



Institut de recherche sur les feuillus nordiques Inc.
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Technical Note

Silviculture

Early Regeneration Response to Different Silvicultural Systems in Hardwood Stands: A Comparison of Recent Treatments

INTRODUCTION

Northern hardwood forests of eastern Canada have become more heterogeneous mostly as a result of past partial treatments that have left a mosaic of structural and compositional conditions. Different silvicultural systems that attempt to integrate both management objectives such as timber and regeneration of the next cohort are currently applied in this region. The objectives of the silvicultural systems that are applied in all forest types are to create environmental conditions favorable for the establishment of desirable regeneration. However, most systems are poorly defined and/or are generally applied in stands that are not suitable. Recently, the NHRI developed a five-step *Silvicultural Prescription System* that utilizes the ecological characteristics of the forest (e.g. species composition, stand structure, and regeneration status of desirable species) to recommend silvicultural systems and practices that favour the establishment of desired species. This study evaluates the early regeneration response of the NHRI proposed treatments against the current *status quo*.

HIGHLIGHTS

- Surface disturbance was the main driver of successful yellow birch regeneration among the treatments.
- Yellow birch dominated the regeneration layer across all treatments; however, sugar maple seedling density increased significantly in group shelterwood with wider trail spacing.
- Group shelterwood with 16m trail spacing produced the highest seedling density among the treatment combinations.
- Trail pattern has a significant impact on the establishment of regeneration (less for sugar maple).

METHODOLOGY

Two operational blocks located in northwestern New Brunswick were used for this study. Both blocks were dominated by tolerant hardwood tree species and had irregular stand structures. The harvesting system was cut-to-length (CTL) executed in December-January (2016-2017) with low snow cover. Each block was divided in three sections which were randomly assigned to one of three treatment, block 1: overstory removal with 20m trail spacing, (OR-20; treatment assigned by the New Brunswick Department of Natural Resources; NBDNR); continuous cover irregular shelterwood with 16m trail spacing (CCIS-16); continuous cover irregular shelterwood with 20m trail spacing (CCIS-20) and block 2: shelterwood with 20m trail spacing (SH-20; treatment assigned by NBDNR); group shelterwood with 12m trail spacing (GSH-12); group shelterwood with 16m trail spacing (GSH-16). Figure 1 shows the experiment design. All sections of the blocks were harvested using the cut-to-length harvesting system. No attempt was made to scarify the soil. In each treatment combination, three variable plots were established. The plots were at least 50m apart. At each variable plot, we established five circular (1.46m radius) plots (one at the center, and one each at the sub-cardinal directions (NE, NW, SE and SW) 6m away from the center of the variable plot. Regeneration (i.e. $30\text{cm} \leq \text{individuals} \leq 130\text{cm}$ tall) were tallied by species in four height classes: *i*) 30 to 54, *ii*) 55 to 79, *iii*) 80 to 103, and *iv*) 104 to 130cm. We recorded the location (within trail or off-trail) of each circular plot. We analysed the first year (1 year after treatment) regeneration responses of American beech, red maple, sugar maple, and yellow birch to the treatments. The data were analysed using generalized linear mixed effect model.

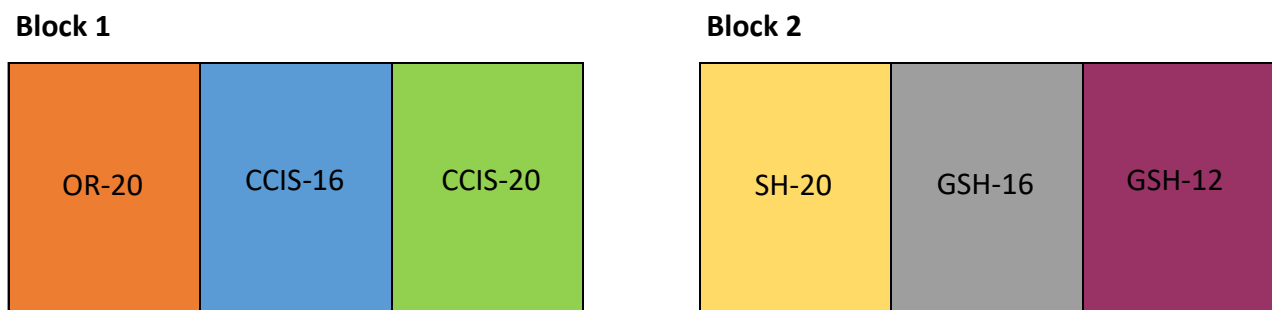


Figure 1: Experiment design

RESULTS

Seedling density was significantly affected by treatment combination, with all treatments except GSH-16 having a significantly lower seedling density than the control (OR-20) (Table 1). Significant differences in seedling densities were found, except between CCIS-20 and GSH-12 (Table 1). Surface soil disturbance through machine movement had a significant positive effect on successful yellow birch and red maple regeneration (Fig. 2). However, there was no significant difference in beech, red maple and sugar maple seedling densities between plots that were outside the harvesting trails and those within the trails.

