

Today's Silviculture: Tomorrow's Forest

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Regenerating Kalmia sites in Québec: What we know and what we wish we knew

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On some sites, invasion by ericaceous shrubs can induce ecosystem retrogression, a phenomenon that has important effects on forest productivity, and possibly biodiversity. Fine-tuning and optimization of management strategies for invaded sites are clearly needed, along with the development of preventive silvicultural approaches based on solid ecological grounds. We recently demonstrated how *Kalmia* and *Vaccinium* dominate the nutrient uptake processes, and that their recalcitrant humus has striking impacts on soil temperature. *Kalmia* and associated species do not seem to directly influence soil temperature or moisture, or to induce water stress to planted seedlings. Ongoing research, in collaboration with academic and industrial partners, will provide further understanding of ericad distribution in Québec's boreal forest, their impacts on conifer seedlings and soil microbiology, and their responses to innovative silvicultural systems.

Popular summary

The problem

In the province of Québec, there are nearly fifty species of ericaceous shrubs. Among them, sheep laurel (*Kalmia angustifolia* L.), bog Labrador tea (*Rhododendron groenlandicum* [Oeder] Kron & Judd) and blueberries (*Vaccinium* spp.) are recognized to rapidly invade some boreal sites following harvesting or wildfire (Jobidon 1995). On some sites, such invasions can induce ecosystem retrogression (Nilsson and Wardle 2005), a phenomenon that has important effects on forest productivity (de Montigny and Weetman 1990), and possibly biodiversity (Mallik 2003).

Direct and indirect effects of ericaceous shrubs on conifer regeneration are believed to be related to competition for nutrients (Yamasaki et al. 2002), allelopathy (Mallik 1987), and the production of recalcitrant humus (Damman 1971). However, our understanding of the interactions among the shrubs, the conifers, and site characteristics is far from complete. As an example, recent work by Lavoie et al. (2006) on Labrador tea illustrates how the suspected effects of ericaceous shrubs cannot be generalized. Moreover, while fine-tuning and optimization of management strategies for invaded sites are clearly needed, the development of preventive silvicultural approaches based on solid ecological grounds remains crucial.

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Understanding the mechanisms

Research has confirmed the importance of belowground competition in the interference between ericaceous shrubs and conifers (e.g., Wallstedt et al. 2002). In the field, we demonstrated how the extensive root systems of *Kalmia* and *Vaccinium* ensure that these species dominate the nutrient uptake processes (Thiffault et al. 2004b). We also confirmed that the recalcitrant ericad-humus has striking effects on soil temperature, greatly reducing the quantity of energy absorbed in the seedling rooting zone (Thiffault and Jobidon 2006; Thiffault et al. 2004b). However, *Kalmia* and associated species do not seem to directly influence soil temperature and moisture, or to induce significant water stress to planted seedlings (Thiffault et al. 2004b). Ongoing research, in collaboration with academic and industrial partners, will provide further understanding the effects of *K. angustifolia*, *R. groenlandicum* and *Vaccinium* spp. on conifer seedling physiology and soil microbiology.

Developing silvicultural solutions

A better knowledge of the underlying mechanisms of ericad interferences is useful in developing an ecologically sound silviculture that will help restore invaded sites to a productive state. In some ecosystems, fertilization has proven effective to overcome plantation establishment problems on sites dominated by other ericaceous shrubs (Prescott et al. 1996; Taylor and Tabbush 1990). In our conditions, we thus verified if fertilizer amendment at time of planting can alleviate the nutritional issues of various *K. angustifolia* dominated sites. Indeed, we measured increased early growth responses following fertilization, compared to unfertilized conditions (Thiffault 2006; Thiffault et al. 2004a; Thiffault and Jobidon 2006; Thiffault et al. 2005). However, the economic advantages of such treatment on these sites needs to be demonstrated based on longer-term results.

Mechanical soil preparation was suggested as a promising silvicultural option to promote seedling establishment on *Kalmia* sites (Titus et al. 1995). Our research results, obtained on various ericad-dominated site types in Québec, confirm the pertinence of the treatment (Thiffault 2006; Thiffault et al. 2004a; Thiffault and Jobidon 2006; Thiffault et al. 2005). As an example, five years following planting, black spruce seedlings in scarified plots exhibited height and diameter gains of almost 100% as compared to seedlings planted in unscarified plots. Without proper site preparation, we observed height growth trajectories typical of stunted seedlings that will likely underperform for several decades (Mallik 2003).

Working on preventive approaches

In the boreal forest of Québec, we observe that forest activities are more and more conducted in regions that are well stocked with ericaceous shrubs (Thiffault and Grondin 2003). We thus believe that the invasion problem may be amplified

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in the coming years. However, we are not yet able to precisely identify the sites where invasion will indeed pose a threat to forest regeneration. In fact, we are not able to fully explain, from an ecological and historical perspective, the distribution of ericaceous shrubs in the landscape. Moreover, it is currently impossible to correctly estimate the regeneration delay induced by ericads in our conditions.

Research is being carried out to answer these specific questions. Our goal is to describe and explain the distribution and dynamics of ericaceous sites in the boreal forest of Québec, in interaction with forestry activities, including innovative silvicultural systems. This new knowledge will be used in the elaboration of succession models that take into account the 'ericad effect'; such models being essential to the correct estimation of the annual allowable cut, and to the development and implementation of ecological management.

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