFT), mechanical full-tree (MFT) and mechanical process system (MPS) which is the equivalent of cut-to-length system.

We also created four categories of treatment intensity based on the four quantiles of the data distribution, low (basal area cut ranging from 0 to 3 m^2/ha), medium (basal area cut ranging from 3 to 9 m^2/ha), high (basal area ranging from 10 to 18 m^2/ha) and very high (basal area cut ranging from 18 to 33 m^2/ha).

We used non-parametric tests to see whether treatment intensity, season of harvest, harvesting method and their interaction term had an impact on sapling density and proportion because of the non-normal distribution of the data. First, we used the Mann-Whitney test to see if the season of harvest had an influence on regeneration and second we used the Kruskal Wallis test to see if the method of harvest, treatment intensity and the interaction of all three terms (season and method of harvest and treatment intensity) impacted regeneration.

RESULTS

No significant difference was found between sapling density in relation to treatment intensity for none of the species or species grouping, contrary sapling proportion of commercial species was significantly higher following a low treatment intensity (less than 3 m^2/ha basal area cut) and significantly lower following a medium (3 to 9 m^2/ha basal area cut) and high (10 to 18 m^2/ha basal area cut) treatment intensity (Figure 1).

RESULTS

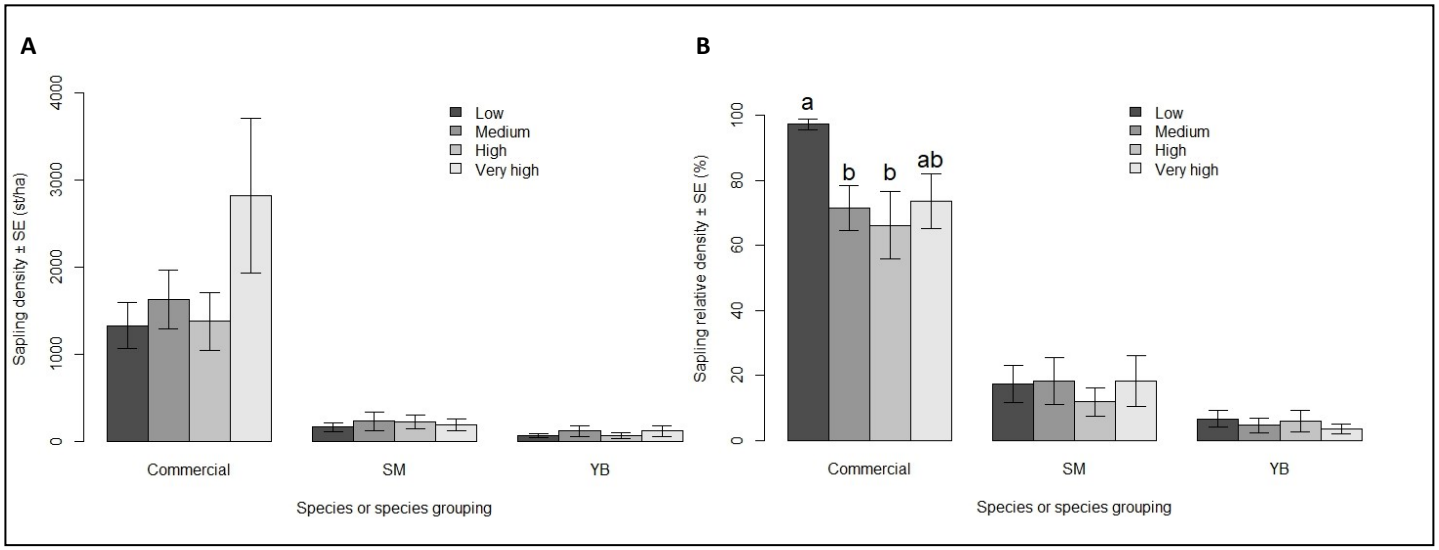

Figure 1: Mean sapling density (A) and proportion (B) ± standard error (SE) of commercial species, sugar maple (SM) and yellow birch (YB) along a gradient of treatment intensity (low: basal area cut ranging from 0 to 3 m^2/ha, medium: basal area cut ranging from 3 to 9 m^2/ha, high: basal area ranging from 10 to 18 m^2/ha, and very high: basal area cut ranging from 18 to 33 m^2/ha).

