Branching out

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Paludification: causes and effects

In northwestern Quebec, a large portion of the boreal forest is subject to paludification, a natural process involving the gradual accumulation of a thick layer of organic matter. Can the degree of paludification be predicted? What impact does it have on forest productivity?

Paludification is a phenomenon that occurs predominantly in the spruce–moss forests of the Abitibi clay belt. Black spruce stands become established after intense fires, and as these stands decline, canopy openings are created in which the prevailing environmental conditions are conducive to invasion by sphagnum moss. Shade intolerant *Sphagnum* species grow fast but decompose very slowly. This leads to the build-up of a thick layer of organic matter, which in turn leads to cold soil temperatures, slower nutrient cycling and a perched water table. Black spruce regeneration is affected by the rapid accumulation of organic matter: it eventually becomes impossible for the trees' shallow roots to reach the mineral soil and tree growth is slowed by the consequent lack of nutrients. Over the years, the stand opens up more and more, thus amplifying the paludification process.

Perched water table.
Photo: D. Paré (CFS)

Black spruce stump whose roots have become overgrown by Sphagnum.
Photo: D. Paré (CFS)

Thickness of the soil organic layer

The paludification rate is primarily influenced by topography (slope) and time elapsed since the last fire (stand age). Researchers at the Canadian Forest Service and the NSERC/UQAT/UQAM Industrial Chair in Sustainable Forest Management conducted a study to assess the respective influence of these two factors. They used soil organic layer thickness as an indicator of the current and future rate of paludification, and they developed an equation for predicting organic layer thickness based on the basal area occupied by black spruce trees and the percent cover of *Sphagnum* spp.

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Site topography and stand age

Stands growing on fairly steep slopes have a thinner organic layer compared with stands of the same age growing on flat sites. To become established and spread, *Sphagnum* spp. need water. Lateral drainage is greater on sites with a steep slope, which means that water availability for *Sphagnum* growth is reduced. Paludification therefore occurs more rapidly on sites that are flat or have a gentle slope. However, all sites, regardless of their slope and initial degree of paludification, appear to become completely paludified within a few centuries after fire. The researchers also developed an equation for predicting organic layer thickness as a function of site topography (slope) and stand age.

Two situations:
regenerating site with vigorous growth after a severe fire and poorly regenerated site with poor growth after winter harvesting. Photos: D. Paré (CFS)

Relationship between paludification and productivity

In the Abitibi clay belt, paludification greatly reduces the productivity of black spruce stands. The relationship between the rate of paludification and site topography (slope) is a useful indicator for determining the management interventions that should be implemented at sites undergoing paludification. Studies have shown that the thicker the organic layer, the less productive the site. However, organic matter builds up more slowly on sites with a steeper slope. It appears to take 180 years for organic layer thickness to increase from 20 cm to 40 cm on a site with a 7% slope, but only 75 years on a flat site. A treatment aimed at reducing organic layer thickness would therefore have a more lasting effect on sites with a steeper slope. In the black spruce forests of the clay belt, priority should be given to managing stands growing on slopes with a view to ensuring an acceptable level of productivity.

Management on sites subject to paludification

The current trend in forest management is to minimize the impact of interventions on soils. However, in the black spruce stands of the Abitibi clay belt, this approach tends to promote *Sphagnum* growth and thereby amplify paludification. Studies have shown that harvesting or site preparation operations that significantly disturb the soil organic layer, similar to a severe fire, can help to restore the productivity of stands that are undergoing paludification.

Site preparation after cutting.
Photo: D. Paré (CFS)

USEFUL LINK:

On paludification (in French only):
http://web2.uqat.ca/cafd/publication/articlePDF/FicheTechnique07.pdf

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