Silvicultural Options for Rehabilitating High-graded Yellow Birch-conifer Stands

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Abstract.—Prior to the 1990s, diameter-limit cutting was widely used in Québec, Canada, to harvest valuable trees in hardwood-dominated temperate forests. This practice can impoverish stands in terms of volume, structure, composition, wood quality and regeneration. As a result, many high-graded stands still require rehabilitation today. This study assessed the 15-year effects of four regeneration methods combined with three scarification treatments in yellow birch–conifer stands. Cutting and scarification treatments did not increase the regeneration of desired species (birches, spruces and fir). Rather, they stimulated competition, because they were applied during a poor seed year. Stand recovery after 15 years in terms of growth, vigor and regeneration in the untreated control and the strip clearcut leave strips reflected the resilient nature of these stands. However, silviculture would be required to improve overall stand quality. An active rehabilitation strategy combining shelterwood and ground disturbance during a good seed year should help to improve stand quality and regeneration.

CONTEXT

Prior to the 1990s, hundreds of hectares of hardwood dominated stands were harvested by diameter-limit cutting in the Laurentian forest of Québec, Canada. By solely focusing on timber trees of economically valuable species, these cuts often left stands with highly variable density that were impoverished in terms of species composition and wood quality. In many cases, the lack of attention to the regenerating layer, combined with damage from a spruce budworm (*Choristoneura fumiferana*) epidemic, caused regeneration deficiencies, especially on productive sites such as those supporting yellow birch (*Betula alleghaniensis*)-conifer stands. As a result, a high proportion of stands were invaded by noncommercial species. Even though diameter-limit cutting is now banned on public land in Québec, many high-graded stands still require rehabilitation treatments to sustain timber production and ecosystem services (Power et al. 2019). In this study, we assessed the 15-year effects of silvicultural rehabilitation scenarios on stand growth, quality, vigor, and regeneration, as a first step toward ecological rehabilitation of natural stands dominated by yellow birch and conifers, a common forest type in the Laurentian forest of eastern Canada.

METHODS

Established in 2001 near La Tuque (Québec, Canada), the trial comprises four blocks comparing four regeneration methods applied on 1-ha experimental units: untreated control (left to grow; basal area 11.5 m^2/ha [50.1 ft^2/ac]); strip clearcutting (20-m [65.6 ft] strips); uniform shelterwood (50 seed bearers/ha, 3.5 m^2/ha [20 seed bearers/ac, 15.2 ft^2/ac]); and seed-tree (10 seed bearers/ha [4 seed bearers/ac]) (Fig.1) (Raymond et al. 2020). Natural regeneration monitoring units (0.5 ha [1.2 acre]) tested site preparation in subplots: no scarification, spot scarification (400 spots/ha [162 spots/acre]), and mechanical raking. Vegetation surveys were conducted in years 0, 1, 5, 10, and 15. Data were analyzed by ANOVA with repeated measurements ($\alpha = 0.05$).