Season of harvest only influenced the proportion of commercial sapling at a significant level. The proportion of commercial sapling was higher following a silvicultural treatment that was done during summer (Figure 2). Commercial sapling density was significantly higher following a silvicultural treatment with a manual full-tree harvesting method and significantly lower with a mechanical full-tree method. Contrary, harvesting method did not impact the proportion of sapling of any species or species grouping (Figure 3).

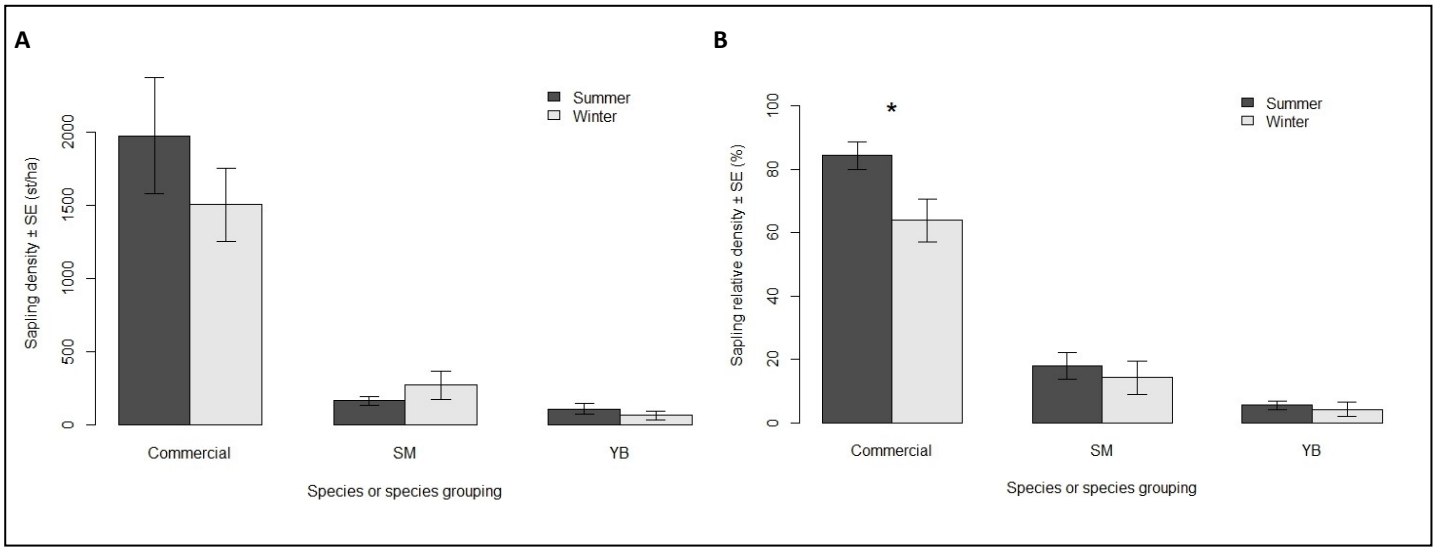

Figure 2: Mean sapling density (A) and proportion (B) ± standard error (SE) of commercial species, sugar maple (SM) and yellow birch (YB) in function of season of harvest.

