The Effects of Various Treatments on Yellow Birch Regeneration: Results from Multiple Midterm Experiments

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Abstract.—In response to concerns about yellow birch (*Betula alleghaniensis* Britton; YB) regeneration in Quebec, new treatments have been tested in the 1990s, including patch cuts and small clearcuts. The objective of this project was to draw an overall portrait, at the scale of the province, on YB regeneration success 10 to 20 years after treatment. We resampled 36 experiments and 466 logging areas. The logging areas sampled were mostly dominated at the sapling stage by sugar maple (*Acer saccharum* Marsh.; SM) (23 percent) and YB (18 percent). The proportion of sites where YB was the dominant species was higher in gaps and small clearcuts than in partial cuts or controls. When we added up the proportions of YB and SM, no significant difference among treatment openings was observed. The high variability in regeneration dominance led us to conclude that, without intense monitoring, early efforts to favor YB may not be worthwhile.

INTRODUCTION

Toward the end of the 1990s, yellow birch (YB) and other mid-tolerant species regeneration arose as a concern in Quebec, as in the whole northeast United States. In response, new treatments have been tested including patch cuts and small clearcuts with or without soil scarification. In the wake of the implementation of these treatments, many experiments have been set up throughout the province of Quebec (Lorenzetti et al. 2008, Raymond et al. 2003,) and in the United States (Hupperts et al. 2020). While these tests increased our understanding of the effect of silvicultural treatments on the short-term success of YB regeneration, few results have been published on the midterm success (i.e., 10 to 20 years). For example, a quick Google® Scholar search using the terms *silviculture treatment regeneration* and *temperate* showed that, in the first 10 relevant articles, a single study had verified—over a period of more than 10 years—the effects of silvicultural treatments on regeneration (Donoso et al. 2019). In addition to the silvicultural effort (Gauthier et al. 2016), many factors—acting from the local to the regional scale—can influence the development of regeneration, including competing vegetation (Bilodeau-Gauthier et al. 2020, Raymond and Bédard 2017, Royo and Carson 2006), herbivory, and invasive species (Ward et al. 2018).

The idea behind this project was to revisit a network of 10-year-old experiments in tolerant hardwood stands in Quebec covering a range of silvicultural treatments including controls, selection cuts (minimum residual basal area of 16 m^2/ha), shelterwood cuts (variable-residual basal area), patch cuts (about 0.1 ha in size) and small clearcuts (1 to 2 ha in size)—with and without scarification. The two main objectives of the project were (1) to draw an overall portrait on the midterm YB regeneration success (10 to 20 years) following the use of various types and intensities of silvicultural treatments; and (2) increase our understanding of the interaction between competition, herbivory, and abundance of short-term regeneration with silvicultural efforts on YB regeneration success.

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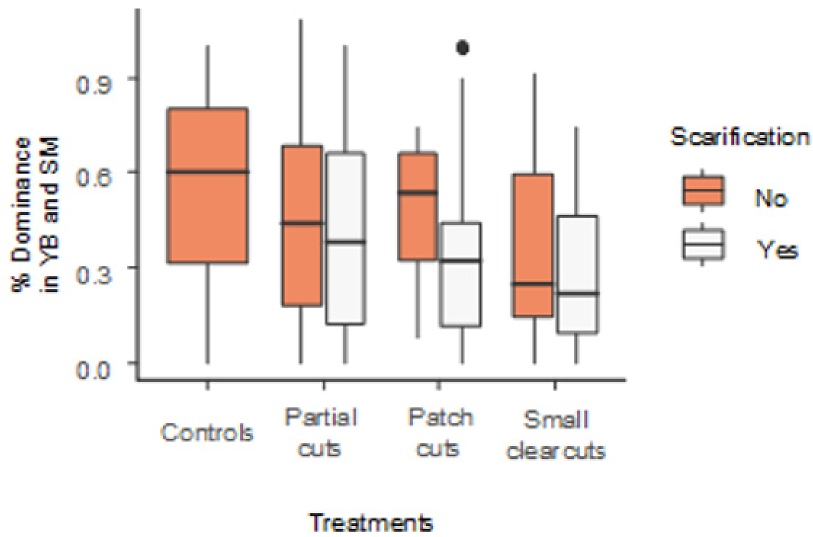

Figure 1.—Boxplots of YB and SM dominance percentage as a function of harvest treatments and scarification. The limits of the box are 25 percent and 75 percent. The separating line between the lower and upper part of the box is the median. The lower and upper limits of the whiskers are the 10th and 90th percentiles. Points are beyond 1.5× the interquantile range (25th to 75th percentiles).

METHODS

We resampled 36 experiments and 466 logging areas (including controls from various research organizations in Quebec that covered the entire tolerant hardwood region of the province). In total more than 7,000 regeneration plots (25 m^2) were remeasured in which we identified the dominant species. This dominant species (commercial or noncommercial) was the one with the tallest sapling, not the most abundant. From the sampling, we calculated for each logging area: (1) for each commercial species, the proportion of plots that this species dominated, (2) for each noncommercial species, the proportion of microplots where this species dominated, and (3) the proportion of microplots where grazing was observed.

We also calculated the distance from each plot to the edge of the nearest deer-wintering habitat. Additionally, we calculated—from the inventories carried out 1 or 2 years after treatment—the initial proportion of each species at the seedling stage.

RESULTS

The 466 logging areas (including the controls) sampled were mainly dominated at the sapling stage in commercial species by sugar maple (*A. saccharum*; SM) with a dominance average of 23 percent followed by YB at 18 percent. Three other species showed an average dominance of more than 10 percent, namely beech (*Fagus grandifolia* Ehrh., 12 percent), balsam fir (*Abies balsamea* [L.] Mill., 12 percent), and red maple (*Acer rubrum*, 10 percent). The proportion of logging areas where YB was the dominant species at the sapling stage was higher in patch cuts and small clearcuts than in partial cuts and controls. On the other hand, when we added up the proportions of YB and SM (the two most valuable species), we observed no significant difference between the canopy opening treatments on regeneration dominance (Fig. 1). The short-term density of YB at the seedling stage was not a good predictor of its dominance 10 to 20 years later at the sapling stage, however the results were highly variable. For noncommercial species, mountain maple was the dominant competitor in scarified-logging areas (44 percent) while striped maple (*Acer pensylvanicum*) was the dominant species in 64 percent of nonscarified-logged areas; yet, when we reviewed the effect of these species on the dominance of commercial species, we observed few significant negative effects. No relationship was observed between the dominance of SM and YB and grazing or the distance to a deer-wintering habitat.

CONCLUSION

Our results showed that the effect of silvicultural treatments on YB regeneration are highly variable 10 to 20 years after treatments. More intense canopy openings and scarification increased YB dominance at the sapling stage but did not guarantee its dominance. Obviously, other factors (e.g., droughts, microclimatic conditions, soil nutrients) interfere with YB regeneration success but we were unable to identify them though we verified the effects of early seedling density, shrub competition, and herbivory among other factors. We conclude that (1) to ensure high YB regeneration, more intense monitoring is required (and probably other treatments such as vegetation control), and (2) if this monitoring is not possible, it may not be worthwhile to make efforts to favor YB establishment.

These two options can be implemented using a zoning strategy with contrasted-management intensities. In a context of climate change it is also worthwhile to question the idea of increasing YB in the landscape as it is susceptible to drought.

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