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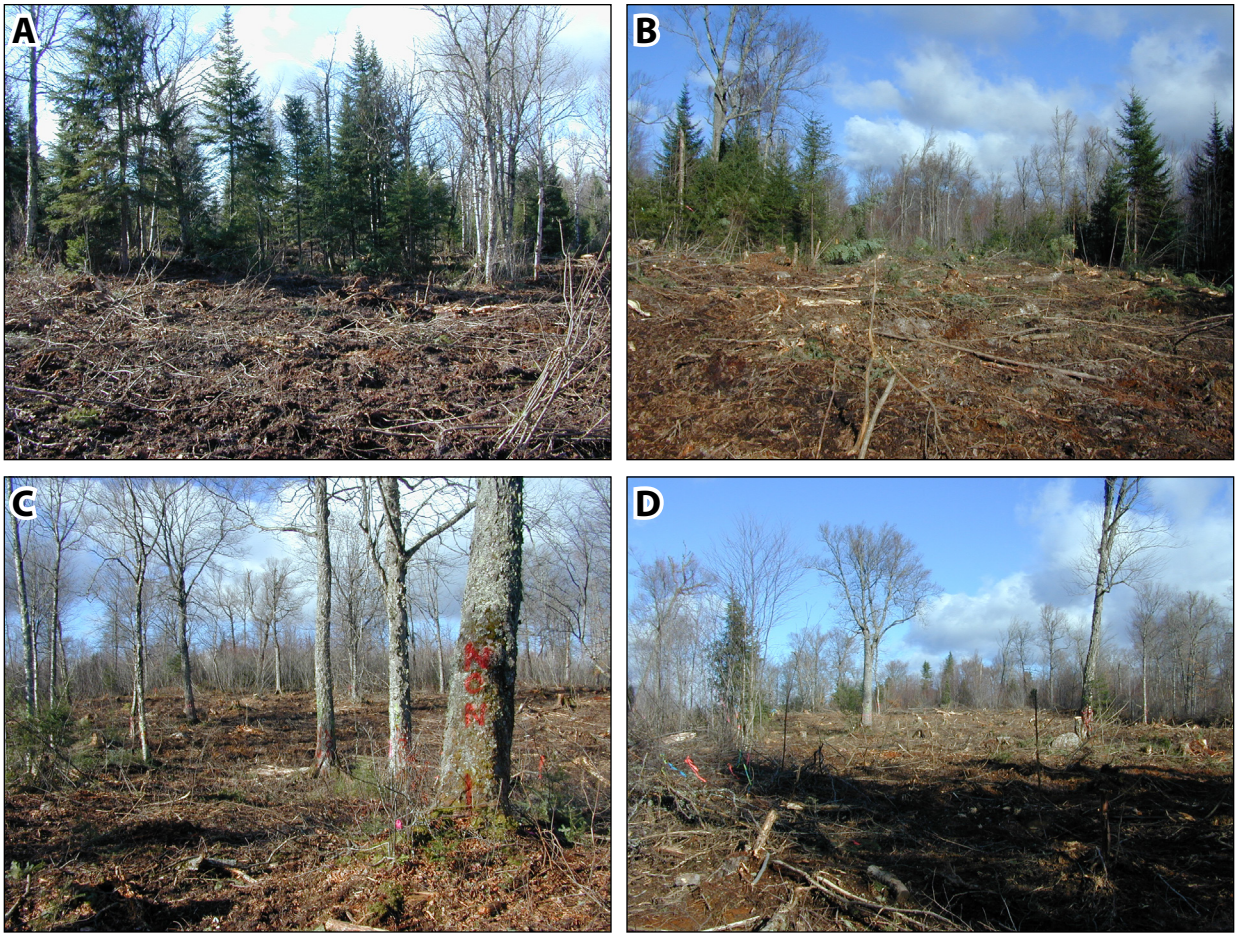

Figure 1.—We compared four regeneration methods in this rehabilitation study: (A) untreated control (left to grow; basal area 11.5 m^2/ha [50.1 ft^2/acre]); (B) strip clearcutting (20-m [65.6 ft] strips); (C) uniform shelterwood (50 seed bearers/ha, 3.5 m^2/ha [20 seed bearers/acre, 15.2 ft^2/acre]); and (D) seed-tree (10 seed bearers/ha [4 seed bearers/acre]). Courtesy photos by Vincent Roy, used with permission.

RESULTS AND DISCUSSION

Stand recovery in terms of growth, vigor, and regeneration after 15 years in the untreated control and the strip clearcutting leave strip reflected the resilient nature of these hardwood-dominated mixedwood stands (Fig. 2), with balsam fir (*Abies balsamea*), red spruce (*Picea rubens*), and white spruce (*Picea glauca*) saplings and poles contributing to the recovery of total basal area (BA) and that of acceptable growing stock (AGS; BA of vigorous trees with potential timber). The untreated control and strip clearcutting treatments, however, had high BA of unacceptable growing stock. Uniform shelterwood treatments recovered more slowly in BA and AGS but had greater BA of high quality trees (vigorous trees with potential sawlogs) than the control. Seed-tree method was less optimal because of its slow recovery and high understory competition.