RESULTS

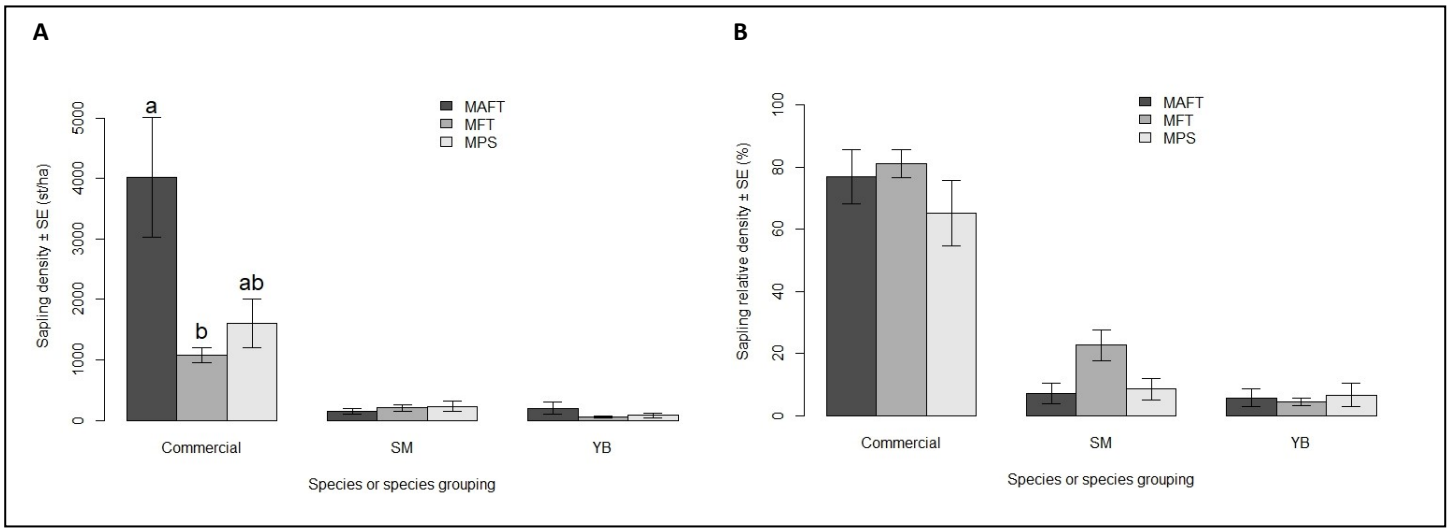

Figure 3: Mean sapling density (A) and proportion (B) ± standard error (SE) of commercial species, sugar maple (SM) and yellow birch (YB) in function of method of harvest (MAFT: manual full-tree, MFT: mechanical full-tree and MPS: mechanical process system).

The interaction between treatment intensity and season did not influence sapling density of any species or species grouping, but influenced sapling proportion. The sapling proportion of commercial species was significantly higher following a low intensity treatment done in summer and significantly lower following a medium intensity treatment done in winter (Figure 4).