Figure 2: Tree seedling densities by location of regeneration plot. Note: OT = Outside harvesting trail; and T = within harvesting trail

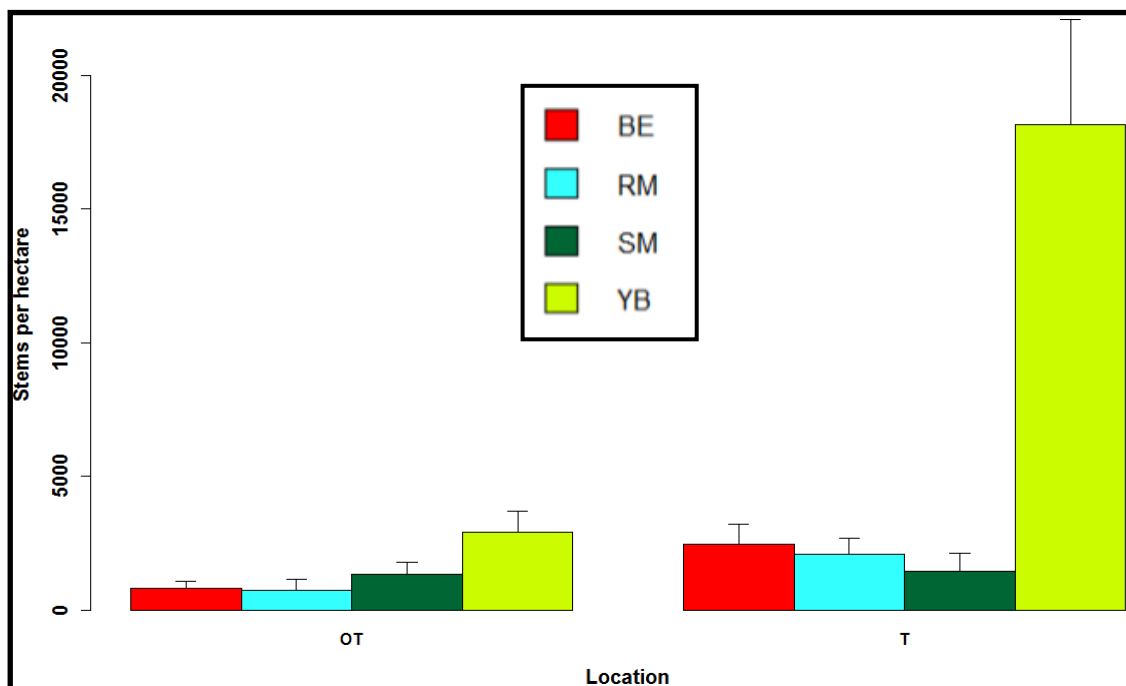


Table 1: Average total density for beech, red maple, sugar maple, and yellow birch seedlings across treatment combinations. Note: Means with different letters are significantly different at alpha = 0.05.

Treatment	Seedling Density (stems/ha)	Standard Error
OR-20	4204.03 ^a	1184.34
CCIS-16	514.67 ^b	278.49
CCISH20	1745.61 ^c	488.33
GSH-12	1728.26 ^c	655.44
GSH-16	4875.67 ^d	1327.80
SH-20	3371.10 ^e	1382.66

Species-to-species regeneration responses to the treatment combinations were observed (Fig. 3). Beech seedlings densities were significantly greater in the GSH-16 treatment relative to all other treatments. The continuous cover irregular shelterwood treatments and the group shelterwood with 12m trail spacing significantly reduced red maple seedling density relative to OR-20 (Fig. 3). However, there was no significant difference between OR-20 and the other treatments, although the GSH-16 and USH-20 tended to decrease red maple seedling density. In the SH-20 treatment, no sugar maple seedling were found (Fig. 3). Besides this treatment, there was no treatment effect on sugar maple seedling density. GSH-16 and SH-20 significantly increased yellow birch seedling density while CCIS and GSH-12 treatments significantly reduced yellow birch seedling density compared with the control (OR-20) (Fig. 3). Yellow birch seedling density did not significantly differ.