The lack of synchronization with a good seed year limited the efficiency of scarification and increased the abundance of noncommercial species instead of promoting desired species (yellow birch, spruces, and balsam fir). Vegetation management constitutes one of the greatest challenges in rehabilitation silviculture, especially in a context of restricted herbicide use like in Québec (Prévost and Charette 2019). Combination of uniform shelterwood with mechanical raking could however adequately regenerate the stands. This scenario could have been more effective if conifers had been maintained in the overstory and understory strata. Spruce regeneration was marginal in terms of density and stocking, so enrichment planting is recommended to rehabilitate this component when seed bearers are scarce (Dumais et al. 2018, Hébert et al. 2013).

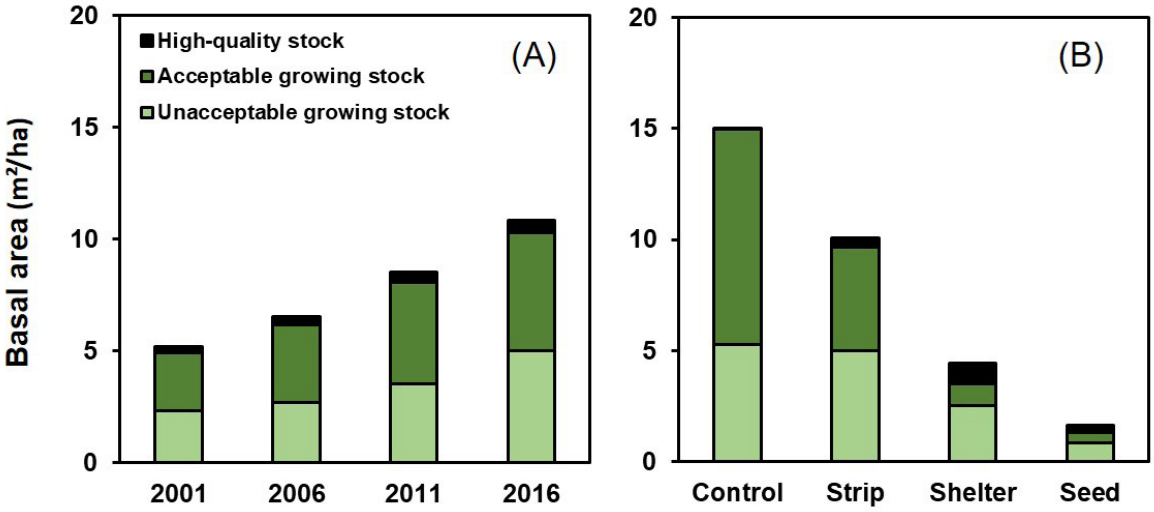

Figure 2.—Effects of year (A) and regeneration method (B) on merchantable basal area (m^2/ha). Note that cumulative bars correspond to total basal area and that acceptable growing stock (AGS) includes basal area of high quality stock. Control = untreated control; Strip = strip clearcutting; Shelter = uniform shelterwood; Seed = seed-tree method.

CONCLUSION

Depending on the goal and initial conditions, a gradient of passive to active rehabilitation can be considered to restore productivity in high-graded mixedwood stands. Without treatment, total BA and AGS can recover, but some ecosystem components (e.g., companion species, deadwood, or other structural attributes) might be lacking or will recover very slowly. Active rehabilitation is required to improve stand composition, quality and structure. In these cases, shelterwood systems retaining overstory and understory conifers, combined with scarification (raking) during a good seed year, are recommended to improve stand quality and regeneration.

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