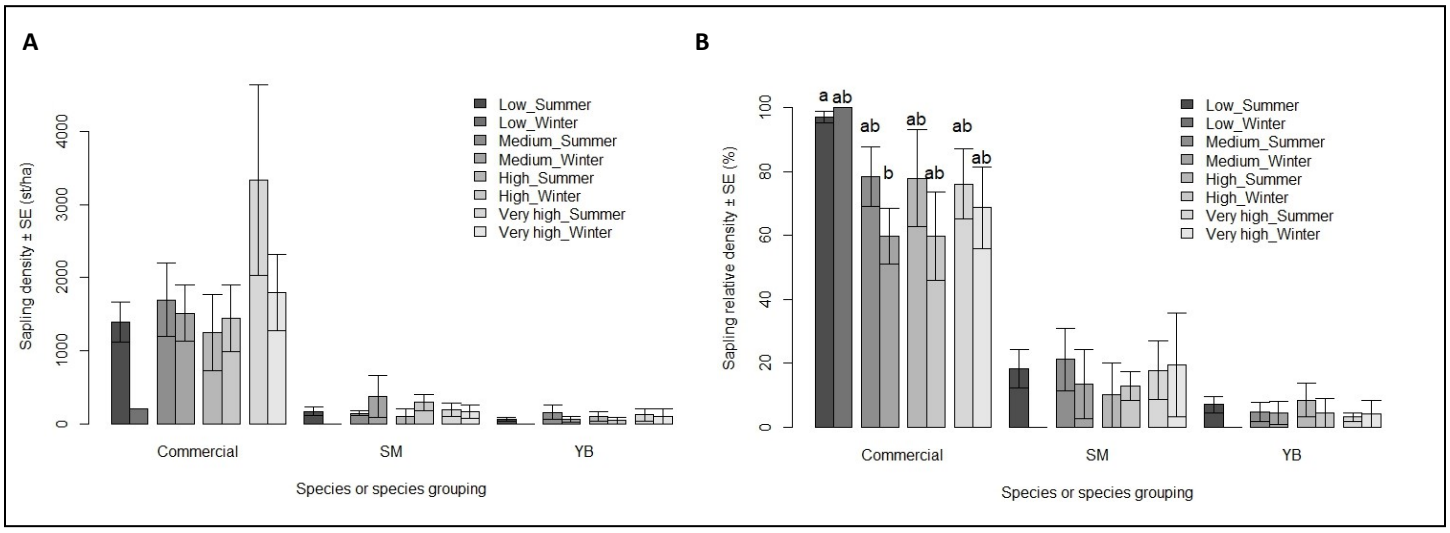

Figure 4: Mean sapling density (A) and proportion (B) ± standard error (SE) of commercial species, sugar maple (SM) and yellow birch (YB) in function of treatment intensity (low: basal area cut ranging from 0 to 3 m^2/ha, medium: basal area cut ranging from 3 to 9 m^2/ha, high: basal area ranging from 10 to 18 m^2/ha, and very high: basal area cut ranging from 18 to 33 m^2/ha) and season of harvest.

RESULTS

Treatment intensity in interaction with harvesting method did not influence sapling density of any species or species grouping, but the proportion of commercial sapling following a low intensity treatment using a mechanical full-tree method was significantly higher and significantly lower after a high intensity treatment using a mechanical process system (i.e. cut-to-length, Figure 5).