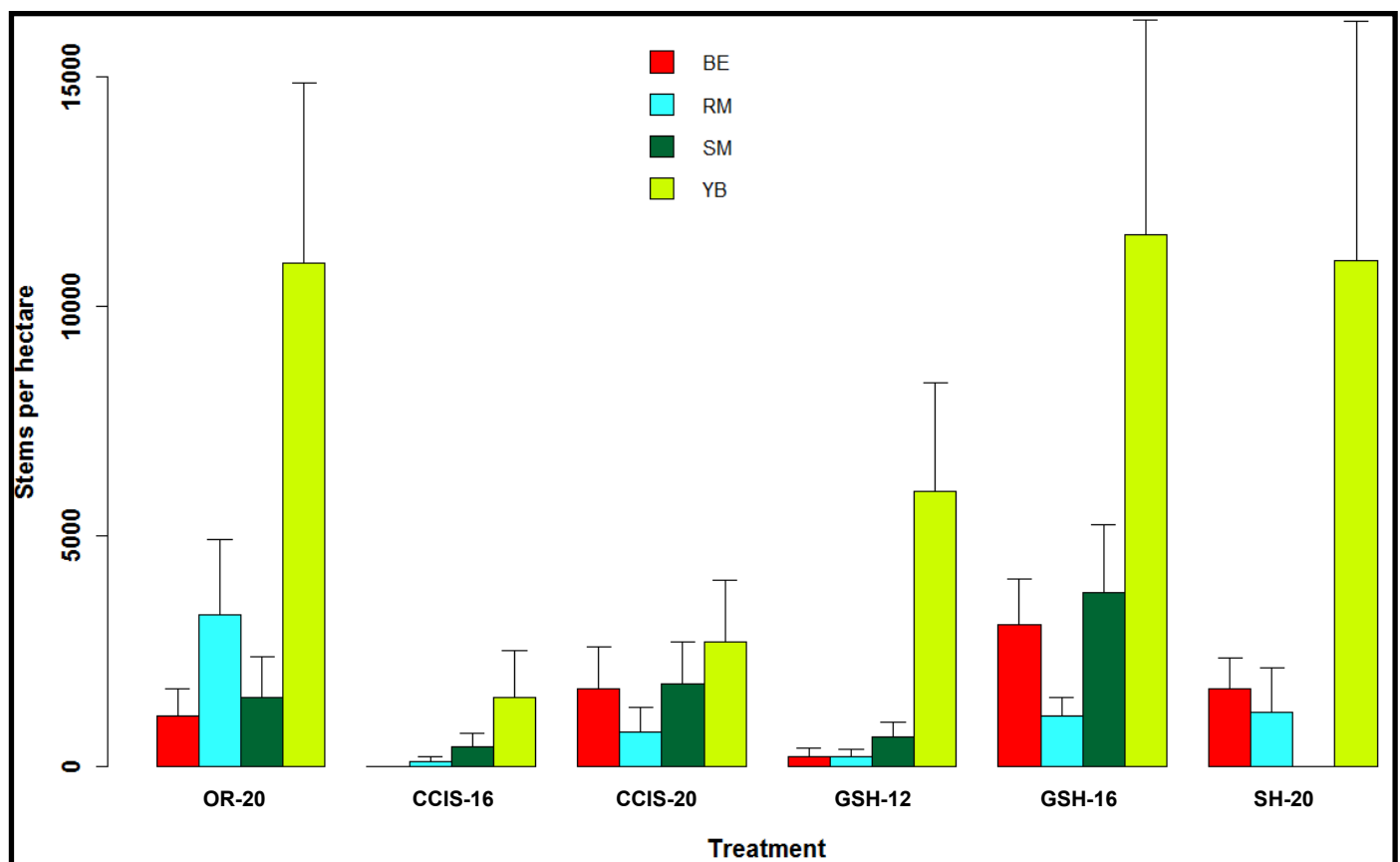


Figure 3: Tree seedling densities across different treatment combinations. CC-20, overstory removal (*status quo*) with 20m trail spacing; CCIS-16, continuous cover irregular shelterwood with 16m trail spacing; CCIS-20, continuous cover irregular shelterwood with 20m trail spacing; GSH-12, group shelterwood with 12m trail spacing; GSH-16, group shelterwood with 16m trail spacing; and USH-20, uniform shelterwood with 20m trail spacing.

CONCLUSION

Species regeneration may respond differently to the regeneration method and the amount of soil surface disturbance that occurs during harvest operations. For example, plots located within harvested trails were the major driver for successful yellow birch regeneration. The trails created suitable seedbed that facilitated the regeneration and establishment of yellow birch. As a result, yellow birch regeneration was present consistently in all regeneration methods compared to beech, red maple or sugar maple regeneration. This suggests that most regeneration methods may be suitable for yellow birch regeneration provided that there is enough seed source and soil surface disturbance. This study was limited to the first year response of the four key hardwood tree species (yellow birch, red maple, sugar maple, and American beech) regeneration following various regeneration methods. However, the results indicate that group shelterwood with 16m trail spacing significantly increased the combined density of these species relative to the other treatments. Among the treatments, the variants of continuous cover irregular shelterwood performed poorly in terms of promoting regeneration establishment of the key hardwood tree species. Longer-term monitoring of these species will be critical to determine if these initial establishment trends are transient or if the shade tolerant species in the continuous cover irregular shelterwood treatments will eventually dominate the canopy in these treatments.

REFERENCES

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