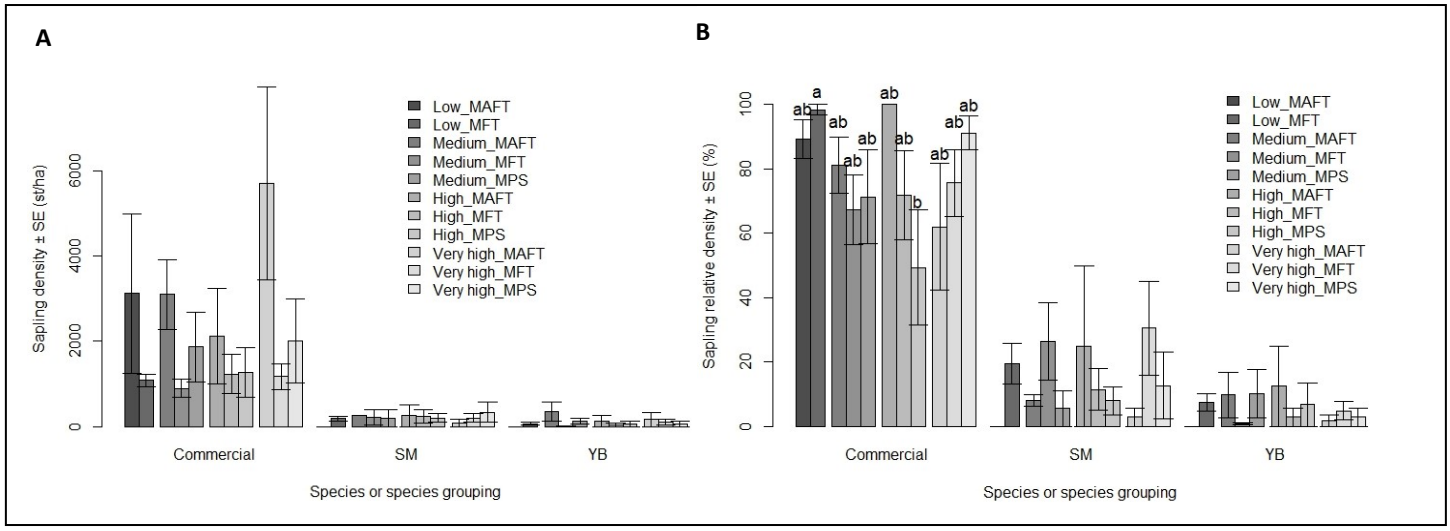

Figure 5: Mean sapling density (A) and proportion (B) ± standard error (SE) of commercial species, sugar maple (SM) and yellow birch (YB) in function of treatment intensity (low: basal area cut ranging from 0 to 3 m^2/ha, medium: basal area cut ranging from 3 to 9 m^2/ha, high: basal area ranging from 10 to 18 m^2/ha, and very high: basal area cut ranging from 18 to 33 m^2/ha) and method of harvest (MAFT: manual full-tree, MFT: mechanical full-tree and MPS: mechanical process system).

Season of harvest in interaction with harvesting method influenced sapling density and proportion. Commercial density of sapling was significantly higher after a treatment done in the summer with a manual full-tree method and significantly lower following a treatment done in the summer with a mechanical full-tree method. Contrarily, the proportion of commercial sapling was significantly higher following a summer treatment with a mechanical full-tree method and significantly lower after a treatment using a mechanical process system (i.e. cut-to-length) done in winter (Figure 6).

RESULTS

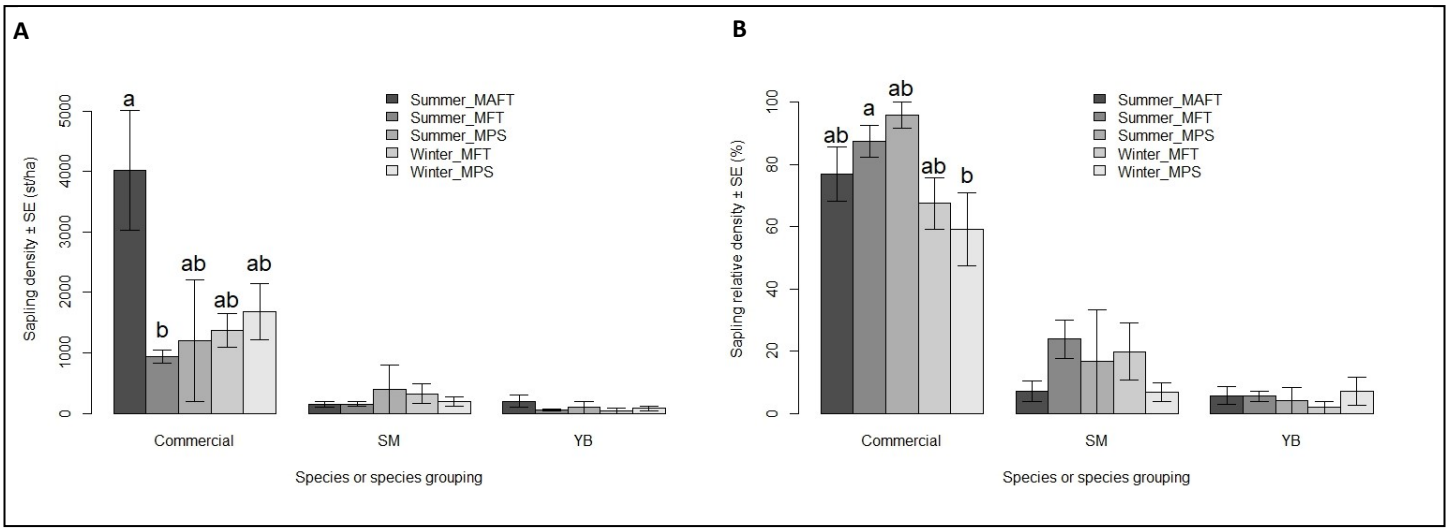

Figure 6: Mean sapling density (A) and proportion (B) ± standard error (SE) of commercial species, sugar maple (SM) and yellow birch (YB) in function of season and method of harvest (MAFT: manual full-tree, MFT: mechanical full-tree and MPS: mechanical process system).

DISCUSSION

Treatment intensity, season and method of harvest and their interaction term all had an influence on regeneration. Showing that silvicultural treatment is not the only factor affecting regeneration success, but season and method of harvest and their interaction need to be taken into account when a silvicultural plan is done.

A low intensity treatment (less than 3 m2/ha) had the highest proportion of commercial species sapling no matter the season and method of harvest. When we look at the interaction of treatment intensity with the season and method of harvest, the higher proportion of commercial species was reached at, 1) a low intensity treatment done in summer and, 2) a low intensity treatment done with a mechanical full-tree method. Hence, at this level of intensity, we can consider that mortality due to machine traffic is very low and even absent. Thus, if the sapling community before the treatment was primarily composed of commercial species, it is normal to have a higher proportion of this species grouping following a treatment.

In addition, the proportion of commercial sapling following a summer treatment is higher no matter the treatment intensity and the method of harvest. Season of harvest in interaction with the method of harvest was the only interacting term influencing the density of commercial sapling, density of commercial species was higher after a treatment done in summer using a manual full-tree method. The higher proportion of commercial species was encountered after a, 1) summer harvest with a low intensity and, 2) summer harvest using a mechanical full-tree method. A summer treatment creates more soil disturbance than a winter treatment due to machine traffic (Berger et al., 2004; Puettmann et al., 2008; Falk et al., 2010) and we think that because of this, seedling recruitment and growth was higher and generate more sapling recruitment and at the same time increase the proportion of commercial species 10 to 18 years after a silvicultural treatment.

DISCUSSION

Method of harvest, independent of the season and the treatment intensity, was the only factor impacting the density of commercial sapling and not influencing the proportion of this species grouping. Once in interaction with treatment intensity and season of harvest, it impacted proportion of commercial sapling. Its response in interaction with treatment intensity, even though not significant, is not stable. At low intensity treatment, mechanical full-tree is yielding the higher proportion of commercial species, at medium and high intensity treatment, manual full-tree method yielded the higher proportion and at very high intensity treatment, mechanical process system (i.e. cut-to-length) had the highest proportion. Soil disturbance in full-tree system is greater than in cut-to-length (Water et al., 2004; Han et al., 2009), thus at very high levels of treatment intensity, maybe soil disturbance in cut-to-length system is greater than in the full-tree system.

The same situation is encountered when the method of harvest is interacting with season of harvest, after a treatment done in summer, mechanical process system show the higher proportion of commercial sapling, but mechanical full-tree method done during winter was yielding the higher proportion. Here again, soil disturbance is greater after a summer treatment (Berger et al., 2004; Puettmann et al., 2008; Falk et al., 2010), thus, maybe that soil disturbance following a cut-to-length method during a summer treatment is greater than full-tree method. However, we need to understand that soil disturbance is different between skid trail and green band (Pinard et al., 2000; Puettmann et al., 2008) and in this study, we did not have access to this information, hence it is possible that the proportion of plot in and out skid trail impacted the response of method of harvest.

CONCLUSION

Treatment intensity, season of harvest and harvesting method all had an influence on regeneration following a silvicultural treatment. Furthermore, they interact together to impact regeneration. A silvicultural treatment done during summer yields the higher proportion of commercial sapling and a higher proportion is achieved following a low intensity treatment. The impact of harvesting method is not clear and its interaction with season of harvest and treatment intensity give contradictory results, but one thing is clear, it has an impact on regeneration. Due to the lack of information on the location of the plots (in or out skid trail), we can hypothesize that the contradictory results for method of harvest can be biased by this variable. Further research needs to be done to better understand the impact of treatment intensity, season and method of harvest and location of the plot (in or out skid trail) on regeneration.

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